SPECIES ACCOUNT: *Abronia macrocarpa* (Large-fruited sand-verbena)

Species Taxonomic and Listing Information

Commonly-used Acronym: LFSV

Listing Status: Endangered; 9/28/1988; Southwest Region (R2) (USFWS, 2016)

Physical Description

This species is a broad-leaved, tap-rooted, herbaceous perennial growing to 20 in (50 cm). The foliage is sticky from glandular hairs. The leaves are usually rounded, and about 0. 75-2. 0 in (2-5 cm) long and 0. 6-1. 4 in (1. 5-3. 5 cm) wide. The magenta flowers are grouped into rounded heads composed of 20-75 individual flowers. These flower heads have bracts at the base that are nearly oval and about 0. 25-0. 5 in (0. 6-1. 3 cm) long and 0. 13-0. 38 inch (0. 3-1. 0 cm) wide. Each flower has a tube about 0. 7-1. 3 in (1. 8-3. 3 cm) long that widens at the top into five nearly divided lobes 0. 3-0. 4 inch (0. 8-1. 0 cm) wide. The fruits are 0. 3-0. 6 inch (0. 8-1. 6 cm) long and 0. 2-0. 5 inch (0. 5-1. 3 cm) wide and papery with five often somewhat twisted wings. The seeds (achenes) are from 0. 06- 0. 19 inch (1. 5-4. 8 millimeters) long and brown. The species is most easily characterized by its large, thin-walled fruits (anthocarps), which are thinner and more papery than any other species of Abronia and among the largest in the genus (USFWS, 1992).

Taxonomy

In the Four-O'clock family (Nyctaginaceae) (NatureServe, 2015). The species' common name has been spelled with and without hyphenation. The Services have chosen to use hyphens, particularly to help clarify the confusion between "sand-verbenas", which are members of the genus Abronia and family Nyctaginaceae, and "verbenas", which are members of the genus Verbena and family Verbenaceae. Sand-verbenas and verbenas are not closely related (USFWS, 2010).

Historical Range

See Current Range.

Current Range

Known from Leon, Robertson, and Freestone counties in eastern Texas (USFWS, 2010).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated

Lifespan

Adult: perennial species (USFWS, 2022)

Breeding Season

Adult: Flowers in March or April and occasionally again in the fall following periods of high rainfall (USFWS, 1992). Williamson (1998) observed that A. macrocarpa seeds in the field have the highest germination rates in the fall and winter, while no seeds germinated from May to September. Laboratory studies revealed that the highest seed germination rates require scarification followed by warm and then cold stratification (Goodson 2007; Williamson 2008). Initial seedling growth is allocated primarily to development of the taproot rather than leaves and flowers (Williamson 1996). The seedling mortality rate ranged from 73 percent to 93 percent after 3 years (Williamson 1998). Abronia macrocarpa plants usually form rosettes from October through February, then begin flowering with the peak of anthesis and fruit set in April and May, followed by senescence of the above-ground portion from mid-May or June until October (Williamson 1996). However, the species occasionally flowers in the fall (Kennedy et al., 1990; Corlies 1991; U.S. Fish and Wildlife Service 1992). During the summer months, the plants perenniate as taproots found at depths of 1 to 12 cm (0.4 to 4.7 in) (Williamson 1996). Williamson (1998) found that 53 percent of 1 cohort of seedlings was flowering at 2 years of age, and 78 percent of another cohort flowered at 3 years of age. (Recovery actions 3234, 331, 332, 333, 322) (USFWS, 2010).

Key Resources Needed for Breeding

Adult: Pollinator observations included mostly moths including Noctuids and some Sphingids, Geometrids, and Pyralids; however, bumblebees and butterflies were also noted as potential pollinators (USFWS, 2022).

Other Reproductive Information

Adult: Large-fruited sand-verbena flowers open from 3:00 or 4:00 pm until 9:00 or 10:00 am and produces a strong sweet aroma resembling honeysuckle that increases until early evening. These floral characteristics are commonly associated with moth pollination (Corlies 1991, p. 12). Williamson et al. (1994, p. 339) observed, captured, and identified several floral visitors of LFSV which included Sphynx and Noctuid moths (family Sphingoidea and Noctuidae, respectively) such as the black alder or pawpaw sphynx (Dolba hyloeus), lettered sphynx (Deidamia inscripta), obscure sphynx (Erinnyis obscura), and large necklace moth (Hypsoroph monilisi). The probosci of these moths were dusted with LFSV pollen, making them likely pollinators. Furthermore, the larval food sources for these likely pollinators have been noted at all of the LFSV sites and include yaupon (Ilex decidua), grape (Vitis spp.), and milkweed (Asclepias spp.) (Figure 3, In Williamson 2008, p. 18; Table 9, In USFWS 2010, pp. 18-22). Among the diurnal floral visitors, some incidental pollination may be due to bees (genus Bombus and Apis) (Williamson et al. 1994, p. 339). Noted pollinator observations of various other Abronia species including Yellowstone sandverbena, pink sand-verbena, and Ramshaw Meadows sand-verbena (A. alpina, RMSV) support the notion that species of Abronia are moth pollinated (Saunders and Sipes 2006, p. 80; Jabis et al. 2011, p. 1587; Doubleday 2012, p. 23). Pollinator observations included mostly moths including Noctuids and some Sphingids, Geometrids, and Pyralids; however, bumblebees and butterflies were also noted as potential pollinators. While observational studies provide insight into potential pollinators, it is important to determine if those visitations result in plant reproductive output (i.e., the production of fruit and seed set and effective pollination). Doubleday and Eckert (2018, p. 71) found floral visitation of pink sand-verbena was higher during the day (8.67 percent) compared to those visits at night. Yet nocturnal visitation by Sphingid moths resulted in significantly higher seed set, suggesting Sphingid moths are the

primary pollinators. Moreover, while honeybees were observed during this study their visitations resulted in no fruit/seed set suggesting that these insects are acting as potential pollen thieves, collecting floral pollen/nectar but not necessarily pollinating the flowers (USFWS, 2022).

Reproduction Narrative

Adult: Williamson (1998) observed that A. macrocarpa seeds in the field have the highest germination rates in the fall and winter, while no seeds germinated from May to September. Laboratory studies revealed that the highest seed germination rates require scarification followed by warm and then cold stratification (Goodson 2007; Williamson 2008). Initial seedling growth is allocated primarily to development of the taproot rather than leaves and flowers (Williamson 1996). The seedling mortality rate ranged from 73 percent to 93 percent after 3 years (Williamson 1998). Abronia macrocarpa plants usually form rosettes from October through February, then begin flowering with the peak of anthesis and fruit set in April and May, followed by senescence of the above-ground portion from mid-May or June until October (Williamson 1996). However, the species occasionally flowers in the fall (Kennedy et al., 1990; Corlies 1991; U.S. Fish and Wildlife Service 1992). During the summer months, the plants perenniate as taproots found at depths of 1 to 12 cm (0.4 to 4.7 in) (Williamson 1996). Williamson (1998) found that 53 percent of 1 cohort of seedlings was flowering at 2 years of age, and 78 percent of another cohort flowered at 3 years of age. (Recovery actions 3234, 331, 332, 333, 322) (USFWS, 2010).

Habitat Vegetation or Surface Water Classification

Adult: Post oak savanna (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Elevations of 360-450 feet (USFWS, 1992)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1992)

Habitat Narrative

Adult: Occurs in deep, well-drained sands, sometimes on actively blowing sand dunes, within a post oak-grassland mosaic vegetation type. The species is one of many herbaceous plants that temporarily dominate these bare sands during spring (NatureServe, 2015). Soils are relatively infertile and unstable; water availability is low and unreliable; and temperatures are extreme and variable both diurnally and seasonally (USFWS, 1992).

Dispersal/Migration

Motility/Mobility

Adult: Abiotic (EPA, 2016)

Dispersal/Migration Narrative

Adult: Dispersed by wind; "Clumped-contagious" distribution (EPA, 2016).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Stable (inferred from USFWS, 2010)

Number of Populations:

10 (USFWS, 2022

Population Size:

Approximately 90,700 individuals in 8 wild populations includes 2 populations with unknown numbers of individuals. In addition, there are nine experimental populations with an unknown number of plants (USFWS, 2022)

Population Narrative:

Nine populations have been documented in Leon, Robertson, and Freestone counties; these include one each in Leon and Robertson counties that were both combined from two previously-recognized populations, based on genetic analyses and field surveys. All known populations are on privately-owned lands that were surveyed with landowner permissions. In addition, three small experimental populations have been successfully established on private land. The total known population has increased from about 35,250 in 1996 to 94,509 in 2008. This increase is due both to the discovery of new populations, and to growth of the known populations resulting from land use changes that are more favorable to conservation of the species (USFWS, 2010). It is important to note there are some discrepancies between the population estimates reported in the previous 5-year review (USFWS 2010) and in this current review. The 2010 5-year review, the population numbers listed for 2008 are interpreted as true population survey counts when in fact, these population estimates are based on visual surveys not quantitative count surveys (P. Williamson, pers. comm. 2022). The estimated population abundance of WP1-WP4, WP7, and WP8 are the same values in both the Williamson (2008, pp. 6-7) and the Services 5-year review (USFWS 2010) reports. Further communication with Dr. Williamson and other contractors indicates these populations are stable in recent surveys (see Table 1). In both the Service's (USFWS 2010, p. 13) and Williamson's report (2008, pp. 6-7), WP5 had an estimated population of 5,000 individuals. However, installation of a fence and development of a natural gas pipeline, both in November 2004, caused soil disturbance such that the population reduced in its abundance to only a few hundred individuals (Williamson 2008, pp. 6-7). Surveys conducted in 2022 by BRIT provided an updated population estimate for WP5 of approximately 61 individuals (see Table 1). Williamson surveyed WP6 in 2005 and discovered a newly established food plot that had caused disturbance to the population resulting in only two plants on-site (Williamson 2008, p. 7). In 2007, Williamson noted the abandonment of the food plot and a notable increase in LFSV flowering plants. Approximately 200 flowering plants were observed which when extrapolated to the full property area of the site (WP6 (10.6 ac)), is approximately 750 individuals (Williamson 2008, p. 7; USFWS 2010, p. 13). Most recently, a survey of WP6 conducted by TPWD in 2016 updated the population estimate to approximately 2,000 individuals (see Table 1). All updates about the species' abundance, status, and last observation date are provided above. Experimental Populations: The creation of reintroduction sites is essential to the recovery of the LFSV (USFWS 1992, pp. 32-33; recovery actions 62 and 23, respectively). The LFSV experimental populations (EPs) were created to determine the species potential success of reintroduction within suitable habitat (Williamson

2008, pp. 29-39). As of 2022, it is unknown how many of the 9 planted EPs remain because no surveys have been conducted on any EP since 2008(USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Habitat could be lost through surface mining; petroleum exploration; highway, power line, and pipeline construction. The conversion of native grasslands to "improved pastures" of introduced grasses is an ongoing threat. Suppression of wildfire and poor rangeland management could lead to increased cover of woody vegetation, which could reduce habitat quality the degree of threat is difficult to assess. Some land uses, including OHV use, mowing, small-scale clearing, herbicide application, and annual wildlife food plots, can directly harm or destroy A. macrocarpa individuals, or reduce their reproductive potential (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: All known A. macrocarpa populations occur on privately-owned land. Approximately 95 percent of Texas land area is privately owned. It is reasonable to assume that the vast majority, if not all existing A. macrocarpa habitat, including sites that have not been documented, occurs on private land. Therefore, the species' populations and habitats are not subject to Federal or State protection unless there is a Federal nexus, such as provisions of the Clean Water Act or a federally-funded project (USFWS, 2010).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Rising temperatures might enable the species to survive further north than at present, but might also reduce the southern limit of the range. Similarly, changes in the frequency and amount of precipitation could favor a shift in geographic range or habitat type. Changes in temperature and rainfall amounts and patterns could alter the species' competitive advantage in the unique micro-habitats it now inhabits. At present, the Services cannot predict how the infinitely complex aggregation of climate change effects will affect the synecology of the species and its habitat (USFWS, 2010).

Stressor: Urban Residential Development (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: The Service is unaware of any large planned residential development projects at any of the WP or EPs. Site visits were not conducted between September 2015 and 2016, so any new disturbances could not be noted (P. Williamson, pers. comm. 2016). In 2022, part of WP6 was split and sold, and is now under multiple ownership (USFWS, 2022)

Stressor: Industrial Habitat Loss, Conversion, Fragmentation (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Two surface mines exist within the known range of the LFSV, the Jewett and Bremond Mines. Both are lignite mines (coal), operated by the Texas Westmoreland Coal Company and Luminant Mining Company, LLC, respectively. The Jewett mine is located approximately eight miles northwest of Jewett in Leon County. For this mine, the Service recommended that the applicant conduct habitat surveys for the LFSV; the applicant indicated that surveys for the LFSV were conducted and yielded negative results. The Bremond Mine is located six miles east of Bremond, Robertson County, and although within the range of the species, did not directly affect the plant. The Service provided recommendations for both applications under Section 7 of the Act and 404 of the Clean Water Act for each permit application. Mining operations can have impacts to the species habitat through removal, disturbance, and direct mortality of plants. Both of these mining facilities included other federally-listed species like the Navasota ladies'-tresses (NLT, Spiranthes parksii) and only NLT has been observed on these sites. It was estimated in 2014, that the total estimated impact acreage from mining projects within range of the NLT and LFSV was 50,600 acres (20,477 hectares (ha)) as of November 2013 (A. Vale, pers. comm. 2014). Lignite mining is the Railroad Commission of Texas (RCC) and our field office has not received any requests for the development of new lignite mines within the range of the LFSV. (USFWS, 2022)

Stressor: Linear Development (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Linear development projects, including transportation and oil and gas activities (i.e., liquid natural gas pipeline development and maintenance), has increased within the known range of the LFSV. Since 2010, the Service has formally consulted under Section 7(a)(1) of the Act (see Table 3) on four consultations that have included LFSV related to these activities, resulting in approximately 175 ac (70.8 hectares (ha)) of effects to suitable habitat (USFWS, 2022)

Stressor: Off Road Vehicle/ Off Highway Vehicle (ORV/OHV) use, Mowing, Clearing, Herbicides, and Wildlife Food Plots (USFWS, 2022).
Exposure:
Response:
Consequence:
Narrative: Other threats noted to impact the LFSV include the loss and fragmentation of habitat from the use of ORV/OHVs, mowing, clearing of habitat, herbicide use, and the development of food plots. Habitat disturbance from ORV and OHV use has been frequently documented as a potential threat to the LFSV. Prior to 2010, vehicular disturbance activities have been documented at WP4. This type of disturbance may be continuing at WP4 as its effects were captured during site visits in 2019 and 2021 (USFWS, 2022).

Stressor: Mowing (USFWS, 2022)
Exposure:
Response:
Consequence:

Narrative: Mowing is a direct threat to LFSV, particularly during the blooming season (February through April). As discussed above mowing could be a potential threat for WP4 although the direct disturbance mechanism at that site isn't clear. As discussed in Williamson (2008, p. 5), and USFWS (2010, p. 25) to best preserve known populations it is recommended to LO's that mowing be done outside the flowering period of the plant (USFWS, 2022)

Stressor: Herbicide Use (USFWS, 2022).
Exposure:
Response:
Consequence:
Narrative: Herbicide use is a direct threat to germinating seeds, seedlings, and flowering plants. It is recommended to LO's delay herbicide application until LFSV seeds have dispersed and plants have become dormant during June-September (Williamson 2008, p. 5; USFWS 2010, p. 25). We lack data about the use and/or effects of herbicide on populations as minimal surveys have been conducted (USFWS, 2022).

Stressor: Herbivory (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Minimal herbivory from deer, domesticated grazing animals, or insects have been noted in the past (USFWS 2010, p. 29) likely due to LFSV being psammophonious thus creating a sand armor to avoid herbivory (LoPresti 2018, p. 826). Experiments have been conducted to determine if levels of herbivory differed between psammophonious and non-psammophonious plants. LoPresti and Karbor (2016, pp. 826-832) compared yellow sand-verbena (A. latifolia), and honey-scented pincushion plant (Navarretia mellita, non-psammophonious) by removing sand from stems, petioles, and leaves of yellow sand-verbena and adding sand to soils of honeyscented pincushion plants, and then exposing both species to leaf-mining caterpillars (Lithariapteryx abroniaeella). Leaves with sand present resulted in less caterpillar herbivory, consistent with a physical defense function, than those without sand (LoPresti and Karbor 2016, p. 831). In a similar experiment, LoPresti (2018, p. 6) found that approximately 50 percent of plants with sand removed had feeding damage on leaves compared to intact (sand present) leaves which exhibited only 25 percent herbivory. Despite these results, the ecological function behind psammophony is not clear. LoPresti and Karbor (2016, pp. 826-827) postulated that plants exhibiting crypsis were also psammophonious. To test this hypothesis, sand was removed from 90 stems of the yellow sand-verbena; tan or green sand was added to 30 plants each to mimic the sand habitat or leaf color, and the remaining 30 plants had no sand added to act as controls (LoPresti 2018, pp. 829-830). Herbivory was highest on stems with no sand (15 percent) than those stems with sand. Overall, there was no difference in caterpillar herbivory due to sand color suggesting that sand armor functions as a defense mechanism is not a result of crypsis (USFWS, 2022).

Stressor: Climate Change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Climate change may be a factor affecting LFSV however, we do not know whether changes in climate that have already occurred have affected populations and/or its distribution.

While future climate projections indicate an increase in average annual temperature and decrease in average annual precipitation (Climate Mapper 2022; see Table 4), the Service is not able to predict how the species might be affected by the type (i.e., temperature or precipitation) and degree of future climate change under different greenhouse gas emission scenarios (representative concentration pathways (RCPs)) (USFWS, 2022).

Recovery

Reclassification Criteria:
At least 20 healthy, stable populations with a minimum of 600 plants in each should be located or established. A healthy population would be considered to be one with a habitat area of at least 25 acres, demographically stable, and genetically viable. These populations should be distributed throughout the natural, potential geographic range of the species, as determined by recovery research activities (USFWS, 2010).

Recovery Priority Number: 8

Delisting Criteria:
The 20 populations described for the reclassification criteria have maintained needed population structure and viability for at least 10 years. In addition, long-term agreements and management plans should be in place that will ensure their continued protection (USFWS, 2010).

Recovery Actions:
- Protect Abronia macrocarpa populations from existing and future threats and develop management plans (USFWS, 1992).
- Maintain a reserve germ bank/cultivated population with a responsible agency/Institution (USFWS, 1992).
- Study population biology. Initiate studies to gather information necessary for protective management and restoration. Study cultivation requirements (USFWS, 1992).
- Search/inventory potential habitat (USFWS, 1992).
- Assess restoration feasibility (USFWS, 1992).
- Develop and implement a reintroduction plan, if feasible (USFWS, 1992).
- Develop public concern and support for the preservation and study of Abronia macrocarpa (USFWS, 1992).
- Develop a post-recovery monitoring plan (USFWS, 1992).
- Revise the recovery plan and recovery criteria to reflect new information on the species' biology, ecology, and range, incorporating the most recent recovery planning guidance (National Marine Fisheries Service 2007). Specifically, the criterion of a minimum viable population area of 10.1 ha (25 ac) is unrealistic, since the known viable wild populations occupy much smaller areas. However, it is important to distinguish between the area requirements of both occupied and unoccupied potential habitat. Abronia macrocarpa inhabits sparsely-vegetated, unstable sandy soil formations; anecdotal observations indicate that the populations respond favorably to occasional light disturbance. Therefore, it is possible that this plant is narrowly adapted to a specific seral stage that continually shifts location as these inland sand dunes form and recede. If this is the case, the area requirement for unoccupied but intact potential habitat will be much greater than the area

occupied by the species at any given time; long-term survival would require landscape-scale conservation (USFWS, 2010).

- Increase the minimum viable population size of 600 individuals for the recovery criteria, as this appears to be too small (McGlaughlin et al. 2002, Williamson, pers. com. 2010) (USFWS, 2010).
- Continue to promote public support for conservation and recovery of the species through local schools and news media, non-governmental conservation organizations, and other forms of public outreach (USFWS, 2010).
- Continue periodic monitoring and surveys of the known populations to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2010).
- Support conservation of wild populations on private lands through the USFWS Partners for Fish and Wildlife Program and section 6-funded grants, and through cooperative efforts with Natural Resources Conservation Service and other state and federal agencies. Establish a private landowner support group, similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus) (USFWS, 2010).
- Continue to search for wild populations. Use GIS technology to identify areas of high potential habitat, and seek landowner permissions to survey those areas (USFWS, 2010).
- Conduct scientific investigation of the species' fire ecology. (USFWS, 2010).
- Continue to develop reintroduction techniques to improve establishment rates in the field and cost effectiveness. Once suitable techniques have been demonstrated through pilot reintroductions, implement a reintroduction program on a scale sufficient to recover the species. (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Establish protected sites (recovery action 111; priority 1): Currently, no known occupied LFSV sites are protected by a conservation easement or other binding mechanism. Efforts between the Service, TNC, and LO to protect WP4 with a conservation easement began in 2019, however no such agreement has been secured. LO outreach and cooperation are vital to the success of these securements and should be a priority for future work with the species. Funding mechanisms should be developed and presented in concert with outreach efforts to the LO to implement protection and management of sites.
- Work with LO to manage sites for existing populations (recovery actions 112 and 113; priority actions 1 and 2, respectively): Both short-term and long-term reduction in threats and management should be explored for each known site once LO contact and coordination has been established and maintained. Once LO contact is established, management plans should be created and revised, as needed (recovery action 14, priority 2).
- Monitor known populations for general condition and reproductive success (recovery action 13; priority 2): Monitoring methods should be developed and used at all sites. Monitoring should occur annually at each known population (both WPs and EPs), where access is allowed, to track demographics and current threats.
- Maintain a reserve germ bank/seed bank and cultivated populations (recovery action 21 and 22; priority 1 and 2, respectively): Currently seeds are banked with CPC partners at Mercer and LBJWC. Seeds should also be banked at USDA's National Laboratory for Genetic Resources Preservation in Ft. Collins, Colorado. Additional seed banking could alleviate pressures should any stochastic event occur. Testing of seed viability needs to be conducted and seeds from current populations should be collected in the near future (to have preservation of current population genetics/flowering plant populations). Formal seed collection and management guidelines should be developed and

coordinated amongst the Service and partners that includes consideration of the species' needs, genetic representation of the species, and built-in redundancy for species/population preservation from stochastic events. Collection guidelines and purposes for reintroduction should be outlined in a species-specific plan and should adhere to the Service's 2000 Controlled Propagation and Reintroduction Policy (recovery action 62; priority 3).

- Continue with cultivation of LFSV for the purposes of restoration and reintroduction (recovery action 23; priority 2): Seed germination studies (Goodson 2007, p.15; Drennan 2008, p. 848; Williamson 2008, pp. 35-39; Goodson and Williamson 2011, p. 144) and early reintroduction experiments (Williamson 2008, pp. 29-39) have shown LFSV can be successfully cultivated in both the greenhouse and field. However, surveys of reintroduced LFSV have not been consistent and are needed for species recovery to determine the need for more restoration and reintroduction. Further research in species cultivation, restoration, and reintroduction would help determine the amount of successful germination/per seeds plants and how microhabitat plays a role in successful reintroduction. Continuing efforts to create and monitor additional reintroduced populations could help achieve the species recovery goal of downlisting as least 20 populations are needed.
- Determine habitat requirements (recovery actions 3111, 3112, and 3113; each priority 2): Species geology, soils, and microclimate should be investigated at a site-specific and landscape scale. Habitat mapping will help identify areas with suitable habitat to focus survey efforts for additional populations; and identify areas of suitable habitat to focus potential reintroduction efforts (recovery actions 41 and 42; priority 1 and 2, respectively).
- Assess the demographic needs and conditions for populations (recovery action 3211; priority 1): Analyses completed show variation among soil composition and characteristics across populations, although the plant species composition (i.e., associated species) at each population seem similar. Further analysis is necessary to monitor site condition changes (i.e., changes in soil composition, pH, etc.) and subsequent changes to LFSV populations (i.e., number of flowering plants).
- Characterize phenology (recovery action 322; priority 2): Investigate the phenological response to variations in timing and frequency of important climatic conditions (i.e., precipitation, temperature).
- Investigate the pollination biology (recovery action 3232; priority 2): Several pollinators have been identified in association with LFSV. While some experiments point to a selfincompatibility mating system (i.e., relying on pollinators for seed/fruit set), confirming if these are effective pollinators is important. Pollination biology research will improve management efforts of both LFSV and associated pollinators, and improve the overall long-term viability of the species.
- Investigate seed biology (recovery actions 331 and 332; each priority 2): Germination techniques have been investigated by Williamson and others using various germination methods including scarification, stratification, and mycorrhizal fungi inoculation. Best methodology, from current research knowledge, includes warm then cold seed stratification with the anthocarp removed. Further investigation is needed to understand the longevity and viability of stored seeds and the best germination methods for stored seed for later reintroduction.
- Conducting searches for existing populations (recovery action 41; priority 1): Efforts to search for additional LFSV populations should be coordinated between the Service, TPWD, and other partners. Working with other agencies, such as NRCS, the Service's Partner's for Fish and Wildlife (PFW) program, that conduct on-the-ground management and LO consultation is important to gaining LO trust and access to LFSV populations. Efforts will need to focus on educating LO's and partner organizations. Another important component of this recovery action should include the identification and refinement of suitable habitat requirements as outlined in recovery actions 3111, 3112, and 3113 above.

- Monitor existing reintroduction populations to understand effectiveness and feasibility of techniques (recovery action 51; priority 2): Several reintroduction efforts occurred by Williamson between 2006 and 2008, creating nine EPs. These efforts demonstrated that spring reintroductions are more successful than fall reintroductions however, this was ultimately dependent on site-specific characteristics (i.e., presence of cutter ants, soil characteristics, precipitation events). Since the initial creation of the EPs, sites have not been surveyed or monitored. Consistent monitoring of EPs is necessary to provide accurate reintroduction methods and management actions in the future. The genetic structure of LFSV has been observed to exhibit high heterozygosity in and among populations, and was used to improve genetic structure of EPs; however, no population genetic research has been conducted since the creation of EPs. Genetic structure research is needed to verify genetic variation was improved with created EPs, and ensure high heterozygosity among LFSV populations to protect the species from stochastic events.
- Continue to promote public support for the conservation and recovery of the species (recovery action 7; priority 2): Efforts should focus on providing the public with knowledge of the species needs and the importance of its conservation. In addition, the public should be made aware of potentially deleterious land management practices (i.e., mowing, ORV use, etc.); how to alter such land management practices so they provide dual benefits to the species and the LO/land manager (i.e., timing and frequency of mowing); other strategies to aid in species recovery (i.e., providing access for monitoring, allowing reintroductions, etc.); and necessary information about plant regulations under the Act.
- Determine response to disturbance, agricultural practices, and other land uses (recovery action 3133; priority 1): Efforts should focus on determining the impact of threats to LFSV including but not limited to ORV use, fire (prescribed burning), herbivory, and climate change. ORV use or mowing was observed at WP4, however, consistent surveys/observations are needed to better understand the types of disturbance occurring and their impact. Little to no information is known about the impacts of prescribed burning on LFSV. This needs to be investigated to determine if it could be a suitable restoration management strategy for the species. Herbivory by caterpillar was investigated by Dr. LoPresti, however LFSV exhibits psammophony (i.e., sand armor) which acts as defense against herbivory. Williamson observed population loss in an EP that was thought to be impacted by cutter ants however, these findings need further investigation.

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SPECIES ACCOUNT: *Abutilon eremitopetalum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Abutilon eremitonetalum (Figure 1, from Degener 1933) is a shrub in the mallow family (Malvaceae) with grayish-green, densely hairy, heart-shaped leaves; the leaves are 7 to 12 cm (2.7 to 4.7 in) long. One or two flowers are on stems up to 4 cm (1.6 in) long in the leaf axils. The calyx of the flowers are green, cup-shaped, and about 1.5 cm (0.6 in) long. The petals are shorter than the calyx and are bright green on the upper surface and reddish on the lower surface. The staminal column extends beyond the calyx and is white to yellow, with red style branches tipped with green stigmas. The fruit is a hairy, brown, dry, cylindrical capsule and about 1 cm (0.4 in) long. It is the only Abutilon on Lana'i whose flowers have green petals hidden within the calyx (Bates in Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Abutilon eremitopetalum was originally described as Abutilon cryptopetalum with type specimen listed as one collected by George C. Munro in 1930 from Maunalei Valley, Lana'i (Caum 1933). The specific epithet refers to, "the very small... petals, which are at all times completely enclosed within the calyx" (Caum 1933). However, unbeknownst to Caum at the time of his original publication, the epithet Abutilon cryotonetalum had already been assigned to an Australian species (Degener 1936). Caum renamed the species Abutilon eremitopetalum (Caum in Christophersen 1934). In 1932, Otto Degener established the genus Abortopetalum (Degener 1932) and in 1936 included this species in that genus as Abortopetalum eremitopetalum (Degener 1936) . However, Christophersen points out that Degener's Abortonetalum does not differ from Abutilon in characters of generic rank (Christophersen 1934); the most recent revision of the Hawaiian flora supports Christophersen's conclusion (Bates in Wagner et al. 1990). Therefore, the current designation for this plant is Abutilon eremitopetalum. (USFWS, 1994)

Current Range

Endemic to Lanai. In 2021, there was one wild population of three mature individuals and more than 100 seedlings within an exclosure at Kahe'a Gulch (Pūlama Lāna'i 2021). When monitored in 2022, there were four immature plants and 22 seedlings (Maui Plant Extinction Prevention Program [PEPP] 2022). This population was augmented with 15 immature individuals in 2014 which were present in a recent survey in 2021 (Pūlama Lāna'i 2021). There are two other fenced reintroduction sites: one of one individual at Maunalei and one of 11 individuals at 'Āwehi Gulch (USFWS, 2023).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Abutilon eremitopetalum under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-

18110).

Critical Habitat Designation

The critical habitat designation for Abutilon eremitopetalum includes two CHUs in Maui County, Hawaii. Approximately 10,705 ac (4,332) ha) of private land on the Island of Lanai are being designated as critical habitat for Abutilon eremitopetalum. (81 FR 17790-18110).

Both Critical Habitat Units are on Lanai and no data is specified except that they are are owned by Lanai Resorts, LLC and Castle and Cooke Properties, Inc.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Abutilon eremitopetalum critical habitat consists of one component (81 FR 17790-18110):

Lowland Dry Ecosystem: Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and

6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum

hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

In 2012, the Service revised critical habitat for Abutilon eremitopetalum, and the proposed rule identified two critical habitat units on Lāna‘i in the lowland dry ecosystem (10,705 ac, 4,332 ha) (77 FR 34464, July 11, 2012). In the final rule the Service excluded critical habitat for this species on the island of Lāna‘i because, as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lāna‘i Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). (USFWS, 2018)

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred form NatureServe, 2015)

Habitat Narrative

Adult: Abutilon eremitopetalum is found in dry forests and shrublands in gulches. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2023)

Population Size:

4 mature individuals. See population narrative (USFWS, 2023).

Population Narrative:

In 2021, there was one wild population of three mature individuals and more than 100 seedlings within an exclosure at Kaheʻa Gulch (Pūlama Lānaʻi 2021). When monitored in 2022, there were four immature plants and 22 seedlings (Maui Plant Extinction Prevention Program [PEPP] 2022). This population was augmented with 15 immature individuals in 2014 which were present in a recent survey in 2021 (Pūlama Lānaʻi 2021). There are two other fenced reintroduction sites: one of one individual at Maunalei and one of 11 individuals at ʻĀwehi Gulch (USFWS, 2023)

Threats and Stressors

Stressor: Introduced species (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Threats include alien vegetation and alien animals (deer). (NatureServe, 2015)

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Abutilon eremitopetalum is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014)

Stressor: Ungulates (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Ungulates may be degrading habitat and eating plants. (USFWS, 2014)

Stressor: Fire (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Fire may be a threat to this species. (USFWS, 2014)

Stressor: Small population size (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Extremely limited populations may be a threat to the survival of the species. (USFWS, 2014)

Stressor: Drought degredation of habitat (USFWS, 2018)
Exposure:

Response:
Consequence:
Narrative: Drought is observed to be a threat to the last population of Abutilon eremitopetalum on Lānaʻi (PEPP 2011, 2012, 2013). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Lack of adequate bio-security legislation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Invasion of the State of Hawaiʻi by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to Abutilon eremitopetalum. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Stressor: Invertebrates (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by invertebrates (USFWS, 2023)

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Climate Change (USFWS, 2023)

Stressor: Reduced viability due to low numbers (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Reduced viability due to low numbers (USFWS, 2023)

Recovery

Reclassification Criteria:
1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Recovery Priority Number: 2

Delisting Criteria:
1. These taxa may be delisted when a total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:
- Protect habitat of current populations and manage threats. (USFWS, 1994)
- Conduct research essential to conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- Ungulate monitoring and control – Maintain fencing to exclude browsing by deer and mouflon sheep. (USFWS, 2014)
- Invasive plant monitoring and control – Continue control of invasive introduced plant species within the exclosure. (USFWS, 2014)
- Captive propagation for genetic storage and reintroduction: a) continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range and b) evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Threats – predator / herbivore research – determine what is eating the seed, and what methods will effectively stop seed predation. (USFWS, 2014)
- Fire monitoring and control - develop and implement a fire management plan at the existing exclosure. (USFWS, 2014)
- Climate change adaptation strategy - research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Alliance and partnership development - initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

Conservation Measures and Best Management Practices:

- Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates.
- Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Abutilon eremitopetalum within and around exclosures.
- Fire prevention and control—Develop and implement fire prevention management plans for areas in which A. eremitopetalum occurs.
- Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change. Additional management actions may be needed, such as locating key microsites that overlap with current and future climate envelopes for translocation efforts.
- Predator and herbivore monitoring and control—Identify invertebrate predator and determine if effective controls are needed and are available to prevent seed predation.
- Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o Evaluate genetic resources currently in storage to determine the need for longterm storage due to this species' vulnerability to climate change.
- Build resiliency, redundancy, and representation—Increase species' viability through habitat restoration, threat control, and reintroduction and translocation into suitable habitat that is being managed for known threats.
- Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon.

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

USFWS. 2018. 5-year Review, Short Form Summary, Abutilon eremitopetalum (no common name). PIFWO, Honolulu, Hawaii.

USFWS. 2018. 5-year Review, Short Form Summary, Abutilon eremitopetalum (no common name). PIFWO, Honolulu, Hawaii. USFWS. 2023. 5-Year Review. Short Form Summary. Species Reviewed: Abutilon eremitopetalum (no common name). Region 1/Pacific Islands Fish and Wildlife Office (PIFWO), Honolulu, Hawai‘i. 8 pp.

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SPECIES ACCOUNT: *Abutilon menziesii* (Ko`oloa`ula)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/26/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Abutilon menziesii (Figure 2, from Wagner et al. 1990) is a shrub in the mallow family (Malvaceae) 2-2.5 meters (6.6 to 8.2 feet) tall with coarsely-toothed, silvery, heart-shaped leaves 2-8 centimeters (0.8 to 3.2 inches) long. The flowers are medium red to dark red and about 2 centimeters (0.8 inches) across. The capsules are hairy and five to eight-parted, usually with three seeds per cell. Variation in flower color from pink through red, purple, and even yellow is reported among different populations of Abutilon menziesii (National Tropical Botanical Garden 2009a, 2010). (USFWS, 1994; USFWS, 2011)

Taxonomy

Abutilon menziesii was originally described based on two specimens, which were in the British Museum of Natural History, collected by Dr. Archibald Menzies from the “Sandwich Islands” (Seemann 1865-1873). No taxonomic variants of this species have been formally described; however, Hillebrand (1888) recognized a beta-variety with “light flesh-colored” flowers from a specimen collected by Lydgate from Lana’i, and it has been noted that specimens from Lana’i have “densely pubescent calyces, pale corollas, and large mericarps” (Bates in Wagner et al. 1990) Although some Lana’i plants have darker petals, nearly all show vestiges of the light coloration (Robert Hobdy, Maui Division of Forestry and Wildlife, personal communication 1992). (USFWS, 1994)

Current Range

Endemic to the islands of Oahu, Maui, Lanai, and Hawaii. (USFWS, 2023)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Abutilon menziesii is a long-lived perennial shrub (> 10 years) (USFWS, 2023)

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Habitat Narrative

Adult: Abutilon menziesii is found in dry shrublands, including ones that are now dominated by alien plant species. Gulches, plateau lands, and old lava flows. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

9 (USFWS, 2023)

Population Size:

~765 (wild individuals) and >300 outplanted (USFWS, 2023)

Population Narrative:

Currently, there are two wild populations on Oʻahu, three wild populations on Lānaʻi, and three wild populations on Maui. On Oʻahu, there were 35 individuals (some wild) at Kapolei in 2018, and 45 mature and one immature wild individuals in three subpopulations at Lualualei in 2022 (Department of Land and Natural Resources Division of Forestry and Wildlife [DLNR DOFAW] 2019, 12 pp.; Waianae Mountains Watershed Partnership [WMWP] 2022, 13 pp.). On Lānaʻi, the wild populations are found at Puʻumāhanalua (approximately 200 individuals in multiple clusters), at Mānele (3 to 13 individuals; however, two of the four subpopulations were impacted by a wildfire); and at Paliamano there are at least 13 individuals with additional multiple clusters in four subpopulations, some of which are within an exclosure (Pūlama Lānaʻi 2021). In 2019, there were multiple clusters in an exclosure at Keone in Paliamano (down from several hundred in 2011) (Pūlama Lānaʻi 2021). On east Maui, wild individuals may still occur at Puʻuokali and Kalialinui Gulch with the last counts of 200 and 8 individuals (respectively) in 2018 (USFWS 2018). An historic occurrence on west Maui could not be relocated; however, another occurrence was found in a nearby area at Pōhākea and is estimated to total 15 to 30 individuals (Maui PEPP 2022). Wild individuals on the island of Hawaiʻi are extirpated but there are seeds in ex situ storage (USFWS, 2023).

Threats and Stressors

Stressor: Invasive plants (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Invasive introduced plants that modify the habitat on Maui include Abutilon grandiflora (hairy abutilon), Bidens pilosa (beggartick), Cenchrus ciliaris, Chloris virgata (fingergrass), Lantana camara (lantana), Leucaena leucocephala, Melinis repens (Natal redtop grass), Prosopis pallida (mesquite), Urochloa maxima, and Setaria verticillata (bristly foxtail)

(Perlman 2009; Wood 2009). Other threats to the habitat there include fire, Axis deer (Axis axis), cattle (Bos taurus), and goats (Capra hircus) (H. Oppenheimer, pers. comm. 2009; Perlman 2009; Wood 2009). The introduced invasive plant species are also a threat to Abutilon menziesii because they compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Fire (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Puu Mahanalua (Twin peaks) area of Lanai suffered a serious fire in 2009. The habitat is degraded by Urochloa maxima, Leucaena leucocephala, Casuarina equisetifolia (ironwood), Lantana camara, and various grasses (Perlman 2009; Wood 2009). (USFWS, 2011)

Stressor: Herbivory (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Deer are reported to chew, trample, and knock down plants of Abutilon menziesii. Rats (Rattus rattus), mouflon sheep (Ovis aries), and insect predators including Hibiscus scale (Pinnaspis strachani) and Chinese rose beetle (Adoretus sinicus) are also reported to eat or damage these plants (National Tropical Botanical Garden 2010b; Perlman 2009; USFWS 1986; Wood 2009). (USFWS, 2011); Axis deer (Axis axis) and mouflon sheep (Ovis musimon) modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil. In addition to areas discussed in the previous 5-year reviews, these ungulates and evidence of their activities have been observed on Lānaʻi at the Keone, Māhāʻulepū, Mānele, and Naupaka occurrences of Abutilon menziesii (NTBG Herbarium 2013a, 2013b; PEPP 2012, 2017b). (USFWS, 2018)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011) ; change loss or degradation of habitat—Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Abutilon menziesii is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.564 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2018)

Stressor: Drougth degradation of habitat or mortality (USFWS, 2018)

Exposure:
Response:
Consequence:
Narrative: Drought is noted as a threat to the occurrences of Abutilon menziesii on Maui (Waikapu), Lānaʻi (Paliamano, Māhāʻulepū, and Mānele), and Hawaiʻi island (Kaʻūpūlehu) (PEPP 2013, 2014, 2017b). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation (D'Antonio and Vitousek 1992). The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Human interaction monitoring and management (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Habitat disturbance by human visitation of occurrences at Paliamano on Lānaʻi is noted as a threat to Abutilon menziesii (PEPP 2013). (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Three of the five known occurrences of Abutilon menziesii on Lānaʻi occur in a State Game Management Area. Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and through direct herbivory or predation. Only some of the occurrences are fenced and habitat destruction and modification, and predation, by axis deer and mouflon sheep are noted as threats to the species. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Invasion of the State of Hawaiʻi by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to Abutilon menziesii. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address many species that could be pests in Hawaiʻi (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2018)

Stressor: Predation and herbivory by rodents (USFWS, 2023)

Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
1. A total of five to seven populations are documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each of these populations must persist at this level for at least 5 consecutive years before downlisting is considered. (USFWS, 1994)

Recovery Priority Number: 2

Delisting Criteria:
1. These taxa may be delisted when a total of 8 to 10 populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. (USFWS, 1994)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. (USFWS, 1994)

3. Each population should persist at this level for at least 5 consecutive years before delisting is considered. (USFWS, 1994)

Recovery Actions:
- Protect habitat of current populations and manage threats. (USFWS, 1994)
- Conduct research essential to conservation of the species. (USFWS, 1994)
- Expand current populations. (USFWS, 1994)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1994)
- Validate and revise recovery objectives. (USFWS, 1994)
- Surveys and inventories—Survey for occurrences of Abutilon menziesii in historic habitat on Hawai‘i island. (USFWS, 2018)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. Protect all occurrences against browsing and habitat disturbances from feral ungulates. (USFWS, 2018)
- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations; Control invasive nonnative species that

compete with the species around all populations. (USFWS, 2018)
- Climate change adaptation strategy—Assess the modeled effects of climate change on this species, and determine future landscape needed for the recovery of the species. (USFWS, 2018)
- Fire monitoring and control—Develop and implement fire prevention management plans. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Continue maintenance of all populations through weed control and fencing. (USFWS, 2011)
- Develop and implement fire management plans for each population. (USFWS, 2011)
- Outplant to augment genetic representation in each Oahu site. (USFWS, 2011)
- Monitor existing populations to track status and historical sites for new recruitment. (USFWS, 2011)
- Collect seeds from those populations not currently well represented. (USFWS, 2011)
- Continue reintroducing individuals into protected suitable habitat within historical range. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species on Lanai and Maui. (USFWS, 2011)

Conservation Measures and Best Management Practices:
- Surveys and inventories—Continue surveys for populations of Abutilon menziesii in areas of potentially suitable habitat
- Ungulate monitoring and control—Continue to maintain fenced exclosures and construct additional exclosures to protect individuals from the negative impacts of habitat destruction and trampling and browsing by ungulates.
- Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with A. menziesii.
- Fire prevention and control—Continue to develop and implement fire prevention management plans for all populations.
- Climate change adaptation strategy—Research suitability of habitat for viability of species, including sites for translocations in the future due to the impacts of climate change.
- Predator and herbivore monitoring and control— o Determine effective methods to control insect pests, including Hibiscus snow scale (Pinnaspis strachani) and the Chinese rose beetle (Adoretus sinicus), and implement if necessary. o Implement effective methods to control predation by mice and rats at all populations.
- Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for translocation.
- Build resiliency, redundancy, and representation— o Increase the species' viability through habitat restoration and threat control. o Continue to augment wild populations and translocate individuals into suitable habitat that is being managed for known threats to this species to reduce impacts of predation, drought, and lack of biosecurity legislation.
- Population biology research—Determine possible causes of the low rate of natural recruitment.

- Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species.

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SPECIES ACCOUNT: *Acaena exigua* (Liliwai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Acaena exigua is a small perennial rosette herb in the rose family (Rosaceae) with narrow, fern-like, divided leaves and slender flowering stalks 5-15 centimeters (2-5.9 inches) long. It is easily hidden among the other low, tufted bogplants with which it grows. The narrow, oblong leaves are usually 10-25 mm (0.4-1.0 in) long with 6-17 leaflets 1-4 mm (0.04-0.16 in) long and 1-2 mm (0.04-0.08 in) wide. The leaflet on the end is wider (to 3 mm [0.12 in]). The upper surface of the leaves is glossy with conspicuous veins; the lower surface is whitish. The flowers lack petals and are arranged in short, dense spikes 5-10 mm (0.2-0.4 in) longheld on slender, sparsely leafy stalks 5-15 cm (2-6 in) tall. The base of the flower is urn-shaped, sometimes with very short spines or bristles, and encloses a single cone-shaped dry fruit (achene) 1 mm (0.04 in) long. (USFWS, 1997)

Taxonomy

Bitter (1910-1911), in a review of the genus Acaena, described three varieties of the Hawaiian species (var. glabriuscula, var. subtusstrigulosa, and var. glaberrima). The current taxonomic treatment (Wagner et al. 1990) treats A. exigua as a single, variable taxon and does not recognize varieties. The genus Acaena is composed of approximately 100 species, centered primarily in the Southern Hemisphere (Wagner et al. 1990). The sole Hawaiian species of the genus Acaenais distinguished from other Hawaiian members of the rose family in that it is a small, compact, high-elevation bog species with flowers that lack petals. The specific epithet, exigua, means “small, short, poor, scanty,” presumably due to the small size of the species. (USFWS, 1997)

Historical Range

Historically, Acaena exigua was known from Puu-kukui on West Maui and from Mount Waialeale on Kauai. (USFWS, 1997)

Current Range

Endemic to mountains of Kauai and West Maui. (NatureServe, 2015). Island Distribution: Extirpated on Kauai, Maui? (USFWS, 2021c)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Acaena exigua under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Acaena exigua includes two CHUs in Maui County, Hawaii. Approximately 1,479 ac (599 ha) of federal, private and state land on the Island of Maui (west

Maui) are being designated as critical habitat for Acaena exigua. (81 FR 17790-18110).

Maui—Montane Wet—Unit 6 (and) Palmeria dolei—Unit 15—Montane Wet (and) Pseudonestor xanthophrys—Unit 15— Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants Bidens conjuncta, Calamagrostis hillebrandii, Cyanea kunthiana, Geranium hillebrandii, Myrsine vaccinioides, and Sanicula purpurea. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants Acaena exigua, Cyrtandra oxybapha, Huperzia mannii, Phyllostegia bracteata, or Platanthera holochila, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 7 (and) Palmeria dolei—Unit 16—Montane Wet (and) Pseudonestor xanthophrys—Unit 16— Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants Cyrtandra oxybapha and Platanthera holochila, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 7 is not known to be occupied by the plants Acaena exigua, Bidens conjuncta, Calamagrostis hillebrandii, Cyanea kunthiana, Geranium hillebrandii, Huperzia mannii, Myrsine vaccinioides, Phyllostegia bracteata, or Sanicula purpurea, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Acaena exigua critical habitat consists of one component (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium. Species- specific physical or biological features: Bogs.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed

plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Small flowers are borne on short spikes. (NatureServe, 2015)

Habitat Type

Adult: Palustrine (inferred from USFWS, 1997)

Habitat Vegetation or Surface Water Classification

Adult: Bogs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,600 and 1,800 meters (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements

Habitat Narrative

Adult: Acaena exigua is known only from montane bogs at elevations of 1,600-1,800 meters (5,250-5,906 feet). This species habitat is characterized by a thick peat substrate overlying an impervious clay substrate, with hummocks of sedges and grasses, stunted trees, and shrubs. Associated native species include the native sedges and grasses Deschampsta nubigena, Dichanthelium cynodon, Dichanthelium hillebrandianum, Dichanthelium isachnoides, and Oreobolus furcatus, and the native shrubs Metrosideros polymorpha and Vaccinium sp. Alien species include Holcus lanatus, Juncus planifolius, Cyperus halpan, and Sacciolepis indica. (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

0 (USFWS, 2021c)

Population Size:

0 (USFWS, 2021c)

Adaptability:

Low (inferred from USFWS, 1997)

Population Narrative:

While no occurrences are currently extant in the wild, this species has a history of disappearing only to be rediscovered decades later (USFWS 2009). Since suitable habitat is still existent within its historical range, it is possible it is not truly extinct in the wild (USFWS 2009). Known only from 2 historical records, last collected in 1950's but recently rediscovered. (NatureServe, 2015). Island Distribution: Extirpated on Kauai, Maui? (USFWS, 2021c) Number of Populations: 0 (USFWS, 2021c) Estimated Number of Individuals: 0 (USFWS, 2021c) Currently, there are no known individuals of Acaena exigua. • In 2016, two critical habitat units in the montane wet ecosystem were designated for A. exigua on west Maui (598 hectares; 1,479 acres) (81 FR 17790, March 30, 2016) (USFWS, 2020).

Threats and Stressors

Stressor: Introduced plants (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Introduced invasive plants such as Juncus planiforlius (rush), J. effusus (Japanese mat rush), Tibouchina herbacea (glorybush), Hypochaeris radicata (hairy cat's-ear), Ageratina

adenophora (Maui mapakani), Ageratina riparia (Hamakua pamakani) and Axonopus fissifolius (narrow-leaved carpetgrass) invade areas disturbed by goats and pigs (USFWS 2009). (NatureServe, 2015)

Stressor: Other threats (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Other possible threats include loss of pollinators and dispersal agents, disease, inbreeding depression, droughts, and/or rare frost episodes (USFWS 2009). (NatureServe, 2015)

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Climate change destruction or degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Acaena exigua is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014)

Stressor: Small population size (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Because Acaena exigua, if it still exists at all, presumably occurs at such low population levels and in such a restricted area a single severe environmental disturbance, such as a prolonged drought, could result in its extinction. In addition, the lack of genetic diversity could depress the reproductive vigor or adaptability of the species. (USFWS, 1997)

Stressor: Human activities (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Trampling of associated native plant species and introduction (long-distance and regional) of invasive alien plant species in its montane bog habitat are threats to Acaena exigua caused by excessive human visitation. (USFWS, 1997)

Stressor: Pigs (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Though impact from herbivory and rooting by pigs is assumed and often cited, feral pigs have become established at Wainleale (Kauni) only within the past two decades. The other known habitat, Puu-kukui (West Maui), is pig-free and apparently has always been so. (USFWS,

1997)

Stressor: Introduced species (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Though undocumented, consumption of vegetative or floral parts of this species by alien slugs and/or rats could have been a factor in the decline of the species and could continue to be a critical limiting factor. Predation by slugs and rats is a concern; specifically, regeneration may be effected by the black rat, European slug, leopard snail, and another unspecified species of slug (USFWS 2009). Species is highly threatened by human impacts, like trampling (USFWS 2009). An alien pathogen such as a disease, fungus or nematode could also be a factor, as could loss of pollinators, or some as-yet-undetected micro-environmental change associated with the species' disappearance. (USFWS, 1997)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:
- Search for any individuals of this species in the former habitat. (USFWS, 1997)
- If plants are found, initiate research on limiting factors. (USFWS, 1997)
- If plants are found, protect and enhance existing population(s) and create new populations. (USFWS, 1997)
- Survey for populations of Acaena exigua in areas of potentially suitable habitat. (USFWS, 2014)

- Captive propagation for genetic storage and reintroduction – If the species is rediscovered collect genetic material for ex situ storage and reintroduction. (USFWS, 2014)
- Threats – predator / herbivore research – If the species is rediscovered, research which threats, herbivory by introduced slugs, rodents, or disease. (USFWS, 2014)
- Loss of mutualists – determine if pollinators are lacking, or if other limiting factors affect the survival of this species. (USFWS, 2014)
- Ungulate monitoring and control – Continue ungulate fencing of suitable habitat for Acaena exigua. (USFWS, 2014)
- Invasive plant monitoring and control – Eradicate invasive introduced plants and maintain Acaena exigua habitat free of invasive introduced plants. (USFWS, 2014)
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

Conservation Measures and Best Management Practices:

- New Management Actions: • Surveys and inventories—In 2018, a survey of the last known location of this species was conducted, but no plants were found. However, excellent habitat still exists in the area and additional surveys may be conducted (PEPP 2018) (USFWS, 2020).

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SPECIES ACCOUNT: *Acanthomintha ilicifolia* (San Diego thornmint)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Acanthomintha ilicifolia (San Diego thornmint) is an annual aromatic herb in the Lamiaceae (mint family). This plant ranges in height from 5 to 15 centimeters (2 to 6 inches) and has white, two-lipped, tubular flowers with lavender- or rose-colored markings on the lower lip (Jokerst 1993, p. 713). Up to four smooth and ovoid seeds may be produced by each flower, but each plant can produce between 70 and 200 seeds (USFWS, 2022).

Taxonomy

Belongs to the Lamiaceae (mint family) (USFWS, 2009).

Historical Range

See current range/distribution.

Current Range

This species is endemic to San Diego County, California, and northwestern Baja California, Mexico (USFWS, 2022).

Critical Habitat Designated

Yes; 8/26/2008.

Legal Description

On August 26, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Acanthomintha ilicifolia (San Diego thornmint) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (73 FR 50454-50496).

Critical Habitat Designation

The critical habitat designation for Acanthomintha ilicifolia includes four CHUs (17 sub-units) in San Diego County, California. This species critical habitat encompasses approximately 671 acres (ac) (272 hectares (ha)) (73 FR 50454-50496).

Unit 1: Northern San Diego County: Unit 1 is located in northern San Diego County, California. The area was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of Acanthomintha ilicifolia that may require special management considerations or protection for A. ilicifolia. The habitat in Unit 1 is gently sloping and occurs in the north coastal portion of San Diego County. The habitat included in this unit provides for the conservation of populations of this species that are at the lowest elevations where this species is found. These areas represent coastal terrace terrain and, therefore, are edaphically and ecologically distinct from the other units of critical habitat (subunit 1A) (see ‘‘Criteria Used to Identify Critical Habitat’’ section criterion 1). This unit contains some of the most stable populations of A. ilicifolia (subunits 1B and 1C) (see ‘‘Criteria Used to Identify Critical Habitat’’ section criterion 3). Below, we present a brief description of subunits designated as critical

habitat in this unit. Subunit 1A, Palomar Airport: Subunit 1A is located in Carlsbad, California, northeast of the intersection of Palomar Airport Road and El Camino Real. Subunit 1A consists of 60 ac (24 ha) of land owned by the County of San Diego. Subunit 1A meets our selection criteria because it supports a population on a unique soil type (see ''Criteria Used to Identify Critical Habitat'' section criterion 1). This is the only area where A. ilicifolia is still known to occupy calcareous clay soils. The features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from exotic plant species and unauthorized recreational activities. A portion of the land that meets the definition of critical habitat in this area (2 ac (1 ha)) is covered by the Carlsbad HMP of the San Diego MHCP. We excluded the portion of critical habitat covered by the Carlsbad HMP from critical habitat because we determined the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation. Furthermore, exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Subunit 1B, Southeast Carlsbad: Subunit 1B is located in Carlsbad, California, east of Calle Acervo and west of Paseo Esmerado. All lands within this subunit (57 ac (23 ha)) are covered by the Carlsbad HMP of the San Diego MHCP. We excluded the lands covered by the Carlsbad HMP under the MHCP in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation. Furthermore, exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Subunit 1C, Manchester: Subunit 1C is located in Encinitas, California, northeast of the intersection of Manchester Avenue and South El Camino Real. Subunit 1C consists of 9 ac (4 ha) of private land. Subunit 1C meets our selection criteria because it supports one of the most stable populations of Acanthomintha ilicifolia (criterion 3). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from exotic plant species and unauthorized recreational activities. The majority of the land that meets the definition of critical habitat in this area (70 ac (28 ha)) is in the Manchester Avenue Mitigation Bank. The Manchester Avenue Mitigation Bank is owned and managed by the Center for Natural Lands Management (CNLM). There is long-term management in place on this site to conserve several sensitive species, including Acanthomintha ilicifolia (Spiegelberg 2005, p. 1). We excluded the portion of critical habitat covered by the Manchester Habitat Conservation Area Management Plan (Spiegelberg 2005) from critical habitat because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation; exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion).

Unit 2: Central San Diego County Unit 2 is located in an east-west line starting in the County of San Diego on private land east of the Sycamore Canyon/Goodan Ranch Preserve (subunit 2D), occurring on Countyowned open space in the Sycamore Canyon/Goodan Ranch Preserve (subunit 2C), occurring on City of San Diego-owned land in Los Pen˜ asquitos Canyon near the border or the City of San Diego and the City of Poway (subunit 2B), and occurring in Pen˜ asquitos Canyon Preserve (subunit 2A). The unit was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of Acanthomintha ilicifolia that may require special management considerations or protection for A. ilicifolia. This unit contains some of the largest populations of A. ilicifolia (subunits 2C and 2D) (criterion 2) and some of the most stable populations of A. ilicifolia (subunits 2A and 2B) (criterion 3). All lands that meet the definition of

critical habitat in Unit 2 are covered by either the City of San Diego subarea plan (subunits 2A and 2B) or the County of San Diego subarea plan (subunits 2C and 2D) under the San Diego MSCP and are excluded from the designation. We determined that the benefits of excluding these lands outweigh the benefits of including these lands in the designation and that exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion).

Unit 3: Viejas Mountain and Poser Mountain: Unit 3 is located in San Diego County, California, on Viejas Mountain and Poser Mountain. The area was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of Acanthomintha ilicifolia that may require special management considerations or protection for A. ilicifolia. Unit 3 is divided into six subunits, five of which are designated as critical habitat. Due to the proximity of the occurrences in this area and the fact that the habitat is not fragmented by any manmade barriers, we consider these occurrences to be a single population of A. ilicifolia. Unit 3 is designated as critical habitat because it supports one of the largest recorded populations of the species (criterion 2). This population is estimated to have greater than 25,000 plants based on the maximum number of plants observed at the different CNDDB element occurrences (EO 12, 6,650 plants in 1991 (subunit 3F); EO 50, 5,600 plants in 1994 (subunit 3B); EO 51, 8,300 plants in 2003 (subunit 3C); EO 62, 1,115 plants in 2000 (subunit 3C); EO 73, 8,750 plants in 1997; and EO 74, 2,000 plants in 2000 (subunit 3E)). The habitat in unit 3 is more mountainous than the other units and provides for the conservation of this species at the highest elevations where this species is found. Therefore, this unit is ecologically distinct from the other units of critical habitat and provides for the largest population of A. ilicifolia as measured by the area occupied by the species. Below, we present a brief description of subunits designated as critical habitat in this unit. Subunit 3A, Viejas Mountain: Subunit 3A is located east of Peutz Valley Road on the western flank of Viejas Mountain. All lands that meet the definition of critical habitat in this area (32 ac (13 ha)) are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation. Furthermore, exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Subunit 3B, Viejas Mountain: Subunit 3B is located east of Alpine, California, and north of Interstate 8 on the western slope Viejas Mountain. Subunit 3B consists of 52 ac (21 ha) of land in the Cleveland National Forest (CNF) owned by the U.S. Forest Service (USFS). This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3B meets our selection criteria because this subunit is part of one of the largest recorded populations of Acanthomintha ilicifolia (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. The privately owned lands that meet the definition of critical habitat in this area (141 ac (57 ha)) are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation and that exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Subunit 3C, Viejas Mountain: Subunit 3C is located east of Alpine, California, and north of Interstate 8 on southern slope of Viejas Mountain. Subunit 3C consists of 276 ac (112 ha) of land in the CNF owned by the

USFS. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3C meets our selection criteria because this subunit is part of one of the largest recorded populations of Acanthomintha ilicifolia (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. Subunit 3D, Viejas Mountain: Subunit 3D is located east of Alpine, California, and north of Interstate 8 on the eastern slope of Viejas Mountain. Subunit 3D consists of 32 ac (13 ha) of land in the CNF owned by the USFS and 50 ac (20 ha) of private land. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3D meets our selection criteria because this subunit is part of one of the largest recorded populations of Acanthomintha ilicifolia (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. Subunit 3E, Poser Mountain: Subunit 3E is located east of Alpine, California, and north of Interstate 8 on western slope of Poser Mountain. Subunit 3E consists of 34 ac (14 ha) of land in the CNF owned by the USFS. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3E meets our selection criteria because this subunit is part of one of the largest recorded populations of Acanthomintha ilicifolia (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities. Subunit 3F, Poser Mountain: Subunit 3F is located east of Alpine, California, and north of Interstate 8 on southern slope of Poser Mountain. Subunit 3F consists of 155 ac (63 ha) of land in the CNF owned by the USFS. This subunit was occupied by the species at the time of listing and is currently occupied. Subunit 3F meets our selection criteria because this subunit is part of one of the largest recorded populations of Acanthomintha ilicifolia (criterion 2). The features essential to the conservation of the species in this subunit may require special management considerations or protection to address the threat from exotic plant species and recreational activities.

Unit 4: Southern San Diego County Unit 4 is located in southern San Diego County, California near the City of Jamul. The area was occupied at the time of listing, is currently occupied, and contains the features essential to the conservation of Acanthomintha ilicifolia that may require special management considerations or protection. This critical habitat unit contains some of the largest populations of A. ilicifolia (subunit 4D) (criterion 2) and some of the most stable populations of A. ilicifolia (subunits 4A, 4B, and 4C) (criterion 3). The habitat for A. ilicifolia in southern San Diego County is located in proximity to rural residential development and in relatively undeveloped areas. Below, we present a brief description of subunits designated as critical habitat in this unit. Subunits 4A and 4C, McGinty Mountain: Subunits 4A and 4C are located east of Jamul, California, on the southwestern slope of McGinty Mountain. The land designated is part of the San Diego National Wildlife Refuge (SDNWR) and is owned by the Service. We are designating 3 ac (1 ha) of critical habitat in subunits 4A and 4C for Acanthomintha ilicifolia. These subunits were occupied by the species at the time of listing and are currently occupied. Subunits 4A and 4C meet our selection criteria because these subunits are part of one of the most stable populations of A. ilicifolia (criterion 3). The features essential to the conservation of the species in subunits 4A and 4C may require special management considerations or protection to address the threat from exotic plant species and recreational activities. The non-Federal lands that meet the definition of critical habitat in this area (18 ac (7 ha) in subunit 4A and 27 ac (11 ha) in subunit 4C) are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan under the MSCP in this subunit because we have

determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation and that exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Subunit 4B, McGinty Mountain: All of the lands in subunit 4B that meet the definition of critical habitat in this area (148 ac (60 ha)) are nonFederal and are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands covered by the County of San Diego subarea plan under the MSCP in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in the critical habitat designation, and that exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Subunit 4D, Hollenbeck Canyon: All of the lands in subunit 4D that meet the definition of critical habitat in this area (84 ac (34 ha)) are non-Federal and are covered by the County of San Diego subarea plan of the San Diego MSCP. We excluded the lands in this subunit because we determined that the benefits of excluding these lands outweigh the benefits of including these lands in a critical habitat designation, and that exclusion of these lands will not result in the extinction of this species (see Table 3 and ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for a detailed discussion of this exclusion). Table 3 below provides approximate areas (ac (ha)) of lands that meet the definition of critical habitat, but are excluded from this final critical habitat designation. Table 3 provides our reason for the exclusion. Also see the ''Exclusions Under Section 4(b)(2) of the Act'' section of this final rule for detailed discussion of the exclusions listed in Table 3.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Acanthomintha ilicifolia critical habitat consists of four components (73 FR 50454-50496):

(i) Within chaparral, grassland, and coastal sage scrub;

(ii) On gentle slopes ranging from 0 to 25 degrees;

(iii) Derived from gabbro and soft calcareous sandstone substrates with a loose, crumbly structure and deep fissures (approximately 1 to 2 feet (30 to 60 cm)); and

(iv) Characterized by a low density of forbs and geophytes, and a low density or absence of shrubs.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the occupied areas contain features that are essential to the conservation of the species and that may require special management considerations or protection. As stated in the final listing rule, threats to Acanthomintha ilicifolia include trampling and grazing, the presence of exotic plant species, offroad vehicles (ORVs), mining, and urbanization (63 FR 54938). Through our review of the existing data on A. ilicifolia, we conclude that the threats listed in the final listing rule continue to impact this species and its essential physical and biological features. Urban development near Acanthomintha ilicifolia populations may alter the habitat characteristics required by this species. The destruction of habitat can change the slope and aspect of a site, making it uninhabitable for A. ilicifolia (PCE

1(b)). The close proximity of development to populations of A. ilicifolia may affect other aspects of the site. For example, increased water runoff from developments may erode the clay lense and change the topography of the site (Bauder et al. 1994, p. 23) (PCE 1(b and c)). The introduction of exotic plant species such as Centaurea melitensis can drastically change the species present in (PCE 1(a)), and eliminate the open character of, the clay lense habitat (PCE 1(d)). Centaurea melitensis has been shown, in field and greenhouse experiments, to negatively effect the biomass (growth) and seed production (reproduction) of Acanthomintha ilicifolia (Bauder and Sakrison 1999, p. 16). Populations of A. ilicifolia that are close to urbanized areas or in areas that are heavily grazed generally have a high density of exotic plant species (PCE 1(a)). In disturbed soils, C. melitensis is a common weed. When this and other exotic plant species become established, they can out-compete A. ilicifolia for light, water, nutrients, and space. Acanthomintha ilicifolia often grows larger and at a higher density when competition with exotic weeds is reduced (Bauder and Sakrison 1999, pp. 12–16; Vinje 2007, p. 10). The final listing rule (63 FR 54938) discusses the impacts of ORV activity and trampling. In recent years, the impacts associated with the use of mountain bikes have been documented to cause similar impacts (Vinje 2006a, p. 1). Trampling, ORV activity, and mountain bike use in Acanthomintha ilicifolia habitat can compact the loose, crumbly soils (PCE 1(c)). Repeated travel over a trail or track degrades the habitat of A. ilicifolia in two ways: (1) By displacing soil; and (2) by compacting soil. These activities, in turn, can destroy individual plants and can reduce the amount of water that can percolate into the soil, thus reducing the plant's ability to grow and reproduce. Mining is documented as a threat at two sites known to support Acanthomintha ilicifolia (63 FR 54938; Bauder et al. 1994, p. 17). Mining can alter many aspects of A. ilicifolia habitat. Heavy machinery can compact or remove clay lenses (PCE 1(c)) or alter the slope of an area (PCE 1(b)). The grading of large areas adjacent to A. ilicifolia habitat can make those areas vulnerable to invasion by exotic plant species and lead to the subsequent crowding and shading of A. ilicifolia habitat (PCE 1(d)). These impacts may in turn lead to the disruption of the growth and reproduction of A. ilicifolia. The protection of habitat for Acanthomintha ilicifolia from development is the first measure of protection needed for populations of this species (PCE 1(a)). The control of exotic plant species, the maintenance and enhancement of clay lense habitat, the control of incompatible and often illegal activities such as off-road vehicle use and other unauthorized recreational impacts, and careful oversight of adjacent activities such as mining, will help to ensure the long-term conservation for A. ilicifolia and the physical and biological features essential for the conservation of the species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization, based on closely related species (USFWS, 2009)

Lifespan

Adult: Annual aromatic herb (USFWS, 2022)

Breeding Season

Adult: April - May (USFWS, 2009)

Key Resources Needed for Breeding

Adult: The most effective pollinators of the recorded insect visitors observed were bees from the Apidae and Halictidae families (USFWS, 2022).

Other Reproductive Information

Adult: Klein (2009, entire) conducted flower observations to determine potential pollinators of Acanthomintha ilicifolia. Overall, there were very few insect visitors to A. ilicifolia plants. Insect visitors observed from most to least common were Coleoptera (beetles, primarily from the Cleridae and Melyridae families); Hymenoptera (bees, primarily from the Apidae and Hallictidae families); Diptera (flies, primarily from the Bombyliidae and Syrphidae families); and Lepidoptera (butterflies, primarily from the Hesperidae family) (Klein 2009, p. 27). The most effective pollinators of the recorded insect visitors observed were bees from the Apidae and Halictidae families (Klein 2009, p. 36). Klein also determined that the most effective pollinators were 6 millimeters (mm) [0.24 inches (in)] or smaller and it is unlikely that A. ilicifolia is pollinated by a specialist or specialists (2009, p. 36). In another study, Marschalek and Deutschman (2016, entire) also conducted flower observations to determine potential pollinators of Acanthomintha ilicifolia. Similar to the study conducted by Klein, there were overall very few visitors to A. ilicifolia plants. Most insect visitors observed by Marschalek and Deutschman were Diptera (flies) and Hymenoptera (bees). Observed fly species were mostly Exiliscelis californiensis and Syrphidae (Marschalek and Deutschman 2016, p. 20). Bee observations were included Apidae, Halictidae, and Megachilidae (Osmia) in relatively equal proportions (USFWS, 2022).

Reproduction Narrative

Adult: This annual species germinates in late winter to early spring and flowers in April and May. Seeds mature in late spring and early summer. Studies show this species has a small seed bank (Bauder and Sakrison 1999, pp. 25-28, 43-44). The breeding system of Acanthomintha ilicifolia has not been studied, but research shows that other members of the genus Acanthomintha are self-compatible to varying degrees (Steek 1995, pp. 27-33). A 1996 study identified several insect species that visited the flowers and moved from plant to plant (Bauder and Sakrison 1997, p. 38) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal sage scrub, grasslands, and chapparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 900 m lelevation (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Restricted to heavy clay soils in coastal sage scrub, grasslands, and chapparral. Often in open areas, clay depressions, vernal pool habitats; below 900 meters (Hickman 1993; Beauchamp 1986; Munz 1959; Abrams 1951). In Mexico, in rocky or gravelly soil on western slope of the Sierra Juarez, and along the coastal area between Ensenada and Tijuana (Wiggins 1980) (NatureServe, 2015). Acanthomintha ilicifolia is restricted to gabbro soils derived from

igneous rock, and gray calcareous clay soils derived from soft calcareous sandstone (Oberbauer and Vanderwier 1991, pp. 208-209) (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: A. ilicifolia seed is not known to disperse in large quantities or over great distances (USFWS, 2009).

Population Information and Trends

Population Trends:

Declining (USFWS, 2022)

Number of Populations:

84 (USFWS, 2022)

Population Narrative:

In summary, monitoring for Acanthomintha ilicifolia has occurred at 61 occurrences throughout its range since 2009 (Table 2), providing new information about the species presence and abundance. For San Diego County occurrences, we reassessed our 2009 occurrence status determinations and updated the status of 22 occurrences based on monitoring data, the date since the last survey, and information in the CNDDB. One occurrence was removed (EO 48) because it is now part of another EO. Nine occurrences were listed in the 2009 occurrence table without assigned EO numbers and now have assigned CNDDB EO numbers; four had no change in status, and five had a change in status. Additionally, we added occurrence information for nine occurrences that were reported since the previous 5-year review. For Baja California, Mexico occurrences, we have updated the information of 16 occurrences based on new survey information. Based on those updates, there are now 84 occurrences of Acanthomintha ilicifolia in San Diego County and 25 occurrences in Baja California, Mexico (Figure 1; Figure 2; Table 2). In total 48 occurrences are extant, 25 are presumed extant, 10 are possibly extirpated, and 26 are extirpated (USFWS, 2022). In total, there are 36 extant occurrences of Acanthomintha ilicifolia in San Diego County. Additionally, there are 16 presumed extant, 9 possibly extirpated, and 23 extirpated occurrences (USFWS, 2022).

Threats and Stressors

Stressor: Urbanization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At this time, 34 of the 55 extant occurrences (62 percent) are adjacent to development, cutslopes, agricultural fields, golf courses, ornamental landscaping, and fuel modification zones. However, very few occurrences have been extirpated due to habitat loss. The Service considers two occurrences to have been extirpated due to impacts associated with

development. Three recent and proposed development projects avoided directly impacting Acanthomintha ilicifolia occurrences and resulted in the conservation of these occurrences. Twelve of the 55 extant occurrences are on private lands in areas that have not yet been fully developed. These areas may be vulnerable to impacts associated with development (USFWS, 2009).

Stressor: Recreation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Presently, several extant occurrences of Acanthomintha ilicifolia are in areas potentially impacted by recreational activities. These activities include jogging, hiking, mountain biking, and motorized ORV activity. 55 extant occurrences (42 percent) are in areas where nonmotorized recreation occurs. In several areas, trails run through or adjacent to occurrences of A. ilicifolia. Four of the 55 extant occurrences (7 percent) are in areas where unauthorized ORV activity occurs. Recreation occurring at over 40 percent of the extant occurrences is a potential threat to Acanthomintha ilicifolia because trail use on wet clay lens soils can cause deep ruts (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Currently, the most prominent nonnative species that threaten Acanthomintha ilicifolia are Avena spp. (wild oats), Brachypodium distachyon (purple false brome), Brassica nigra (black mustard), Centaurea melitensis (yellow star thistle), Cynara cardunculus (artichoke thistle), and Foeniculum vulgare (fennel) (Bauder and Sakrison 1997, p. 40). Invasive, nonnative plants impact A. ilicifolia by competing for nutrients, light, water, and space. For example, Centaurea melitensis, a nonnative thistle, can dry out soils because this plant species takes moisture out of the soil that would have been available to co-occurring native plants (DiTomaso 2001, pp. 3, 12). The biomass and reproductive output of A. ilicifolia was reduced in a greenhouse experiment where A. ilicifolia was grown with C. melitensis, (Bauder and Sakrison 1999, p. 12). In a field experiment at the Hollenbeck Wildlife Area occurrence (Table 1), nonnative species near A. ilicifolia plants were removed. Researchers found that there was no increase in the number of A. ilicifolia plants, but that the reproductive output of the plants in the treatment area was significantly higher (Lawhead 2006, pp. 1-2). The impacts associated with nonnative plants have the potential to diminish the reproductive output of Acanthomintha ilicifolia and occupy space that provides habitat for this species (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Most occurrences of A. ilicifolia have an average of less than 1,000 plants and could be vulnerable because of their small size. At this time, no genetic analysis has been conducted to determine if inbreeding is a problem for A. ilicifolia. Additionally, there has been no research to determine if seeds from smaller occurrences have lower germination rates when compared to larger occurrences. Occurrences with fewer plants are more susceptible to extirpation by threats

such as nonnative species competition, trampling, and too frequent fire. Small occurrences output fewer seeds each year; therefore, the ability of these occurrences to withstand the impacts from various threats is decreased. This is a limitation to Acanthomintha ilicifolia's survival because there may not be a persistent seed bank or the species may not be able to recolonize areas of suitable habitat due to dispersal barriers such as intervening development (USFWS 1998a, p. 54950) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Rainfall and temperature both affect the germination rate and successful reproduction of Acanthomintha ilicifolia. Five factors associated with a changing climate may affect the longterm viability of A. ilicifolia occurrences in its current habitat configuration: (1) Drier conditions may result in a lower percent germination and smaller population sizes; (2) higher temperatures may inhibit germination (Bauder and Sakrison, p. 32); (3) a shift in the timing of the annual rainfall may favor nonnative species; (4) the timing of pollinator life-cycles may become out-ofsync with timing of flowering A. ilicifolia; and (5) drier conditions may result in increased fire frequency, making the ecosystems in which A. ilicifolia currently grows more vulnerable to the threats of subsequent erosion and nonnative/native plant invasion. In a changing climate, conditions could change in a way that would allow both native and nonnative plants to invade the habitat where A. ilicifolia occurs (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 8

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Identify opportunities to work with private landowners to encourage conservation actions for Acanthomintha ilicifolia on sites that are not conserved. This could be done through the Partners for Fish and Wildlife Program as well as other cooperative programs. Projects could identify and reduce threats, and enhance areas that support A. ilicifolia (USFWS, 2009).
- Develop relationships with landowners and managers of conserved lands where Acanthomintha ilicifolia occurs to minimize threats associated with urban preserves, such as nonnative plant species (USFWS, 2009).
- Develop a working group for Acanthomintha ilicifolia to coordinate monitoring efforts, share effective methods of reducing threats, and gather data on less surveyed occurrences of A. ilicifolia. Include land mangers, CDFG, USFS, academics, and local governments in this working group (USFWS, 2009).
- Encourage the participation of academic researchers to investigate questions of pollination and seed set, climate change, and fire effects in relationship to Acanthomintha ilicifolia

(USFWS, 2009).

- Develop restoration projects to benefit Acanthomintha ilicifolia in areas that have been impacted by ORV and grazing activity (USFWS, 2009).
- Continue to work with CDFG to strengthen opportunities to conserve Acanthomintha ilicifolia through State protections (USFWS, 2009).
- Work with researchers and government agencies in Mexico to evaluate the status of Acanthomintha ilicifolia in northwestern Baja California, Mexico (USFWS, 2009).

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SPECIES ACCOUNT: *Acanthomintha obovata ssp. duttonii* (San Mateo thornmint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/1985; Pacific Southwest (R8)

Physical Description

An aromatic (strong-scented) annual herb of the mint family (Lamiaceae). The 4 to 20 centimeters (1.6 to 7.9 inches) high plants are typically unbranched, though most populations contain some plants branched from near the base. The plants have squarish stems and opposite leaves. The leaves are 8 to 12 millimeters (0.3 to 0.5 inch) long and are oblong to egg-shaped and may have toothed margins (Jokerst 1991, Hickman 1993). The flowers are white or sometimes tinged with lavender and occur in tight clusters surrounded by almost round prominently spined bracts (California Native Plant Society 1986). Bracts are small leaf- or scale-like structures associated with an inflorescence (Hickman 1993). (USFWS, 1998)

Taxonomy

The taxonomic classification of Acanthomintha obovata subsp. duttonii has not changed; however it was elevated to species rank by Jokerst (Jokerst 1991, p. 278) since the taxon was listed in 1985. Jokerst treated the taxon as a full species in his treatment for the genus in the Jepson Manual (Jokerst 1993, p. 713). The Service refers to the listed entity as Acanthomintha (obovata) subsp. duttonii; however, will shortly contact the current author(s) of treatments of the genus for the revision of the Jepson Manual (John Miller) and upcoming relevant volume of Flora of North America (USFWS, 2010).

Historical Range

San Mateo County, California. (USFWS, 2010)

Current Range

A single localtion in Edgewood Park in San Mateo County, California. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, self-pollination (USFWS, 1998)

Lifespan

Adult: 1 year (USFWS, 1998)

Breeding Season

Adult: April - June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 1998)

Reproduction Narrative

Adult: Flowers appear from April to June (USFWS, 2010). The species lives less than 1 year and completes its entire life cycle from seed germination to seed production in a single growing season. Acanthomintha obovata ssp. duttonji is thought to be insect-pollinated (McCarten 1986b, Pavlik and Espeland 1991, Steeck 1995) although no specialized pollinators have been observed (D. Steeck, pers. comm., 1996). Generalist pollinators are likely to include native bees from the families Apidae (bumble bees, honey bees, euglossine bees), Anthophoridae (cuckoo bees, digger bees, carpenter bees), and Megachilidae (leafcutting bees). Although Acanthomintha obovata ssp. durtonji possessestraits typical of outcrossing plants (open, colorful, nectar-producing flowers), the species also has traits that permit self-pollination and lead to inbreeding. The hand pollination and isolation treatments ofSteeck (1995) show that Acanthomintha obovata ssp. duttonji is self-compatible (capable ofselffertilization) and capable of autogamy (self-pollination in the absence of pollinators). Survival ofplants (survivorship) until reproduction was more than 50 percent in each year measured (Pavlik and Espeland 1991, 1993, 1994, Pavlik et a/. 1992). Pavlik and Espeland (1994) feel that the observed high fecundity (production of offspring) and survivorship indicate that the potential for continued population growth exists at Edgewood Park (USFWS, 1998).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Serpentine grasslands, vernal pools (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 300 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (inferred from USFWS, 1998)

Habitat Narrative

Adult: Serpentine grasslands with heavy clay inclusions in the rocky serpentine soil. Reported from grassy slopes, and from shallow depressions and vernal pools at < 300 m elevation (NatureServe, 2015). The specific soil habitat in which Acanthomintha obovata ssp. duttonii occurs is apparently extremely limited (N. McCarten, in /itt., 1998). The deep clay soils appear to have a low calcium/magnesium ratio (due to low levels of calcium along with high levels ofmagnesium), high percent moisture (with a broad range between field capacity and permanent wilting point), and high cation exchange capacity (McCarten I 986a) (USFWS, 1998).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 1998)

Dispersal/Migration Narrative

Adult: In 1992, the population expanded downslope by approximately 4.4 meters(14.5 feet), perhaps due to nutlets being carried by storm runoff to the unoccupied area (USFWS, 1998).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Declining (USFWS, 2010)

Number of Populations:

6 (USFWS, 2021)

Population Size:

~43,000 (USFWS, 2021)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

The area which supported 395 in 2009 only supported 250 in 2010 (C. Niederer pers. comm., July 21, 2010) indicating that the species is continuing to decline. A. obovata ssp. duttonii plants currentlyoccur in about 0.05 acres (USFWS, 2010). Since the last status review, a reseeding and habitat management project, begun in 2008, has resulted in a total of six currently extant occurrences (Niederer and Schwind 2020, p. 2). An occurrence is a group of plants separated by at least 0.25 miles from other such groups (CDFW 2020, p. 10). We consider this amount of spatial separation sufficient to prevent most genetic interchange between occurrences, and so consider each occurrence to qualify as a separate population for purposes of meeting recovery goals (Service 2019, p. 18). The six occurrences include five locations in Edgewood Park (the Original Site, Switchbacks, North Hill, Butterfly, and Harrier Hollow), and one site just north of Edgewood Park, in Pulgas Ridge (Niederer and Schwind 2020, pp. 2, 3, 6). In total, the six sites produced about 43,000 plants in 2020, and covered a total area of about 540 square (sq) meters (Niederer and Schwind 2020, p. 2). Currently, three thornmint populations (Switchbacks, North Hill, and Butterfly) have at least 5,000 individuals (Niederer and Schwind 2020, pp. 12–13). The Original, Pulgas Ridge, and Harrier Hollow populations have roughly 900, 4,200, and 1,600 individuals, respectively. All of the current thornmint populations except for the Original Site and Pulgas Ridge are stable or increasing (Niederer and Schwind 2020, pp. 12–13). The Pulgas Ridge site was first seeded in 2018 and has fluctuated from 2,075 to 6,856 plants prior to this year's total of 4,200. Seeding at the Original Site began in 2009, but despite additional seedings in 2010, and 2014–2016, total numbers have fluctuated unpredictably since 2007 without ever reaching higher than 3,450 (Niederer and Schwind 2020, pp. 12, 17). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat degrdation and curatilment (USFWS, 2010)
Exposure:

Response:
Consequence:
Narrative: Pavlik and Espeland (1998) documented a shift in the plant's distribution downslope at the Edgewood Park occurrence as the result of an intense winter storm that caused soil erosion. Acanthomintha obovata ssp. duttonii seed moved downslope into an area that had not previously supported the plant. The occurrence is now found within about 10 meters of the lower edge of its potential habitat, with little room to continue dispersing downhill. Many plants are within one meter of the lateral edge of the habitat (Niederer et al., 2010). The occurrence is bound on all sides by barriers of either inappropriate habitat or urban development; to the north and west are woodlands, to the east is a rocky, upland slope and to the south is a road and housing (C. Niederer, pers. comm., July 21, 2010) (USFWS, 2010).

Stressor: Population size (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The species is still represented by a single, small occurrence which is downslope of a development. The low numbers of plants continues to threaten the species with genetic depletion and reduced reproductive potential. Additionally, this occurrence which is small in area and in numbers of plants is readily threatened by stochastic events such as fire, erosion from flooding, herbivory, and disease (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Climate is predicted to change in California during the 21st century (Field et al. 1999; Cayan et al. 2005). The effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species (USFWS, 2010).

Stressor: Competition and moisture (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Germination trials at the UC Berkeley Botanical Garden, where San Mateo thornmint was successfully grown in different soil types, point to competition (from invasive nonnative plants and thatch) and moisture as the most important factors limiting wild San Mateo thornmint to serpentine vertisol (Niederer et al. 2010). Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine, facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors. (USFWS, 2019)

Stressor: Parasitic plants (USFWS, 2019)
Exposure:
Response:

Consequence:
Narrative: A serious threat that has arisen in recent years is dodder (Cuscuta californica). Dodder is a native parasitic plant that is parasitizing San Mateo thornmint, and other species, at Edgewood Park (Niederer and Weiss 2018). (USFWS, 2019)

Stressor: Seed loss / mortality (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Seed loss/mortality from falling into deep vertisol cracks (one year estimated to be 24% seed loss; Niederer and Weiss 2018) is likely a natural stressor for serpentine vertisol plants (Niederer et al. 2010, Pavlik and Espeland 1998). However, this reproductive loss may be exacerbated by other threatening conditions such as low production years, drought (more cracking), and heavy rain (more surface seeds wash into cracks and/or into unsuitable habitat). Seed loss may also increase with erosion, altered hydrology, and the effects of climate change (e.g. weather events, seed bank response to temperature and moisture changes). Significant seed loss could also play a role in creating negative feedback loops in declining populations, which would accelerate population declines, extirpations, and losses in genetic diversity. (USFWS, 2019)

Recovery

Reclassification Criteria:
A/1: A minimum of five populations6,7 of San Mateo thornmint are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area should include occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the populations described in A/1 and any adjacent areas identified as essential to continued survival. The plans must include provisions for standardized annual monitoring of populations. (USFWS, 2019)

E/1: Each population described in A/1 contains a minimum of 5,000 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

E/2: Each population described in A/1 has numbers of individuals that exhibit a stable or increasing trend over a period of 20 years that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

E/3: Impacts from competing nonnative species are managed so they do not p (USFWS, 2019)ose a threat to the persistence of any of the San Mateo thornmint populations described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 10 years12 in order to ensure seed viability. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of ten self-sustaining populations of San Mateo thornmint are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. Additional populations should be protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the populations described in A/1 are protected from incompatible uses. (USFWS, 2019)

A/3: The populations described in A/1 each contain a minimum of 100 square meters (1076 square feet) that are occupied by San Mateo thornmint. (USFWS, 2019)

C/1: Negative effects from dodder infestations to the populations described in A/1 are absent or below a level at which a population viability analysis indicates that dodder is negatively affecting long-term persistence. (USFWS, 2019)

C/2: Long-term management of dodder is both practically and financially sustainable. Financial resources for control of present and potential future dodder infestations are secured. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years that include two normal precipitation cycles, each of the populations described in A/1 exhibits a stable or increasing population trend with a rolling average of at least 50,000 individuals. During low-density years (presumably from natural population fluctuations), the populations described in A/1 must contain a minimum of 6,700 individuals and densities do not fall below 160 per square meter for two or more consecutive years. (USFWS, 2019)

E/3: The populations described in A/1 occupy habitats that sustain a minimum cover of 20% bare ground and a maximum cover of 30% nonnatives (live and thatch). (USFWS, 2019)

E/4: Long-term management to maintain the conditions described in criterion E/3 is both practically and financially sustainable. Active management is not required more frequently than once every 5 years. Financial resources for long-term habitat management are secured. (USFWS, 2019)

Recovery Actions:

- 1. Protect San Mateo thornmint habitat and establish new populations. 1.1. Identify serpentine vertisol and protect potential introduction sites. (Priority 1). 1.2. Develop, or continue the existing, seed increase program. (Priority 1). 1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous sites should be seeded to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 1). (USFWS, 2019)

- 2. Research San Mateo thornmint life history and conservation strategies. 2.1. Research and develop methods of dodder control that are effective and efficient for San Mateo thornmint populations. (Priority 2). 2.2. Research optimal habitat characteristics, mechanisms of dispersal, and potential impacts from climate change. (Priority 2). 2.3. Study the demography, reproductive biology, and genetic structure of populations. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage San Mateo thornmint populations. 3.1. Implement site-specific management plans for San Mateo thornmint and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). . Best habitat management practices may include complete eradication of nonnative species and restoration of native serpentine plant communities. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the San Mateo thornmint. Some of these recommendations have already been discussed in our previous status review (Service 2010, p. 28): 1. Continue to support the conservation work carried out by Creekside Science to establish new populations, increase the extent of existing populations, and manage the species habitat where those populations are found. 2. Conduct surveys at known occurrences at least every five years to determine population trends, habitat changes, and potential for reintroduction of extirpated sites. 3. Continue to search for suitable locations for outplanting, using habitat preference data by Niederer et al. (2010, appendix 1). 4. Work with partners to establish new populations, using (as appropriate) the adaptive management plan provided by Niederer et al. (2010, pp. 12–26). 5. Seek additional information on identity and importance of pollinators, and incorporate habitat management practices beneficial to such pollinators, as needed. Current information is that pollinators include common native bees and that San Mateo thornmint is largely selfpollinating (Niederer et al. 2010, p. 20). 6. In order to reflect the most current understanding of the species taxonomy, the name should be formally changed in the Code of Federal Regulations from Acanthomintha obovata ssp. duttonii to Acanthomintha duttonii. 7. Determine whether hydrological changes affecting the Original Site can be mitigated by introducing topological changes to improve water flow. (USFWS, 2021)

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SPECIES ACCOUNT: *Aconitum noveboracense* (Northern wild monkshood)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/27/1978; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

Species of the genus Aconitum have showy, zygomorphic flowers that are adapted for pollination by bumblebees, and it is from this hood-shaped flower that the genus derives is common name. Besides the diagnostic flower shape, monkshoods in general are perennial herbs arising from short tuberous roots, with basal and cauline leaves that are palmately cleft or dissected, and with usually blue to whitish flowers that are borne in a terminal raceme or panicle. (USFWS, 1983). The northern wild monkshood is an erect to reclining or climbing perennial herb with stems up to 2.5 m long. Small clusters of pale to dark blue or white flowers bloom in July and August. (NatureServe, 2015)

Taxonomy

The genus Aconitum, known generally worldwide as monkshood, is a highly specialized and widely distributed group of species in the Ranunculaceae, the crowfoot or buttercup family. Aconitum noveborancense was described as a species by Harvard botanist Asa Gray in 1886 from material collected by F. V. Coville in Chenango County, New York. Early collections of northern monkshood from native habitats before and after 1886 in New York, Ohio, Wisconsin and Iowa were often mis-identified as Aconitum napellus L. (the common European monkshood) or Aconitum uncinatum L. (the mainly Appalachian species ranging as far north as southern Pennsylvania). (USFWS, 1983)

Historical Range

This species ranges over nearly half the continent, from northeastern Iowa and southwestern Wisconsin to northeastern Ohio and the Catskill Mountains of New York. (USFWS, 1983)

Current Range

This species is restricted to 20 currently extant sites in three distinct regions: in and adjacent to the unglaciated (Wisconsin epoch) portion of Iowa and Wisconsin, the northeastern Ohio glaciated area and the Catskill Mountains of New York (glaciated area). (USFWS, 1983)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and vegetative (NatureServe, 2015)

Breeding Season

Adult: Flowers from June until August (NatureServe, 2015)

Reproduction Narrative

Adult: The showy, zygomorphic flowers are adapted for pollination by bumblebees; seeds are probably dispersed by water. In sexual reproduction, the northern monkshood produces flowers from June until August and produces 30-45 seeds from each flower. In vegetative reproduction, 'daughter' ramets or stems can grow out of parent tubers and this is the main form of vegetative reproduction; bulbils may be formed in some populations at the leaf axes. These bulbils can produce tubers and apical meristems. This species over winters as a tuber (Mabry et al. 2009). (NatureServe, 2015)

Habitat Type

Adult: Algific talus slopes (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock cliff bases (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist cold air flow (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1978)

Environmental Specificity

Adult: Very narrow; key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The typical habitat for northern wild monkshood over much of its range is shaded to partially shaded cliffs and talus slopes. In New York, in addition to these more typical habitats, northern wild monkshood also occurs in semi-shaded seepage springs at high elevation headwaters and in stream-side crevices downstream (USFWS, 1983).

Dispersal/Migration

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Dispersal of the species is very limited by lack of environments with cold flowing air. (NatureServe, 2015)

Population Information and Trends

Population Trends:
Variable (NatureServe, 2015)

Species Trends:
Variable to declining (NatureServe, 2015

Population Growth Rate:
Variable, but generally slow (inferred from NatureServe, 2015)

Number of Populations:
81 - 300 (NatureServe, 2015)

Population Size:
2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:
Very sensitive to disturbance (NatureServe, 2015)

Population Narrative:
The monkshood is very sensitive to disturbance, generally slow-growing and not very viable when transplanted. The largest populations are found in Iowa (one population is estimated at 10,000 individuals); population sizes are smaller in Wisconsin, ranging from 65 to 1,000 individuals; two small populations (ca. 100 individuals) are found in Ohio; in New York population sizes range from < 10 to ca. 1,000 individuals. (Hanowski, 1983 (updated 1986)). There are 84 sites known in Iowa, 19 in Wisconsin, 3 in Ohio and 11 in New York. There may only be two sites of this species left in Ohio. In 2006 the habitat of one of the sites was dramatically altered and only one plant was found, this being a large decline from the nearly 100 plants found at this site in the late 1980s (Ohio Natural Heritage Program 2007). The species may decline in one year and recover in another year, probably as related to drought. (NatureServe, 2015)

Threats and Stressors

Stressor: Dams and reservoirs (USFWS, 1983)
Exposure:
Response:
Consequence:
Narrative: The proximity of monkshood cliffs to water courses has sometimes put monkshood close to dams and their resultant reservoirs. In certain cases, the pre-existing condition of the reservoir basin as monkshood habitat is not known, so it is speculative to guess whether the reservoir did in fact inundate monkshood. However, the occurrence of reservoirs downstream from monkshood habitats does curtail seed dispersal via flowing water. Such is the case in one New York habitat (Peekamoose), and was historically the case in two Wisconsin sites (Loddes Mill Bluff and Parfreys Glen) where mill ponds (now defunct) may have impacted the monkshood population nearby. (USFWS, 1983)

Stressor: Road and powerline construction and maintenance (USFWS, 1983)

Exposure:
Response:
Consequence:
Narrative: On a number of occasions, road construction and maintenance activities have been implicated in threatening northern monkshood populations. Excessive use of deicing agents in winter and herbicides in summer are potential problems for one site in Iowa (Elkader), one site in New York (Peekamoose), and possibly one site in Ohio (Akron). Road construction impacts on a small northern monkshood population were avoided during a state highway upgrading in 1978-79 near Elkader, Iowa. By a short narrowing of the paved shoulder in a road-cut containing this species, the rather anomalous habitat was spared. The only other northern monkshood population which may be affected by existing road maintenance activities is at the Peekamoose, New York, site where the roadside ravine habitat has been infringed upon in places by the placement of riprap in the right-of-way to stabilize the roadbed. Unless this practice is continued in other places along the stream and right-of-way, the habitat damage has been done already and no further infringement is expected. - Iowa, has been crossed by two power line corridors which have destroyed habitat by clearing and maintenance activities. The main threat from in-place corridors is further habitat degradation from maintenance activities, especially herbicide drift from aerially dispersed weed retardants. (USFWS, 1983)

Stressor: Logging operations (Read and Hale, 1983)
Exposure:
Response:
Consequence:
Narrative: All northern monkshood habitats are in wooded situations, and some of these sites may be subject to periodic logging operations. Destruction of the habitat may not be due only to logging machinery and skidding of logs, but also to modification of requisite light conditions caused by the removal of shade trees. Logging is difficult to accomplish in certain habitats due to steepness of slopes and inaccessibility, but woodland spring and streamside populations in New York's Catskill Mountains have been subject to logging in the past. Recent logging of canopy trees on one slope of the Chase Creek, Wisconsin, site has skirted the edge of the algific slope containing a major monkshood population. Certain habitats in Iowa and Wisconsin are subject not only to logging for commercial harvest, but they may be cleared of trees by girdling, cutting, and burning to create pasture on the otherwise non-productive farmland. (USFWS, 1983)

Stressor: Quarrying operations (USFWS, 1983)
Exposure:
Response:
Consequence:
Narrative: The association of northern monkshood with cliffs and talus slopes sometimes makes the species susceptible to damage from quarrying. Such has been the case in the past at the Loddes Mill Bluff (Wisconsin) and Elkader (Iowa) locations. It is difficult to assess how much of the original populations were affected by the quarrying (if any), but their close proximity to the quarries indicates that there may have been impacts. (USFWS, 1983)

Stressor: Grazing and browsing (USFWS, 1983)
Exposure:
Response:
Consequence:

Narrative: Browsing by a number of animals, most commonly cattle and white-tailed deer, has been a problem at a number of sites, most notably at the Maquoketa and Pine Creek (Iowa) locations (accessible to cattle), Coon Valley and Chase Creek (Wisconsin) populations (cattle grazing), and the Akron (Ohio) site (white-tailed deer browsing). Before Federal acquisition, much of the Kickapoo River Valley (Wisconsin) population was accessible to cattle grazing. The major threats to a northern monkshood population caused by grazing animals are weakening of the plants by loss of their photosynthetic organs, loss of reproductive potential when flowers or fruits are consumed, and trampling of the plants, especially when grazing animals are at high density and the site is used as a pathway, resting place, or wallow. (USFWS, 1983)

Stressor: Developments (USFWS, 1983)
Exposure:
Response:
Consequence:
Narrative: Two types of developments have been noted to affect existing northern monkshood populations. Foot trail developments have affected or have the potential for affecting populations at Parfreys Glen (Wisconsin) and Beaverbrook (New York). At the former site, over 10,000 visitors pass through the scenic glen each year, creating a muddy path at the base of the cliff where northern monkshood occurs. No northern monkshood reproduction can be expected to take place at the cliff base due to the amount of foot traffic. At the Beaverbrook, New York, site a state trail crosses within a few meters of the monkshood population, and should this trail be redirected or expanded from its present course, a portion of the population could be adversely affected. Low density foot traffic occurs at the base of other cliffs containing northern monkshood (Bixby Park, Iowa; Nelson, Ohio; Akron, Ohio; Loddes Mill Bluff, Wisconsin; some of the Kickapoo, Wisconsin cliffs) but the level of traffic on these volunteer trails does not pose a threat to the species presently. The other type of development having negative impact implications for northern monkshood is residential and urban development. Since most of the known populations of the species are in rural locations, urban/residential development poses a problem in only a few cases. The Akron, Ohio, site is in an urban setting and the small Nelson, Ohio, population is within a few hundred meters of surburban houses. It is reported, too, that the Chenango County, New York, site(s) is in a developed area, a factor which may have contributed to its presumed extirpation. While such developments may not be directly placed on northern monkshood locations, the probability of various harmful activities increases with increased human presence, be it higher coincidental visitation, vandalism, or accidents. Also, higher land costs, taxes, and complex ownership patterns make preservation more difficult to accomplish in surburban and urban environments. (USFWS, 1983)

Stressor: Scientific overcollection and visitation (USFWS, 1983)
Exposure:
Response:
Consequence:
Narrative: Over the course of several generations, scientific curiosity about a rare species may contribute to its demise, caused by too many people visiting the site (sometimes resulting in habitat degradation) and overcollecting (resulting in population depletion). This problem is suggested in the case of northern monkshood by the collection of plants from the small Parfreys Glen (Wisconsin) population on at least nine independent occasions in less than 45 years. Collectors often gather more than one plant so that duplicates can be distributed to the herbarium collections at various institutions. Together with collections housed in herbaria not

seen in the preparation of this recovery report, total scientific collections from the Parfreys Glen site may account for a significant portion of the population remaining today in the glen. Scientific collecting was also mentioned as a threat to the Akron, Ohio, population by its property manager. He cited the time a few years ago when he led a professional botanist to the site, only to have him collect 25 specimens for comparative intra-population variation studies back in his lab. The property manager is now very wary of leading other biologists to the site. The high scientific and public interest in endangered and threatened species also poses a threat to the species' welfare in some instances. With even a small number of visitations to certain northern monkshood sites each year, trampling of plants and surrounding vegetation, compaction of soil, and destruction of vulnerable spring seeps can become a problem. This has been true with habitats visited periodically in the course of these studies, and foot damage to a steep-slope habitat was noted at one other northern monkshood site in Iowa where the ecology of another rare cliff plant was being studied. The small number of northern monkshood populations, the fragile nature of many of their habitats, and the large number of people who would like to study, collect, photograph, or simply observe this rare plant make it susceptible to being "loved to death." (USFWS, 1983)

Stressor: Natural catastrophes (USFWS, 1983)
Exposure:
Response:
Consequence:
Narrative: There are a number of natural events and factors which can adversely affect a population of monkshood. Such factors which were observed over the last six years with northern monkshood are drought, flooding, cliff failure, disease, and predation. With the exception of cliff failure, northern monkshood populations seem to be able to rebound from these events, with only limited mortality or more often only a weakening or death of the present year's growth. Unless a particular monkshood population is subjected to a single or combination of damaging events over a sustained period of years, it is unlikely that any northern monkshood population will be lost due to the natural catastrophies to which the species was subjected periodically in its evolution. Failure of the cliff face on which or over which the northern monkshood occurs is the one natural event which could almost totally eliminate a known population. All but three plants at the Nelson, Ohio, site are located in a small patch no larger than nine square feet in area, and are located at the base of a slightly overhanging cliff. Nearby, cliff failure has taken place, resulting in a rubble pile at the base of the cliff. Should failure occur in the cliff face above this small monkshood population, it would probably be lost. (USFWS, 1983)

Stressor: Invasive plants (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Garlic mustard (Alliaria petiolate), and invasive plant, may invade and outcompete the monkshood. (NatureServe, 2015)

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
Not defined. (USFWS, 1983)

Recovery Actions:

- Secure some level of protection for all known habitats. This may be accomplished by a variety of means, such as fee acquisition, easement, preserve designation, or simple landowner contact. The lead agency and type of preferable protective measure must be considered for site-by-site conditions, such as degree of threat, ability for adequate management by acquiring agency, need for controlled access, etc. (USFWS, 1983)
- Continue research on the propagation of northern monkshood under greenhouse and garden conditions. The goal of this research should be the production under controlled conditions of northern monkshood from seed to the survival of first generation plants through seed production. This would supply a demand for seed by horticulturists and the establishment of experimental colonies on which to develop management techniques, and enhance life history knowledge. (USFWS, 1983)
- Taxonomic studies are needed to solve the dispute over the specific validity of noveboracense. (USFWS, 1983)
- Conduct life history research on northern monkshood in native habitats to determine such factors as breeding (pollination) systems, dispersal mechanisms, predation, juvenile mortality, adult longevity, and habitat requisites. (USFWS, 1983)
- Initiate northern monkshood population monitoring effort in each state, with the goal of an early warning system to indicate population declines, threats, and land use or ownership changes. (USFWS, 1983)
- Resolve La Farge Reservoir Flood Control Project issue in Wisconsin. The completion of this flood control project along the Kickapoo River, in any one of its several alternatives, poses the single largest threat to northern monkshood numbers anywhere. The project was halted in 1977 due to the projection of poor water quality in its conservation reservoir, lack of flood control for an adequate distance downstream, and impacts to the scenic valley and its biota. Despite these problems, the projects may be reactivated unless it is deauthorized by Congress. It would be prudent to have the issue of the La Farge Reservoir resolved. (USFWS, 1983)
- Revise New York Endangered Species Law to include protection of northern monkshood. (USFWS, 1983)
- Complete field surveys for additional northern monkshood habitats. It is probable that all northern monkshood locations have not yet been found. State surveys to search for additional northern Monkshood populations should be initiated or completed. Exhaustive searches should also be made of old, as yet unverified sites. (USFWS, 1983)
- Pursue acquisition of properties that are found to be available on a willing-seller basis. The goal of this activity is to prepare an acquisition plan for all properties found to be available as a result of landowner contacts. (USFWS, 1983)
- Pursue land-use zoning and/or nature preserve designation where appropriate to the enhancement of habitat protection. The goal of this task is an analysis of zoning or designation categories that would be compatible with a particular population's preservation. Evaluation of zoning should be especially stressed on state, city and federal properties where master planning can often put sensitive areas into protective categories without divulging the identity of the specific resource being protected. (USFWS, 1983)

- Initiate an educational effort with the scientific community, requesting their cooperation in not collecting or conducting student field trips at northern monkshood populations. The goal of this activity is to heighten the scientific community's awareness of the damaging results of overcollecting and trampling, and how they can participate in recovery activities. (USFWS, 1983)
- Implement most important management activities. (USFWS, 1983)
- Conduct a research program to develop tissue culture techniques for the propagation of northern monkshood. This activity is not recommended at this time because northern monkshood population levels are not critically low enough to warrant such research. The creation of genetic clones is not conducive to maintenance of genetic diversity now existing in out-crossing, native populations. Research aimed at growth of northern monkshood through seeds--which most plants produce copious numbers-- should have a higher research priority, however, if population size drops to a critical level tissue culture would be the last chance for survival. (USFWS, 1983)
- Strengthening protection laws for plant species at the state and federal level. It may be argued that legislative protection for endangered species has reached a plateau, based on several years of experience with existing laws. Constitutional restraints, regularity backlash, and enforcement limitations may have determined the limits of further legislative initiatives toward protection of endangered and threatened plants. The present level of recognition of endangered resource conservation may be adequate to be effective for plants in most cases. The one exception for the need of further legislation is in the state of New York, where northern monkshood (as well as other biologically endangered and threatened state species) should be added to the statutorily protected list of plants. (USFWS, 1983)
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SPECIES ACCOUNT: *Aeschynomene virginica* (Sensitive joint-vetch)

Species Taxonomic and Listing Information

Commonly-used Acronym: SJV

Listing Status: Threatened; 5/20/1992; Northeast Region (R5) (USFWS, 2016)

Physical Description

A robust annual legume that typically attains a height of 1.0-2.0 m in a single growing season, although it may grow as tall as 2.4 m. The stems are single, sometimes branching near the top, with stiff or bristly hairs. The leaves are even-pinnate, 2.0-12.0 cm long, with entire, gland-dotted leaflets. Each leaf consists of 30-56 leaflets. Leaflets are 0.8-2.5 cm long and 0.2-0.4 cm wide. The leaves fold slightly when touched. Pedicles are 3.0-8.0 mm long, bearing toothed bractlets about 4.0 mm long and 2.0-3.0 mm wide immediately below the flowers. The yellow, irregular, legume-type flowers are 1 .0-1 .5 cm across, streaked with red, and grow in racemes 2.0-6.0 cm long. The flowers have uniformly shaped anthers. The fruit is a loment with 4-10 one-seeded segments, the lowest 5.0-7.0 mm wide, turning dark brown when ripe. Fruits are 3.0-7.0 cm long, on a stipe 10.0-25.0 mm in length, and shallowly scalloped along one side (USFWS, 1995).

Taxonomy

In the pea family, Fabaceae (USFWS, 1995)

Historical Range

Tidal marshes of New Jersey, Pennsylvania, Delaware, Maryland, and Virginia, and ditches and agricultural fields in North Carolina (USFWS, 2013).

Current Range

Current range includes New Jersey, Maryland, Virginia, North Carolina. Delaware and Pennsylvania occurrences have not been observed since the 1800s (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (USFWS, 2019)

Breeding Season

Adult: Germination begins late May to early June; flowers from July to September; fruits are produced simultaneously from July to late October (NatureServe, 2015).

Key Resources Needed for Breeding

Adult: Small bumblebees, some self-pollination (EPA, 2016)

Reproduction Narrative

Adult: Plants flower from July through September and occasionally into October. In autumn, senescence may be triggered by the drop in water temperature or by salinity intrusion due to a decrease in freshwater flow. Bumblebees have been observed pollinating the flowers. Fruits form shortly after the first signs of flowering in July. Although flowering continues until late fall, production of vigorous fruits appears to decline significantly by mid-October. Seed maturation begins in August and continues through October. Germination takes place from late May to early June. Seedlings grow quickly, approximately doubling in size every 2 weeks during the first 6 weeks (USFWS, 2019).

Habitat Vegetation or Surface Water Classification

Adult: Fresh to slightly brackish tidal river shores and estuarine-river marsh borders (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Majority are found in natural tidal marsh habitats, but also a few documented cases of a pocket marsh wetland, edge of a moist soybean field, and a mowed grassy strip between a manmade drainage channel and dirt road (EPA, 2016). Usually grows within 2 m of low water mark on raised banks in peaty, sandy or gravelly substrates. Salinity of one site in New Jersey ranges from 0.7 to 0.8 ppt with an average pH of 4.4. In North Carolina, A. virginica has been found in a few ditches and wet fields, but these are not considered stable populations. Associated species include Zizania aquatica, Petlandra virginica, Pontederia cordata, Bidens laevis, Polygonum arifolium, P. saggitatum, and Leersia oryzoides (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Number of Populations:

Approximately 20 (NatureServe, 2015)

Population Size:

Approximately 7000 individuals (NatureServe, 2015)

Adaptability:

Sensitive to water pollution and marsh drainage; difficulty in controlling headwater pollution (NatureServe, 2015)

Population Narrative:

Species shows considerable annual fluctuations in population numbers. Over 3 years one population varied from approximately 50 to 2,000 individuals. Long-term trend is a decline of 50-70%; short-term trend is a decline of 10 - 30%. Many populations are no longer extant, or have not been relocated recently. New Jersey: 2,000 +/- 50; Maryland: several hundred individuals; Virginia: ca. 5,000 plants; North Carolina; all populations unstable in ditches. About twenty recently documented occurrences. New Jersey: 2 occurrences; Maryland: 5 occurrences; Virginia: 12 occurrences; North Carolina: 1 marginal occurrence (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Aeschynomene virginica is susceptible to population and habitat destruction or degradation from a wide variety of anthropogenic sources, including: sedimentation, competition from exotic plant species, dams, dredging and filling activities, boating activities, shoreline stabilization and structural development, road and bridge construction, commercial and residential development, water withdrawal projects, changes in water quality, agricultural practices, introduced pest species, mining, timber harvest, over-visitation to sensitive joint-vetch sites, declines in muskrat populations, sea level changes (possibly in conjunction with natural cycles), plant collection (USFWS, 1995).

Stressor: Natural disturbances (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Natural threats are often identified with disturbances, such as wave and ice action associated with severe storm events, competition, channel migration, sea level rise, and natural sedimentation processes. Healthy metapopulations of the sensitive joint-vetch are adapted to these stresses, and in some cases dependent upon them over time. Certain subpopulations may be locally extirpated, but others are able to establish and reproduce in newly opened habitat patches if seed viability and mobility are good and the frequency of disturbance events allows for biotic responses. Small populations are more vulnerable to these stresses than larger populations, especially if the disturbance event occurs during the growing season and plants are unable to compensate for high mortality rates within a particular year class. Severe hurricanes along the mid-Atlantic coast have the potential to temporarily or permanently destroy A. virginica habitat (USFWS, 1995).

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
1. The sensitive joint-vetch and the ecosystems upon which it depends are adequately protected within the following six watersheds: Manokin Creek in Maryland; Manumuskin River in New

Jersey; and Rappahannock, Pamunkey, Mattaponi, and Chickahominy Rivers in Virginia (USFWS, 1995).

2. Annual monitoring over a 10-year period shows that the populations in these six river systems are stable or expanding (USFWS, 1995).

3. Life history and ecological requirements of the species are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 1995).

Recovery Actions:

- Maintain the integrity of the tidal wetland systems upon which the sensitive joint-vetch depends (USFWS, 1995)
- Protect extant sensitive joint-vetch populations and sites (USFWS, 1995).
- Survey for additional populations (USFWS, 1995).
- Establish monitoring priorities, develop reliable monitoring techniques, and monitor populations accordingly (USFWS, 1995).
- Determine the ecological and distributional characteristics and requirements of the sensitive joint-vetch (USFWS, 1995).
- Develop an informational brochure on the importance of the sensitive joint-vetch and the tidal wetlands upon which it depends (USFWS< 1995).
- More consistent monitoring of all of the Virginia occurrences is needed to confirm the population trends in the portion of its range that has the greatest number of extant occurrences/subpopulations. This monitoring can also serve to detect current threats and identify areas where management actions such as Phragmites control may be needed in Virginia (USFWS, 2013).
- A review of the monitoring methodologies being used across the range of this species should be conducted with the purpose of increasing standardization. Monitoring protocols likely vary across the species range. Although long-standing monitoring programs may not want to abandon established methodology for fear of making their year-to-year data less comparable, a review could highlight where changes might be made and lead to increased standardization and therefore more comparable data rangewide (USFWS, 2013).
- Conduct genetic research to ensure that seeds representing the genetic diversity of SJV are in the collection of the National Center for Genetic Resources Preservation (Formerly National Seed Storage Laboratory) in Fort Collins, Colorado (USFWS, 2013).
- Investigations should continue into the effects of invasive plants such as Murdannia keisak and the introduced insect species, tobacco budworm (Heliothis virescens) and corn earworm (Helicoverpa zea) on SJV (USFWS, 2013).
- The role of muskrats in creating and maintaining SJV habitat needs to be investigated (USFWS, 2013).
- Consideration should be given to what role proactive measures such as habitat management, seed additions, and introductions in upstream habitat should play in a long term management strategy for SJV in light of dwindling populations in parts of its range, the serious threat from sea level rise, and questions about the ability of this species to migrate to upstream habitat. Recent publications mention the use of vegetation management and seed additions for the conservation and management of SJV or recommend directing research efforts to introducing the species into new upstream sites. Guidelines should be developed in case more aggressive management strategies are warranted (USFWS, 2013).

- Surveys should be conducted in potential habitat throughout the range of the species (USFWS, 2013).
- Revise the recovery plan to update information and to consider the incorporation of the James River Basin in the Recovery Criteria (USFWS, 2013).

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SPECIES ACCOUNT: *Agalinis acuta* (Sandplain gerardia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/7/1988; Northeast Region (R5) (USFWS, 2016)

Physical Description

The sandplain gerardia is an annual light-green herb from 4 to 8 inches (1 to 2 decimeters) and occasionally up to 16 inches (four decimeters) tall. The stem is weakly angular and has few branches. The leaves are opposite, linear, and up to 1 inch (2.5 centimeters) long. The pink-purple, bell-shaped flowers appear from late August through September, are 0.4—0.5 inches (1 to 1.3 centimeters) long, and have two yellow lines and red or purple spots in the corolla throat. The corolla lobes are slightly notched at the tip. (USFWS, 1988)

Taxonomy

The sandplain gerardia is in the snapdragon family (Scrophulariaceae). (USFWS, 1988) In a 2019 document, the Service summarized more than 10 years of research and associated discourse regarding the phylogenetic studies that inform the Service's consideration of the taxonomic status of A. acuta. Based on a detailed review of all the available scientific and commercial information, it was concluded that "the taxonomic entity known as A. acuta is not a distinct species (Neel and Pettengill 2009; Pettengill 2010; Pettengill and Neel 2011; Hays pers. comm. 2018a, 2018b). The Service therefore concurs with the taxonomic revision recommended by Pettengill and Neel (2011) and the FNA synonymizing A. acuta under A.decemloba." (USFWS, 2019)

Historical Range

See current range/distribution.

Current Range

In 2017, known populations were present in the states of Connecticut, Rhode Island, Massachusetts, Maryland, and New York. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: < 1 year (inferred from USFWS, 1989)

Dependency on Other Individuals or Species

Adult: Insects for pollination (EPA, 2016)

Breeding Season

Adult: Flowers from mid-August to mid-October (USFWS, 1989)

Reproduction Narrative

Adult: Flowers from mid-August to mid-October. Life span is less than 1 year (USFWS, 1989).

Habitat Type

Adult: Terrestrial (USFWS, 1989)

Habitat Vegetation or Surface Water Classification

Adult: Dry, sandy, poor-nutrient soils of sparsely vegetated sandplain environments and serpentine barrens (USFWS, 1989)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: This species typically occurs on dry, sandy, poor-nutrient soils of sparsely vegetated sandplain environments and serpentine barrens, whose harshness may eliminate potentially competitive species (USFWS, 1989). It is dependent on periodic disturbance that maintains an open habitat. The soils are nutrient-poor, usually acidic, and excessively drained. An underlying factor common to all sites is the lack of competition from other species - a factor imposed by conditions that include extremely nutrient-poor, and sometimes minerally toxic, soils and regular or sporadic disturbance. Fire has played a role in maintaining open habitat at a number of Agalinis acuta sites (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal is possibly by wind or small animals (USFWS, 1989). If wind dispersed, seeds are not likely to travel far. Some dispersal may occur through ingestion by small animals such as meadow voles or cottontail rabbits (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Increase of > 10% (NatureServe, 2015)

Number of Populations:

22 - 23 (NatureServe, 2015)

Population Size:

100,000 - 1,000,000 individuals (NatureServe, 2015)

Population Narrative:

While there are about 6 sites with reasonably large, stable, well managed populations, few have good viability/integrity. "Large" represents a population that has maintained an average of 3000+ individuals over the past 5 years. Many populations are still very small or occur on

marginal habitat such as small expanses of grassland surrounded by development or unsuitably dense vegetation (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification, or absence of disturbance within habitat (USFWS, 1989)
Exposure:
Response:
Consequence:
Narrative: The most significant threat to A. acuta is the direct loss or degradation of its habitat. Residential, commercial, and recreational development has encroached on the species community. Shopping malls, condominiums and expanding highway systems have taken the place of much of the species natural habitat. Agricultural development and sand and gravel mining have destroyed large amounts of potential habitat (USFWS, 1989). The loss of grazing animals and the suppression of fires have allowed woody vegetation to claim many of its historical sites (NatureServe, 2015).

Stressor: Other factors with the potential to affect the species (USFWS, 1989)
Exposure:
Response:
Consequence:
Narrative: Due to the relatively small population size of extant occurrences, It is likely that other factors may have the potential to affect the species. Natural disasters, reproductive failures and other influences on growth, reproduction and distribution have the potential to eliminate a site, if the effects are dramatic enough to prevent the plants from fully recovering (USFWS, 1989).

Recovery

Reclassification Criteria:
1. There are 20 stable, wild populations located throughout the species historic range to ensure against any unpredictable events that could lead to reproductive failure and subsequent population decline. In order to be deemed “stable,” a population must maintain a 5-year running geometric average population size of at least 100 individuals. The geometric average is considered a better indicator of the stability of a population that exhibits wide year-to-year size fluctuations than is the arithmetic average (USFWS, 1989).

2. At least 15 of these populations are located on protected sites. Protection may be accomplished through: 1) ownership by government agency or a private organization that considers maintenance of the A. acute population to be the predominating management objective for the site; or, 2) a deeded easement or covenant that effectively commits present and future landowners to implementing any management activities needed to perpetuate the population. This high level of landowner commitment to site protection is necessary because of the species apparent need for active habitat manipulation to counteract the effects of removing natural sources of disturbance from the plants environment (USFWS, 1989).

3. There must be a proven technology for: 1) propagating the species in a cultivated setting; or, 2) storing seed in a seed bank and successfully sowing then on a wild site (USFWS, 1989).

Delisting Criteria:
Not available.

Recovery Actions:

- Protect known populations (USFWS, 1989).
- Investigate species and habitat characteristics necessary to maintain and establish populations throughout the range of the species (USFWS, 1989).
- Formulate and implement measures to maintain existing sites and locate, establish and maintain new sites (USFWS, 1989).
- Develop technology for cultivating plants and provide for long-term seed storage (USFWS, 1989).
- Periodically review progress towards species recovery and modify elements as appropriate (USFWS, 1989).
- Not available.

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SPECIES ACCOUNT: *Amaranthus pumilus* (Seabeach amaranth)

Species Taxonomic and Listing Information

Listing Status: Threatened; 4/7/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

An annual herb with reddish-colored, prostrate, highly branched stems that form clumps, often reaching 30 cm in diameter. Leaves are spinach-green, clustered towards the tips of the stems. Flowers and fruits are inconspicuous. (NatureServe, 2015)

Historical Range

Formerly occurred from vicinity of Charleston, SC north to islands south of Cape Cod, MA. Actual area formerly occupied was quite small; occurring only in a narrow band of suitable habitat. (NatureServe, 2015)

Current Range

Extant from vicinity of Cape Hatteras, NC, to vicinity of Cape Romain, SC, and at scattered sites on Long Island, NY, and in coastal Delaware, Maryland, Virginia, and New Jersey. (NatureServe, 2015) Populations in the latter four states were not known at the time of listing, but were subsequently rediscovered. (USFWS, 2007)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Annual seed production (USFWS, 1996)

Lifespan

Adult: Less than one year (USFWS, 1996)

Breeding Season

Adult: April to January (USFWS, 1996)

Other Reproductive Information

Adult: Probably wind pollinated (USFWS, 1996)

Reproduction Narrative

Adult: Flowering of the Seabeach Amaranth begins as soon as plants have reached sufficient size, typically commencing in July and continuing until their death in late fall or early winter. Seed production begins in July or August and reaches a peak in most years in September; also continuing until the plant dies. Seeds are regularly produced by nearly all adult plants; fertility is assumed to be high (Baskin and Baskin 1994). The relative roles of the fresh seed crop and banked seeds from previous years are unknown in seabeach amaranth. Weather events

(including rainfall, hurricanes, and temperature extremes) and predation by webworms can significantly reduce the length of the reproductive season. Based on morphology of the flower and inflorescence, seabeach amaranth is probably wind-pollinated, as are most species of amaranth. It is clear that seabeach amaranth is capable of self-pollination, and it is likely that self-pollination plays a large, probably dominant, role in seed production.Seeds may survive many years buried in the sand; they germinate when brought near the surface by severe storms. The seabeach amaranth is a classic example of a fugitive species--"an inferior competitor which is always excluded locally under interspecific competition, but which persists in newly disturbed habitats by virtue of its high dispersal ability; a species of temporary habitats" (Lincoln et al. 1982). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (USFWS, 1996)

Habitat Vegetation or Surface Water Classification

Adult: Sparsely vegetated sand (USFWS, 1996)

Dependencies on Specific Environmental Elements

Adult: Requires tidal overwash (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: Occurs 8 inches to 5 feet above mean high tide. (USFWS, 1996)

Spatial Arrangements of the Population

Adult: Sparse (USFWS, 2007)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1996)

Habitat Narrative

Adult: The species occurs on barrier islands, mainly on coastal overwash flats at the accreting ends of the islands and lower foredunes and on ocean beaches above mean high tide (occasionally on sound-side beaches). It is intolerant of competition, not occurring on well-vegetated sites. According to Weakley and Bucher (1991), this species appears to need extensive, dynamic, natural areas of barrier island beaches and inlets, especially with fresh sand. Within this dynamic landscape, this amaranth functions as a fugitive species, occupying suitable habitat as it becomes available. (NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: Moderate for seeds (USFWS, 2007)

Dispersal

Adult: Moderate for seeds (USFWS, 2007)

Dispersal/Migration Narrative

Adult: Seabeach amaranth produce numerous seeds. Seeds are blown along the surface of the sand to reach new habitat within an island. They also float in water. In addition to being washed inland by waves, the seeds can withstand the conditions necessary to move among islands. It is also likely that they have the ability to persist as seed banks in inlets and possibly offshore (Strand 2002). (USFWS, 2007)

Additional Life History Information

Adult: Seeds may survive many years buried in the sand; they germinate when brought near the surface by severe storms. (USFWS, 2007)

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Species Trends:

Declining (USFWS, 2023)

Number of Populations:

21 - 300 (NatureServe, 2015)

Population Size:

8,164 (latest population/observed number in 2021)

Adaptability:

Low (inferred from USFWS, 2007)

Population Narrative:

Given the fugitive nature of the species and the constantly changing environment where it occurs, it is difficult to make determinations about population size or trends based on limited data from annual surveys which had only been conducted for the last ten years (as of 2007). Northern populations are generally seen as declining, but southern populations fluctuate significantly, which is consistent with its occurrence in a geologically dynamic landscape. Total seabeach amaranth numbers reported in 2005 range-wide surveys were the lowest since 1999. Annual census data indicate up to 100,000 individuals, with up to 300 populations. However, in many cases, groups of existing mapped sites should be lumped to represent single, dynamic populations. Once the occurrences are re-mapped in this fashion, the range-wide number may be on the order of 30-50. (USFWS, 2007; NatureServe, 2015); USFWS provided detailed Census Data on the Seabeach amaranth in the addendum to the 2007 5-year review (USFWS, 2018). The nine historically occupied States identified in the plan are: Delaware (DE), Massachusetts (MA), Maryland (MD), North Carolina (NC), New Jersey (NJ), New York (NY), Rhode Island (RI), South Carolina (SC), and Virginia (VA). These recovery criteria have only been partially met. The natural range of seabeach amaranth includes Atlantic Coast barrier beaches, from Cape Cod, MA south to Charleston, SC, with the exception of CT where no plants have ever been reported (Figure 1.) Natural populations of seabeach amaranth currently persist in five states: NY, NJ, DE, MD and NC. The single population in SC persists mainly due to annual plantings. Seabeach amaranth is an annual species and therefore the number of individual plants observed at a population in any given year fluctuates greatly as the species goes through boom-and-bust

years. Prior to 2000, surveys were inconsistent and focused mainly on NY, NC and SC beaches and total numbers were between 3,000 and 34,000. Since 2000, more consistent range-wide surveys have been conducted in NY, NJ, DE, MD, NC and SC. Limited surveys also occurred in MA and VA following the 2017 reintroductions, but plants have not been found there in recent years. Between 2000 and 2020, the range-wide numbers varied from a high of 249,261 in 2000 to a low of 1,323 in 2013. During the early 2000s (2000-2003), very large populations of seabeach amaranth (~200,000 plants) were found on Long Island, NY. Those numbers dropped off significantly in 2004 (~31,000 plants) and reached their lowest numbers in 2010 and gradually increased from 2014 to 2019. NJ populations reached a low in 2013, the year after hurricane Sandy decimated beaches there and in NY. The numbers in NY and NJ have rebounded some since the 2013. In NC, historically a stronghold for this species, numbers have declined since 2005 with only a few plants found state-wide in recent years. This reduction in resiliency and redundancy may be attributable to shorter hurricane return period in Carolinas compared to NJ and NY (NOAA 2023). The total number of plants, range-wide, is much less than it was in the early 2000s with only 6,964 plants found in 2020. The species was reintroduced to MA and VA in 2017, but those populations have not persisted. Unfortunately, 75% of the sites with suitable habitat within each state have not been occupied by seabeach amaranth for 10 consecutive years. Seabeach amaranth is an annual species and populations fluctuate from year to year. Some populations that occurred in excellent habitat and were considered stable in the past have not been seen for several years (USFWS, 2023).

Threats and Stressors

Stressor: Beach hardening (sea walls, jetties, rip-rap, etc) (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: The primary threat to the seabeach amaranth is from beach-hardening (sea walls, riprap, etc.) that prevents sand accretion. Dune fencing was thought to be a significant threat. Seabeach amaranth often occurs around sand fencing on newly created dunes. It doesn't appear that sand fencing is detrimental to the species, but the dune stabilization that they facilitate encourages other vegetation to colonize these areas and effectively reduces habitat for seabeach amaranth. USFWS, 2007)

Stressor: Development (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Development of barrier islands, especially by hotels and condominiums, threatens the seabeach amaranth by removing potential habitat, by stabilizing beaches, and by introducing non-native competing vegetation. Beach nourishment projects and beach raking are also associated with development. (USFWS, 2007)

Stressor: Pedestrians (USFWS, 2007)
Exposure:
Response:
Consequence:

Narrative: Pedestrian impacts are most common on beaches in resort towns and especially in close proximity to large hotels and condominiums. In populated areas, there is often an increase in human traffic on the sand. Beach chairs and umbrellas are frequently set up in the upper beach area near the edge of the dunes and informal sand volleyball courts are delineated on the upper beach. (USFWS, 2007)

Stressor: Off-road vehicles (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: While seabeach amaranth populations are somewhat tolerant of ORV use from December until May, the brittle, fleshy stems are easily broken, and growing plants (May to December) do not generally survive a single pass by a truck tire. Thus, even minor beach traffic directly across the plants during the growing season is detrimental, causing mortality and reduced seed production. It appears that vehicles are most harmful to seabeach amaranth on beaches that are less accessible to pedestrians. Often, little to no seabeach amaranth is found in areas that receive high ORV use. (USFWS, 1996; USFWS, 2007)

Stressor: Beach raking. (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: On many beaches, especially those used recreationally, vehicles are regularly driven along the beach pulling various types of rakes in order to collect trash, seaweed, marsh grasses and other things that are considered undesirable to human beach visitors. This activity increases the potential of running over, or pulling up seabeach amaranth plants. Little vegetation occurs in the areas where beach raking occurs (Steve Sinkevich, USFWS, Long Island Field Office, pers. comm., 2006). (USFWS, 2007)

Stressor: Herbivory by webworms (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: At least 4 species of webworms, along with other larval insects are known to feed on seabeach amaranth, as well as other plant species. The insect threat is variable from year to year and is more important in southern seabeach amaranth populations. In addition, deer, feral horses, nutria, rabbits, and songbirds have been observed feeding on the seabeach amaranth. While impacts from predation are localized, poorly understood and mostly based on observations, it is generally believed that vertebrate predators may negatively affect seabeach amaranth growth and reproduction, while invertebrates do not. USFWS, 2007)

Stressor: Climate change (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: According to NOAA's Tides and Currents web page, the mid Atlantic coast is currently experiencing a rise in mean sea level of 0 to 2 feet per century. Given that Seabeach amaranth grows at very low elevations and is often the species found growing closest to the ocean, even a

minor rise in sea level could be detrimental to existing populations. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: At the time of the listing, webworms were the only known predator of seabeach amaranth. Since that time, several species of animals have been identified as feeding on seabeach amaranth. While impacts from predation and disease on seabeach amaranth plants are localized, poorly understood, and mostly based on observations, it is generally believed that vertebrate predators may negatively affect seabeach amaranth growth and reproduction, while invertebrates do not. (USFWS, 2018)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Delisting Criteria:
Delisting will be considered when a minimum of 75 percent of the sites with suitable habitat within at least six of the nine historically occupied States are occupied by seabeach amaranth populations for 10 consecutive years. (USFWS, 1996)

Recovery Actions:
- Survey suitable habitat for additional populations. (USFWS, 1996)
- Monitor and protect existing populations including enforcement of laws protecting the species and/or its habitat. (USFWS, 1996; USFWS, 2015)
- Determine habitat protection priorities. (USFWS, 1996)
- Determine and implement the management necessary for long-term reproduction, establishment, maintenance, and vigor. (USFWS, 1996)
- Conduct research on the biology of the species including long-term demographic studies and determining the effects of past and ongoing habitat disturbance. (USFWS, 1996; USFWS, 2015)
- Develop techniques and reestablish populations in suitable habitat within the species' historic range. (USFWS, 1996)
- Develop a cultivated source of plants and provide for long-term seed storage. (USFWS, 1996)
- Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining. (USFWS, 1996)
- Investigate and conduct necessary management activities at all key sites, and annually assess the success of recovery efforts. (USFWS, 1996; USFWS, 2015)
- Prepare articles for popular and scientific publications; prepare and distribute news releases and informational brochures. (USFWS, 2015)
- Revise or clarify sections of the Recovery Plan to determine when the recovery criteria have been met. The recovery plan does not define some terms used and other recovery criteria need to be clarified. Recovery criteria in future amendments or revisions need to include additional threats in the listing package that were not included in the 1996 Recovery Plan.

(USFWS, 2007)

- Define what constitutes "Likely to Adversely Affect" and "Jeopardy" for this species in order to improve consistency in USFWS consultations. (USFWS, 2007)
- Develop a list of list of conservation measures that Service biologists can use in formal consultations that address impacts to seabeach amaranth. (USFWS, 2007)
- Develop survey protocols, continue annual range-wide monitoring, and submit annual survey data to the lead recovery biologist for analysis. (USFWS, 2007)
- Develop management recommendations in accordance with USFWS policy. (USFWS, 2007)
- Develop guidelines for restoration, augmentation and transplantation. (USFWS, 2007)
- Discuss potential impacts of ORV use and beach raking with local governments. (USFWS, 2007)
- Ensure that seed collections and herbarium specimens represent a variety of populations from throughout the species range. (USFWS, 2007)
- Work with academic institutions to address the additional research needs. (USFWS, 2007)
- Work with partners to revise the photo identification cards, produce interpretive signs for beach access sites, encourage media coverage, and maintain an up-to-date web site. (USFWS, 2007)
- Develop guidelines or recommendations for restoration, augmentation and transplantation projects (USFWS, 2023).
- Develop criteria for consistently defining a “site” across the range, allowing for better tracking of progress toward the recovery objective (USFWS, 2023).
- Reintroduce populations to natural areas that may serve as refugia for the species. Example locations may include but are not limited to: Cape Romain NWR (SC), Huntington Beach State Park (SC), Hammocks Beach State Park (NC), Cape Lookout National Seashore (NC), Cape Hatteras National Seashore (NC), NC Coastal Reserve (NC), Volgenau Virginia Coast Reserve (VA), Chincoteague NWR (VA), Cape May NWR (NJ), E.B. Forsythe NWR (NJ), Nantucket NWR (MA), Monomoy NWR (MA) and other protected coastal reserves with associated habitat (USFWS, 2023).
- Continue working with coastal municipalities, parks and wildlife agencies to maintain protective fencing and restrict beach driving in areas with historically good populations of seabeach amaranth. Beach driving and raking should not be allowed at all during the growing season when seabeach amaranth plants are actively growing and/or producing seeds (April – December). If this is not possible, surveys should be conducted during the growing season prior to these activities and a wide protective buffer should be created around seabeach amaranth plants. Work with municipalities to designate Plant Protection Strips such as the ones that have been successful in NJ (USFWS, 2023).
- Ensure that seed collections for long term storage represent a variety of populations from throughout the species range. The North Carolina Botanical Garden has over 25 accessions of Seabeach amaranth seeds from populations across the range of the species (NJ, DE, MD, NC and SC) in long term protective storage to be used for future reintroduction and research. They should continue increasing the number of seeds in their collections through seed amplification projects (USFWS, 2023).
- Control invasive species on beaches and dunes and consider the potential negative impacts of native beach grasses sometimes planted after nourishment projects (USFWS, 2023).
- Monitoring and Research Activities Develop survey protocols and coordinate annual range-wide monitoring. Work with partners to fill in survey gaps as needed. Submit annual survey data to the lead recovery biologist. Conduct research on the effects of climate change,

beach driving, beach nourishment and inlet dredging/sand deposition projects (USFWS, 2023).

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SPECIES ACCOUNT: *Ambrosia cheiranthifolia* (South Texas ambrosia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/23/1994; Southwest Region (R2)

Physical Description

South Texas ambrosia is a herbaceous, ashy blue-gray, rhizomatous perennial in the Asteraceae Family (sunflowers) (Figure 4). Stems of the plant stand erect and are approximately10–60 cm (3.9– 23.6 in) tall. The number of individuals at any site is difficult to count due to rhizomatous growth habits that produce multiple stems from plants that are growing in closely-spaced colonies, thus inhibiting accurate stem number counts. The leaves are usually opposite at the base, and alternate above. The leaves are mostly oblanceolate or oblong-lanceolate, 2–7 cm (0.8–2.8 in) long, depending on the area of placement and the age of the stem, with the blade narrowing gradually at the base. Most leaves are unlobed and entire, although the lower and larger leaves of juvenile plants may be undulate or shallowly-pinnate. Both sides of the leaves appear whitened due to a fine and short appressed pubescence, giving the leaf an ashy, blue-gray color. The inflorescence is usually unbranched and composed of separate, inconspicuous male and female flowers. The male flowers occur in a terminal raceme 5–10 cm (2–4 in) long, composed of 10–12 small, light yellow, saucer-shaped flowers that are about 4 mm (0.16 in) broad with 4–6 acute, triangular lobes. The female flowers are in small clusters in the axils of the leaves. The fruit is an achene, somewhat angled and long with a stout beak. The fruit has 4- 5 blunt spines spread across the surface (Poole et al. 2007). (USFWS, 2018)

Taxonomy

In the Asteraceae (sunflower) family. The first ambrosia collection on record was taken by Luis Berlandier in 1835 in San Fernando, Tamaulipas, Mexico (USFWS 1993). In 1859, Asa Gray named the plant Ambrosia cheiranthifolia (Payne 1964). In 1932, the first collection of Ambrosia cheiranthifolia in the United States was taken from an area near Barreda (now Russelltown) in Cameron County, Texas, by Robert Runyon (Turner 1983). (USFWS, 2018)

Historical Range

Nueces County, Texas, on the north; as far south as San Fernando in Tamaulipas, Mexico, a distance of approximately 322 kilometers (USFWS, 2018).

Current Range

In Texas, north-central Kleberg County through north-central Nueces County. (USFWS, 2018)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (EPA, 2016)

Breeding Season

Adult: Flowers and fruits in late summer and fall (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Wind and possibily insects for pollination (USFWS, 2010)

Reproduction Narrative

Adult: Ambrosia cheiranthifolia's primary reproductive period occurs in late summer/fall, dependent on rainfall, and lasts until the lack of water or cold temperatures curtails growth. At the Robstown site, most stems produced a terminal inflorescence of staminate (male) heads that released abundant winddispersed pollen. Below that, in the leaf axils of the upper 1/3rd to 2/3rds of the vegetative portion of the stem, a series of small, sessile pistillate (female) heads was normally produced throughout the reproductive season. It was noted that some stems produced only or predominately pistillate or staminate heads, but most stems produced both types of heads. A single achene was produced per pistillate head. The phyllaries (bracts surrounding the flower head on a composite plant) hardened around the single fruit as it matured, producing a somewhat star-shaped, bur with the "seed" embedded inside. Multiple female heads were produced in each axil throughout the reproductive period, so burs of varying maturity sometimes occurred at the same node simultaneously. Burs darkened, hardened, and most easily dehisced (dried, opened, and detached) at maturity, with most falling to the base of the plant. A number of burs remained on the stems as the leaves senesced and persisted for several weeks into the winter time. Plants at Robstown County Park produced a consistent average of 2.98 mature burs/cm (7.57 burs/in) the pistillate reproductive region of the stem (USFWS, 2010). More often than not ambrosia is seen reproducing vegetatively by rhizomatous regrowth in the upper portion of the soil. As a result, a single individual may be represented by several-tohundreds of stems, depending on the age of the plant (Turner 1983). The most current scientific information suggests that ambrosia patches represent several separate individual members of a larger metapopulation, as is thought to be the case on NASK. In 2010, Overath began work on NASK ambrosia to answer a number of genetics-related questions including variation within patches (whether dominated by one or a few clones) and relatedness among patches; as well as analysis of the genotypes within patches. Overath (pers. comm. 2012) found little genetic variation among ambrosia samples collected and compared to 13 genetic markers, implying that all the separate patches on NASK are likely part of one larger population (or metapopulation). Small patches of ambrosia may be part of the same clone, but larger patches are not composed of single clones (Overath 2013b). However, these genetic studies also suggested that some NASK ambrosia patches (2013b) were reproducing sexually or that they had in the relatively recent past. Overath's genetic studies to determine the reproductive mode at other sites, including the St. James Cemetery (Nueces County), are incomplete at this time. (USFWS, 2018)

Habitat Type

Adult: Terrestrial (USFWS, 2018)

Habitat Vegetation or Surface Water Classification

Adult: Coastal grasslands and shrublands (USFWS, 2018)

Geographic or Habitat Restraints or Barriers

Adult: Low elevations; 26 to 66 ft

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2018)

Habitat Narrative

Adult: This plant grows in the Gulf coastal grasslands of southern Texas, and is found in grassland and mesquite shrubland habitat on various soils. It is associated with sites where native short-grass prairie species persist, and also on moderately disturbed sites such as cemeteries, right-of-ways, roadsides, parkfields, and eroded areas along creeks. Typically grows on well-drained, heavy soils associated with subtropical woodland communities. Found in various soils, both heavy clays to lighter-textured sandy loams, mostly of the Beaumont and Victoria Clay series (USFWS, 2018)).

Dispersal/Migration

Motility/Mobility

Adult: N/A

Dispersal/Migration Narrative

Adult: Thought to be dispersed by wind (USFWS, 2010).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Not available.

Number of Populations:

7 (USFWS, 2019)

Population Size:

Uncertain (USFWS, 2019)

Population Narrative:

As of 2014, there are seven extant, or presumed extant, ambrosia populations from north-central Kleberg County through north-central Nueces County. One site occurs on state land, on both the north and southbound ROWs of US Hwy 77. The largest population occurs on Federal land at the Naval Air Station Kingsville (NASK). There are two sites on city or county-owned lands; the Bishop City Park and the Nueces County Park in Robstown. Two sites are located on private land, including a large population at the St. James Cemetery in Bishop and a small group of plants on a lot in Kingsville (General Cavazos Boulevard). Additionally, a National Guard training area formerly leased from a private landowner, known as the KRTA, has several sites (Table 9). These KRTA populations became inaccessible and thus unverifiable after the lease expired in the mid-1990s. Observations using Google Earth show the habitat still exists and the ambrosia is assumed to be extant. All of these separate KRTA occurrences are less than 1.0 kilometer (km) (3, 280 feet (ft)) apart and may therefore be a single metapopulation. The same

is true for the occurrences in the St. James Cemetery, Bishop City Park, and the US Hwy 77 ROW, as well as the separate patches of ambrosia on NASK (see paragraph below). If the ambrosia is sexually reproducing, the close proximity between occurrences allows for the genetic exchange between each occurrence, or sub-population, and may mean that these sub-populations constitute at least 3 different metapopulations based on these distances. The population at Robstown and the one in Kingsville would be considered separate populations. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Invasion of short-grass prairie by non-native grasses, conversion of native prairie to row crops and improved pasture, development in urban and rural areas, and restricted geographic distribution and abundance are historic, as well as ongoing, habitat-related threats (USFWS, 2010).

Stressor: Limited genetic diversity (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The current limited geographic distribution of A. cheiranthifolia may be expected to result in lower genetic diversity due to a lack of gene exchange through pollen, seed, or ramets between different sub-populations and populations. The existence of the species in fragmented, unconnected habitat patches can lead to restrictions in genetic variability, reducing the species' ability to overcome environmental stresses, especially during stochastic events or in response to climate change, and thereby render the populations vulnerable to extirpation and extinction (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Projected climate changes across the South Texas plains and the southern coastal region include higher temperatures, more frequent and prolonged droughts, and intensified rainfall events (Intergovernmental Panel on Climate Change 2007). These climatic conditions can cause or exacerbate direct stress to vegetation communities and individual plant species by decreasing water availability, altering temperature regimes to which the species has adapted, and subjecting the plants to flooding and potentially increased erosion from more severe storms (USFWS, 2010)

Stressor: Drainage improvements (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Since most of the plants are located near or along drainage corridors and in close proximity to one another, improvements or diversion of water could perhaps impact the species.

These improvements could cause an increase/decrease in water amounts reaching natural drainages, cause a channelizing of natural drainage routes, and cause habitat fragmentation to an existing population or otherwise potential sites of A. cheiranthifolia (USFWS, 2010).

Stressor: Effects of pesticide drift (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Remaining areas of the native coastal prairie habitat of A. cheiranthifolia populations are surrounded by agricultural fields, pastures, and urban development, from which aerial drift of pesticides has potential to harm or kill individuals of the species. Insecticides could be considered a potential threat because they can directly or indirectly kill pollinators of A. cheiranthifolia (USFWS, 2010).

Stressor: Inadequacy of existing regulations (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Inadequacy of existing regulations (USFWS, 2022)

Stressor: small population size (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: small population size (USFWS, 2022)

Stressor: Climate change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Climate change (USFWS, 2022)

Recovery

Reclassification Criteria:
Downlisting Criteria 1: A recommended minimum of nine populations are necessary for downlisting and should have at least 7,500-15,000 mature stems per population. Each population should be stable or increasing over the next 20 years. The extant populations (seven total), as well as any that may be restored, augmented, or created, should be maintained with at least one natural population located in each of the drainage systems (Oso, Chililpitin Creek-San Fernando, Alazan Bay-Baffin Bay, and Santa Getrudis Creek basins) where the species is known to naturally occur to ensure genetic representation. (USFWS, 2018)

Downlisting Criteria 2: Each ambrosia site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie

habitat should contain species commonly associated with ambrosia (see Table 7 of 2018 Recovery Plan). Although ideal high quality shortgrass prairie habitat would be located in unplowed/undisturbed habitat areas, this scenario means only remnant pieces of land in Nueces County which has been largely converted to cropland, and is restricted in Kleberg County to areas that can be accessed for plant surveys. As a consequence, existing patches of shortgrass prairie may need intensive restoration or habitat may need to be created on areas that are currently devoid of vegetation due to previous land use. Unplowed/undisturbed habitats should be sought out and restored as a priority before attempting creation of new habitat amidst disturbed shortgrass prairie. Prolific and aggressive nonnative grasses and woody species should not constitute more than small patches within each high quality shortgrass prairie site and these undesirable species should not be spreading throughout the site or inhibiting growth and reproduction of ambrosia. Each ambrosia site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat and to minimize and control threats over a period of 20 years. (USFWS, 2018)

Recovery Priority Number: 8

Delisting Criteria:
Delisting Criteria 1: A minimum of 15 populations are necessary for delisting and should have at least 7,500-15,000 mature stems per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 40 years. All extant populations, as well as any that are restored or created in the future, should remain secure. Also, a minimum of one natural population or genetically distinct population is extant within each drainage system (Oso, Chililpitin Creek-San Fernando, Alazan BayBaffin Bay, and Santa Getrudis Creek basins). (USFWS, 2018)

Delisting Criteria 2: At least seven of the populations that meet the delisting MVP minimum will be protected long-term (protection in perpetuity being optimum) via fee title acquisitions, conservation easements, or conservation agreements. These agreements will be between the USFWS, TPWD, or conservation organizations and landowners or land managers controlling areas with suitable habitat who carry out active management under USFWS-approved monitoring and management plans. See Downlisting Criteria 1 for a description of high-quality habitat. (USFWS, 2018)

Recovery Actions:

- 1. Habitat protection and management of all known population sites of South Texas Ambrosia in the United States. - Establish positive working relationships with landowners and land managers of all known sites. Maintain contact with all landowners or land managers each year. Educate landowners about the extreme rarity and significance of both the ecosystem and species on their property. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, conservation easements, and conservation agreements. - Cooperate with landowners and land managers to develop and implement management plans that address landowner and species goals. With willing landowners, determine short- and long-term land use goals and their effects on South Texas Ambrosia. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary

landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management. - Enforce applicable laws and regulations. Work with regulatory agencies (DOD– NASK, TXDOT, TPWD, USDANRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat. (USFWS, 2018)

- 2. Monitor South Texas Ambrosia on an annual basis. - Develop a monitoring plan for ambrosia. Monitoring plan will include population assessment and abundance measures to ascertain plant abundance and spread. Monitoring plan will include measurements of habitat conditions, ecological integrity, and conservation status of sites. - Use the approved monitoring plans to annually monitor ambrosia, its habitat, management actions, and threats at extant sites. - Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites. (USFWS, 2018)
- 3. Initiate studies to gather biological information needed for effective management and recovery of ambrosia. - Determine specific habitat requirements (specifically limiting factors). Study soils and underlying geology. Determine the plant community structure for South Texas Ambrosia. Study community dynamics/ecology. - Study population dynamics. Analyze the demographic structure of all populations. Characterize phenology and assess the most vulnerable stages of life cycle. Determine the primary means of reproduction in the wild. Study pollination biology and determine effective pollination requirements and effective pollinators. Study seed production and dispersal. Study seedling recruitment. Study population genetics to determine the genetic diversity within and among populations. (USFWS, 2018)
- 4. Survey for additional populations of ambrosia. As more information about the habitat and biology of the species becomes available, determining areas capable of supporting the species may be more predictable. Models, maps, and other tools will be developed showing the vegetative and edaphic characteristics of occupied sites. This information will help to determine where coastal shortgrass prairie habitats currently might remain intact and/or where the species could be located. These potential areas are a high priority to survey and engage in stewardship efforts. These surveys should be performed to locate existing and new populations and for use as potential reintroduction sites in Texas. (USFWS, 2018) (USFWS, 2018)
- 5. Cooperatively work with landowners and land managers to restore additional shortgrass prairie sites located in one or more of the drainage areas from which ambrosia is known to co-occur. (USFWS, 2018) (USFWS, 2018)
- 6. Establish seed or propagule banks and ex-situ (botanical garden, refugium, research institute, etc.) populations for the species. These banks and ex-situ populations will be established using approved reintroduction plans for South Texas Ambrosia (see Recovery Action 7 below). (USFWS, 2018)
- 7. Conduct a reintroduction program on public and private lands where there are willing partners. Evaluate and document the success of different cultivation techniques, site preparation, and other management techniques based on research, and assess any additional information necessary to attempt reintroduction. If reintroduction is feasible, a USFWS-approved Propagation and Reintroduction plan should be developed and implemented for ambrosia. This should provide for all phases of reintroduction, including site selection, site preparation, monitoring, and short- and long-term management strategies, particularly the effective management (eradication and prevention) of nonnative, invasive grass species. Reintroduced populations for South Texas Ambrosia should not be

considered successful until they are established, reproductively active, self-perpetuating, and demonstrated to be demographically and genetically viable. (USFWS, 2018)

- 8. Develop an education and outreach program. Develop any necessary educational or outreach materials. Provide educational and outreach materials to landowners and land managers. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.
- 9. Conduct Population Viability Analyses (PVA) and update the existing MVPs for the species based on current biological and ecological information. . Investigate South Texas Ambrosia' population genetics to ensure long-term persistence. Develop traditional MVP estimates for South Texas Ambrosia. Reassess the MVP size when new information is made available. (USFWS, 2018)
- 10. Review and track recovery. Maintain the STXPRT to help review the status of South Texas Ambrosia and assess the effectiveness of the management plans and other recovery tasks. Revise the Recovery Plan as appropriate. Develop a post-delisting monitoring plan when appropriate. (USFWS, 2018)
- The continued loss of habitat from invasive grasses exceeds impacts from all other currently known threats to A. cheiranthifolia in the extant populations in Nueces and Kleberg Counties. Evaluation of best management practices, including prescribed burns, grazing, and mowing, that will favor A. cheiranthifolia in these existing population sites is among the highest of priorities. Determining the best methods of controlling invasive plants, particularly introduced grasses, within A. cheiranthifolia populations is a critical need (USFWS, 2010).
- Further investigation of reproductive biology in wild populations is needed to ascertain if A. cheiranthifolia is reproducing sexually as well as vegetatively. Research is needed to describe pollination ecology and pollinator species of the plant. A thorough genetic analysis of A. cheiranthifolia, including a determination of the relatedness of subpopulations and populations, is needed to clarify the genetic diversity that exists within the species. New information collected on the genetics, pollinators, and dispersal of the species may help in understanding maximum or minimum distances between populations that would allow for transfer of genetic material (USFWS, 2010).
- Additional surveys for new populations of A. cheiranthifolia are needed in potential habitat areas in both counties, where permission to access land can be attained. Building good relationships with private landowners is a prerequisite to conducting these surveys. The Service, TPWD, and other partners should develop presentations and materials to share with landowners and their representatives that provide reassurance that threatened and endangered plants will not restrict land uses (USFWS, 2010).
- Soil analyses should be conducted at all known population sites. Soil analysis will help to elucidate the substrate that supports shortgrass prairie in the Texas Coastal Bend region. This would aid in focusing A. cheiranthifolia surveys as well as providing information needed to more fully understand habitat requirements for the shortgrass prairie species, including A. cheiranthifolia. A reintroduction plan for A. cheiranthifolia should be developed that identifies potential sites for both restoration and pilot introduction efforts (USFWS, 2010).
- Annual monitoring of existing populations should be undertaken to monitor status and trends and to evaluate condition of the plants and the habitat (USFWS, 2010).

Conservation Measures and Best Management Practices:

- The 2018 Recovery Plan includes actions that are needed to recover the South Texas ambrosia. The status of the species is still precarious, and we continue to recommend all the actions be implemented and that conservation partners actively seek funding to implement the actions

References

USFWS. 2018. Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (Hoffmannseggia tenella) and South Texas Ambrosia (Ambrosia cheiranthifolia). U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 130 pp. August 23, 2018.

USFWS. 2018. Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (Hoffmannseggia tenella) and South Texas Ambrosia (Ambrosia cheiranthifolia). U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 130 pp. August 23, 2018.

USFWS. 2010. South Texas Ambrosia (Ambrosia cheiranthifolia) 5-year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Corpus Christi Ecological Services Field Office Corpus Christi, Texas. 34 pp.

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USFWS. 2010. South Texas Ambrosia (Ambrosia cheiranthifolia)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Corpus Christi, Texas. 34 pp. December 20, 2010. https://ecos.fws.gov/docs/five_year_review/doc3601.pdf

SPECIES ACCOUNT: *Ambrosia pumila* (San Diego ambrosia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/2/2002; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Ambrosia pumila is a clonal herbaceous perennial plant. Individual stems are generally 5 to 30 centimeters (cm) (2 to 12 inches (in)) tall, but may grow to 50 cm (20 in), and are densely covered with short hairs. The leaves are two to four times pinnately divided into many small segments and are covered with short, soft, gray-white, appressed (lying flat on surface) hairs. The species has separate male and female flowers on the same plant (monoecious). Male flowers have no petals, are yellow to translucent, and are borne in clusters on terminal flower stalks. Female flowers have no petals, are yellowish-white, and occur in clusters in the axils of the leaves below the male flower clusters (Nuttall 1840, pp. 344–345; Gray 1882, p. 217; Munz 1935, p. 544; Keck 1959, p. 1103; Ferris 1960, p. 148; Munz 1974, p. 112; Beauchamp 1986, p. 94; Payne 1993, p. 194) (USFWS, 2010).

Taxonomy

Ambrosia is a genus of 35 to 50 wind pollinated species of annuals and perennials in the Asteraceae (sunflower) family. The perennial taxa range from woody shrubs to herbaceous rhizomatous (possessing underground stems) taxa (USFWS, 1999).

Historical Range

Only known from southern San Diego County (Lake Hodges to the border) in the United States and from northern Baja California, Mexico (to Colonet acc. to Oberbauer or to El Arco acc. to Wiggins, or to 23 km south of Parador Catarina acc. to CNNDD), California. Also in Riverside County, California (Fish and Wildlife Service 1999) (NatureServe, 2015).

Current Range

Occurs in southern California from northwestern Riverside County, south through western San Diego County, to northwestern Baja California, Mexico (USFWS, 2010).

Critical Habitat Designated

Yes; 11/30/2010.

Legal Description

On November 30, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Ambrosia pumila (San Diego ambrosia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (75 FR 74546-74604).

Critical Habitat Designation

The critical habitat designation for Ambrosia pumila includes six CHUs (including 12 sub-units) in Riverside and San Diego Counties, California. This species critical habitat encompasses approximately 783 acres (ac) (317 hectares (ha)) (75 FR 74546-74604).

Unit 1: Santa Ana River Watershed: Unit 1 is located in western Riverside County and consists of two subunits totaling approximately, 26 ac (11 ha) of State or local government-owned land, and 85 ac (35 ha) of private land for a total of approximately 112 ac (45 ha) (values do not sum due to rounding). Subunit 1A: Alberhill Subunit 1A is located near Alberhill, north of Lake Elsinore and just west of Interstate Highway 15 in Riverside County, California. This subunit is near the northern base of Alberhill Mountain, and near the intersection of Lake Street and Temescal Canyon Road. Subunit 1A consists of approximately 23 ac (10 ha) of County-owned land, and 18 ac (7 ha) of privately owned land for a total of approximately 41 ac (17 ha). The approximately 23 ac (10 ha) of Countyowned land in Subunit 1A are conserved and currently managed by the Western Riverside County Regional Conservation Authority; transfer of ownership by the County of Riverside to the Western Riverside County Regional Conservation Authority is planned for the near future. This conserved area is not yet receiving active management. This subunit was occupied at the time of listing and remains occupied and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 1A contains the physical and biological features essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and potentially periodic flooding presumed necessary for the plant's persistence (PCE 1); and coastal sage scrub vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and from human encroachment and development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 1B: Nichols Road Subunit 1B is located about 2.1 mi (3.5 km) southeast of Subunit 1A (Alberhill), on the north and south sides of Nichols Road, in Riverside County, California. This subunit is near the southeastern base of Alberhill Mountain, just west of Durant Road and Temescal Creek. Subunit 1B consists of approximately 3 ac (1 ha) of State or local government-owned land, and 67 ac (27 ha) of privately owned land for a total of approximately 70 ac (29 ha) (values do not sum due to rounding). No lands in Subunit 1B are conserved or managed for biological resources. This subunit was occupied at the time of listing and remains occupied, and is essential to the conservation of this species because this subunit (along with Subunit 1A) represents the northernmost occurrences of this species, which is geographically situated to potentially assist this species expand its range northward. Like all other extant occurrences, this subunit is also essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). However, due to impacts from unauthorized grading and disking, and a permitted road realignment project, Ambrosia pumila within this subunit may be in imminent danger of extirpation. Subunit 1B contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and from activities (grading, construction, human encroachment) that occur in the area. Please see the Special Management Considerations or

Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Unit 3: Santa Margarita River Watershed: Unit 3 is located in western Riverside County and consists of two subunits totaling approximately, 8 ac (3 ha) of State or local government-owned land, and 69 ac (28 ha) of private land for a total of 77 ac (31 ha). Subunit 3A: Santa Gertrudis Creek Subunit 3A is located about 1 mile (1.6 km) southwest of Unit 2, along the San Diego Aqueduct, south of the intersection of Chandler and Suzi Roads and north of Santa Gertrudis Creek in Riverside County. Subunit 3A consists of approximately 8 ac (3 ha) of Stateowned land and 25 ac (10 ha) of privately owned land for a total of approximately 33 ac (13 ha). No lands in Subunit 3A are conserved or managed for biological resources. This unit was occupied at the time of listing and remains occupied, and like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 3A contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, and utility maintenance activities. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 3B: Murrieta Creek Subunit 3B is located in the City of Temecula in southwestern Riverside County, California. This subunit is near the western end of 1st Street, just west of Murrieta Creek. Subunit 3B consists of approximately 44 ac (18 ha) of privately owned land. No lands in Subunit 3B are conserved or managed for biological resources. This subunit meets the definition of critical habitat for this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 3B contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, from human foot and vehicle traffic that may occur in the area, and from development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Unit 4: San Luis Rey River Watershed: Unit 4 is located in northwestern San Diego County and consists of four subunits of approximately 17 ac (7 ha) of State or local government-owned land and approximately 74 ac (30 ha) of privately owned land, for a total of approximately 91 ac (37 ha). Subunit 4A: Calle de la Vuelta Subunit 4A is located near junction of State Route 76 and Calle de la Vuelta in unincorporated San Diego County. Subunit 4A consists of approximately 0.8 ac (0.3 ha) of State or local government-owned land and 14 ac (6 ha) of privately owned land, for a

total of approximately 15 ac (6 ha). No lands in Subunit 4A are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4A contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and ruderal vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, road maintenance activities, and future widening of State Route 76. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 4B: Olive Hill Road Subunit 4B is located on the west side of State Route 76, south of Olive Hill Road in unincorporated San Diego County. Subunit 4B consists of approximately 16 ac (6 ha) of State or local government-owned land and approximately 8 ac (3 ha) of privately owned land, for a total of approximately 23 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 4B are conserved (a portion of Subunit 4B is within the Groves mitigation preserve, managed by the California Department of Transportation (Caltrans); this area has not yet been conserved). The occurrence in this subunit was erroneously considered extirpated at the time of listing, but has since been found to be extant. Like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4B contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and flooding presumed necessary for the plant's persistence (PCE 1), and grassland vegetation which allow adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, road maintenance activities, and future widening of State Route 76. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 4C: Jeffries Ranch Subunit 4C is located approximately 0.7 mi (1 km) southwest of Bonsall Bridge, adjacent to the south side of State Route 76 in the City of Oceanside, San Diego County. Subunit 4C consists of approximately 0.1 ac (0.05 ha) of State or local government-owned land and approximately 33 ac (13 ha) of privately owned land for a total of approximately 33 ac (13 ha). No lands in Subunit 4C are conserved. This subunit was occupied at the time of listing and, like all other extant occurrences, we believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4C contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where

nonnative species are outcompeting A. pumila for resources, human encroachment, road and utility maintenance activities, future widening of State Route 76, and potential development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 4D: Gird/Monserate Hill Subunit 4D is located in the Fallbrook area of northern San Diego County, California. This subunit is adjacent to the north side of State Route 76, almost equidistant from Gird Road (to the west) and Monserate Hill Road (to the east). Subunit 4D consists of 0.7 ac (0.3 ha) of State-owned land and 20 ac (8 ha) of privately owned land, for a total of 21 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 4D are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we believe this subunit is also essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 4D contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1); and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, from human encroachment that may occur in the area, and from development and road maintenance. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Unit 5: San Dieguito River Watershed— Lake Hodges: Unit 5 is located in central San Diego County and consists of two subunits comprised of approximately 129 ac (52 ha) of State or local government-owned land and approximately 121 ac (49 ha) of privately owned land, for a total of approximately 249 ac (101 ha) (values do not sum due to rounding). This total does not include a portion of Subunit 5B (52 ac (21 ha)) that we have excluded from this designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule). Subunit 5A: Lake Hodges East (Via Rancho Pkwy) Subunit 5A is located on the west side of Interstate 15, just north of Lake Hodges and south of Via Rancho Parkway in San Diego County. Subunit 5A consists of approximately 16 ac (6 ha) of State or local government owned land and approximately 5 ac (2 ha) of privately owned land, for a total of approximately 21 ac (9 ha) (values do not sum due to rounding). No lands in Subunit 5A are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 5A contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, human encroachment, utility maintenance activities, and potential development. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management

considerations. Subunit 5B: Lake Hodges West—Crosby Estates Subunit 5B is located just west of Lake Hodges in the western portion of central San Diego County, California. This subunit is on and adjacent to the west side of the Crosby National Golf Club. Subunit 5B consists of approximately 113 ac (46 ha) of State or local government owned land, 115 ac (47 ha) of privately owned land for a total of approximately 228 ac (92 ha) (values do not sum due to rounding). This subunit meets the definition of critical habitat for this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 5B contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, from human encroachment that may occur in the area, and from golf course maintenance. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Unit 6: San Diego River Watershed— Mission Trails Regional Park: Unit 6 is located in Mission Trails Regional Park in the City of San Diego. Unit 6 consists of approximately 6 ac (3 ha) of State or local government owned land, and approximately 32 ac (13 ha) of privately owned land, for a total of 38 ac (15 ha) (values do not sum due to rounding). This total does not include a portion of Unit 6 (160 ac (65ha)) that we have excluded from this designation under section 4(b)(2) of the Act (see the Exclusions under Section 4(b)(2) of the Act section of this rule). This unit was occupied at the time of listing and remains occupied, and like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Unit 6 contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Unit 7: Sweetwater River Watershed: Unit 7 is located in southwestern San Diego County and consists of three subunits containing approximately 146 ac (60 ha) of federally owned land (San Diego National Wildlife Refuge), approximately 13 ac (5 ha) of State or local government owned land, and approximately 57 ac (23 ha) of privately owned land, for a total of approximately 215 ac (87 ha) (values do not sum due to rounding). Subunit 7A: Jamul Road Subunit 7A is located southeast of the City of El Cajon at and near junction of Jamul Road and Steele Canyon Road, on the north and south sides of Jamul Road. Subunit 7A consists of approximately 3 ac (1 ha) of State or local government owned land, and approximately 36 ac (15 ha) of privately owned land, for a total of approximately 39 ac (16 ha). No lands in Subunit 7A are conserved or managed for

biological resources. This subunit was occupied at the time of listing and remains occupied. This subunit, like all other extant occurrences, is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7A contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland habitat type, which allows adequate sunlight and airflow for A. pumila (PCE 2). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, alterations of site hydrology, and offhighway vehicle use. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 7B: San Diego National Wildlife Refuge (SDNWR) Subunit 7B is located on the San Diego National Wildlife Refuge, south of Sweetwater River between Rancho San Diego Golf Course and the hills to the south, and on the north and south sides of a dirt trail adjoining the end of Par Four Drive in unincorporated San Diego County. Subunit 7B consists of approximately 118 ac (48 ha) of Federal land owned and managed by the Service, and approximately 15 ac (6 ha) of privately owned land, for a total of approximately 133 ac (54 ha). No private lands in Subunit 7B are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329 see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7B contains physical and biological features that are essential to the conservation of A. pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and periodic flooding presumed necessary for the plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require continued management and protection on federally owned lands to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations. Subunit 7C: Steele Canyon Bridge Subunit 7C is located mainly on the east side of State Route 94 on a slope between a concrete-lined ditch and a fence adjacent and parallel to State Route 94, approximately 0.7 mi (1.1 km) southeast of Subunit 7B, in unincorporated San Diego County. A small portion of the subunit is located on the opposite side of State Route 94 just south of Steele Canyon Bridge in a split-rail exclosure. Subunit 7C consists of approximately 28 ac (11 ha) of federally owned land managed by the Service, approximately 10 ac (4 ha) of State or local government owned land, and approximately 6 ac (2 ha) of privately owned land, for a total of approximately 44 ac (18 ha) (values do not sum due to rounding). No private or state/local government owned lands in Subunit 7C are conserved or managed for biological resources. This subunit was occupied at the time of listing and, like all other extant occurrences, we also believe this subunit is essential to the conservation of this species because of its contribution to the genetic diversity of the species (McGlaughlin and Friar 2007, p. 329; see Genetics section of the proposed rule (74 FR 44241, August 27, 2009)). Subunit 7C contains physical and biological features that are essential to the conservation of Ambrosia pumila, including sandy loam or clay soils located on an upper terrace of a water source, which provide nutrients, moisture, and flooding presumed necessary for the

plant's persistence (PCE 1), and nonnative grassland vegetation, which allows adequate sunlight and airflow for A. pumila (PCE 2). The PCEs in this subunit may require continued management and protection on federally owned lands to address threats from nonnative plant species in situations where nonnative species are outcompeting A. pumila for resources, and human encroachment. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. pumila habitat and potential management considerations.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Ambrosia pumila critical habitat consists of two components (75 FR 74546-74604):

(i) PCE 1—Sandy loam or clay soils (regardless of disturbance status), including (but not limited to) the Placentia (sandy loam), Diablo (clay), and Ramona (sandy loam) soil series that occur on or near (up to several hundred meters from but not directly adjacent to) a river, creek, or other drainage, or within the watershed of a vernal pool, and that occur on an upper terrace (flat or gently sloping areas of 0 to 42 percent slopes are typical for terraces on which Ambrosia pumila occurrences are found).

(ii) PCE 2—Grassland or ruderal habitat types, or openings within coastal sage scrub, on the soil types and topography described in PCE 1, that provide adequate sunlight, and airflow for wind pollination.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the occupied areas contain the physical and biological features that are essential to the conservation of the species, and whether these features may require special management considerations or protection. The area designated as critical habitat will require some level of management to address the current and future threats to the physical and biological features essential to the conservation of the species. In all units, special management will be required to ensure that the habitat is able to provide for the growth and reproduction of the species. Records indicate that Ambrosia pumila historically was known from over 50 locations in San Diego and Riverside counties, but the number of extant occurrences has been dramatically reduced because much of the species' habitat has been impacted by human activities (Burrascano and Hogan 1997, p. 7; Dudek 2000, p. 17; CNDDB 2010). A detailed discussion of threats to A. pumila and its habitat can be found in the final listing rule (67 FR 44372, July 2, 2002). The features essential to the conservation of A. pumila require special management considerations or protection to reduce the following threats, among others: • Habitat destruction caused by urban development, including highway and utility corridor construction and maintenance, highway expansion, and development of recreational facilities (such as golf courses and campgrounds). These activities can destroy the PCEs by removing or compacting soil, making habitat unsuitable for Ambrosia pumila. • Soil compaction caused by the creation and use of trails by hikers, horses, and vehicles. Ambrosia pumila appears to be tolerant to some level of disturbance caused by trail creation and use; it is often found in the disturbed areas along margins of dirt trails. However, it is found less often in trailways, implying that although the appropriate soil type might be present, soil compaction can alter soil physical characteristics such that the soil can no longer support plant growth (PCE 1). • Habitat alteration caused by invasion of nonnative plant species that may, if present in large enough numbers,

change the plant assemblage or cover density to the extent that Ambrosia pumila plants can no longer receive adequate sunlight and airflow (PCE 2). • Alteration of hydrological and floodplain dynamics, such as channelization and water diversions, (an additional threat not discussed in the listing rule), which can change the frequency of flooding in occupied areas or eliminate natural periodic flooding presumed necessary for the plant's longterm persistence (PCE 1). Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include fencing Ambrosia pumila occurrences and providing signage to discourage encroachment by hikers, horses, and offroad vehicle users; control of nonnative plants using methods shown to be effective (for examples, see CNLM 2008); guiding the design of development projects to avoid impacts to A. pumila habitat; and restoring and maintaining natural hydrology and floodplain dynamics of waterways associated with A. pumila occurrences where feasible. These management activities will help protect the PCEs for the species by reducing soil compaction (PCE 1), lowering the density of nonnative plants thereby maintaining the appropriate community structure (PCE 2), and maintain periodic flooding of A. pumila habitat where possible (PCE 1).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative, presumed self-pollination, sexual (USFWS, 2010)

Lifespan

Adult: Unknown - presumed long-lived (USFWS, 2010)

Breeding Season

Adult: May - October (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Winter rains, presumed wind-pollinated (USFWS, 2010)

Reproduction Narrative

Adult: Ambrosia pumila spreads vegetatively by means of slender, branched, underground root-like rhizomes from which new aboveground stems (aerial stems or ramets) arise each year (Nuttall 1840, p. 344; Munz 1974, p. 112; Payne 1993, p. 194). Aerial stems of Ambrosia pumila sprout from their underground rhizomes in early spring after winter rains, and flower between May and October (Keck 1959, p. 1103). However, aerial stems have been observed sprouting under dry conditions in late fall (A. Folarin, USFWS, 2008, pers. obs.). Ambrosia pumila is presumed to be wind-pollinated because most other species of Ambrosia are wind pollinated, and because biological pollinators have not been observed visiting A. pumila flowers (Johnson et al. 1999, p. 4; Dudek 2000, p. 16; Dudek 2003, p. P-331). Alternatively, pollinator(s) of A. pumila may have been extirpated (Dudek 2003, p. P-331). The species is presumed to be capable of self-pollination and of being self-fertile (i.e., self-compatible, where pollen from an individual plant can fertilize an ovule on the same plant, resulting in production of viable seed), because other species of Ambrosia are capable of self-pollination (Payne 1976, pp. 171–172). Ambrosia pumila is thought to have limited sexual reproductive output due to low production of viable seed

(Johnson et al. 1999, pp. 1–5; Dudek 2000, pp. 16–17; Dudek 2003, pp. P-331–P-332). Low seed production in this species is inferred by the lack of fertile fruits on all but a few preserved A. pumila museum specimens (G. Wallace, USFWS, 1999, pers. obs.), and field observers have found seed production in A. pumila to be low (Dudek 2000, p. 17; Dudek 2003, p. P-332). The longevity of individual plants is also unknown, although plants with clonal growth patterns tend to be long-lived (Watkinson and White 1985, pp. 44–45; Tanner 2001, p. 1980) (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2010)

Habitat Vegetation or Surface Water Classification

Adult: Coastal scrub, grasslands, open floodplains (NatureServe, 2015); vernal pool (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at ~600 ft. or ~1,600 ft. elevation (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Colonial (USFWS, 2010)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2010)

Habitat Narrative

Adult: Coastal scrub, grasslands, open floodplains and low valley bottoms below 150 m. Persists where disturbance has been superficial (NatureServe, 2015). The species is found primarily on upper terraces of rivers and drainages; however, several patches of the plant occur within the watershed of a large vernal (ephemeral) pool at the Barry Jones (Skunk Hollow) Wetland Mitigation Bank in Riverside County. It is generally found at or below elevations of 487 meters (m) (1,600 feet (ft.)) in Riverside County, and 183 m (600 ft.) in San Diego County (CNDDB 2010). Because of the clonal nature of Ambrosia pumila's growth, it is not possible to directly determine the number of genetically distinct plants (genets) present in an area simply by counting stems (McGlaughlin and Friar 2007, p. 320). The species is found primarily on sandy loam or clay soils (Johnson et al. 1999, p. 1; Dudek 2000, p. 18; CNDDB 2010; USDA 2008). The species may also be found in ruderal habitat types (disturbed communities containing a mixture of native and nonnative grasses and forbs) such as fire fuel breaks and edges of dirt roadways (Beauchamp 1986, p. 94; Payne 1993, p. 194; CNDDB 2010), however nonnative plants can out-compete A. pumila plants for resources in some situations. Ambrosia pumila consistently occurs in areas near waterways such as upper terraces of rivers or other water bodies. These areas do not necessarily provide high levels of soil moisture, and A. pumila is adapted to dry conditions (Keck 1959, p. 1103; Munz 1974, p. 112; Dudek 2000, Appendix A; CNLM 2008, p. 18) (USFWS, 2010).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The dispersal strategy of Ambrosia pumila is unknown. Ambrosia pumila seeds lack structures that facilitate dispersal by wind or passing animals (Nuttall 1840, p. 344; Payne 1993, p. 194). The species may depend on periodic flooding of nearby waterways for dispersal of seeds and rhizomes that can produce new aerial stems (Dudek 2003, p. P- 332) (USFWS, 2010).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

37 extant or presumed extant including translocations (USFWS, 2021)

Population Size:

Unknown (USFWS, 2010)

Adaptability:

Low (inferred from USFWS, 2010)

Population Narrative:

Reduced sexual reproduction may negatively impact the ability of the species to adapt to rapid environmental change or environmental change over the long term, which is especially deleterious to a rare species with disjunct occurrences such as A. pumila (Dudek 2000, p. 17; Dudek 2003, p. P-332). There are 16 extant native occurrences. Because of the clonal nature of Ambrosia pumila's growth, it is not possible to directly determine the number of genetically distinct plants (genets) present in an area simply by counting stems (McGlaughlin and Friar 2007, p. 320). Number of stems/patches visible each year may vary due to environmental factors (e.g., rainfall or temperature), and reliable, precise stem counts are not often available for occurrences (USFWS, 2010). Payne (1976) notes that self-pollination and self-fertility contribute strong inbreeding, as does seed longevity (USFWS, 1999).

Threats and Stressors

Stressor: Development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Habitat loss associated with development is the result of destruction and modification of Ambrosia pumila habitat (associated soils and plant community) due to filling, grading, discing, construction, landscaping, and other activities. Urban development has displaced habitat supporting one occurrence of A. pumila since the species was listed in 2002, and will soon displace habitat supporting another. Of the 16 currently known extant occurrences of A. pumila, 7 are conserved or partially conserved. The remaining 9 of 16 occurrences are not conserved and are more vulnerable to habitat loss from urban development (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)
Exposure:

Response:
Consequence:
Narrative: Nonnative plants continue to encroach upon Ambrosia pumila populations and pose a significant threat to the species throughout its range (CNDDB 2010; CNLM 2009, p. 3; Folarin, 2008, 2009, pers. obs.). Since listing, no research has been done to clarify the specific effects of nonnative plants on A. pumila. A recent study by CNLM demonstrated that reduction of nonnatives increases percent cover of A. pumila (CNLM 2008, p. 5; 2009, pp. 8 - 9) (USFWS, 2010).

Stressor: Fuel modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Weed abatement, fire suppression, and landscaping practices (including mowing, discing, and plowing) are fuel modification activities that were recognized as a threat to several occurrences of Ambrosia pumila in the listing rule. Mowing A. pumila plants, if done in midsummer to early fall, can remove flowering portions of the aerial stems, thus decreasing or preventing seed output. Mowing stems at other times may reduce the vegetative vigor of the plants. Discing, grading, or plowing occupied areas can break apart stems and rhizomes and leave rhizomes vulnerable to desiccation, potentially killing plants. Grading can also remove stems and rhizomes from a site completely (USFWS, 2010).

Stressor: Recreation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Human encroachment into Ambrosia pumila habitat on foot, bicycles, or horses can result in trampling of A. pumila stems along often-used trails (Dudek 2000, p. 20). Trampling and soil compaction were identified in the listing rule as a significant threat to A. pumila, affecting the species through direct destruction of stems and affecting its habitat by reducing percolation of water into the soil. The effects of soil compaction on A. pumila are not known (USFWS, 2010).

Stressor: Fragmentation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Most occurrences of Ambrosia pumila are patchy in nature, composed of a few to numerous smaller groups of aerial stems (McGlaughlin and Friars 2007, p. 319). While some of this patchiness may be inherent to the growth habit of the species, many occurrences are also fragmented by development activities, competition by nonnative plants, and human encroachment (CNDDB 2010). The creation and continued use of paths through occurrences of A. pumila has been a major source of fragmentation. Fragmentation of Ambrosia pumila occurrences could diminish the efficacy of wind pollination or biological pollinators by increasing the between-population distances (USFWS, 2010).

Stressor: Altered hydrology (USFWS, 2010)
Exposure:
Response:

Consequence:
Narrative: Ambrosia pumila occurrences are almost always found on the upper terraces of rivers/streams or near the margins of vernal pools, where under natural conditions they would likely be subjected to inundation during large-scale flooding events (McGlaughlin and Friars 2007, p. 320). If A. pumila is dependent on these periodic flooding events for some aspect of its life history (e.g., seed germination, dispersal) or control of competing plants, altering the flooding regimes of associated waterways or vernal pools could have a significant impact on the species. However, since the Service is unsure if or to what degree A. pumila is dependent upon periodic flooding or other aspects of its proximity to waterways, it is unknown to what degree altering the hydrology of adjacent waterways would impact the species (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Since listing, it has become apparent that there is potential for threats to biota from ongoing accelerated climate change (IPCC 2007). The impacts of local climatic shifts on populations of native and nonnative plants that compete with Ambrosia pumila and the interaction of these shifts with other ongoing threats are as yet unmeasured. Habitat conditions altered as a result of climate change impacts could favor invasive nonnative plants, which could then out-compete A. pumila for resources. Climatic change could also impact hydrological systems on which the species may depend. While the Service recognizes that climate change is an important issue with potential effects to listed species and their habitats, the Service lacks adequate information at this time to make accurate predictions regarding its effects to particular species and habitats, including A. pumila (USFWS, 2010).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan

Delisting Criteria:
Not available - this species does not have a recovery plan

Recovery Actions:
- Not available - this species does not have a recovery plan
- Identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities (USFWS, 2010).
- Work with partners to implement nonnative plant control methods such as those demonstrated effective by CNLM's 2008 study (USFWS, 2010).
- Work within the Service and with outside researchers to design studies aimed at gaining insight into sensitive aspects of the biology and life history of Ambrosia pumila (USFWS, 2010).
- Conduct field surveys to verify persistence of occurrences that are in question and accurately map extant occurrences (USFWS, 2010).
- Determine whether a program to propagate Ambrosia pumila in greenhouses and outplant the resulting plants in unoccupied areas would be biologically sound and feasible (USFWS,

2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Ambrosia pumila. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Develop a habitat suitability model and conduct surveys on potentially suitable habitat to inform our understanding of the species distribution, as new occurrences continue to be recorded in both the United States and Mexico. 2. Work with partners to secure conservation of the occurrences that currently receive no protection. 3. Work with partners to manage occurrences to support the long-term viability of the species including nonnative plant control and identifying opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities. 4. Conduct research on the biology and life history of Ambrosia pumila to understand the factors that contribute to the production of viable seed and the role of sexual reproduction in maintaining resilient populations such as confirming the pollination mechanism, testing for self-compatibility, seed germination requirements, mechanism of seed dispersal, and seed viability. This will assist in identifying reasons for the persistence of certain occurrences and actions needed to help conserve others. 5. Develop a translocation program that details successful approaches, greenhouse techniques for propagation and identifies potential sites for translocation within a genetic framework. The plan should maximize redundancy in terms of the geographic locations and number of occurrences to be established. (USFWS, 2021)

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SPECIES ACCOUNT: *Amorpha crenulata* (Crenulate lead-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/19/1985; Southeast Region (R4)

Physical Description

The crenulate lead-plant is a rhizomatous, perennial, deciduous shrub that grows to 1.5 m in height. The branches are red/purple, and contain 25 to 33 leaflets borne on leaves that are 0 to 15 centimeter (cm) long, with petioles 1 cm long or less. The crenulate leaflets are gray and green above, paler and glandular dotted below, and 5 to 11 cm long. The racemes are terminal, 15 to 20 cm long, solitary, or in clusters of two to three. The 8 millimeter (mm)-long flowers are held in loose clusters. The calyx is dark green or purplish, 3.2 to 4.0 mm long with the upper half glandular dotted. The showy white standard flower is 5.2 mm long and 4.2 mm wide with long exerted stamens. The fruit is 6 to11 mm long, laterally compressed, and glandular dotted on the upper two-thirds. The seeds produced in the fruit are 5 mm long and compressed. (USFWS, 1999)

Taxonomy

The crenulate lead-plant was described by Rydberg in 1919, citing his type specimen as J.K. Small and Percy Wilson #1898, May 9, 1904, In hammocks, between Coconut Grove and Cutler (New York Botanical Garden herbarium). Small (1933) followed this treatment. Isley (1986, 1990) argues that A. crenulata is an isolated variant of A. herbacea, distinguished only by the presence of crenulate leaf margins. He published the new combination as A. herbacea Walt. var. crenulata (Rydberg) Isley (Isley 1986). Synonyms: Amorpha crenulata Rydberg, A. herbacea auct. non. Walt. (USFWS, 1999)

Historical Range

The historical range of Amorpha crenulata encompasses only a 20 square-mile (52 km2) area from Coral Gables to Kendall (Service 1999) within Miami-Dade County, Florida. (USFWS, 2019)

Current Range

The current range of Amorpha crenulata encompasses only a 20 square-mile (52 km2) area from Coral Gables to Kendall (Service 1999) within Miami-Dade County. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known of the life history of crenulate lead-plant. In two years of life history monitoring of one population, no seedlings were observed. Plants showed little to no growth and flowered primarily following human disturbance. Crenulate lead-plant is semi-deciduous, about 70 percent of plants losing most or all leaves between December and February. Pollinators or dispensers have not been observed (DERM 1993). New sprouts, when observed,

have been identified as primarily adventitious roots (DOT 1997). In addition, the viability of germplasm is not known (DOT 1997). This species is relatively easy to cultivate, indicating that the lack of reproduction in the wild may not be due to a lack of viable seeds (A. Herndon, personal communication 1998). (USFWS, 1999)

Habitat Type

Adult: Pine rocklands

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: The crenulate lead-plant occurs in plant communities that were historically associated with seasonally hydrated soils and frequent burning, including wet pinelands, transverse glades, and hammock edges. It can be found growing in poorly-drained Opalocka sands within pine rocklands or in wet prairies with Opalocka-rock outcrop complex soils. It requires open sun to partial shade. The type specimen (Small and Wilson #1898) cites the habitat as "In hammocks." No recent collections have been seen from within hardwood hammocks. Many of Small's specimen labels were pre-printed with habitat data and some species were collected and labeled as occurring in hammocks that were actually collected in habitats outside hammocks. It may be that crenulate lead-plant was never collected in hammocks. (USFWS, 1999)

Dispersal/Migration

Population Information and Trends

Number of Populations:

5 populations (USFWS, 2019)

Population Size:

~ 650 individuals (USFWS, 2019)

Population Narrative:

The current and historical range of Amorpha crenulata encompasses only a 20 square-mile (52 km2) area from Coral Gables to Kendall (Service 1999) within Miami-Dade County. Two of the four known historical A. crenulata populations (Matheson Hammock and Coral Pines Parks) are extirpated. Five A. crenulata populations, including three that are reintroduced, remain. The total population size of A. crenulata is approximately 649 individuals (Possley, Fairchild Tropical Botanic Gardens [FTBG], pers. comm. 2017a; Lange, FTBG, pers. comm. 2017; Lange et al. 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation
Exposure:
Response:
Consequence:

Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Indequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: Currently, regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated these species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants, nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Inadequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire suppression continues to affect Amorpha crenulata(Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Nonnative invasive plants
Exposure:
Response:
Consequence:
Narrative: Invasion by exotic plant species continue to affect Amorpha crenulata (Factor E). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree (Bradley and Gann 1999; Bradley 2006; Bradley and Saha 2009; Bradley and van der Heiden 2013). (USFWS, 2019)

Recovery

Reclassification Criteria:
Not developed (USFWS, 1999; USFWS, 2010)

Delisting Criteria:
1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

2. A network of 5 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)

4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:
- Conduct surveys to determine distribution of crenulate lead-plants. Crenulate lead-plants on county-owned pine rockland sites have been thoroughly surveyed in Miami-Dade County. However, other populations may be noted during pine rockland purchase and restoration program implementation. Fire may eliminate litter concealing listed species, or enable seeds in the seed bank to germinate. For that reason, pine rocklands that did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the stabilization of crenulate leadplants that additional populations not be lost. The existing populations should be mapped, including obtaining GPS coordinates and developing GIS coverage. Herbarium voucher specimens should be collected and archived for all populations. (USFWS, 1999)
- Collect biological information important to species recovery. Additional information on the ecology and life history of pine rockland plants needs to be collected. Determine size and viability of all populations. Known populations of the listed pine rockland plants should be evaluated. Population viability needs to be investigated and determined for each listed plant species. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring based upon the protocols developed by FNAI should be used for pine rockland species in order to determine the effect of management actions on these species and make the date compatible to existing databases. (USFWS, 1999)
- Continue to provide public information about pine rocklands and their unique flora. Public support will increase the chances of recovery for pine rockland species. Informational and educational materials have been produced. DERM and Miami-Dade County Parks and Recreation Department's Natural Areas Management have developed flyers, displays, newsletters, and press releases, and have held workshops with the general public. Organizations best able to carry out information and education programs include Metropolitan Miami-Dade County Parks and Recreation Department, the Florida Native Plant Society, Everglades National Park, and Miami-Dade County DERM. Support of local press coverage should continue. DERM has developed a web page that will also aid in

disseminating information about this endangered plant community to the public. (USFWS, 1999)

- Habitat-Level Recovery Actions: Develop a GIS database on all listed pine rockland species and their habitats, and distribute the database to researchers, land managers, and conservationists. Continue to protect and prevent degradation of pine rockland plant habitat. Restore areas to suitable habitat. Monitor habitat and ecological processes. Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. (USFWS, 1999)

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SPECIES ACCOUNT: *Amphianthus pusillus* (Little amphianthus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/5/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

A diminutive aquatic annual with both floating and submerged leaves. The floating leaves are 4-8 mm long and are attached to the submerged plant base by thread-like stems. Flowers are tiny, white to pale purple, and are produced among the floating and the submerged leaves. This is an ephemeral species - it completes its entire life cycle in as little as 3-4 weeks in the spring. (NatureServe, 2015)

Taxonomy

A monotypic genus of uncertain placement within the family. Highly distinct, no close relatives. (NatureServe, 2015)

Historical Range

The range of the Amphianthus has not changed although suitable habitat within the range has diminished. (USFWS, 2008)

Current Range

Granite outcrop areas of Piedmont Alabama, Georgia, and South Carolina. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (NatureServe, 2015)

Lifespan

Adult: 3-4 weeks to several months (USFWS, 2008)

Breeding Season

Adult: February to March, possibly later (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Light and moisture (USFWS, 2008)

Reproduction Narrative

Adult: Amphianthus pusillus is an annual plant with a short life cycle of as little as 3-4 weeks (Garris 1980, Kral 1983, Rayner 1986), but may be longer depending upon when rains start and how quickly its pools dry out in spring. Germination may occur in as little as four days and seems to be dependent only on the presence of light and of sufficient standing water or soil

saturation in its habitat. In some areas, a second germination may occur after summer rains. It has a high reproductive capacity, and a substantial seedbank. It appears to be self-pollinated. The seeds can remain viable in the soil for several years (Pennell 1935, Lunsford 1939). (USFWS, 2008) The plants grow slowly through the winter months; flower buds form early and are clearly visible by early February; flowering generally peaks in mid-March. During this period, if sufficient water and sunshine are present, the plants continue to produce more flowers, both submersed and floating. The plants continue to grow as long as the soil remains moist. By mid-April in most years, most pools are experiencing dry periods between heavy rains. At this time, the plants are totally exposed and the process of fruit maturation continues. In the pools holding water for the longest periods, the plants become relatively large, with 10-15 or more flowers or fruits. Eventually, these dry up also, and by late May or June, all the seeds have been shed, the plants have desiccated and are disintegrating, and there is little if any sign that Amphianthus ever existed (Lunsford 1939, McVaugh and Pyron 1937, Garris 1980, personal observations). Seeds of floating flowers are shed into the water of the pool, and those of the basal flowers and capsules which are totally exposed at maturation are shed onto the soil surface. (NatureServe, 2015)

Habitat Type

Adult: Pools on granite outcrops (USFWS, 2008)

Habitat Vegetation or Surface Water Classification

Adult: Temporary pools (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Isolated pools (USFWS, 2008)

Environmental Specificity

Adult: Very Narrow (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 2008)

Habitat Narrative

Adult: Amphianthus pusillus is totally confined to vernal pools on granite outcrops of the southeastern Piedmont. Optimal habitat has been described as a shallow, flat-bottomed pool almost invariably surrounded by a rock rim several centimeters in height (Garris 1980). These pools tend to be best developed in flatter outcrop areas, such as the flattened crests of dome-shaped outcrops or the extensive flat to gently rolling outcrops (Lester 1938 in Lunsford 1939, Garris 1980). Water depths in the pools at the time of flowering range from 0-10 cm. In the pools which hold less water, or hold water for shorter periods after a rain, deeper soil is required. The number of occupied pools may vary in an area probably due to environmental factors being inconsistent from year to year. Biotic associates of Amphianthus are generally few and of low coverage within the population habitat. Isoetes piedmontana is the most consistently associated species. (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Several species of birds and mammals are known to use the granite outcrops. Tracks have been found on the soils in drying ponds, and it is likely that seeds are dispersed by animals in this manner. It is possible that seeds could overflow in heavy rains and disperse to the other pools, but this is not very likely because there is generally little or no connections between the pools. (NatureServe, 2015)

Population Information and Trends

Population Trends:

Declining (USFWS, 2019a)

Species Trends:

Declining (USFWS, 2019a)

Number of Populations:

77 (20 = extirpated; 3 = Alabama; 51 = Georgia; 3 = South Carolina; USFWS, 2019)

Population Size:

10,000 to >1,000,000 individuals (NatureServe, 2015)

Adaptability:

Low (USFWS, 2008)

Population Narrative:

Because this annual plant has a high reproductive capacity and a substantial seedbank, it may exist in large numbers and high densities when water is in its pool habitat. But plants die when the pools desiccate in the spring, usually March-May. The number of populations is therefore more relevant than numbers of individuals. That population number is declining due to loss of outcrop pools and the inability of the plant to adapt to other habtats. (USFWS, 2008); Cumulatively, between the three states, there has been 77 populations of little amphianthus. Twenty known populations of amphianthus have been documented as extirpated. Of the non-extirpated populations, three occur in Alabama, 51 occur in Georgia, and three occur in South Carolina. Forty-six populations are currently considered extant and 11 populations are in an unknown condition. Fifteen of the extant populations occur on protected lands (e.g. state, county, and private conservation lands). Two additional populations were introduced into a single pool on each protected site outside of the known historic range of the species (Cobb and Jackson Counties, Georgia). Of the known populations, 24 are listed in poor condition because of either low pool redundancy (the population consists of less than three pools) and/or populations occur at outcrops where there still is active quarrying. The populations in Alabama consist of some occupied pools with a limited number of plants, which could indicate the potential of the species being extirpated in that state in the near future (Frings and Davenport 2017). Nine new populations have been discovered in Georgia since the last 5-year review (USFWS 2008), but five of those populations are already classified as poor condition. Nine of the past extant populations have declined in status and three have been classified as extirpated since the last 5-year review (USFWS 2008). Seed bank sources may provide some adaptive capabilities of amphianthus to respond to poor reproductive years, but as the number of plants

decline in individual pools the seed bank also declines making population recovery more unlikely (Boyd and Bartig 1992). (USFWS, 2019). Cumulatively, between the three states, there has been 76 known populations of little amphianthus (Amphianthus pusillus). Of those populations, 20 are currently considered extirpated, 42 are considered extant, and 14 populations are in an unknown condition because of lack of surveys (9 populations) or an inability to relocate the populations (2 populations). Of the non-extirpated populations, 3 occur in Alabama, 50 occur in Georgia, and 3 occur in South Carolina. Thirteen of the extant populations occur on protected lands (e.g. state, county, and private conservation lands), and two additional populations were introduced into a single pool on protected locations outside of the known historic range of the species (Cobb and Jackson Counties, GA). Since the last 5-year review, we have modified how we define populations. Please refer to section C.1.a. for a description of how we define populations. Of the known extant populations, 24 are listed in poor condition because of either low pool redundancy (the population consists of less than three pools) and/or populations occur at outcrops where there still is active quarrying. Populations with less than three pools can make the population vulnerable to extirpation events caused by human activities, because pools close together could all be impacted by a single catastrophic event. Nine new populations of little amphianthus have been documented since the last 5-year review, but five of those populations are classified as poor condition. One population, Clover Community Park (York County, SC; Appendix B.), was extirpated in 2018 from construction run-off (Bradley, University of South Carolina, pers. comm. 2018). One population, St. Mary's Outcrop (Cobb County, GA), was introduced into a single pool in 1986. One population, Rocky Comfort (Warren County, GA), was discovered while a naturalist was documenting the potential travels of William Bartram across Georgia in the 1770's. The six remaining new populations were discovered during an extensive survey in 2012 of all known Lithonia gneiss granite outcrops in Georgia by Allison (2013). Since the last 5-year review, two additional outcrops were listed as extirpated (Sunflower Rock, Heard County, GA, and The Rocks II, Rockdale County, GA). All of the Alabama outcrops where little amphianthus is still extant have seen declines in condition and these populations may be extirpated before the next review, unless conservation efforts prevent their decline. (USFWS, 2019a)

Threats and Stressors

Stressor: Quarrying (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: By far, the greatest threat to these species is the destruction of habitat due to quarrying activities. Of the 16 documented local extinctions of the listed species, eleven can be attributed to this cause. Amphianthus may have been extirpated at up to four additional sites now being quarried. The numerous exposures of granites and gneisses in the Piedmont, particularly in Georgia, have been quarried extensively since the Civil War (Watson 1902, 1910), and an unknown number of undocumented populations of the listed species were doubtless unknowingly destroyed. There are many more abandoned quarries than active ones. Most of the abandoned quarries are small, and may have areas of intact outcrop habitat, sometimes supporting the listed species. (USFWS, 1993) Quarrying companies own 17.4% of the outcrops investigated for Amphianthus in Georgia (Garris 1980). (NatureServe, 2015)

Stressor: Farm animals (USFWS, 1993)

Exposure:
Response:
Consequence:
Narrative: Habitat supporting these species has been degraded through conversion to pasture. Excessive animal wastes have resulted in eutrophication of pools, promoting excessive algal growth, which competes with these species for dissolved carbon dioxide and light. Addition of matter to the habitat increases soil depth, with concomitant reduction in potential water depth. Increased soil depth and organic matter may benefit these species in the short term, but soon result in the invasion of more aggressive native and exotic species. (USFWS, 1993) Cattle using the pools for water may trample Amphianthus. (NatureServe, 2015)

Stressor: Dumping (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Because granitic outcrops are regarded by the uninformed as worthless, they are frequently subjected to dumping of waste materials. This leads, in some cases, to destruction of the microhabitat through covering over or filling in of pools, or through eutrophication. (USFWS, 1993)

Stressor: Vehicular traffic (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Vehicular traffic is a serious problem at many of the extant sites. This can be due to recreational traffic, such as off-road vehicles, motorbikes, or even automobiles in some cases. Even more destructive are the heavy vehicles used in logging operations. At one outcrop explosives were stored in tractor-trailers on the outcrop. As part of the site preparation, many depressions, including all Amphianthus pools, were filled with concrete to provide a smoother surface. Potentially serious disturbance can result from vehicular traffic, often motorbikes, through the pools. These crush the plants, loosen the soil, and probably hasten erosion of the pool rims.

Stressor: Recreational impacts (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Many sites exhibit signs of recreational overuse or abuse. Although those sites that are publicly owned are protected from quarrying, they are subjected to excess foot traffic, littering, or vandalism, such as spray painting. Rearrangement of stones within a pool has caused serious declines of Amphianthus.

Stressor: Other environmental factors (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: In some cases, other environmental factors may have led to the decline of certain populations. As these species require high light intensities (Lammers 1958), excessive tree

growth is suspected to be a problem at a few sites, due to shading. A few pools appear to be moving toward a later stage of succession due to excessive soil accumulation. Amphianthus is sometimes killed by freezes but, being an annual, can recover population size readily. The effects of widespread environmental changes, such as acid rain and possible global warming, are unclear.

Stressor: Inadequacy of existing regulation (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: The Georgia Wildflower Preservation Act has not had a significant effect upon retarding habitat loss, the primary threat. Recreational overuse of publicly owned sites is not always addressed by current ordinances. Existing ordinances against littering, spray-painting, fire-building, off-road vehicles, etc., have proved difficult to enforce, and not fully effective.

Stressor: Fire ants (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Invasive fire ants have been hypothesized to be an additional threat (Malcolm Hodges, pers. comm. March 2006). Fire ants have become well established on some outcrops and their impact is unclear. Fire ants may impact insects that play a role as pollinators or in seed dispersal. (USFWS, 2008)

Recovery

Delisting Criteria:
1. Twenty (20) populations exhibit a stable or increasing trend, evidenced by natural recruitment. (USFWS, 2019)

2. All 20 populations occur on lands protected via a conservation mechanism (addressed listing Factor A and D). (USFWS, 2019)

3. All 20 populations consist of at least 3 occupied pools at least 2.4 m 2 (26 ft 2) in size (addresses listing factor E). (USFWS, 2019)

4. At least 2 populations occur in Alabama and 2 populations occur in South Carolina. (USFWS, 2019)

Recovery Actions:
- Protect existing populations on publicly owned land, and secure plants on private property through negotiated management agreements or through land acquisition. (USFWS, 1993)
- Preserve genetic stock and conduct germination experiments on Amphianthus. Research is needed to determine this species' germination requirements. (USFWS, 1993)
- Monitor populations to determine trends and developing threats. All Amphianthus populations in Alabama and South Carolina should be assessed yearly, as well as at least the best Georgia sites.

- Searches should be made for additional populations. These species have been searched for extensively. However, a few outcrops remain to be explored at the optimal time of year (January through March). (USFWS, 1993)
- Reestablish populations and augment populations at protected locations, if deemed necessary. This requires that the microhabitat of the listed species be present or that similar microhabitat occurs which can be modified or maintained by addition or removal of soil. (USFWS, 1993); Through partnerships with state, non-government, and other sources, populations at Heggie's Rock, Greensboro South, Bradley Mountain, Arabia Mountain, and Stone Mountain have all been modified through pool creation and/or pool modification. Artificial deepening of existing pools or artificially created pools should target the minimum pool size identified in the recovery criteria for the species. Pool creation should target areas at the highest elevation (top of the watershed) of the outcrop and minimize impacts to surrounding landscape. Because of the natural geology of the sites, site choice should also assess likelihood of exfoliation fissures beneath the surface. When intersected, these fissures result in the failure of the pool to hold water. Coordination with the Service in determining locations, size, depth, and source populations should occur. (USFWS, 2019)
- Use management techniques to maintain and/or enhance populations. Maintenance of populations chiefly requires protection from disturbance, i.e., whether certain natural or experimental such actions as manipulation of soil depth or the cutting of nearby trees will benefit the particular microhabitats. (USFWS, 1993)
- Educate the public about the value and fragility of these species and their habitat. Granite outcrops support the most distinctive natural community in the Piedmont. Relatively undisturbed outcrops can provide an all-too-rare primeval experience as well as serving to educate the public on geological, ecological, and evolutionary processes. (USFWS, 1993)
- Protect and/or enhance each of these listed plants as well as other community associates of the granite outcrop. (USFWS, 2008)
- At outcrops with conservation potential, contact the land owners to seek conservation easements or fee simple acquisition. (USFWS, 2008)
- Contact private landowners to request their cooperation in plant conservation. (USFWS, 2008)
- Status surveys need to be completed for these species in all three States. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Before any future efforts to move any of the three plants, we along with partners need to develop a protocol and monitoring schedule prior to moving plants. Any protocol must consider how to limit the potential of hybridization of black-spored quillwort with other Isoetes. Little amphianthus cannot reasonably be expected to be kept in cultivation, therefore, an effort to maintain seed stock from the various pools should be established. The implications of seed storage should be studied to evaluate germination success and techniques. The recovery plan suggested that the effects of quarry dust should also be investigated. Management plans for each of the protected populations should be developed to ensure that future uses of the property (e.g. film industry use and increasing pressures for expanding populations). Studies should be conducted to assess the status of the introduced populations and the viability of plants in the artificial pools. Because most natural pools of both quillworts are larger than the artificially-created pools, these pools may be less resilient to drying out and may not hold water long enough for the species to persist when facing variability in water availability. Efforts may be beneficial to create and research differing pool sizes and depths to understand their impacts on

species viability. Conservation priorities need to be developed that protect and/or enhance each of these listed plants as well as other community associates of the granite outcrop. At outcrops with conservation potential, the landowners need to be contacted to seek conservation easements or fee simple acquisition. The Service and State Heritage programs should continue to contact private landowners to request their cooperation in plant conservation. Status surveys need to be continued for these species in all three States. The Implementation schedule in the recovery plan needs to be updated (USFWS, 2019a)

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Mat-forming quillwort (Isoetes tegetiformans)

Little amphianthus (Amphianthus pusillus)

5-year review

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SPECIES ACCOUNT: *Amsinckia grandiflora* (Large-flowered fiddleneck)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/7/1985; Pacific Southwest (R8)

Physical Description

An annual dicot herb. Flowers are red-orange, 14-20mm. Fruit is smooth and shiny. (NatureServe, 2015). This annual species has bright, red-orange, trumpet-shaped flowers arranged in a fiddleneck-shaped inflorescence. Its bright green foliage is covered with coarse, stiff hairs (USFWS, 2009).

Taxonomy

Amsinckia grandiflora (large-flowered fiddleneck) is an herbaceous plant in the Boraginaceae (borage family) (USFWS, 2009).

Historical Range

Historically, A. grandiflora ranged from northern Contra Costa County, California, at the San Joaquin River Delta, south to Corral Hollow and adjacent areas in San Joaquin County (USFWS, 2009). The full range encompasses about 550 square miles, though much of that is either extirpated or poor introduction sites today (NatureServe, 2015).

Current Range

Currently, A. grandiflora is only found in two reintroduced locations, one at Site 300 in southwestern San Joaquin County and the second at Lougher Ridge in Contra Costa County (USFWS, 2009).

Critical Habitat Designated

Yes; 6/7/1985.

Legal Description

On May 8, 1985, the Service designated critical habitat (effective June 7, 1985) for Amsinckia grundiflora (large-flowered fiddleneck) (50 FR 19374 - 19378).

Critical Habitat Designation

The critical habitat designation for Amsinckia grandiflora includes one area of approximately 180 acres in San Joaquin County, California (50 FR 19374 – 19378). (USFWS, 1985)

California. San Joaquin County, Mount Diablo Meridian, T3S R4E Section 28 W1/2 NW1/4 and W1/2 SW1/4.

Primary Constituent Elements/Physical or Biological Features

This area includes the following known primary constituent elements (50 FR 19374 – 19378). (USFWS, 1985)

A steep, west- and south-facing slope with light textured but stable soils.

Special Management Considerations or Protections

Any activity that would result in a disturbance of the soil or the hydrological regime where the large-flowered fiddleneck occurs would probably adversely modify the critical habitat. Also, any activity that may increase the frequency of grass fires in the area may adversely affect the population and modify the critical habitat. Consturction activities, such as high explosives and controlled burns, could have an adverse impact on the large-flowered fiddleneck and its habitat unless they are undertaken carefully. (USFWS, 1985)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization, vegetative (USFWS, 2009)

Lifespan

Adult: < 1 year (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: Possibly A. edwardsii (USFWS, 1997)

Breeding Season

Adult: Spring (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Fall/winter rain (USFWS, 2009)

Reproduction Narrative

Adult: This species has a low reproductive potential and a primitive reproductive system (NatureServe, 2015). Amsinckia grandiflora is an herbaceous annual that germinates with the onset of fall or early winter rain, grows vegetatively throughout the winter, flowers in the early spring, sets seeds and dies prior to the summer drought. Pollination studies by Carlsen (1996) and Carlsen et. al. (2002) indicate that A. grandiflora is not completely self-incompatible and, under greenhouse conditions, this species' nutlet output can approach that of A. tessellata, a common, self-compatible, homostylous species. Pollinators are needed for A. grandiflora to produce seeds (Carlsen et al. 2002) (USFWS, 2009). Bees, primarily Anthophora edwardsii (a solitary wood-boring bee in the family Megachilidae), were the most consistent visitors to A. grandiflora. However, there is no direct evidence of actual pollination by Anthophora (USFWS, 1997).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal grasslands (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occupies inner coast range grasslands on steep slopes and sandy soil. The environmental specificity is very narrow; it is only known from a very narrow distribution (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unavailable (USFWS, 2019)

Species Trends:

Stable (NatureServe, 2015)

Number of Populations:

2 extant natural populations; 9 extant introduced populations (USFWS, 2019)

Population Size:

~2500 or greater (natural and introduced sites) (USFWS, 2019)

Population Narrative:

At the time of listing, there was only one known population, which consisted of fewer than 50 plants. This population was located in southwestern San Joaquin County, California, at the Lawrence Livermore National Laboratory at the Droptower site at Site 300. In 2017, there were no plants at this site. There are two introduced populations adjacent to the Droptower site with a combined population of 132 plants in 2017 (Carlsen and Paterson 2018). The Draney Canyon site at the Lawrence Livermore National Laboratory at Site 300 was not visited in 2017 (Carlsen and Paterson 2018). There were 84 plants in the Carnegie Canyon site (formerly called the Etchelet site) in 2017 on Contra Costa Water District property (Carlsen and Paterson 2018), and a combined 2,559 plants at ten introduction sites in three counties in 2017 (Schweitzer, pers. comm. 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Invasive species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the primary threat to Amsinckia grandiflora was the invasion of aggressive Amsinckia species and weedy nonnatives into the grassland habitat. This is still an ongoing threat (USFWS, 2009).

Stressor: Grazing (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: At the time of listing it was thought that grazing may have been responsible, in part, for the extirpation of some populations of this species. The introduction of grazing animals to the Livermore area was thought to have degraded the native grasslands that once existed there. Since listing, a combination of either the change in the intensity of grazing or the change from cattle grazing to sheep grazing is thought to have possibly extirpated the natural population located at Carnegie Canyon (T. Carlsen, Lawrence Livermore National Laboratory, pers. comm. 2008). No plants were seen at this site in 2003 (T. Carlsen, pers. comm. 2008) (USFWS, 2009).

Stressor: Reproductive biology (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the relatively primitive reproductive system of Amsinckia grandiflora was thought to put the species at a competitive disadvantage with its congeners and with nonnative plants. This factor continues to threaten A. grandiflora. Additionally, because of the small number of populations and their small sizes, stochastic (chance) extinction also threatens this species (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Small population size increases the susceptibility of a population to extirpation from random demographic, environmental and/or genetic events (Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In this 5-year review populations of 200 growing plants (not counting ungerminated seeds) or less are considered to be small, in keeping with Menges' (1992) calculation that populations of this size are especially vulnerable to even moderate levels of environmental uncertainty. The combination of few populations, small range, and restricted habitat renders Amsinckia grandiflora susceptible to extinction or extirpation from a significant portion of its range due to random events, such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006). Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991; Ellstrand and Elam 1993). Populations that are continually small in size are particularly susceptible to adverse genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes (e.g., undergo population bottlenecks). Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Climate is predicted to change in California during the 21st century (Field et al. 1999; Cayan et al. 2005). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer,

more winter flooding, and drier summer soils (Field et al. 1999; Cayan et al. 2005). The predicted impacts on California's ecosystems projected with a high certainty include higher sea level; decreased suitable habitat for many terrestrial species as climate change intensifies human impacts; and increased competition among urban, agricultural, and natural ecosystem uses (Field et al. 1999). Although the specific effects of climate change on Amsinckia grandiflora are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect this species (USFWS, 2009).

Recovery

Reclassification Criteria:

1. A minimum of six management areas are secured and protected from the threats that caused listing initially, including urbanization, agricultural conversion, competition with invasive vegetation, and livestock overgrazing. (USFWS, 2019)

2. Sufficient information has been obtained to ensure the perpetuation of suitable habitat , and appropriate management, based on this information, is being implemented at each management area in perpetuity. (USFWS, 2019)

3. Each management area has an average of 3,000 individuals over two precipitation cycles or 10 years, whichever is longer, with sufficient acreage of suitable habitat to support an expanded population and provide an appropriate buffer. (USFWS, 2019)

4. The six management areas concurrently demonstrate self-maintenance without intensive management intervention (e.g. hand-pollination, seed collection, off-site propagation) needed to prevent population decline for two precipitation cycles or 10 years, whichever is longer. (USFWS, 2019)

Delisting Criteria:

A/1: A minimum of 12 management areas that encompass sufficient acreage with suitable habitat characteristics and an appropriate buffer area to conduct site specific management actions have been protected in perpetuity. Twelve areas will provide sufficient redundancy for the species to withstand potential catastrophic events. (USFWS, 2019)

C/1: Predation pressure by granivores and herbivores is at a level that does not result in a declining population trend for any of the management areas over four precipitation cycles or 20 years, whichever is longer. (USFWS, 2019)

E/1: Each management area has an average of 16,000 individuals over four precipitation cycles or 20 years, whichever is longer. (USFWS, 2019)

E/2: The twelve management areas concurrently demonstrate self-maintenance without intensive management intervention (e.g. hand-pollination, seed collection, off-site propagation) needed to prevent population decline for four precipitation cycles or 20 years, whichever is longer. (USFWS, 2019)

Recovery Actions:

- Conserve the genetic diversity of Amsinckia grandiflora. As added insurance against extinction, seeds shall be collected from all natural populations. This seed will be available to use for augmentation or reintroduction, if remaining natural populations decline or are extirpated. It is important to ensure that the collected seeds are representative of the entire range of the species' genetic variability, as indicated in Pavlik 1996. Because of the small number of natural populations known at this time, it is very important that propagules be taken in such a way that the donor plants or populations are not reduced. Possible impacts of seed collection or removal of plants from natural populations must be closely monitored to detect any effect harvest may have on source populations. (USFWS, 1997)
- Secure and protect the habitat for at least six management areas within the historical range. To meet the downlisting criteria, at least six management areas need to be established. At least two of these management areas shall comprise natural populations. Habitat also needs to be surveyed for reintroduction sites. If new populations are discovered and confirmed as A. grandflora, the areas where they occur should be protected and enhanced by appropriate means. (USFWS, 1997)
- Contact Landowners. To downlist to threatened status, at least six viable management areas must be protected by perpetual administrative agreements with the landowners on whose land A. grandflora or essential habitat for A. grandflora is found. Landowner contact constitutes the first step in this process.
- Establish six management areas and maintain or enhance populations of Amsinckia grandiflora that may occur within any area. Despite much ongoing habitat work, Amsinckia grandifiora management areas have not yet been designated. Until sites are selected, as many of the natural and reintroduced sites as possible shall be protected. Once the sites have been selected, management areas need to be established. Establishing management areas will include delineating boundaries of each area and securing and protecting habitat within the boundaries. At least two management areas shall contain natural populations. (USFWS, 1997)
- Characterize habitat and management requirements. An understanding of the population trends of each site, and interactions of key community members, including pollinators and dispersal vectors, is necessary to refine management plans and to revise management techniques. Many aspects of the basic life history and ecology of Amsinckia grandflora are not known. Factors that would be the most important for increasing the population size of each natural population need to be determined. Information gained from appropriate studies is needed to establish recovery goals, and to effectively and efficiently manage and protect natural and reintroduced populations of the species and its habitat. (USFWS, 1997)
- Develop and implement site-specific management plan for each management area . Management plans, which direct actions essential for preserving the populations as long as active management is deemed necessary, should be individually tailored to each management area. Because management actions, including habitat protection, monitoring, and population reintroduction are ongoing, these plans have, in practice, been partially completed. However, they should be written down, for the benefit of future managers and researchers, and to promote future management consistency. (USFWS, 1997)
- Reintroduce populations into management areas. Downlisting and recovery of Amsinckia grandflora require that additional populations be established and maintained. The interim goal, for downlisting, is to have at least six management areas with 1,500 reproductive plants each. To accomplish this goal, unless new populations are discovered, A. grandflora must have success in reintroductions on four management areas. The potential sites must

be identified and tested for suitability as reintroduction sites. Specific establishment test sites must be selected, secured, and managed. (USFWS, 1997)

- Determine delisting criteria . Information gathered needs to be analyzed to establish delisting criteria. Genetic factors also need to be studied to determine if they are limiting
- Secure the Carnegie Canyon population. The Carnegie Canyon population should be secured from a willing seller by fee title for the benefit of several listed species (USFWS, 2009).
- Conduct a management study whose first objective is the establishment of 6 to 10 acres of thriving Amsinckia grandiflora populations with the ultimate objective of determining what factors enable and prevent sufficient recruitment to sustain the populations. This study would be done in a completely controlled and intensively managed basis. Amsinckia grandiflora has been grown successfully in greenhouses, but we do not know why it is not thriving in the wild. Such a study would provide the information needed for recovery, while maintaining the seed stocks and as much genetic variability and adaptability as is needed to implement recovery. The expanded scale would also allow the study of more extensive techniques and the study of more kinds of management techniques simultaneously (USFWS, 2009).
- Maintain seed bank to have viable seeds for restoration (USFWS, 2009).
- Determine causes for the extirpations of the natural and reintroduced occurrences and remedy the decline of Amsinckia grandiflora (USFWS, 2009).
- Conduct a study to help determine the effect of grazing and other vegetation management on Amsinckia grandiflora populations and the restoration of perennial grasslands (USFWS, 2009).
- Conduct surveys to try to locate additional natural occurrences of Amsinckia grandiflora (USWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS 1. Continue to study the habitat requirements of the large-flowered fiddleneck to determine what factors enable sufficient recruitment to maintain population viability (i.e., selfmaintenance without augmentation) and to identify future recovery sites. 2. Continue working with the Natural Resources Conservation Service to develop guidance for grazing on properties where fiddleneck occurs and grazing is allowed. 3. Ensure self-perpetuating fiddleneck populations are protected in perpetuity. 4. Continue to maintain a seed bank to have viable seeds for restoration. 5. Conduct surveys to try to locate additional natural occurrences of the fiddleneck. 6. Continue to monitor the populations selected for Phase 2 of the reintroduction effort through the remainder of the precipitation cycle. (USFWS, 2021)

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SPECIES ACCOUNT: *Amsonia kearneyana* (Kearney's blue-star)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/19/1989; Southwest Region (R2) (USFWS, 2016)

Physical Description

A perennial herb; the root crown produces many erect, rarely branching, pubescent stems. Leaves are alternate, lance-shaped, 0.4 - 0.7 inch (11 - 17 mm) long, 0.1-0.3 inch (3 - 8 mm) wide, soft, and bright green with short petioles. Mature plants are about 2.3 feet (0.7 m) high and 3.0 feet (0.9 m) across. The pale blue flowers are 1.2 - 3.9 inches (12 - 15 mm) long . The fruits are follicles 1.2 - 3.9 inches (3 - 10 cm) long and are usually paired, a characteristic of the dogbane family. The follicles are terminal and extend above the foliage. Seeds are corky cylinders 0.1 - 0.2 inch (3 - 4 mm) wide and 0.3 - 0.4 inch (8 - 11 mm) long with tapered ends (USFWS, 1993).

Taxonomy

In the dogbane family (Apocynaceae) (USFWS, 1993)

Historical Range

See Current Range

Current Range

Known from the Baboquivan Mountains in Pima County, Arizona (USFWS, 1993).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect, Bird (USFWS, 2013)

Breeding Season

Adult: Flower clusters form in April; fruits from June to July (USFWS, 1993).

Key Resources Needed for Breeding

Adult: Insects and hummingbirds for pollination (EPA, 2016)

Reproduction Narrative

Adult: Flower clusters form in April; fruits from June to July. Butterflies, beetles, and hummingbirds have been observed feeding on flowers (USFWS, 1993). A. kearneyana is known to be pollinated by a wide range of insect and hummingbird pollinators (Reichenbacher et al. 1994; Service 2012). Many of these pollinators may travel hundreds of meters between individual A. kearneyana plants and may be utilizing associated plant species with overlapping bloom periods that occur geographically between A. kearneyana plants (USFWS, 2013).

Habitat Type

Adult: Terrestrial

Habitat Vegetation or Surface Water Classification

Adult: Open unconsolidated slopes and intermittent stream beds (USFWS 2013); The habitat of A. kearneyana lies at the lower elevation transition of the Madrean pine-oak woodland and the semi-desert grassland (USFWS, 2021). Within this habitat, Amsonia kearneyana occurs in both open woodland on unconsolidated slopes of over 20 degrees, and canyon bottoms in full sun to partial shade (USFWS, 2021).

Dependencies on Specific Environmental Elements

Adult: Drainage bottoms support some individuals, but most A. kearneyana occur on 20-30 degree slopes (USFWS, 2021).

Geographic or Habitat Restraints or Barriers

Adult: 3,600-6,000 ft elevation (USFWS, 2013)

Environmental Specificity

Adult: Moderate. Generalist or community with some key requirements scarce (NatureServe, 2015)

Habitat Narrative

Adult: The habitat of A. kearneyana lies at the lower elevation transition of the Madrean pine-oak woodland and the semi-desert grassland (The Nature Conservancy [TNC] 2006, p. 5-1; Arizona Rare Plant Guide Committee 2001, unpaginated). Within this habitat, Amsonia kearneyana occurs in both open woodland on unconsolidated slopes of over 20 degrees, and canyon bottoms in full sun to partial shade (Figures 6-8; Arizona Rare Plant Guide Committee 2001, unpaginated). This species is known only from the slopes and canyons of the Baboquivari Mountains of Pima County in southern Arizona at elevations from 1,095 to 1,830 m (3,600 to 6,000 feet [ft]). The Baboquivari Mountains are a granitic outcrop containing a mixture of species from four distinct floras, making this a very diverse region floristically (Austin 2009, p. 1). Donovan (1998, p. 4) states that drainage bottoms support some individuals, but most A. kearneyana occur on 20-30 degree slopes. Associated species in the upslope locations include sparse Quercus emoryi and obolngifolia (Emory and Mexican blue oaks), Pinus cembroides (Mexican pinyon pine), Acacia greggii (catclaw acacia), Dasylirion wheeleri (sotol), Agave schottii (shindagger agave), Garrya wrightii (Wright's silktassel), Rhus trilobata (squawbush), and Nolina microcarpa (beargrass). Associated species of the canyon bottom habitat include Celtus reticulata (netleaf hackberry), Juglans major (Arizona walnut), A. greggii, Q. obolngifolia, D. wheeleri, and Plumbago scandens (doctorbush) (USFWS, 1993).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The nature of the seeds and the riparian habitat suggest that floodwater associated with storms that occur mostly from July to September disperse the seeds (USFWS, 1993).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015); There is a single population with multiple groups; we do not know the current status of each group on the Tohono O'ohdam Nation; all other groups known historically are still present.

Species Trends:

Decline of 10-30% (NatureServe, 2015); There has been a 48 percent decline in the number of known individuals since the 1980s.

Resiliency:

Low (inferred from NatureServe, 2015)

Representation:

Low (inferred from NatureServe, 2015)

Redundancy:

Low (inferred from NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015); Documentation of reproduction has beenvery limited (USFWS, 2021).

Number of Populations:

1 - 5 (NatureServe, 2015); There is a single population with multiple groups, all within the distance primary pollinators may travel.

Population Size:

1 - 1000 individuals (NatureServe, 2015); We are aware of 332 individuals, down from 785 in the 1980s and 1990s (USFWS, 2021).

Minimum Viable Population Size:

Based on our current understanding of the species, as well as minimum rare plant population sizes called for in the literature, a minimum viable population (MVP) of 1,225 may be needed to achieve resiliency for A. kearneyana (USFWS, 2021).

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

From a very isolated area in Arizona and Sonora, Mexico. Unknown 8 individuals from one population in Arizona - formerly 25 (5/93 Recovery Plan). In fall 1988 and winter 1989, 181 individuals were transplanted to another canyon in the same mountain range. A flood removed most of the individuals except for 33 in the summer of 1990. Another planting was made in the winter of 1992 (FWS, in AGFD 2012). Abundance of this plant is considered low (Laurenzi and Spence, 2012). Occupies a few canyons in the Baboquivari Mountains. Formerly known only from (probable) type locality in Arizona, on west-facing drainage. Occupies a few canyons in the Baboquivari Mountains. Discovered about 1996 nearby in Sonora, Mexico (NatureServe, 2015).

Since it was listed as Endangered in 1993, A. kearneyana has been discovered at new locations; however, overall the number of A. kearneyana individuals has decreased (Table 2) and documentation of reproduction is limited. Comparing recent and historical survey results of A. kearneyana at subsites to which we had access, the number of individuals has declined by about 48 percent (USFWS, 2021).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013); Factor A: poorly managed livestock grazing, nonnative plant presence and spread, altered wildfire regime, and border activities (USFWS 2021)
Exposure:
Response:
Consequence:
Narrative: Kearney's blue star and its habitat is susceptible to damage from livestock grazing, wildfire, flooding, nonnative plant invasion, small population size, drought and climate change, and foot traffic resulting from border activity at the U.S.-Mexico border (USFWS, 2013; USFWS 2021).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2013); Factor E: low numbers and limited distribution, drought and climate change, and trampling by livestock (USFWS 2021)
Exposure:
Response:
Consequence:
Narrative: Low numbers, few populations, and apparently insufficient reproduction and climate change are threats to the species. Amsonia kearneyana has a very restricted geographic range with a small number of known subpopulations ranging in size from a single plant to roughly 130 individuals (Donovan 1998; Service 2012). Additionally, seedlings are rare in both wild subpopulations and in the transplant population (USFWS, 2013).

Stressor: Predation (USFWS, 1993); Factor C: seed predation (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Due to predation by some insect on the plants at Brown Canyon, Reichenbacher et.al. (1991) noted that all of the follicles produced by 31 Kearney's blue star plants had to be collected prematurely. The predator, in this case, was never identified. Thus, it appears Kearney's blue star may be subject to intense periodic predation by several insects (USFWS, 1993). The native stink bug, Chlorochroa ligulata, is likely primary seed predator and predation increases in wetter years (USFWS, 2021).

Stressor: Drought and Climate Change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Climate change is likely to adversely affect the long-term survival and distribution of native plant species, including Kearney's blue-star, through changes in temperature and

precipitation. In addition to low precipitation impacting Kearney's blue-star germination and growth, the increased severity of storms also impacts the species. Climatic projections for the southwestern United States indicate both increased summer drought coupled with more intense periodic rainfall events (Zhang et al. 2012, p. 390; Karl et al. 2009, p. 24). Such extreme rainfall is projected to increase runoff and soil erosion (Zhang et al. 2012, p. 390). Kearney's blue-star is known to be impacted by flooding, as evidenced by the loss of roughly 75 percent of the plants in the Lower Brown Canyon Introduction Site due to extreme flood events during the early 1990s (Reichenbacher et al. 1994, p. 2). In addition, in April 2019, it was reported the area around the transplant population is now more channelized and flashier (M. Radke pers. comm. April 22, 2019). An increase in the intensity of seasonal flooding could reduce or even remove Kearney's blue-star plants growing in canyon bottoms and severely damage slope-side plants due to erosion of their associated friable soils. (USFWS, 2022)

Recovery

Reclassification Criteria:
A minimum of 1,225 A. kearneyana thorughout the species' known range are stable or increasing over a 20-year period, with the number of individuals ≥1,225 at the last two monitoring events (USFWS, 2021).

At least 60 percent or 1,239 ha of the 2,064 total ha of habitat across the currently known range supports A. kearneyana or its pollinators. Of the 1,239 ha, at least 65% (805 ha) must be in optimal condition and 35% (434 ha) must be in good condition (USFWS, 2021).

At least 25 percent of the remaining habitat across the currently known range supports A. kearneyana or its pollinators although this habitat may be of lesser quality (USFWS, 2021).

Cooperative programs are being developed and partially implemented to address threats and conserve habitat, seedbank, and pollinator habitat to ensure continued existence of A. kearneyana. These efforts include sharing of collected data between land managers and researchers, as well as development and partial implementation of land management plans that effectively manage nonnative plants, restore a more natural fire regime, and promote pollinator diversity and habitat (USFWS, 2021).

Delisting Criteria:
A minimum of 1,225 A. kearneyana throughout the species' known range are stable or increasing over 25 years of a 30-year period with the number of individuals ≥1,225 at the last two monitoring events (USFWS, 2021).

At least 75 percent of habitat (1,548 ha) of the 2,064 total ha of habitat across the currently known range supports A. kearneyana or its pollinators. Of the 1,548 ha, at least 65% (1,006 ha) must be in optimal condition and 35% (542 ha) must be in good condition (USFWS, 2021).

At least 40 percent of the remaining habitat across the currently known range supports A. kearneyana or its pollinators although this habitat may be of lesser quality. There is potential for habitat improvement with land management practices (USFWS, 2021).

Cooperative efforts are being fully implemented to address threats and conserve habitat, seedbank, and pollinator habitat in perpetuity to ensure continued existence of A. kearneyana. These efforts include sharing of collected data between land managers and researchers, as well as implementation of land management plans that effectively manage nonnative plants, restore a more natural fire regime, and promote pollinator diversity and habitat (USFWS, 2021).

Recovery Actions:

- Census known A. kearneyana subsites; Monitor A. kearneyana individuals and their habitat; Survey for new A. kearneyana individuals and subsites; Augment the number of A. kearneyana individuals at existing subsites; Establish new A. kearneyana subsites; Acquire A. kearneyana habitat with existing and new subsites and protect subsites; Establish and maintain A. kearneyana seeds and plants in botanical institutions; Conduct research relating to A. kearneyana biology, ecology, threats, management, etc.; Monitor threats to A. kearneyana; Reduce threats to A. kearneyana and manage habitat quality; Conduct outreach, education, and coordination relating to A. kearneyana conservation and recovery (USFWS, 2021).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS A full suite of recovery actions is included in the 2021 Kearney's Blue Star (Amsonia kearneyana) Final Recovery Plan First Revision (Service 2021, entire). The status of the species is still precarious, and we continue to recommend all the actions be implemented to recovery the species. In addition to these needed actions, the Kearney's blue-star continues to have many information gaps that, if known, could aid in its recovery. The following is a list of known information gaps and research needs for Kearney's blue-star. i. Surveys - Additional Kearney's blue-star surveys in Arizona and Mexico are needed to determine distribution and status across the entire range. Donovan (1998, p. 4) states the species does not appear to be habitat limited and that there is a high possibility that more plants occur on the TON. Difficulty, however, lies in the inaccessibility of both the remote and rugged terrain, as well as, in attaining permission to access to lands administered by the ASLD, the TON, and possibly sites in Mexico. It is possible that the use of drones, scent detection dogs, or other innovative methods may assist in this endeavor, given landowner permissions are attained. ii. Biology - Basic Kearney's blue-star biology studies are needed. For example, what is the lifespan of Kearney's blue-star? Are flowers self-compatible, obligate outcrosser, or facultative (e.g., greenhouse studies to see if selfing produces viable seed)? Also, a map of the daily production of nectar, the receptivity of stigmatic surfaces, and the dehiscence of anthers, would be useful in determining pollinator effectiveness. How do populations of known pollinators vary across habitat types and conditions in the site? iii. Genetics - Studies of Kearney's blue-star genetics within and between subsites are needed to determine the functioning and structure of populations, the level of genetic diversity, if inbreeding depression is occurring, and how frequently sexual vs. vegetative reproduction is required to maintain or improve genetic diversity. Given human induced changes to the environment that occur more rapidly than historical changes, sexual reproduction may become more important than it was in the past in order to adapt more rapidly (Fehlberg pers. comm. February 28, 2019). iv. Threats - Studies on the effects to Kearney's blue-star from nonnative plant competition, livestock use of habitat, shade and nurse tree reduction, and fire frequency and severity shifts are necessary to better understand how these impact Kearney's blue-star germination, growth, and reproduction. For example, how does regular low severity fire vs. irregular high severity fire impact the species? Does the loss of shade trees to fire and drought impact moisture, humidity, and Kearney's blue-star germination and survival? Is smoke a germination cue that is missing? v. Introductions - Studies of the best methods for

Kearney's blue-star introduction are needed to create new viable populations. For example, what is the best introduction location for this species? Can plants be grown in the field with direct seeding under protective wire mesh? How can seed germination be improved when seed availability must coincide with wet years for germination and initial seedling survival? vi. Management – Determine the best management practices for optimal habitat and pollinator health. (USFWS, 2022)

- THE 1993 RECOVERY PLAN WAS REPLACED IN JANUARY 2021 AND NOW CONTAINS UPDATED, OBJECTIVE, MEASURABLE CRITERIA.
- The 1993 Recovery Plan should be updated with recovery criteria that reflect current threats to A. kearneyana. Updated objective, measurable criteria for downlisting and delisting should be established (USFWS, 2013).
- Studies should be conducted to evaluate impacts of climate and long-term drought on this species. Studies should focus on site specific climate changes such as precipitation, snowfall, and temperature that influence flower and seed production, and seed germination (USFWS, 2013).
- Studies should be conducted to evaluate the impacts of nonnative plant invasion and fire of varying severity on this species. Comparisons to non-burned subpopulations on Tohono O'odham lands would be very helpful (USFWS, 2013). NOTE that most TON Amsonia has burned in the past few years.
- Studies should be conducted to evaluate the pollination ecology of A. kearneyana and evaluate if pollinators are connecting all subpopulations, thereby maintaining genetic diversity (USFWS, 2013). Studies of pollination ecology have been done, but genetics is needed.
- Establish monitoring within several subpopulations that allows comparison of data over time and across various disturbance regimes (USFWS, 2013). This has also been done, though more monitoring is needed, especially on State and TON lands.
- Studies specific to genetics or trends in genetic variation should be completed (USFWS, 2013).

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SPECIES ACCOUNT: *Apios priceana* (Price's potato-bean)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/5/1990; Southeast Region (R4)

Physical Description

A twining, herbaceous, perennial vine that grows from a stout, thick, roundish tuber often 18 centimeters (cm) or 7.2 inches (in.) in diameter (Figure 1). The stem is round in cross section, somewhat twisted and slightly ridged. It is finely hairy early in its growth, but later becomes smooth and glabrous. Leaves of the main stem are 20 to 30 cm (8 to 12 in.) long, alternate, and pinnately compound with 7 (5 to 9) leaflets. The leaflets are 4 to 10 cm (1.6 to 4.0 in.) long and half as wide, ovate and obtuse or rounded at the base and on 3 to 5 millimeter (mm) (0.1 to 0.2 in.) hairy stalks. The upper leaflet surface is smooth at maturity, and the lower surface is pale, slightly hairy, and veiny. Leaves and leaflets of branches are smaller than those of the main stem. Racemes are 5 to 15 cm (2 to 6 in.) long, dense with flowers (50 to 70) and are usually in clusters of two and three in the axils of the leaves. Pedicels (flower stalks) are thin and 3 to 5 mm (0.1 to 0.2 in.) long; the bracts (small leaves at base of flowers) are longer than the pedicels and are ovate with a slender, tapering tip. The greenish-white or brownish pink flowers are 1 cm long (0.4 in.) and tinged with magenta at the apex. The standard (large, upper petal) is bi-auriculate (ear-shaped appendages) at the base with a fleshy beak-like apex, the wings (lateral petals) are shorter and narrowly oblong but rounded at the base, and the keel (bottom, ridged petals) are fleshy and curved upward. Pods are 12 to 15 cm (5 to 6 in.) long, 1 cm (0.4 in.) wide, and tapering at both ends. There are usually 4 to 10 seeds per pod. Seeds are 7 to 8 mm (0.3 in.) long and separated in the pod by a silvery white endocarp. The roots of A. priceana produce nodules 2 to 3.5 mm (0.1 in.) in diameter (Robinson 1898; Kral 1980; Woods 1988; Isely 1990; L. McCook, Missouri Botanical Garden, personal communication, 1992). (USFWS, 1993)

Taxonomy

A member of the pea family (Fabaceae). The genus Apios was described by Cornut in 1633; however, Linnaeus called the genus Glycine in 1753. In 1905, at the botanical congress in Vienna, Apios was conserved over Glvcine (pro parte). The genus consists of three Asian species and two North American species (Woods 1988). Common names for Apios oriceana include Price’s potato-bean, Sadie Price’s potato-bean, potato-bean, and Price’s ground nut. Type specimens are in the Gray Herbarium, Cambridge, Massachusetts. (USFWS, 1993). Woods (2005) revised the taxonomy of the North American species of Apios (Fabaceae). In doing so, he maintained recognition of Price’s potato-bean as Apios priceana Robinson, as originally published. A phylogenetic analysis indicated that the genus Apios originated in Southeast Asia, and that the North American species (A. americana and A. priceana) are more closely related to one another than to any of the Asian species (Li et al. 2014) (USFWS, 2016).

Historical Range

At time of Recovery Plan, found in 22 counties in five states: Alabama, Illinois, Kentucky, Mississippi, and Tennessee. Originally found in 1896 by Sadie Price in open woods near Bowling Green in Warren County, Kentucky. (USFWS, 1993)

Current Range

Mississippi (Clay, Oktibbeha and Lee counties); Alabama (Madison, Autsuga and Marshall counties); Kentucky (Lyon, Livingston and Trigg counties); Tennessee (Marion, Montgomery and Williamson counties) (NatureServe, 2015). The species is considered extirpated from the State of Illinois (Ebinger et al. 2010) (USFWS, 2016).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: primarily cross-pollination, self-pollination possible (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Multiple floral visitors/multiple effective pollinators (USFWS, 2022)

Breeding Season

Adult: June through September (NatureServe, 2015)

Other Reproductive Information

Adult: Various floral visitors (potential pollinators) have been identified, including Bombus spp. (bumble bees), Megachile sculpturalis (giant resin bee), M. campanulae (bellflower resin bee), and Hemaris thysbe (hummingbird clearwing) (Campbell et al. 2016). Of note is M. sculpturalis, which is non-native to the U.S., originating in eastern Asia, but may provide pollination services to dozens of plant species in the U.S. (including A. priceana) and is generally considered a benign introduced species (Campbell et al. 2016; Stevens et al. 2019). Paris and Boyd (2018) found multiple bee species were equally effective pollinators for Price's potato-bean, indicating pollinator redundancy provides resilience from the species perspective (Senapathi et al. 2015). Considering reports of widespread declines in North American bumblebee populations (e.g., Cameron et al. 2011), reliance of Price's potato-bean upon a suite of pollinating bees might buffer potential impacts of individual bumblebee population declines. However, the bee fauna Price's potato-bean relies on may need additional conservation consideration to sustain adequate pollination services (Paris and Boyd 2018). Additionally, loss of pollination services by native bees may be offset somewhat by non-native bees, such as M. sculpturalis although the effectiveness of such non-native species as pollinators of Price's potato-bean is unknown (USFWS, 2022).

Reproduction Narrative

Adult: Flowers of A. priceana bloom from June through August, possibly as late as September (Kral 1983, Mahler 1970). Legumes mature in August to September (Kral 1983). Early reports by the discoverer of the species, Sadie Price, suggested that it does not frequently set fruit (Robinson 1898). Flowers of A. priceana bloom from June through August, possibly as late as September (Kral 1983, Mahler 1970). Legumes mature in August to September (Kral 1983). Early reports by the discoverer of the species, Sadie Price, suggested that it does not frequently set fruit (Robinson 1898). Potential pollinators include a butterfly (Eudamus tityrus), honey and bumble bees (Robinson 1898). Apparently the bees find the nectaries very difficult to access.

Apios priceana can be readily germinated by scarification of the seed coat through chipping (Seabrook 1973) or acid (Walter et al. 1986). Plants can grow 5-6 feet during the first summer, but do not flower. Flowering is apparently initiated only in plants that have over-wintered (Baskin pers. comm.). Tubers of A. priceana apparently require vernalization for growth (Bowden pers. comm.). Plants die back to the tuber in the mid-summer (NatureServe, 2015). Apios priceana plants produce very few seeds (Robinson 1898, Chester and Holt 1990). This low level of sexual reproduction may result in small population sizes and little dispersal of the species to new sites. It also is likely to result in low genetic diversity within populations (USFWS, 1993). During 2013, 10,752 flower buds were initiated, from which 2,550 flowers were produced, resulting in 97 mature fruits bearing a total of 234 seeds. Reproductive output was lower during 2010, when a sample of five plants that generated 4,299 flower buds ultimately produced only 7 mature fruits, yielding a total of 51 seeds. Results of a field-based study of the species' breeding system indicated that A. priceana is not self-compatible (Boyd 2014). However, production of viable seeds by a lone plant at Missouri Botanical Garden indicates that selfcompatibility is possible (M. Albrecht pers. comm. 2008). At least four species of medium (~1-1.5 cm length; Bombus pennsylvanicus, Bombus sp.) to large bees (>1.5 cm; Bombus bimaculatus, Megachile sculpturalis) were relatively efficient pollinators in the breeding system study (Boyd 2014) (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Palustrine: forested wetland, riparian; Terrestrial: Cliff, Forest - Mixed, Forest/Woodland, Woodland - Mixed (NatureServe, 2015)

Environmental Specificity

Adult: Broad (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Open, rocky, wooded slopes and floodplain edges. Sites are usually under mixed hardwoods or in associated forest clearings, often where bluffs or ravine slopes meet creek or river bottoms. Soils are well-drained and loamy, formed on alluvium or over calcareous boulders. Several populations extend onto road or powerline rights-of-way. Price's potato-bean is an inhabitant of open, mixed-oak forests, forest edges and clearings on river bottoms and ravines, being unable to tolerate deep shade (USFWS 1989, Kral 1983). The species occurs on well-drained loams on old alluvium or over calcareous boulders (Kral 1983). According to the Missouri Botanical Garden, A. priceana prefers acidic, water retentive soils, requires no soil additives, can withstand winter temperatures below 5 degrees Celsius, shows no intolerance to supplemental feedings, and possesses no apparent pests (Bowden pers. comm.) (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Unlike its close relative, Apios americana, which produces numerous tubers, A. priceana produces only one. This fact may serve to severely limit natural dispersal of the species. Since A. priceana has just the single tuber, it is unable to be dispersed effectively along rivers by spring freshets as is A. americana (Seabrook and Dionne 1976) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2022)

Number of Populations:

57 (USFWS, 2022)

Adaptability:

Relatively resistant (NatureServe, 2015)

Population Narrative:

There are now 57 extant populations of Price's potato-bean distributed among 27 counties in 4 states (Table 1; Figure 1; ANHP 2022; KSNPC 2022; MNHP 2022; TDEC 2022). These populations are distributed across multiple U.S. Environmental Protection Agency (EPA) Level III ecoregions, which represent different ecological zones that share a characteristic set of natural communities, floral and faunal species, ecological dynamics, and environmental conditions (Figure 1; Omernik 1987). We are presuming the 15 populations that were not surveyed since the last 5-year review remain extant (Service 2016; ANHP 2022; KSNPC 2022; MNHP 2022; TDEC 2022). The general spatial extent of the species remains similar to what was reported in the last 5-year review. There is one new county included in the species distribution (e.g., adding Warren County, Kentucky), and the species remains extirpated from Illinois. A number of the populations are small and isolated from other known extant populations, limiting connectivity and potential gene flow. Because Price's potato-bean is known to periodically assume dormancy during the growing season until conditions are more suitable, numbers in this document should be considered best available estimates (Service 1993; Schotz 2018). Of the 59 total populations reported in the 2016 5-year review, 7 are presumed extirpated. However, an additional five populations have been identified since the last 5-year review (Service 2016). Four of the new populations were found in Alabama ranging in size from 12-24 plants and an additional new, very small population, i.e., 2 plants, was discovered in Kentucky. Of the extant populations, 13 in Alabama, 5 in Kentucky, 2 in Mississippi, and 6 in Tennessee are located on publicly owned lands or private conservation lands that are currently considered protected (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 1993)
Exposure:

Response:
Consequence:
Narrative: Logging may threaten A. priceana populations. Selective removal of trees that shade plants can enhance growth and reproduction of A. priceana by increasing levels of light; however, clearcutting or heavy logging can eliminate populations (U.S. Fish and Wildlife Service 1989). It is unclear whether clearcutting will result in permanent destruction of populations. Populations of A. priceana are found in secondary-growth forest suggesting that the species may recover after heavy logging (Kral 1983). Landowners who do not know that the species is on their land or who are not interested in its continued survival may make land management decisions that are harmful to the species. The location of 11 populations on rights-of-way (road edges, powerlines, etc.) is also a potential threat to the species. Maintenance of these areas by herbicides, mowing, and clearing of trees could damage or extirpate these populations (U.S. Fish and Wildlife Service 1989, Chester and Holt 1990). Clearing trees may be harmful if the debris is piled on top of the populations. Widening of a road adjacent to an A. priceana population could easily wipe out an entire population. Mining for limestone is a potential threat to A. priceana populations found over limestone bedrock (Kral 1983). Grazing and trampling of plants by cattle can cause severe damage. The erosion of soil that results from heavy grazing and trampling also can harm the species (Medley 1980) (USFWS, 1993).

Stressor: Low reproductive potential (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Apios priceana plants produce very few seeds (Robinson 1898, Chester and Holt 1990). This low level of sexual reproduction may result in small population sizes and little dispersal of the species to new sites. It also is likely to result in low genetic diversity within populations. It is not known whether A. priceana reproduces vegetatively; 1993).

Stressor: Pests and pathogens (USFWS, 1993; 2016)
Exposure:
Response:
Consequence:
Narrative: A variety of pests are reported to damage A. priceana plants, including spider mites (D. Wright, Missouri Botanical Garden, personal communication, 1991), a powdery mildew virus, and root-knot nematodes (Blackmon and Reynolds 1986). An unidentified insect has been observed to damage the flowers and fruits of A. priceana (E. Chester, personal communication, 1991). These pests may have a significant effect on A. priceana (USFWS, 1993). The bean leaf beetle (Certoma trifurcate) was observed eating leaves and flower buds, causing the formation of holes in the leaves and interrupting development of flowers and fruits. A second species of beetle, Chalepus scapularis, was collected from an A. priceana plant, but its feeding behavior was not observed. The extent to which these observations of insect herbivory indicate a threat to A. priceana is not known, but monitoring efforts for the species should include assessments of the extent of insect herbivory when observed and collection of specimens to identify potentially threatening species (USFWS, 2016).

Stressor: Invasive species (USFWS, 1993)
Exposure:
Response:

Consequence:
Narrative: An introduced, invasive plant, Coronilla varia (crown vetch), is threatening to outcompete one Kentucky population (Chester and Holt 1990). Other exotics, Ligustrum sinense and Rosa multiflora, are reported to be competing with populations in Mississippi (M. Morris, University of Florida, personal communication, 1992) (USFWS, 1993).

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Davenport (2007) included A. priceana in an analysis of potential effects of climate change on Alabama's plant life. The analysis was based on best professional judgment of how various habitat types and associated species would respond to climate changes that models predict Alabama will experience. Davenport (2007) concluded that "species demanding shady ravines and stream banks will constrict in distribution", including the hardwood forests inhabited by A. priceana. (USFWS, 2016).

Stressor: Feral hogs (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: we have identified feral hogs (Sus scrofa) as a potential new threat to the species. Noted to be among the most destructive exotic vertebrates established in the Southeast, feral hogs severely damage a variety of habitats and sensitive ecological communities, including those containing federally listed species (Lewis et al. 2019; Fern et al. 2020; Glow et al. 2020). Extensive feral hog damage has been observed across Bankhead National Forest, Alabama, where three protected Price's potato-bean sites occur (A. Cochran pers. comm. 2022). While there is no known record of direct damage to Price's potato-bean plants therein, as feral hog numbers increase, direct impacts to the species are anticipated, which necessitates additional research to assess their impacts on Price's potato-bean populations and habitats. (USFWS, 2022)

Stressor: Herbicide overspray (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: In addition, we have identified herbicide overspray from agricultural fields as another emerging threat. Overspray has been observed near a protected population in Tennessee, but is most notable in Mississippi, where three of four known Price's potato-bean populations occur on property adjacent to cropland (MNHP 2022). Most recently, the Chickasaw Preserve (part of the larger Coonewah population and one of Mississippi's two protected populations) sustained substantial herbicide damage due to its proximity to neighboring soybean fields (J. Franklin pers. comm. 2022). While seed set is expected to be reduced or eliminated for the year because of exposure, uncertainty remains regarding the extent, severity, and precise impacts of how Price's potato-bean individuals will be affected by herbicide activity for agricultural purposes; therefore, more directed assessments are required (USFWS, 2022).

Stressor: Climate change (USFWS, 2022)
Exposure:

Response:
Consequence:
Narrative: First proposed as an emerging issue in the 2016 5-year review, the threat of climate change has been intensifying in recent years and is now considered a major driver limiting species viability (Service 2016). Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, species interactions, and myriad plant physiological responses (Hawkins et al. 2008). The predicted increase in drought frequency, intensity, and duration could adversely affect the habitats inhabited by Price's potato-bean by reducing soil moisture and increasing plant mortality rates or reducing flowering and seed production rates. A positive effect of increased drought could result from increased mortality of woody vegetation and reduced rates of vegetation succession. Climate change may also disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Hawkins et al. 2008; Hegland et al. 2009), which may thereby reduce sexual reproduction of Price's potato-bean. However, while climate has changed in recent decades in the region where Price's potato-bean occurs and the rate of change is expected to continue increasing for the foreseeable future, uncertainty remains regarding the extent, severity, and precise impacts of how Price's potato-bean's habitats and its interspecific interactions will be affected by these changes and how the species will respond to these changes (USFWS, 2022).

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 8

Delisting Criteria:
1. When there are at least 25 geographically distinct, self-sustaining, protected populations and they have been maintained for 10 years. A population will be considered self-sustaining if the population size is stable and there is evidence of successful reproduction. Protected populations will have appropriate legal protection and appropriate management. (USFWS, 1993).

Recovery Actions:

- Protect known populations. Twenty-one of the 25 known populations of A. priceana are on privately—owned land; the remaining four populations are on federally-owned land. One of the privately-owned populations is owned by The Nature Conservancy and is adequately protected. Four of the privately-owned populations are Registered Natural Areas. The remaining 16 privately-owned populations are unprotected. Legal protection of these areas is necessary to provide long—term security and prevent land use that is harmful to the species. Management plans should be developed for all populations that are protected, particularly those owned by the Federal government and conservation organizations. Management plans should be developed for the remaining populations once some sort of protection is achieved. Without this protection, A. priceana habitat will continue to be destroyed, and the species may become extinct. (USFWS, 1993)
- Investigate effects of potential management techniques. Potential management techniques for A. priceana should be tested to determine their effectiveness. Because there are few populations of A. priceana and population sizes are small, it is essential that work begins to

enhance growth and reproduction of plants and to reestablish populations (if found necessary). Without this active management, the species is likely to become extinct. The selection of populations used for these experiments should be based on their need for this type of management and the size and vigor of the population. The experimental treatment should be applied within replicated plots. The number and size of the plots should be determined by the size of the population and the density of the plants. An equal number of unmanipulated plots should be established as controls. (USFWS, 1993)

- Search for new populations. The search for new populations of A. priceana must continue. The most accurate information on the number and distribution of populations is necessary to make appropriate decisions about management of the species.(USFWS, 1993)
- Study biology of Apios priceana. An increased understanding of the biology of A. priceana is necessary to develop appropriate management practices for the species. (USFWS, 1993)
- Maintain plants and seeds ex situ. Plant material should be preserved in artificial conditions in case catastrophes destroy all or most populations of the species. This stored material also could be used to establish new populations if natural populations become depleted. The Center for Plant Conservation (Center) has extensive experience in this area and should be involved in the planning and implementation of these tasks. (USFWS, 1993)
- Provide public information . Priority should be given to providing landowners with information about the species. Apios priceana is already on display at the Missouri Botanical Garden (a member botanical garden of the Center for Plant Conservation) and is used to educate the public about rare plants and conservation needs. The artificial population at Land Between the Lakes should be maintained and similarly used to educate the public. Providing the public with information about the species could also encourage amateur and professional naturalists to search for new A. priceana populations. (USFWS, 1993)
- Apios priceana plants are being grown artificially in several locations. These plants will provide seeds and tubers for further studies of the species. Seeds from these plants also may be used in the future to reestablish extirpated populations (USFWS, 1993).
- Work is also being done to protect several naturally occurring populations of A. priceana. Four populations are Registered Natural Areas. Although this is not legally binding protection, it does indicate that the owners of the property are showing an active interest in the survival of the species. A population in Tennessee has been purchased by The Nature Conservancy (USFWS, 1993).
- Four populations are on federally-owned land. These populations are legally protected by the Endangered Species Act. Two populations in Kentucky are on land owned by the Tennessee Valley Authority within an area designated as a Conservation Education Center (Table 1, number 7 and number 8) (U.S. Fish and Wildlife Service 1990). TVA has shown active involvement in the protection of the species. Two populations in Alabama are owned by the U.S. Army Corps of Engineers (U.S. Fish and Wildlife Service 1990) (USFWS, 1993).
- Searches for new populations of A. priceana were carried out in Tennessee and Illinois during the 1990 growing season. The search in Tennessee resulted in the discovery of four new occurrences of the species (Tennessee Department of Conservation 1991). The Illinois search did not result in the discovery of new sites or the relocation of the two populations previously known from the State (Hutchinson 1990). A search for the species in Tennessee in 1991 resulted in the discovery of five new populations (Tennessee Department of Conservation 1991) (USFWS, 1993).
- Continue efforts to work with local governments and highway officials to reduce threats associated with roadside maintenance, including establishing cooperative agreements when

possible (USFWS, 2016).

- Continue management at LBL and Sauta Cave NWR to reduce canopy cover and invasive species encroachment and promote flowering, seed production, and population growth. Encourage similar management efforts at other protected sites (USFWS, 2016).
- Work with Natural Heritage Programs, NPS, USFS, and others to establish consistent range wide monitoring program (USFWS, 2016).
- Work cooperatively with Redstone Arsenal, Alabama, to manage and monitor population on Department of Defense lands (USFWS, 2016).
- Work cooperatively with ADCNR to manage and monitor population at Old Cahawba Forever Wild Tract in Alabama (USFWS, 2016).
- Work cooperatively with NPS to develop conservation strategies for populations at Fort Donelson National Battlefield, in Tennessee, and Natchez Trace Parkway, in Mississippi (USFWS, 2016).
- Work with landowners of protected sites to develop conservation agreements that establish biological goals for A. priceana, identify management strategies to achieve those goals, and include a monitoring plan for measuring effectiveness of conservation efforts as relates to the species' status (USFWS, 2016).
- Ensure that ex situ accession information and propagation protocols are maintained and curated in the Center for Plant Conservation National Collection of Endangered Plants centralized database (USFWS, 2016).
- Conduct experimental studies that examine the species' habitat needs in order to develop management protocols that bolster population size and fitness. While it has been assumed that A. priceana will respond favorably to opening forest canopies, current monitoring protocols are not adequately designed to compare population responses across light gradients. Future work should include design of experiments to examine the response of natural or experimental populations to fire, canopy thinning, and other management tools. Greenhouse studies to explore effects of varying levels of shade, soil moisture, and soil fertility could also improve understanding of factors that regulate growth of A. priceana individuals and populations (USFWS, 2016).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery criteria and actions is presented in the species' recovery plan (Service 1993). In conducting this status review new and/or targeted potential recovery activities were identified and are included below. These actions are recommended to support and promote recovery of Price's potato-bean. Use of a numbered list for these recommendations is for convenient reference only and does not necessarily imply prioritization of any activity over others. Recovery Activities 1. Continue efforts to work with local governments and highway officials to reduce threats associated with roadside maintenance, including installing signage, training staff and contractors on appropriate management techniques and avoidance measures, and establishing cooperative agreements, when possible. 2. Continue management at Land Between the Lakes National Recreation Area and Sauta Cave National Wildlife Refuge to reduce canopy cover and invasive species encroachment and promote flowering, seed production, and population growth. Encourage similar management efforts at other protected sites. 3. Work cooperatively with the National Park Service and U.S. Forest Service to develop conservation strategies for populations at Fort Donelson National Battlefield in Tennessee, Natchez Trace National Parkway in Mississippi, and Bankhead National Forest in Alabama. 4. Collaborate with State and Federal agencies to initiate and perform feral hog eradication and control efforts across

the range of Price's potato-bean. 5. Work with landowners of protected sites to develop conservation agreements that establish biological goals for Price's potato-bean, identify management strategies to achieve those goals, and include a monitoring plan for measuring effectiveness of conservation efforts as related to the species' status. 6. Work cooperatively with the Chickasaw Nation to develop strategies for expanding populations at Chickasaw Preserve in Mississippi, while also increasing protections for the existing population. 7. Ensure that ex situ accession information and propagation protocols are maintained and curated in the Center for Plant Conservation National Collection of Endangered Plants centralized database. Monitoring and Research Activities 1. Work with state Natural Heritage Programs, National Park Service, U.S. Forest Service, National Wildlife Refuges, and other partners to establish a consistent range wide monitoring program. 2. Coordinate with the National Park Service, Mississippi Natural Heritage Program, and other partners to identify suitable outplanting strategies and locations at Natchez Trace Parkway in Mississippi. 3. Build on earlier experimental studies that examine the species habitat needs to develop/improve management protocols that bolster population size and fitness. Future work should include design of experiments to examine the response of natural or experimental populations to fire, canopy thinning, herbicide application, and other management tools, as well as to emerging threats.

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SPECIES ACCOUNT: *Arabis georgiana* (Georgia rockcress)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A slender, erect biennial, with white flowers produced on a leafy stem to 9 dm in height. Leaves disposed at the base and along the stem, are alternate, lanceolate to narrowly elliptic, 1-5 cm long, and slightly clasp the stem. The flowers are produced in a terminal inflorescence that is sometimes loosely branched; 4-merous with petals 6-9 mm long. The fruit is an erect pod roughly 1 mm wide and 5-7 cm long. Flowering season: late March to early May. (NatureServe, 2015)

Taxonomy

Georgia rockcress was first collected in 1841, by Boykin from the vicinity of the Chattahoochee River in Georgia. Several other collections of this species were made in the late 1800s; however, Harper was the first to document its distinctiveness, after seeing it in fruit in 1901, on the bank of the Chattahoochee River in Stewart County, Georgia. Harper later described it as a distinct species in 1903 (Allison 1995, p. 4). Georgia rockcress was maintained as a distinct species (Arabis georgiana) in Hopkins's 1937 monograph of Arabis in the eastern United States (Allison 1995, p. 3) (USFWS, 2013).

Historical Range

Georgia rockcress is known from the Lower Gulf Coastal Plain, Upper Gulf Coastal Plain, Red Hills, Black Belt, Piedmont, and the Ridge and Valley Physiographic Provinces (Schotz 2010, p. 6; Allison 1995, p. 6) (USFWS, 2014).

Current Range

Despite fairly extensive searches, this species is currently known from fewer than 25 populations in Alabama and western Georgia. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/12/2014.

Legal Description

On September 12, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Arabis georgiana (Georgia rockcress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 17 critical habitat units (CHUs), in Alabama and Georgia (79 FR 54635-54667).

Critical Habitat Designation

The critical habitat designation for Arabis georgiana includes 17 CHUs in Gordon, Floyd, Harris, Muscogee, and Clay Counties Georgia and Bibb, Dallas, Elmore, Monroe, Sumter, and Wilcox Counties, Alabama. This species critical habitat encompasses approximately 732 acres (ac) (297 hectares (ha)) (79 FR 54635-54667).

Unit 1. Fort Tombecbee, Sumter County, Alabama: The 6-ha (14-ac) Fort Tombecbee unit is approximately 0.5 kilometers (km) (0.3 miles (mi)) northeast of the city of Epes, Alabama, and is owned by the University of West Alabama. This Georgia rockcress occurrence inhabits the crest and steep slopes of a deeply incised stream bank overlooking a small intermittent creek approximately 91 m (300 ft) upstream from its confluence with the Tombigbee River. Livestock grazing was observed during a visit made in May 2010, in a portion of the site where the species was previously observed; it is conceivable that livestock may have further impacted the occurrence. Only four plants were found in 2010 (Schotz 2010, p. 51). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with road crossings, development and potentially grazing.

Unit 2. Marshalls Bluff, Monroe County, Alabama: The 11-ha (27-ac) Marshall Bluff unit is a privately owned tract 9.6 km (6 mi) southwest of Perdue Hill, Alabama, on the eastern bank of the Alabama River on a high bluff (Marshalls Bluff) overlooking the Alabama River. An abandoned quarry exists approximately 150 m (500 ft) distant to the east, and while the quarry may have destroyed bluff habitat, the quarry currently poses no threat to the occurrence, and there are no plans to expand the quarry (Schotz 2010, p. 22). More than 400 plants were found in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with mining.

Unit 3. Prairie Bluff, Wilcox County, Alabama: Privately owned, the 13-ha (32-ac) Prairie Bluff unit is located along the banks of the Millers Ferry (William ‘‘Bill’’ Dannelly) Reservoir, approximately 1.6 km (1 mi) north of the Lee Long Bridge on State Route 28. Georgia rockcress is scattered along the bluffs and ravines associated with the Alabama River. Nonnative species, most notably Ligustrum sinense (Chinese privet) and Lonicera japonica (Japanese honeysuckle), threaten this site (Allison 1999, p. 2; Schotz 2010, pp. 54–55). More than 500 plants were found in this unit in 2010; however, some habitat was likely inundated by the reservoir. This site is slated for residential development with lakeside lots, and the infestation of nonnatives will likely become worse. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, development, hydropower, and nonnative species.

Unit 4. Portland Landing River Slopes, Dallas County, Alabama: Privately owned, the 12-ha (31-ac) Portland Landing River Slopes unit is located 18 km (11.5 mi) south of Orrville, Alabama, on the south side of the Alabama River at Portland Landing. This occurrence of Georgia rockcress is restricted to the unstable, highly erodible, sandy soils along the bank of the Alabama River. Nonnatives, most notably Melia azedarach (Chinaberry or bead-tree), Japanese honeysuckle, and Pueraria montana var. lobata (kudzu), are present, and although not severe, these nonnatives will persist without active management (Schotz 2010, p. 40). In 2010, 498 Georgia rockcress plants were recorded (Schotz 2010, p. 40). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest, hydropower, and nonnative species.

Unit 5. Durant Bend, Dallas County, Alabama: Privately owned, the 12-ha (28-ac) Durant Bend unit occurs 16 km (10 mi.) east of Selma in a sharp bend on the Alabama River. Fewer than 50 plants were reported in sandy alluvium along the Alabama River under a partially open to filtered

canopy in 2010 (Schotz 2010, p. 37). While the majority of plants occur in forested conditions, a small number of plants were observed in relatively open and exposed soils of actively eroding sections of the riverbank. Nonnatives, including Chinese privet and Japanese honeysuckle, are present but not severe. Timber harvesting has recently taken place approximately 46 m (150 ft) north of the site, but it currently has not impacted species' viability or habitat integrity (Schotz 2010, p. 37). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 6. Murphys Bluff Bridge Cahaba River, Bibb County, Alabama: Privately owned, the 11-ha (26-ac) Murphys Bluff Bridge Cahaba River unit is 11.4 km (7 mi) southwest of Centreville, Alabama, and located along the west bank of the Cahaba River downstream (southwest) of the Murphy Road Bridge. Chinese privet, Japanese honeysuckle, and other nonnatives are present, but are relatively sparse. Infestation of nonnative plants could worsen. Timber harvesting has been observed nearby and may pose a potential concern (Schotz 2010, p. 22). Sixteen Georgia rockcress plants were found at this location during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with road crossings and nonnative species.

Unit 7A. Creekside Glades, Bibb County, Alabama: Privately owned, the 11-ha (26-ac) Creekside Glades subunit is located 9.6 km (6 mi) north-northeast of Centreville, Alabama, along the banks of Little Schultz Creek. Georgia rockcress occurs in association with a small dolomite glades complex on either side of Little Schultz Creek. The plants (mostly rosettes, i.e., non-reproductive) predominantly occur in the ecotone of the glades and the encompassing woodland, in association with a mix of shrubs and low-growing trees. A smaller number of individuals (mostly mature) can be found in the glades and surrounding woodlands (Allison 1999, p. 2; Schotz 2010, p. 30). This subunit contained 42 plants in 2010. A utility line right-of-way passes through this subunit, and while there is no canopy on the right-of-way, it provides essential supporting habitat such that the right-ofway has not been excluded from critical habitat. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with development and utility right-ofway maintenance. Unit 7B. Little Schulz Creek, Bibb County, Alabama Privately owned, the 12-ha (28-ac) Little Schulz Creek subunit is located 8.9 km (5.5 mi) north-northeast of Centreville, Alabama. In 2010, 29 plants occurred on limestone outcrops along the west bank of the Cahaba River. The site is characterized as a bouldery limestone woodland situated along a low bluff overlooking the Cahaba River. Georgia rockcress inhabits shallow soils associated with the bluff, occurring under an open to lightly shaded canopy (Schotz 2010, p. 32). This subunit consisted of 29 plants in 2010. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with development and utility right-ofway maintenance.

Unit 8A. Cottingham Creek Bluff and Unit 8B. Pratts Ferry, Bibb County, Alabama: Privately owned, the Cottingham Creek Bluff subunit is located on the east side of the Cahaba River, upstream of Pratts Ferry Bridge, 10 km (6.2 mi) northeast of Centreville, Alabama. The Pratts Ferry subunit is located on the west side of the Cahaba River, downstream of Pratts Ferry Bridge, 10 km (6.2 mi) northeast of Centreville, Alabama. A small portion (26 percent (5.88 ha (14.5 ac)) of the Cottingham Creek Bluff subunit is owned by The Nature Conservancy (TNC). A small

number of plants are confined to an abandoned limestone quarry several hundred feet back from the southeastern side of the river's edge. Chinese privet and Japanese honeysuckle impact this site, particularly in the vicinity of the abandoned quarry. Nonnatives could become worse. Timber harvesting is of potential concern in an area adjacent to the population on the west side of the Cahaba River, which was selectively logged in the 1990s (Allison 1999, p. 3; Schotz 2010, pp. 34–35). Subunit 8A is 22 ha (55 ac), and subunit 8B is 11 ha (28 ac). In 2010, these two subunits together contained 299 Georgia rockcress plants. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with road crossings, timber harvest, and nonnative species.

Unit 9A. Fern Glade, Bibb County Alabama: The 14-ha (34-ac) Fern Glade subunit is centered near the confluence of the Little Cahaba River and Sixmile Creek approximately 14.2 km (8.9 mi) northeast of Centreville, Alabama. Twelve percent of the Fern Glade subunit (4.2 ha (1.7 ac)) is owned by TNC, and 79 percent (10.9 ha (27 ac)) of this subunit is part of the Cahaba National Wildlife Refuge. A moderate incursion of invasive Chinese privet and Japanese honeysuckle occurs at this site. Nonnatives will likely become worse (Allison 1999, p. 3; Schotz 2010, p. 26). A small glade on the north side of the Little Cahaba River had 81 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with timber harvest and nonnative species. Unit 9B. Sixmile Creek, Bibb County, Alabama Privately owned, the Sixmile Creek subunit is located 13.7 km (8.5 mi) northeast of Centreville, 0.8 km (0.5 mi) upstream on Sixmile Creek from its confluence with the Little Cahaba River. The majority of this subunit (96.6 percent or 8.2 ha (20.3 ac)) was acquired by TNC in 2013. This population of Georgia rockcress is on the west side of Sixmile Creek. In a relatively isolated site, Georgia rockcress occupies the upper slope and summit of a steep forested bluff overlooking Sixmile Creek. This 13-ha (31-ac) subunit had 59 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 10A. Browns Dam Glade North and Unit 10B. Browns Dam Glade South, Bibb County, Alabama: Privately owned, the Browns Dam Glade subunits are located 15.8 km (9.8 mi) northeast of Centreville, Alabama, on both sides of the Little Cahaba River. Subunit 10A is on the north side of the river, and subunit 10B is in a sharp bend on the south side of the River. More than 96 percent of subunit 10A (13.7 ha (33.8 ac)) and all of subunit 10B are owned by TNC. A combination of open woodland and dolomitic glades characterize the site. An infestation of nonnatives, most notably Chinese privet, occurs at this unit. This site serves as a primitive recreation area for local residents, resulting in some trash disposal and the construction of fire pits (Allison 1999, p. 5; Schotz 2010, pp. 24– 25). Subunits 10A and 10B are 14 ha (35 ac) and 15 ha (37 ac), respectively. A complex of dolomitic glades and associated woodlands along both sides of the Little Cahaba River contained 71 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with nonnative species.

Unit 11. McGuire Ford/Limestone Park, Bibb County, Alabama: Privately owned, the McGuire Ford/ Limestone Park unit is located 18.7 km (11.6 mi) northeast of Centreville, Alabama, on the

southeast side of the Little Cahaba River. A small number of plants occupy shallow soils of low, rocky limestone outcrops along the Little Cahaba River under a lightly shaded canopy of eastern red cedar, chinquapin oak, white ash, Southern sugar maple, and redbud, among others (Allison 1999, p. 5; Schotz 2010, p. 20). This 6-ha (15-ac) unit contained 50 Georgia rockcress plants during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, development, and maintenance of a pasture.

Unit 12. Fort Toulouse State Park, Elmore County, Alabama: State-owned, the Fort Toulouse State Park unit is located 16 km (10 mi) north of Montgomery, Alabama, on the south side of the Coosa River. Georgia rockcress is widely scattered along the bluffs overlooking the Coosa River, primarily occupying mesic, sandy soils of upper slopes and crest. Japanese honeysuckle is beginning to severely impact many areas of the site (Allison 1999, p. 2; Schotz 2010, p. 42). This 7- ha (17-ac) unit contained 47 Georgia rockcress plants during the 2010 survey. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with maintenance of a recreational field and nonnative species.

Unit 13. Fort Gaines Bluff, Clay County, Georgia: Privately owned, the Fort Gaines Bluff unit is located 1.5 km (0.9 mi) south of Fort Gaines, Georgia, on the Chattahoochee River. This high, steep, eroding river bank has sandy loam soils and an intact hardwood overstory. Japanese honeysuckle has become severe over much of area (Allison 1995, pp. 18–29; Moffett 2007, p. 9). This 17- ha (43-ac) unit contained 84 Georgia rockcress plants in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 14A. Goat Rock North and Unit 14B. Goat Rock South, Harris and Muscogee Counties, Georgia: Privately owned, the Goat Rock Dam is 18.5 km (11.5 mi) north of Columbus Georgia. The Goat Rock North subunit is immediately north of Goat Rock Dam on the banks of Goat Rock impoundment, while the Goat Rock South subunit is immediately downstream of Goat Rock Dam along the high bluffs overlooking the Chattahoochee River. All of Goat Rock North subunit and the majority of the Goat Rock South subunit are owned by a corporation that supports conservation efforts for Georgia rockcress. The corporately owned property is provided modest protection in the shoreline management plan, which was developed during Federal Energy Regulatory Commission (FERC) licensing (FERC 2004, pp. 29–30). However, the southernmost portion of the Goat Rock South subunit is privately owned. This high rocky bluff is mostly covered by a mature canopy of trees. A narrow portion of this habitat has a transmission line passing over the top where all woody species have been removed; however, Georgia rockcress plants are scattered in the transmission line right-of-way. This area contains PCEs 1 and 2; therefore, it is included in the final designation. Nonnative species, including Chinese privet and Japanese honeysuckle, have severely impacted this site (Allison 1995, pp. 24– 27; Moffett 2007, pp. 6–9). Conservation actions here have included invasive species/woody competition removal (both manually and chemically) to benefit existing Georgia rockcress plants, and prescribed burning to open up new adjacent sites for outplanting enhancement. The Chattahoochee Nature Center (CNC) outplanted approximately 300 Georgia rockcress plants of the Goat Rock genotype at this site in 2008. The local office of TNC has also expressed interest in possibly including this site in their long-range ecosystem planning (Elmore 2010, pp. 1–3). Subunits 14A and 14B are 7 ha (19

ac) and 24 ha (59 ac), respectively, and contain two or more of the PCEs throughout the subunits. In 2007, approximately 1,000 Georgia rockcress plants were found scattered across these subunits. The physical or biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats associated with hydropower, utility line maintenance, and nonnative species.

Unit 15. Blacks Bluff Preserve, Floyd County, Georgia: Privately owned, the 37-ha (92-ac) Blacks Bluff Preserve unit is located 6.5 km (4.0 mi) southwest of Rome, Georgia, on the Coosa River. Blacks Bluff is in private ownership with a conservation easement on the property. There were 27 Georgia rockcress plants reported on this site in 1995; however, the presence of nonnative species has since extirpated all Georgia rockcress from this site. The Georgia Plant Conservation Alliance (GPCA) and TNC agreed to bolster the existing population with plants grown from seed collected at the two nearby (Ridge and Valley physiographic province) populations, Whitmore Bluff, and Resaca Bluffs. The CNC collected seed and grew 35 plants from Whitmore Bluff and 65 plants from Resaca Bluffs. In 2008, 100 Georgia rockcress plants were planted in this unit, with 84 Georgia rockcress surveyed on this site in 2011 (Goldstrohm 2011, p. 1). This steep bluff with limestone ledges and boulders has a mature deciduous canopy. Multiple sources of disturbance, including an abandoned quarry, have impacted this site and resulted in the establishment of many nonnative species, including Japanese honeysuckle and Nepalese browntop (Allison 1995, pp. 19–20; Moffett 2007, pp. 5–9; Elmore 2010, pp. 1–3). The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with roads, mining, and nonnative species.

Unit 16. Whitmore Bluff, Floyd County, Georgia: Privately owned, the Whitmore Bluff unit is located 6.5 km (4 mi) northeast of Rome, Georgia, on the east bank of the Oostanaula River. This steep bluff with limestone boulders has a mature canopy with Ulmus alata (winged elm), Quercus montana (chestnut oak), and Fraxinus americana (white ash), and an understory including Hydrangea arborescens (wild hydrangea), Toxicodendron radicans (poison ivy), and Sedum ternatum (woodland stonecrop). Japanese honeysuckle has severely impacted this site (Allison 1995, p. 21; Moffett 2007, pp. 6–9; Elmore 2010, pp. 1–3). This 17-ha (43- ac) unit contained 63 Georgia rockcress plants in 1995, but only 12 in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with timber harvest and nonnative species.

Unit 17. Resaca Bluffs, Gordon County, Georgia: Privately owned, the Resaca Bluffs unit is located 0.8 km (0.5 mi) southwest of Resaca, Georgia, immediately east of I–75 along the northern bank of the Oostanaula River. This unit includes a rocky limestone bluff with a mature canopy, including eastern red cedar, Quercus nigra (water oak), Quercus velutina (black oak), winged elm, white ash, southern sugar maple, and redbud. Nonnative species, including Chinese privet and Japanese honeysuckle, have severely impacted this site (Allison 1995, pp. 22–23; Moffett 2007, pp. 5–9; Elmore 2010, pp. 1–3). This 5-ha (13-ac) unit contained 51 plants in 1995, and 42 in 2010. The physical or biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats associated with road crossings, development, and nonnative species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Arabis georgiana critical habitat consists of four components (79 FR 54635-54667):

(i) Large river bluffs with steep and/ or shallow soils that are subject to localized disturbances that limit the accumulation of leaf litter and competition within the Lower Gulf Coastal Plain, Upper Gulf Coastal Plain, Red Hills, Black Belt, Piedmont, and Ridge and Valley Physiographic Provinces of Georgia and Alabama.

(ii) Well-drained soils that are buffered or circumneutral generally within regions underlain or otherwise influenced by granite, sandstone, or limestone.

(iii) A mature, mixed-level canopy with spatial heterogeneity, providing mottled shade and often including species such as Juniperus virginiana (eastern red cedar), Ostrya virginiana (American hophornbeam), Quercus muehlenbergii (chinquapin oak), Fraxinus americana (white ash), Acer barbatum (southern sugar maple), and Cercis canadensis (eastern redbud) with a rich diversity of grasses and forbs characterizing the herb layer.

(iv) Intact habitat that is fully functional (i.e., with mature canopy and discrete disturbances) and buffered by surrounding habitat to impede the invasion of competitors.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. A fully functioning bluff habitat (i.e., with mature canopy and discrete disturbances) is required to provide the features essential to the conservation of this species and may require special management considerations or protection to reduce the following threats: Land-clearing activities that alter the canopy, including silvicultural management, building of utility lines, structures, roads, or bridges; construction of reservoirs that inundate habitat; mining activities; or introduction of invasive species that compete directly with Georgia rockcress. Large-scale disturbances, such as fire or soil-disturbing activities, should be minimized. A mature canopy with spatial heterogeneity should be maintained to impede invasive species while providing an opportunity for localized disturbances as canopy-gap dynamics develop. Invasive species should be eliminated from the critical habitat units. A mature canopy on the bluffs and a surrounding buffer area will help to exclude nonnatives.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Pollinators (inferred from USFWS, 2013)

Breeding Season

Adult: March - April

Reproduction Narrative

Adult: Flowering occurs from March to April, with fruiting beginning in May and into early July (Allison 1995, p. 4; Patrick et al. 1995, pp. 17–18; Chafin 2007, pp. 47–48; Schotz 2010, p. 3) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Palustrine: herbaceous wetland, riparian; Terrestrial: bare rock/talus/scree, barrens, cliff, mixed forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High to moderate light conditions (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Heavy shade, acidic soils (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Shallow soil accumulations on rocky bluffs, ecotones of gently sloping rock outcrops, outcrops along rivers, and sandy loam along eroding riverbanks. It is occasionally found in adjacent mesic woods but it will not persist in heavily shaded conditions. Requires high to moderate light conditions, occurs on soils which are circumneutral to slightly basic (Norquist 2000). Ketona Glades and other locations in Bibb County, AL (Allison and Stevens 2001). The environmental specificity is narrow as this species is a specialist with key requirements common (NatureServe, 2015). This species requires large river bluffs with steep slopes and/ or shallow soils that are subject to localized disturbances (USFWS, 2014).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Resiliency:

Currently there are three populations with excellent resilience, six populations with good resilience, five populations with fair resilience, three populations with poor resilience, five historical populations, and two extirpated populations. (USFWS, 2021a)

Representation:

Representative units for this species correspond to a North Georgia, South Georgia, and Alabama group according to genetic analysis. (USFWS< 2021a)

Redundancy:

Georgia rockcress is endemic to Alabama and Georgia. Populations of Georgia rockcress are restricted to small patches of suitable habitat associated with large river bluffs with steep and/or shallow soils that are subject to localized disturbances that limit the accumulation of leaf litter and competition, underlain with granite, sandstone, or limestone. The habitat specificity for this species has resulted in limited and fragmented suitable habitat resulting in low redundancy; therefore, Georgia rockcress may be at a higher risk for extinction from habitat loss or degradation associated with localized events (manmade or natural). (USFWS, 2021a)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

17 (USFWS, 2021)

Population Size:

~ 5,000 plants (USFWS, 2013)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

No studies have been conducted on population dynamics and reproduction biology. However, based on field inspections, recruitment appears low. Most occurrences are small, containing only a few plants. This species has experienced a short-term decline of 10 - 30%; although many occurrences have remained relatively stable over the past 10-20 years, some have decreased in size primarily as a result of invasive species, logging, and succession. (NatureServe, 2015). Currently, 18 populations are documented to occur across Alabama and Georgia. Georgia rockcress is rare throughout its range. Moffett (2007, p. 8) found approximately 2,140 plants from all known sites in Georgia. Moffett (2007, pp. 1–2) indicated that the overall status of the three populations in the Ridge and Valley ecoregion (Floyd and Gordon Counties, Georgia) was poor, as these populations tended to be small, and declining in size and vigor. Schotz (2010, p. 8) documented fewer than 3,000 plants from all known sites in Alabama. Only the Goat Rock Dam and Fort Benning populations are sufficiently large (greater than 1,000 individuals) to preclude a genetic bottleneck (Schotz 2010, pp. 13–57; Moffett 2007, p. 8) (USFWS, 2013). Georgia rockcress continues to be threatened with extinction throughout its range. Only about half (9 of 17) of the extant Georgia rockcress populations are currently resilient (good to excellent resiliency) and more than 75 percent of the populations are threatened by habitat degradation

from invasive plant species. In the future under "Status Quo" conditions, only four to two populations are expected to be resilient in 20 to 40 years, respectively, without additional conservation efforts which may be facilitated by the ESA and prioritized with ESA protections and recovery programs. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Currently, habitat degradation, more than its outright destruction, is the most serious threat to this species' continued existence. Most of the Coastal Plain rivers surveyed by Allison (1995, p. 11) were considered unsuitable for Georgia rockcress because their banks had been disturbed to the point where there was no remaining vegetative buffer. Recent habitat degradation (i.e., vegetation denuded and replaced by hard-packed, exposed mineral soil) has occurred at several Georgia sites in association with residential development and campsites atop the bluffs (Moffett 2007, pp. 3–4). Disturbance associated with timber harvesting, road building, and grazing in areas where the plant exists has created favorable conditions for the invasion of nonnative weeds in this species' habitat (Factor E) (Schotz 2010, p. 10). Timber operations that remove the forest canopy promote early successional species and result in the decline of Georgia rockcress (Schotz 2010, p. 10). Encroachment of development in the form of bridges, roads, houses, commercial buildings, or utility lines allowing for the introduction of nonnative species (Factor E) also result in the decline of Georgia rockcress (Schotz 2010, pp. 9–10; Moffett 2007, pp. 2–7; Alison 1995, pp. 7–18). Quarrying destroys the bluff habitat by removing the canopy and soil. Rock bluffs along rivers have also been favored sites for hydropower dam construction. Historically, suitable habitat was destroyed or degraded due to quarrying, residential development, timber harvesting, road building, recreation, and hydropower dam construction. Severe impacts continue to occur across the range of this species, from quarrying, residential development, timber harvesting, road building, recreation, and hydropower dam construction, and one or more of these activities pose ongoing threats to all known populations (USFWS, 2013)

Stressor: Small population size (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Given the extremely small size of Georgia rockress populations, projects that destroy even a small amount of habitat can have a serious impact on this species, including existing genetic diversity of the species. Given the extremely small number of total plants (fewer than 5,000 in a given year; 12 of the 18 populations have fewer than 50 plants (Schotz 2010, p. iii; Elmore 2010, pp. 1–4; Moffett 2007, pp. 2–7; Alison 1999, pp. 1–5; Alison 1995, pp. 7–18)), and that the species is distributed as disjunct populations across five physiographic provinces (Schotz 2010, pp. 9–10; Moffett 2007, pp. 2–7; Alison 1995, pp. 7–18) in three major river systems, each population is important to the conservation of genetics for the species (Garcia 2012, pp. 30–36). Any threats that remove or further deteriorate populations can also have a detrimental effect on the existing genetic diversity of the species (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: Climate change will be a particular challenge for biodiversity because the interaction of additional stressors associated with climate change and current stressors may push species beyond their ability to survive (Lovejoy 2005, pp. 325–326). The synergistic implications of climate change and habitat fragmentation are the most threatening facet of climate change for biodiversity (Hannah and Lovejoy 2005, p. 4). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, pp. 1–3; Hayhoe et al. 2004, p. 12422; Cayan et al. 2005, p. 6; Intergovernmental Panel on Climate Change (IPCC) 2007, p. 1181). Climate change may lead to increased frequency and duration of severe storms and droughts (Golladay et al. 2004, p. 504; McLaughlin et al. 2002, p. 6074; Cook et al. 2004, p. 1015).). While severe drought would be expected to have an effect on the plant community, including the mature canopy and canopy gap dynamic, and increased storm intensity could accelerate erosion-related disturbances, the information currently available on the effects of global climate change and increasing temperatures does not make sufficiently precise estimates of the location and magnitude of the effects. In addition, we are not currently aware of any climate change information specific to the habitat of the Georgia rockcress that would indicate which areas may become important to the species in the future (USFWS, 2013).

Stressor: Nonnative species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The primary threat to extant populations of Georgia rockcress is the ongoing invasion of nonnative species due to the degradation of its habitat. Encroachment from timber management and development in the form of bridges, roads, houses, commercial buildings, or utility lines allowing for the introduction of nonnative species has resulted in the decline of Georgia rockcress (Schotz 2010, pp. 9–10; Moffett 2007, pp. 2–7; Alison 1995, pp. Human-induced disturbance (quarrying, residential development, timber harvesting, road building, recreation and hydropower dam construction) has fragmented river bluff habitats and created conditions so that these bluff habitats are receptive to invasion of nonnative species (Honu and Gibson 2006, pp. 263–264). Disturbance of 17 of the 18 known sites occupied by this species has provided opportunities for the invasion of aggressive, nonnative weeds, especially Lonicera japonica (Japanese honeysuckle).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Finalize the recovery plan. • Conduct regular monitoring or resurvey all known accessible populations. • Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity and long-term viability. • Continue and expand work with federal and state conservation agencies, nongovernmental organizations, and private individuals and organizations to protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. • Identify, implement, and assess management actions to sustain extant populations, including but not limited to invasive species management and forest management practices that set back succession. • Establish methods to effectively reintroduce and monitor Georgia rockcress. • Develop a captive propagation and reintroduction plan. • Conserve germplasm (genetic material; e.g. seed) and promote genetic diversity. • Conduct studies of genetic variation within and between known sites. • Investigate potential pest and disease threats for Georgia rockcress. • Conduct studies into the species' life history, biology, and ecology to improve management of the species and its habitat. • Look for opportunities to protect existing populations through acquisition, easements and/or management agreements. • Develop and implement management strategies for the Georgia rockcress, initially with the two State parks in Alabama. • Search for new populations within suitable habitat. (USFWS, 2021)
- Conservation Scenario 1: Status Quo Maintaining the current level of management and conservation in an effort to offset habitat degradation and canopy closure resulted the extirpation of three populations by 2040 and six in 2060 (Table 6-15; Figure 6-2). Of nine currently resilient populations, only four are expected to be resilient by 2040, and only two will remain so in 2060. Of 24 known populations, 20 populations will be either not resilient or extirpated by 2040 and 22 will be either not resilient or extirpated by 2060. Three populations change from fair (C) to extirpated between 2040 and 2060, as their current population size made persistence unlikely (Table 6-9). Over half (16 of 24; 67 percent) of the populations are extirpated in the 2060 projection. Extirpated populations occur on private lands subject to canopy closure and/or the spread of invasive species, and on protected state lands that do not utilize management to limit the impacts of these threats. (USFWS, 2021a)
- The loss of resilient populations within representative units in the Status Quo Scenario indicates a potential decline in the species' adaptive capacity that can be offset through increased conservation and management. Under the Status Quo there is a great loss of resilient populations from representative units resulting in a loss of species level adaptive capacity. Given the reductions in resiliency and the extirpation of populations at 2040 and 2060, the species' representation is predicted to be greatly reduced from current levels in this scenario. However, these losses are offset under the Focused Scenario where resilient populations are maintained in all representative units, with the Expansion Scenario maintaining or increasing representation in all units with the potential to expand the species range. (USFWS, 2021a)

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SPECIES ACCOUNT: *Arabis hoffmannii* (Hoffmann's rock-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with slender stems, 5-7 dm tall, bearing white to lavender flowers at the tips (NatureServe, 2015).

Taxonomy

Hoffmann's rock-cress (Arabis [Boechera] hoffmannii) is a short-lived, perennial herb in the mustard (Brassicaceae) family. Arabis [Boechera] hoffmannii was formerly known as Arabis hoffmannii until recent taxonomic revisions placed it in the genus Boechera (USFWS, 2011).

Historical Range

It is endemic to Santa Rosa, Santa Cruz, and Anacapa Islands in the Channel Islands National Park located off the coast of southern California, although it has not been seen on Anacapa Island since 1941 (USFWS, 2011).

Current Range

Currently, the species is known from Santa Cruz Island and Santa Rosa Island (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative, possibly self-fertilization (USFWS, 2011)

Lifespan

Adult: Up to 5 years (USFWS, 2011)

Breeding Season

Adult: February - April (NatureServe, 2015).

Reproduction Narrative

Adult: The plant is believed to be monocarpic (bearing fruit only once, then dying); however, the plant has been observed to live for up to 5 years if two or more vegetative and reproductive rosettes are present on the plant (Wilken 2006). Hoffmann's rockcress can produce tens to hundreds of slightly curved fruits (siliques) borne on long stalks with thousands of seeds. Hoffmann's rock-cress does not appear to be dependent upon pollinators for seed set, and individual plants may produce as many as 3,000 to 4,000 seeds. The small sizes of natural populations indicate that establishment success of new plants is low despite the large number

of seeds produced per plant. Results from demographic monitoring suggest that approximately 10 to 15 percent of Hoffmann's rock-cress plants within a population flower each year (McEachern and Chess 2006). In studies conducted on plants germinated at SBBG, it was found that plants can reproduce as early as 2 years after germination. Hoffmann's rock-cress was found to be self-compatible and can produce more than 30 fruits per plant and 3,000 to 4,000 seeds per plant. It is unknown at this time whether or not the breeding system is autogamous (self-fertilizing). However, high proportions of fruit set and many seeds per fruit under insect-free conditions suggest that Hoffmann's rock-cress does not need pollinators to set seed. If the plants are self-fertilizing, a very low level of genetic variability would be expected. Overall seed germination rates ranged from 59 to 89 percent and most seeds germinated within 9 to 14 days of planting (Wilken 2006) (USFWS, 2011). Blooms February-April (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, coastal bluff scrub, chaparral, coastal scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 60 - 390 m elevation, restricted to CA channel islands (NatureServe, 2015); may be intolerant of high cover of annual species (USFWS, 2011)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Grows on cliffs and ledges of loose volcanic rock, coastal bluff scrub, chaparral, coastal scrub / rocky, and volcanic areas, at elevations between 60 and 395 m (California Native Plant Society 2001). The environmental specificity is narrow; it is only known from a few sites on California's Channel Islands (NatureServe, 2015). Surviving plants tend to be found in the shade of shrubs where the cover of annual species is low, suggesting that Hoffmann's rock-cress cannot tolerate competition with a high cover of annual species (Service 2000) (USFWS, 2011).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Increasing (USFWS, 2022)

Species Trends:

Increasing (USFWS, 2022)

Number of Populations:

The total known (or possible) populations to 13 (USFWS, 2022)

Population Size:

>500 wild (USFWS, 2022)

Additional Population-level Information:

On Santa Cruz Island, the Centinela site has plant counts from 1985 to 2005; over that time period the number of plants seemed to erratically increase to the highest count of 485 in 2005. The Alberts site appears to have a gradual increase in plant numbers from 1995 to 2008 to more than 138 plants. It may be that these sites responded positively first to the removal of the sheep and then the pigs. Trident had a fairly constant number of plants from 2004 to 2006 at about 140 plants, but only one tenth the number in 2008 and 2009. These sites generally have not been surveyed since the late 2000s, and more recent numbers are unknown. The 2019 discovered sites had hundreds to thousands of plants; perhaps they also had many fewer plants in the 2000s. On Santa Rosa Island, the South Point population increased from 29 to 450 plants from 2010 to 2015; a partial survey of the site in 2022 found 80 plants (Shea 2022), with more likely in the unsurveyed area. The increase coincides with the removal of the deer from Santa Rosa Island in the early 2010s (USFWS, 2022). Recovery outplanting: Experimental outplanting was conducted at three sites on Santa Cruz Island starting in 2005 and at several sites on Santa Rosa Island starting in 2018 (McEachern and Gados 2021 pp. 6-8). Plants have persisted at the Santa Cruz Island sites; a technical report is expected after 2022 fieldwork. Data collection on the Santa Rosa Island plantings is ongoing. While about one quarter of outplanted plants at 3 sites survived to reproduction in 2019, fewer were seen in 2020, and by 2021 no live plants were present, although there may be seeds in the soil. In early 2021, plots were seeded at four additional sites, and at least 140 seedlings germinated, but by August 2012 no seedlings could be found. One apparent difference between Santa Cruz Island and Santa Rosa Island outplanting is the effect of mice and perhaps arthropod herbivores on seedlings. On Santa Cruz Island these animals did not seem to affect seedlings, while on Santa Rosa Island they did. Experiments to examine seedling herbivory on Santa Rosa Island began in early 2020, but were discontinued because of COVID-19 restrictions (Schneider and Carson 2020 p. 15). There are plans to reinitiate the experiments in the future. Conservation seed banking: There are 21 accessions of wild collected Hoffmann's rock-cress seed in Center for Plant Conservation approved conservation seed banks (Table 3). Some populations (Centinela and Alberts on Santa Cruz Island) may have conserved adequate numbers of seeds over a sufficient range of years, although ideally more would be segregated by maternal line. Note that the species is easily grown in the nursery to increase seed numbers for recovery projects (Schneider et al. 2021); seed viability is 99%. (USFWS, 2022).

Population Narrative:

Historically, Hoffmann's rock-cress has been found in 7 populations designated by the California Natural Diversity Database (CNDDB, CDFW 2022) as Element Occurrences. There have been no additional reports of Hoffmann's rock-cress to CNDDB since the 2005 5-year review. However, since listing, 6 more natural populations have been discovered. This brings the total known (or possible) populations to 13: one on Middle Anacapa Island, 7 on Santa Cruz Island, and 5 on Santa Rosa Island. The Middle Anacapa Island and two of the Santa Rosa Island occurrences may be extirpated (USFWS, 2022).

Threats and Stressors

Stressor: Ungulates (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: While the threat of rooting from feral pig populations is gone, subsequent trampling by elk and deer of potential seed germination sites adds to the already low establishment success of new plants compounding the effects and vulnerability of small population size. On Santa Rosa Island, nonnative sheep and cattle have been absent since 1999; deer and elk have remained, though in reduced numbers (Rutherford and Chaney 1999). It is estimated that no more than 60 nonnative ungulates are present on the island at this time and plans to remove the deer and elk are underway with a projected removal deadline of the end of 2011 (K. Niessen, C. Cory, and P. Power, TNC and NPS, pers. comm. 2011; Environmental Defense Center (EDC) 1998; K. Faulkner, NPS, in litt. 2011). In summary, trampling and grazing by remaining deer and elk continues to be the biggest threat to all Santa Rosa Island populations of Hoffmann's rock-cress (Rodriguez and Niessen, pers. comm. 2011). For populations on Santa Cruz Island, residual habitat degradation from nonnative ungulates and competition with nonnative annual plants are the biggest threats (USFWS, 2011).

Stressor: Small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The species is threatened by stochastic extinction due to small population size and limited distribution, which remains a threat since the time of listing. Small population size makes it difficult for the species to persist while sustaining the impacts of soil loss, shrub canopy loss, and competition with nonnative annual plants; while impacts from deer and elk populations have been reduced, they still remain a concern on Santa Rosa Island (USFWS, 2011).

Stressor: Nonnative plants (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The disruption of native habitats and displacement of native species by alien plants, particularly fennel (Foeniculum vulgare) and nonnative grasses, among others, were considered major threats at the time of listing. Currently, once-continuous canopies of chaparral, coastal scrub, and island woodland are still either fragmented or missing from large areas on Santa Cruz Island (McEachern and Chess 2006). Coastal sage and coastal bluff scrub plant communities, canyon live oak stands in the Central Valley, and Bishop pine woodland of the Sierra Blanca Ridge have been replaced by nonnative annual grasses, perennial stands of fennel, or barren landscapes (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" to higher elevations and

northward, depending on the ability of each species to do so. In the case of smaller island ecosystems, such as the Channel Islands, opportunities to move to higher elevations or further north are limited. We lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species; however, small-ranged species such as Hoffmann's rock-cress are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2011).

Recovery

Reclassification Criteria:
1. Discover or establish 10 populations per island (Santa Rosa and Santa Cruz) (USFWS, 2011).

2. Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (USFWS, 2011).

Downlisting criteria for Hoffmann's rock-cress 1. Discover or establish 10 populations per island (Santa Rosa and Santa Cruz). • Several new populations of Hoffmann's rock-cress have been discovered since time of listing, but not 10 for each island. This criterion has not been met. 2. Populations remain stable or increase for a period of 15 years that includes the normal precipitation cycle. • Populations have not been monitored consistently over time to determine stability or increase. This criterion has not been met. 3. Seed stored in CPC cooperating facilities. • There is seed in CPC (Center for Plant Conservation) cooperating facilities, but it is not comprehensive across the species range or across years. This criterion has not been met. 4. Seed germination and propagation techniques understood. • Seeds have been successfully germinated and bulked in the nursery. This criterion has been met. 5. Successful outplanting techniques developed. • Seeds and seedlings have been successfully outplanted on Santa Cruz Island, less so on Santa Rosa Island. This criterion has been met. 6. Life history research conducted and incorporated into recovery criteria. • Life history characteristics and habitat requirements have been researched for the species. This criterion has been met. 7. If declining trend documented, determine cause and reverse trend. • Data are not available to effectively evaluate trends in abundance. This criterion has not been met (USFWS, 2022).

Recovery Priority Number: 5

Delisting Criteria:
Delisting criteria for Hoffmann's rock-cress 1. No decline after downlisting for 10 years. • This criterion is not currently applicable. 2. All potential habitat surveyed. • There is remaining insufficiently surveyed potential habitat on Santa Cruz Island, and new populations continue to be found. Santa Rosa Island also has additional potential habitat that could contain plants. This criterion has not been met (USFWS, 2022).

Recovery Actions:
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the

U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).

- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).
- Seek additional funding to continue field surveys and monitoring, demographic monitoring, outplantings, population viability analyses and further investigations into recovery prescriptions (USFWS, 2011).
- Continue nonnative vegetation removal on Santa Cruz Island (USFWS, 2011).
- Implement nonnative vegetation removal, particularly nonnative grasses, on Santa Rosa Island (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue searching for additional populations of Hoffmann's rock-cress on Santa Cruz and Santa Rosa Islands. 2. Establish regular monitoring for known natural populations of Hoffmann's rock-cress on both islands. 3. Collect seed for restoration seed bulking, and augment natural populations of few individuals with population-specific seed to boost population sizes. 4. Establish new recovery populations on both islands, especially Santa Rosa Island. 5. Improve the completeness of coverage of Hoffmann's rock-cress in conservation seed banks, with all populations over a wider range of years (USFWS, 2022).

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SPECIES ACCOUNT: *Arabis macdonaldiana* (McDonald's rock-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/28/1978; Pacific Southwest (R8)

Physical Description

A perennial species having relatively large, conspicuous lavender to purplish flowers and a rosette, usually flattened, of obovate to broadly oblanceoate leaves from which the flowering stems arise (Rollins 1973). Seeds are winged at the distal end and have trichomes (hairs) on the leaves which are simple. Arabis mcdonaldiana is glabrous (without hairs) except for a few marginal trichomes on the basal leaves; is less than 1.5 decimeters high, and has truncate petals . (USFWS, 1990)

Taxonomy

Arabis mcdonaldiana was first described by Alice Eastwood (1903). In her original description, Eastwood (1903) employed the spelling used in this recovery plan, naming the species in honor of Captain James M. McDonald. Critchfield (1977) altered the spelling to "macdonaldiana" following Recommendation 73C.4 of the International Code of Botanical Nomenclature (Latest edition: Stafleu 1978). Critchfield considered the Eastwood spelling to be an orthographic error. Since, however, the spelling change is based on a recommendation of the Code, not a rule, and because it is unclear whether this recommendation applies to previously published names, the original spelling "mcdonaldiana" is retained. (USFWS, 1990) Genetics research summarized in the USFWS 2013 Five-Year Review reported that Harbaugh-Reynaud and Vorobik sampled 42 specimens within the purple-flowered Arabis group. Their results indicated that Arabis macdonaldiana is represented by two distinct lineages: (1) Red Mountain, Mendocino County, California; and (2) Siskiyou and Del Norte counties, California, and Curry and Josephine counties, Oregon. In their summary report of the 2012 research, Harbaugh-Reynaud and Vorobik recommended that Arabis macdonaldiana specimens from Red Mountain retain the name Arabis macdonaldiana, while the other lineage be revised to be a distinct species (yet to be named), or a subspecies of Arabis aculeolata. Furthermore, Harbaugh-Reynaud and Vorobik determined that Arabis macdonaldiana on Red Mountain is clearly distinct from any other taxon (Harbaugh-Reynaud and Vorobik 2012). Therefore, although there has been much confusion and uncertainty related to the taxonomy genetics of the purple-flowered Arabis group, the most recent genetic work indicates that Arabis macdonaldiana on Red Mountain is distinct from any other taxon. (USFWS, 2013)

Historical Range

At the time it was listed, Arabis macdonaldiana was considered to be restricted to a single population at Red Mountain, Mendocino County. However, in 1993, the taxonomic treatment of the species was revised to include populations of purple-flowered rock-cress located near the Oregon border. Since 1993, the species was thought to occur in Mendocino, Del Norte, and the very western portion of Siskiyou counties in California, and the very southern portion of Curry County in Oregon (USFWS, 2013).

Current Range

Recent genetic work indicates that Arabis macdonaldiana is confined to Red Mountain, Mendocino County, California (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 2013; see habitat narrative)

Breeding Season

Adult: April - May (USFWS, 2013)

Reproduction Narrative

Adult: Flowering typically occurs between April and May (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest, shrubland (NatureServe, 2015); open scrub (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~1,200 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in rocky serpentine areas or reddish soils derived from serpentinite, in dry open woods or brushy steep slopes or ledges; usually at elevations of about 1200 m. The environmental specificity is narrow; it is known from 2 or 3 specific areas on serpentine on the north coast of California and in Oregon (NatureServe, 2015). Arabis macdonaldiana occurs in soils derived from ultramafic parent material, containing high levels of heavy metals and low levels of nutrients. Its habitat ranges from barren gravel slopes to open scrub and pine woodlands. Arabis macdonaldiana is highly rhizomatous and clonal, making the determination of an individual difficult. Fire is an important factor affecting vegetation patterns in general across the Klamath Bioregion, including the Red Mountain area where Arabis macdonaldiana occurs, and appears particularly important in maintaining many open habitats (Skinner et al. 2006; U.S. Forest Service [USFS] 1995; Baad 2002) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decline of 30-50% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

34 (NatureServe, 2015)

Population Size:

> 10,000 (USFWS, 2013); 17,500 (NatureServe, 2015)

Population Narrative:

This species has experienced a long-term decline of 30-50%. The total number of known plants is about 17,500. CNDDB currently has 29 EO's, 9 of which are historic. 10 additional field forms remain unprocessed. California has 29 occurrences, 4 of which are historic. Oregon has 10 occurrences but one is historic. The short term trend is estimated to be slightly declining (10 - 30%) due to mining activities (NatureServe, 2015). Taken together, population survey data suggest the overall population size probably exceeds 10,000 plants (USFWS, 2013).

Threats and Stressors

Stressor: Mining (USFWS, 2013; USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Mining continues to pose a threat to Arabis macdonaldiana at Red Mountain, because the entire distribution of Arabis macdonaldiana continues to be held under unpatented lode and/or placer mining claims. However, the degree of threat is less than when the species was listed, due to Red Mountain Wilderness designation, which has reduced the vulnerability of Arabis macdonaldiana to impacts from new mining claims. Any mining operation on Red Mountain would most likely be an open-face bench type that would involve removal and processing of the mineral-bearing ore containing nickel, chromium, and cobalt (Service 1984). All vegetation and habitat for Arabis macdonaldiana would be removed in the affected area. Although the operations plan would require restoration of the affected areas, plant species composition would undoubtedly be altered. There is no evidence in the literature indicating Arabis macdonaldiana is able to recolonize disturbed soils. Regardless of existing mining claims, Arabis macdonaldiana habitat and serpentine soils in general contain an attractive source of heavy metals, particularly nickel, subject to technological improvements and market fluctuations. Therefore, future pressure to open these lands to mining is possible (USFWS, 2013). The 2019 Amended Recovery Plan reported that new information regarding threats has been obtained that

suggest the threat of mining has been greatly reduced, but not entirely eliminated based on the expiration of several previously valid mining claims near the populations. Several of the mining claims in the Red Mountain Unit of the South Fork Eel River Wilderness Area (Red Mountain Wilderness) have been forfeited. These forfeited claims cannot be relocated, which reduces the threat of mining in the area. However, there are areas occupied by McDonald's rock-cress outside of the Red Mountain Wilderness that are still open for mineral entry. (USFWS, 2019)

Stressor: Fire suppression (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: A potential threat not identified when the species was listed, and not yet well characterized, is the progressive encroachment into Arabis macdonaldiana habitat by woody species in the absence of fire. Fire suppression efforts can cause adverse effects on Arabis macdonaldiana as a result of fire breaks constructed with heavy equipment or hand crews. Fire breaks are often placed along ridge lines, potential suitable habitat for Arabis macdonaldiana. The heavy equipment generally scrapes a layer of earth, eliminating all vegetation and permanently altering the soils. Fire suppression would also maintain existing scrub and forested habitat, allowing progressive encroachment on the species. At the same time, fire control measures could be beneficial by reducing fire intensity in situations where Arabis macdonaldiana is vulnerable to incineration. Without fire to periodically restore early successional conditions and an open canopy, Arabis macdonaldiana would likely decline in a portion of its range (USFWS, 2013).

Stressor: Genetic diversity (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The genetic implications of habitat fragmentation, genetic isolation and declining effective population size are threats common to rare species (Saunders et al. 1991; Meffe and Carroll 1997). At Red Mountain, small breeding populations and the potential loss of genetic diversity from inbreeding and/or random genetic drift could be a problem, given the limited population size and limited range of the species, particularly if the decline observed at Red Mountain continues in future years (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Global climate change likely constitutes a new threat for the species. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller subregions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. Arabis macdonaldiana at Red Mountain may not have access to environmental heterogeneity, due in part to its more limited extent (USFWS, 2013).

Recovery

Reclassification Criteria:
1. At least ten viable subpopulations are protected and managed to assure their continued existence. Subpopulations include at least 1,000 reproductive individuals (have flowered at least once or are capable of flowering), and a population structure indicating stable or increasing reproductive plant numbers. Subpopulations are polygons or clusters of individuals that are separated by >100 meters. (USFWS, 2019)

2. The ten viable subpopulations must be distributed between both soil types that currently support McDonald's rock-cress (Littlered and Hiltebiden/Dann soils), with at least two viable subpopulations in each of the two soil types from which the species is currently known to occur. For the purposes of this plan, a subpopulation includes at least 1,000 reproductive individuals, and a population structure indicating stable or increasing reproductive plant numbers. (USFWS, 2019)

Delisting Criteria:
1. Over a 20-year survey period, monitoring demonstrates a stable or increasing trend in abundance and distribution over the entire Red Mountain population (or across the minimum ten subpopulations). During a minimum of 80 percent of the survey period (i.e., 16 years), an estimated population of 10,000 reproductive individuals will remain extant across all subpopulations. Monitoring will demonstrate a minimum average patch occupancy rate (number of subpopulations with occupied habitat divided by total number of subpopulations) of 60 percent. (USFWS, 2019)

2. At least 10 subpopulations of 1,000 or more reproductive individuals should be protected and managed in perpetuity to reduce or eliminate threats to the species, or perpetual endowments are secured for management necessary to maintain the continued existence of the species. Agreements for the protection and appropriate management of the selfsustaining subpopulations should be in place. Perpetual protection on public land will be assured via management plans. Formal stewardship agreements (e.g., conservation easements or similar instruments) should be in place to ensure perpetual long-term, species-appropriate management on privately owned land. (USFWS, 2019)

3. Lands in public ownership (federal lands) should consider land use allocations compatible with managing habitats to maintain or enhance McDonald's rock-cress occupied habitat. Habitat management plans (HMPs) should be developed and implemented that include restoration opportunities, use restrictions, and/or management actions for the conservation of sensitive, threatened, and endangered plants and wildlife resources. Approved HMPs should include a minimum of a 100-meter (300-foot) surface disturbance buffer around occupied McDonald's rock-cress habitat, and would prioritize avoidance of occupied habitat and assist in connectivity for pollination between subpopulations. (USFWS, 2019)

4. An ex situ collection of plant material is established in a Center for Plant Conservationaffiliated botanic garden. A soil seedbank would typically provide a strategy for a species to regenerate populations in the face of stochastic events as well as natural senescence; however, this species is known to be susceptible to high rates of seed predation. (USFWS, 2019)

5. A monitoring plan to cover a minimum of 10 years post-delisting of McDonald's rockcress has been approved by the Pacific Southwest Regional Director and is ready to be implemented at the time of delisting. (USFWS, 2019)

Recovery Actions:

- Enforce laws and regulations that may affect conservation of the species. To accomplish the primary objective of this recovery plan it is necessary for the appropriate Federal and State agencies to rigorously enforce all laws and regulations which may affect conservation of Arabis mcdonaldiana. Foremost among these laws and regulations is the Endangered Species Act of 1973, as amended, and its associated regulations. Other relevant laws and regulations include the California Native Plant Protection Act, applicable to those areas within the range of A. mcdonaldiana that are privately owned; the Federal Land Policy and Management Act, under which the Bureau administers lands under its jurisdiction; the National Environmental Policy Act and California Environmental Quality Act; the Wilderness Act and Bureau regulations and policies applying to lands under wilderness review for those applicable portions of the species' range; the Bureau regulations governing the surface management of Federal lands under the U.S. Mining Laws; the State of California Surface Mining and Reclamation Act of 1975; the Clean Water Act of 1977 as it applies to the regulation of surface disturbing activities such as mining which pollute waterways; and the Clean Air Act as applicable to air pollution associated with the processing of minerals. (USFWS, 1990).
- Protect essential habitat. Sufficient habitat must be protected to insure the well-being of Arabis mcdonaldiana. This will require identification and precise mapping of the essential habitat as well as determining and selecting the appropriate means to do so. Much of the opportunity to protect A. mcdonaldiana will depend upon the authority of the State and Bureau to regulate surface mining. (USFWS, 1990).
- Monitor agency compliance with the recovery plan. To assure that all aspects of the recovery program are proceeding in an effective and timely manner, a compliance monitoring effort should be initiated. (USFWS, 1990).
- Enhance public awareness of Arabis mcdonaldiana recovery effort through informational and educational programs. Although an awareness program does not contribute direct benefits to the recovery effort, it can provide important long-term benefits. Audio-visual programs, a small brochure on the unique resources of Red Mountain, and a pamphlet on Arabis mcdonaldiana could help foster respect for the values addressed in this plan. In addition, scientific study of the soils, vegetation, and fauna of Red Mountain should be encouraged. Additional studies could provide as yet unknown benefits to future generations. (USFWS, 1990).
- A field study of A. macdonaliana should be conducted to determine the degree to which shrub and tree encroachment may be impacting the population (USFWS, 2013).
- A field study of A. macdonaliana should be conducted to determine the continued presence of Arabis macdonaldiana in previously mapped habitat polygons, or other locations at Red Mountain (USFWS, 2013).
- A field study of A. macdonaliana should be conducted to determine the cause for the observed decline in Arabis macdonaldiana in the vicinity of the study sites used by Baad (2002) (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Because there is some evidence to suggest that the population may have declined since listing (Service 2013, entire), a field study of McDonald's rock-cress should be conducted to determine: (1) The degree to which shrub and tree encroachment may be impacting the population; (2) The continued presence of McDonald's rock-cress in previously mapped habitat polygons, or other locations at Red Mountain; (3) The cause for the observed decline in McDonald's rock-cress in the vicinity of the study sites used by Baad (2002). (USFWS, 2020)

References

USFWS. 2013. Arabis macdonaldian.a (McDonald's rock-cress), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office. 26 pp. May 13, 2013. https://ecos.fws.gov/docs/five_year_review/doc4151.pdf

USFWS. 1990. McDonald's rock-cress (Arabis mcdonaldiana Eastwood), Recovery Plan. U.S. Fish and Wildlife Service, Portland, Oregon. 40 pp. https://ecos.fws.gov/docs/recovery_plan/840228.pdf

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2013. Arabis macdonaldian.a (McDonald's rock-cress), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office. 26 pp. May 13, 2013.

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USFWS. 2019. Amendment to Recovery Plan for Arabis macdonaldiana (McDonald's rock-cress). U.S. Fish and Wildlife Service, Sacramento, California. 11 pp. December 10, 2019.

USFWS. 2020. 5-YEAR REVIEW McDonald's rock-cress (Arabis macdonaldiana). 2 pp.

SPECIES ACCOUNT: *Arabis perstellata* (Braun's rock-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/2/1995; Southeast Region (R4)

Physical Description

Braun s rockcress is distinguished from other members ofthe genusArabis by the white stellate (star-shaped) hairs on stems and leaves that give the plant a grayish appearance. These stellate hairs are mixed with simple hairs on the upper surface of the leaves. Braun's rockcress is a perennial, while most other Arabis species are biennials. The stem, which can reach 80 centimeters (cm) or 31.5 inches in length (but is usually much smaller), is branched at the base and can be decumbent or partially erect. The mostly lanceolate stem leaves are auriculate at the base where they clasp the stem. Leaf size (2 to 5 cm) becomes reduced on the upper stem, and the shape may become more ovate. Small white to lavender flowers are produced in a terminal raceme and are barely emergent beyond the sepals. The fruit is a round, elongate, and densely hairy silique. Flowers are produced from late March to early May; fruits mature from mid-May to early June. (USFWS, 1997)

Taxonomy

The genus Arabis has undergone major taxonomic revision due to recent molecular phylogenetic studies. Based on the results of this research, the majority of species within the Genus Arabis have been transferred to the genus Boechera. This includes Braun's Rockcress (formerly Arabis perstellata, now Boechera perstellata) (Al-Shehbaz 2003, 2010; Alexander et al. 2013; ITIS 2018). (USFWS, 2018)

Historical Range

See Current Range information.

Current Range

Franklin, Henry, and Owen Counties in Kentucky; Davidson, Rutherford, and Wilson Counties in Tennessee. (USFWS, 2018)

Critical Habitat Designated

Yes; 7/6/2004.

Legal Description

On June 3, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective July 6, 2004) for Arabis perstellata (Braun's rock-cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 22 critical habitat units (CHUs) in Tennessee and Kentucky (69 FR 31460-31496).

Critical Habitat Designation

The critical habitat designation for Arabis perstellata includes 22 CHUs in Rutherford and Wilson Counties, Tennessee; and Franklin, Owen and Henry Counties, Kentucky. These units encompass approximately 648 hectares (ha) (1,600 acres (ac)) of upland habitat. Kentucky has approximately 328 ha (810 ac) and Tennessee has approximately 320 ha (790 ac) designated as critical habitat for Arabis perstellata . Brief description and the promulgated description of each critical habitat

unit is provided below; maps depicting the CHU location are available in the Final Rule (69 FR 31460-31496). (USFWS, 2004)

Unit 1. Sky View Drive in Franklin County, Kentucky. Unit 1 is located on the west side of the City of Frankfort. It occurs along U.S. 127 and Skyview Drive on the slopes of the first large ravine system due west of the confluence of Benson Creek and the Kentucky River. It contains approximately 22 ha (54 ac). Promulgated Unit 1 description: Sky View Drive, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1453158.08, 257013.95; 1455318.02, 258193.89; 1455537.40, 256159.34. (USFWS, 2004)

Unit 2. Benson Valley Woods in Franklin County, Kentucky. Unit 2 is located west of the City of Frankfort. The unit lies southeast of Benson Valley Road on the south side of Benson Creek. It contains approximately 37 ha (91 ac). Promulgated Unit 2 description: Benson Valley Woods, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Frankfort East, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1450864.02, 256869.46; 1453925.25, 260160.79; 1454705.56, 258980.31; 1451054.09, 256519.32. (USFWS, 2004)

Unit 3. Red Bridge Ridge in Franklin County, Kentucky. Unit 3 is located west of Kentucky (KY) Highway 1005, at the confluence of South Benson and Benson Creeks. The site is privately owned. It is approximately 6 ha (15 ac) in size. Promulgated Unit 3 description: Red Bridge Road, Franklin County, Kentucky. From USGS 1:24,0000 quadrangle Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1442614.00, 258863.10; 1443144.60, 258502.62; 1441670.26, 257801.90; 1441581.15, 258012.52. (USFWS, 2004)

Unit 4. Tributary to South Benson Creek in Franklin County, Kentucky. This unit is located northeast of the City of Frankfort. It occurs along the southeast side of South Benson Creek and the north and south slopes of an unnamed tributary. The site is 10 ha (25 ac) in size. Promulgated Unit 4 description: Tributary to South Benson Creek, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1443620.37, 253609.15; 1444037.01, 253294.00; 1442925.97, 252129.54; 1442210.20, 252471.40. (USFWS, 2004)

Unit 5. Davis Branch in Franklin County, Kentucky. This unit occurs along the east side of Harvieland Drive and Davis Branch. This unit contains approximately 3 ha (7 ac). Promulgated Unit 5 description: Davis Branch, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Polsgrove, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1450167.05, 277739.69; 1450767.00, 277750.87; 1450761.41, 277314.88; 1450202.46, 277180.73. (USFWS, 2004)

Unit 6. Onans Bend in Franklin County, Kentucky. Unit 6 occurs north of Onans Bend Road and east of KY Highway 12. The unit lies along the banks of an unnamed stream near its mouth with the west bank of the Kentucky River. This unit contains approximately 12 ha (30 ac). Promulgated Unit 6 description: Onans Bend, Franklin County, Kentucky. From USGS 1:24,000 quadrangle map Polsgrove, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1458610.26, 289401.40; 1459066.14, 289401.50; 1459484.82,

288182.67; 1458210.30, 287759.68; 1458191.76, 288155.34. (USFWS, 2004)

Unit 7. Shadrock Ferry Road in Franklin County, Kentucky. This unit is located along the north side of Shadrock Ferry Road (KY Highway 898). This unit is approximately 15 ha (37 ac) in size. Promulgated Unit 7 description: Shadrock Ferry Road, Franklin County, Kentucky. From USGS 1:24,0000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1461695.27, 280422.79; 1462823.09, 280986.70; 1463880.43, 280256.18; 1463463.90, 279506.43. (USFWS, 2004)

Unit 8. Hoover Site in Franklin County, Kentucky. This unit lies northwest of the City of Frankfort, along the west side of the Kentucky River on slopes bordering two unnamed tributaries. Plants are widely scattered in small groups along the Kentucky River bluff from river kilometer (km) 98.6 to 101.7 (river mile 61.3 to 63.2). This unit contains approximately 83 ha (205 ac). Promulgated Unit 8 description: Hoover Site, Franklin County, Kentucky. From USGS 1:24,0000 quadrangle Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1479208.72, 296984.32; 1480548.19, 297074.83; 1480548.19, 296260.28; 1479407.83, 295690.11; 1479177.04, 295694.63. (USFWS, 2004)

Unit 9. Longs Ravine Site in Franklin County, Kentucky. Unit 9 is located north of the City of Frankfort and Lewis Ferry Road. This unit lies east of the Kentucky River in a large ravine and along the steep slopes above the river. Promulgated Unit 9 description: Longs Ravine Site, Franklin County, Kentucky. From USGS 1:24,0000 quadrangle Frankfort West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1457404.81, 269596.23; 1457959.89, 270126.46; 1460205.09, 268958.30; 1459003.79, 267607.86.(USFWS, 2004)

Unit 10. Strohmeiers Hill in Franklin County, Kentucky. This unit is located south of the Town of Swallowfield and adjacent to Strohmeier Road and U.S. 127. It occurs on steep slopes on the south side of Elkhorn Creek and on the east bank of the Kentucky River, south of the confluence with Elkhorn Creek. The site is approximately 20 ha (49 ac) in size. Promulgated Unit 10 description: Strohmeiers Hills, Franklin County, Kentucky. From USGS 1:24,0000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1467733.92, 298729.06; 1468218.13, 298978.50; 1468695.00, 297144.38; 1469854.17, 296131.94; 1469568.53, 295848.76; 1468658.32, 296498.77; 1468247.47, 297181.06; 1468056.72, 297936.72; 1467763.26, 296704.19; 1467440.46, 297415.83. (USFWS, 2004)

Unit 11. U.S. 127 in Franklin County, Kentucky. Unit 11 is located along the east side of U.S. 127 in a ravine just southeast of Elkhorn Creek. This unit is approximately 11 ha (27 ac) in size. Promulgated Unit 11 description: U.S. 127, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1469164.24, 295115.19; 1469939.07, 295511.62; 1470629.82, 294466.49; 1469662.78, 294058.06. (USFWS, 2004)

Unit 12. Camp Pleasant Branch Woods in Franklin County, Kentucky. Unit 12 is located along the south side of Camp Pleasant Road (KY Highway 1707). This site contains approximately 14 ha (35 ac). Promulgated Unit 12 description: Camp Pleasant Branch Woods, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky

State Plane North / NAD83 (Feet) coordinates: 1453446.71, 269919.75; 1454641.35, 269410.27; 1453921.05, 266476.39; 1452392.62, 264561.46; 1451250.69, 265879.07. (USFWS, 2004)

Unit 13. Saufley in Franklin County, Kentucky. Unit 13 occurs west of the KY Highway 1900 bridge over Elkhorn Creek on the hillside above the creek. The land ownership for this unit is private. The site is approximately 8 ha (20 ac) in size. Promulgated Unit 13 description: Saufley, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Switzer, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1476234.26, 281055.05; 1476538.92, 281115.98; 1476924.83, 280171.52; 1477848.97, 279612.98; 1476538.92, 279887.17. (USFWS, 2004)

Unit 14. Clements Bluff in Owen County, Kentucky. This unit is located in a ravine facing the Kentucky River along the east side of KY Highway 355. The site is owned by the State of Kentucky and is part of the Kentucky River Wildlife Management Area. This unit is approximately 11 ha (27 ac) in size. Promulgated Unit 14 description: Clements Bluff, Owen County, Kentucky. From USGS 1:24,000 quadrangle Gratz, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1451615.01, 349295.36; 1452022.39, 349505.61; 1452910.30, 347908.24; 1452180.35, 347473.85. (USFWS, 2004)

Unit 15. Monterey U.S. 127 in Owen County, Kentucky. Unit 15 is located 1.6 km (1 mile) north of the City of Monterey, just north of the junction of U.S. 127 and KY Highway 355. This unit is approximately 12 ha (30 ac) in size. Promulgated Unit 15 description: Monterey U.S. 127, Owen County, Kentucky. From USGS 1:24,000 quadrangle Monterey, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1462791.17, 342357.03; 1463347.35, 341639.38; 1462109.41, 340778.21; 1461660.88, 341370.27. (USFWS, 2004)

Unit 16. Craddock Bottom in Owen County, Kentucky. This unit is located south of the City of Monterey. It occurs along the west side of Old Frankfort Pike on the westfacing slope just east of Craddock Bottom. The site contains approximately 23 ha (57 ac). Promulgated Unit 16 description: Craddock Bottom, Owen County, Kentucky. From USGS 1:24,000 quadrangles Frankfort East and West, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1463039.86, 332602.65; 1463575.00, 332555.43; 1464377.71, 331784.20; 1464377.71, 329218.68; 1463748.13, 329202.94; 1463716.65, 330918.53.(USFWS, 2004)

Unit 17. Backbone North in Franklin County, Kentucky. Unit 17 is located north of KY Highway 1900. It occurs in an old river oxbow west of the existing Elkhorn Creek . The unit size is approximately 11 ha (27 ac). Promulgated Unit 17 description: Backbone North, Franklin County, Kentucky. From USGS 1:24,000 quadrangle Frankfort East, Kentucky; land bounded by the following Kentucky State Plane North / NAD83 (Feet) coordinates: 1470487.13, 273240.06; 1471988.00, 273697.42; 1472199.59, 273279.29; 1471168.97, 272953.00; 1470516.94, 272031.81; 1470339.01, 272116.74.(USFWS, 2004)

Unit 18. Scales Mountain in Rutherford County, Tennessee. This unit is located west of the City of Murfreesboro on Scales Mountain, 1.6 km (1 mile) south of Highway 96. This unit is 103 ha (255 ac) in size and consist of three knobs. Promulgated Unit 18 description: Scales Mountain, Rutherford County, Tennessee. From USGS 1:24,000 quadrangle Rockvale, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1797871.97,

548892.57; 1800101.59, 549457.83; 1800070.19, 547856.27; 1797934.77, 547071.19. (USFWS, 2004)

Unit 19. Sophie Hill in Rutherford County, Tennessee. Unit 19 is located west of the City of Murfreesboro on Sophie and Townsel Hills which lies between Newman and Coleman Hill Roads. The unit is approximately 53 ha (132 ac) in size and consists of two hills. Promulgated Unit 19 description: Sophie Hill, Rutherford County, Tennessee. (i) From USGS 1:24,000 quadrangle Rockvale, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1804270.37, 539691.44; 1805958.29, 539809.20; 1806076.05, 538867.10; 1804427.38, 538631.58. (USFWS, 2004)

Unit 20. Indian Mountain in Rutherford County, Tennessee. Unit 20 is located west of the City of Murfreesboro on Indian Mountain between Highway 96 and Coleman Hill Road. The unit size is approximately 87 ha (214 ac) and consists of three knobs. Promulgated Unit 20 description: Indian Mountain, Rutherford County, Tennessee. (i) From USGS 1:24,000 quadrangle Rockvale, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1800305.71, 546168.35; 1802111.40, 546443.12; 1802543.19, 544794.46; 1800423.48, 544676.69.(USFWS, 2004)

Unit 21. Grandfather Knob in Wilson County, Tennessee This unit is located 1.8 km (1.1 miles) west of Cainesville between State Route 266 (Cainesville Road) and Spain Hill Road. The unit is 43 ha (106 ac) in size. Promulgated Unit 21 description: Grandfather Knob, Wilson County, Tennessee. From USGS 1:24,000 quadrangle Lascassas, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1888463.64, 602182.29; 1890759.35, 602182.29; 1890842.07, 601189.55; 1889518.42, 599969.31; 1888877.28, 599638.40; 188670.46, 599638.40; 1888401.59, 600300.23. (USFWS, 2004)

Unit 22. Versailles Knob in Rutherford County, Tennessee Unit 22 is located 1.3 km (0.8 mile) south of Versailles between Versailles Road and Bowles Road. The unit size is approximately 34 ha (83 ac). Promulgated Unit 22 description: Versailles Knob, Rutherford County, Tennessee. From USGS 1:24,000 quadrangle Rover, Tennessee; land bounded by the following Tennessee State Plane / NAD83 (Feet) coordinates (E,N): 1806361.65, 504515.38; 1808616.22, 505711.83; 1809308.27, 504327.51; 1808517.23, 503872.66; 1807034.03, 503477.14. (USFWS, 2004)

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Arabis perstellata critical habitat consists of four components (69 FR 31460-31496):

(i) Relatively undisturbed, closed canopy mesophytic and sub-xeric forest with large, mature trees (such as sugar maple (Acer saccharum), chinquapin oak (Quercus muhlenbergii), hackberry (Celtus occidentalis), or Ohio buckeye (Aesculus glabra)), and

(ii) Open forest floors with little herbaceous cover and leaf litter accumulation with natural disturbance to allow for Arabis perstellata germination and seedling germination, and

(iii) Areas with few introduced weed species such as Alliaria petiolata or Lonicera maackii, and

(iv) Rock outcrops on moderate to steep calcareous slopes defined by: (A) Ordovician limestone, in particular the Grier, Tanglewood, and Macedonia Bed Members of the Lexington Limestone in Kentucky and the Lebanon, Carters, Leipers, and Catheys, and Bigby-Cannon Limestones in Tennessee; and (B) Limestone soils such as the Fairmont Rock outcrop complexes in Kentucky and the Mimosa Rock outcrop complexes in Tennessee.

Special Management Considerations or Protections

We have determined that the critical habitat units may require special management or protection, largely because no long-term protection or management plans exist for any of the units and due to the existing threats to this plant. Absent special management or protection, these 22 units are susceptible to existing threats and activities such as the ones listed in the ''Effects of Critical Habitat'' section, which could result in degradation and disappearance of the populations and their habitat.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Arabis perstellata is facing potential inbreeding problems because of low population numbers (Rollins 1993).; (NatureServe, 2015)

Habitat Type

Adult: Wooded slopes (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: Typically found on mesic, shady, steep, north-facing wooded slopes, however, no exposure is 'preferred' in Kentucky, above streams or in ravines that lead into streams. The soils at these sites are derived from limestones, which often outcrop. The plants often occur either in sheltered areas, such as around the bases of larger trees, or in areas where there is little competition, such as in places regularly scoured by talus movement or erosion. It can also occur in areas of disturbance such as animal trails and roadcuts. It should be sought on shady forested limestone slopes with wild ginger (Asarum canadense), in forests dominated by sugar maple (Acer saccharum), chinquapin oak (Quercus muehlenbergii), blue ash (Fraxinus quadrangulata), Ohio buckeye (Aesculus glabra), and Kentucky coffeetree (Gymnocladus dioicus). (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

3 occurrences are increasing, 21 are stable, 16 are declining, and 17 are unknown (57 total occurrences) (USFWS, 2023)

Number of Populations:

51 (45 in KY, 6 in TN) (USFWS, 2023)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Persistent and fairly resilient if habitat integrity maintained. (NatureServe, 2015)

Population Narrative:

Based on current monitoring and distributional data compiled by the Office of Kentucky Nature Preserves (OKNP) and the Tennessee Department of Conservation (TDEC), Braun's Rockcress is represented by a total of 57 extant occurrences (51 populations) in Kentucky and Tennessee (Table 1; Appendix A, Tables A-1 and A-2) (OKNP 2020, 2021; Crabtree 2023, pers. comm.). Of this total, 45 occurrences (45 populations) are in Kentucky, and 12 occurrences (6 populations) are in Tennessee. Since completion of the last review, the number of extant occurrences increased by two in Kentucky and remained constant for Tennessee. The increase in Kentucky occurrences was the result of a status change for one occurrence (EO#2) and discovery of a new occurrence by OKNP (EO#66, Peyton site). Currently, 17.5% of extant occurrences are A-ranked (10 of 57), 10.5% are B-ranked, 38.5% are C-ranked, 35.1% are D-ranked, and 3.5% are F-ranked (F = failed to find). OKNP has not assessed the viability of the new Kentucky occurrence, EO#66 (USFWS, 2023)

Threats and Stressors

Stressor: Destruction and deterioration of habitat (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The recovery plan (USFWS 1997) and subsequent critical habitat rule (69 FR 31460) listed the primary threats to the species as alteration or loss of habitat through development (primarily home and road construction), competition with native and exotic weedy species, grazing and trampling, and timber harvesting . These threats still exist. (USFWS, 2016)

Stressor: Invasive plants (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Invasive plants continue to affect all Kentucky populations, and the magnitude and scope of these threats increase every year without active management (Appendix C, Table 6). Garlic Mustard (Alliaria petiolata) and Bush Honeysuckle (Lonicera maackii) have the greatest impact on Braun's Rockcress populations, followed by Chickweed (Stellaria media), Winter Creeper (Euonymous fortuneii), and Privet (Ligustrum sp.). Bush Honeysuckle appears to be reducing overall wildflower numbers across the species' range in Kentucky and may be causing erosion of Braun's Rockcress habitats on lower slopes (D. White, pers. comm., 2018). Tennessee populations have less competition from invasive species in part due to topography. The Tennessee populations occur on isolated knobs in contrast to the Kentucky populations existing along steep slopes of the Kentucky River and its tributaries. Despite these conditions, Garlic

Mustard was noted as a threat to two of Tennessee's historic/extirpated sites (TN EO 1 and 4), and monitoring of new infestations is critical to the viability of TN populations (TDEC 2018) (Appendix C, Table 7). The two main clusters of Braun's Rockcress occurrences in Tennessee are located on opposite sides of an extensive urban corridor, with virtually no habitat connectivity. This differs from the higher connectivity of Kentucky occurrences along the Kentucky River corridor in a largely rural area. (USFWS, 2018)

Stressor: Lack of adequate existing regulatory mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The inadequacy of exiting regulatory mechanisms also represents a threat to the species. Most populations occur on private property and are vulnerable to landowner activities that might result in some kind of habitat disturbance. Within Kentucky, the species' endangered status is only a KSNPC designation that carries no legal protection (KSNPC 2005). (USFWS, 2016)

Stressor: Loss of ash trees (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Dramatic impacts have been observed over the past six years in the forest canopy of Franklin, Henry, and Owen counties, Kentucky due to the spread of the Emerald Ash Borer (Agrilus planipennis) and its impact on White Ash (Fraxinus americana) and Green Ash (Fraxinus pennsyvannica). At least two Braun's Rockcress sites have been logged by landowners as a result of the impending ash decline (KY EO 16 and 24), and the majority of Braun's Rockcress sites in KY have experienced some canopy loss and increased disturbance from ash tree death. The loss of ash trees has resulted in open canopy conditions, allowing for rapid colonization by invasives such as Garlic Mustard (Littlefield, 2018b). (USFWS, 2018)

Stressor: Erosion due to large rainfall events (USFWS,2018)
Exposure:
Response:
Consequence:
Narrative: Over the past 10 years, erosion caused by large rainfall events has impacted at least three populations in Tennessee (TN EOs 8, 16, 17) and at least one population in Kentucky (KY EO 51A/B) (TDEC, 2009, 2011, 2015; Littlefield 2009-2017). Significant rainfall events in 2010 contributed to extensive erosion at several Braun's Rockcress sites. Documented population declines were noted at four sites in Tennessee and Kentucky (TDEC, 2009, 2011, 2015; Littlefield 2009-2017; NOAA 2010). (USFWS, 2018)

Stressor: Herbivory (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Whitetail Deer herbivory of Braun's Rockcress has been noted at a few sites (KY EO 51, 13) over the past five years in Kentucky, but it does not appear to be a significant threat. Because Whitetail Deer in particular seem to play a role in Braun's Rockcress seed dispersal, occurrences are often associated with deer trails and rock outcrops and along the base of large trees on steep

slopes. Anecdotal evidence suggests that as Whitetail Deer move along these steep forested slopes, passing through Braun's Rockcress populations, seeds are trapped (with soil) on deer hooves and distributed passively along trails. If not for these modes of seed dispersal, Braun's Rockcress plants would only recolonize downslope by means of gravity and would get concentrated on lower slopes and rock outcrops above creeks, eventually disappearing when most seeds would fall into unsuitable habitat along the creek (Littlefield 2018). (USFWS, 2018)

Recovery

Reclassification Criteria:
When 10 geographically distinct self-sustaining populations consisting of 50 plants or more each are protected within a significant portion of the species' range in Kentucky and Tennessee. At least half of these should be populations of 100 plants or more. It must also be demonstrated that these populations are stable or increasing through 5 years of monitoring. Protection can be achieved through ownership by government or private actions. It can also include legal dedication or the placement of conservation easements on private land. Site registry may be used to protect up to three of the sites; it is expected that this form of protection will be preferred for lower-quality sites. All protected sites must have management plans or agreements in place that ensure the long-term maintenance of Arabis perstellata habitat. (USFWS, 1997)

Recovery Priority Number: 5

Delisting Criteria:
When 20 geographically distinct self-sustaining populations, also consisting of 50 or more plants each, are protected in Kentucky and Tennessee and it has been demonstrated that they are stable or increasing after another 5 years of monitoring following reclassification to Threatened. Registry agreements may be used for up to six of these sites. (USFWS, 1997)

Recovery Actions:
- 1. Develop a site protection plan for all sites rangewide. (USFWS, 1997)
- 2. Conduct inventories in an effort to locate new populations. An inventory conducted in Kentucky in 1996 (KSNPC 1996a) increased the number of known sites, and several of these were some of the highest-quality sites discovered to date. Additional surveys are particularly warranted in Tennessee and, to a lesser degree, in Kentucky. (USFWS, 1997)
- 3. Determine the demographic trends. Develop a census technique that will detect general demographic trends in the population numbers. Criteria to be used in the census must evaluate population viability and identify threats at each site. For instance, size classes should be used in conjunction with population counts to determine whether population numbers are changing and whether demographic shifts are occurring. The census technique can also be used to determine whether more intensive monitoring may be needed at a site. An effort should be made to include as many representative populations as feasible. (USFWS, 1997)
- 4. Determine whether populations are self-sustaining and determine the population attributes needed to attain viability. Aspects of the life history that are to be specifically addressed in these studies are: (1) age class distribution relative to population stability; (2) minimum viable population size; (3) the role of seedling establishment in population stability; (4) pollination and self-fertilization; (5) seed dispersal; and (6) longevity of seeds

under natural conditions. (USFWS, 1997)

- 5. Determine optimal habitat conditions. Environmental factors affect population success. A description ofthe optimal conditions for the species is needed in evaluating management applications and evaluating sites for protection. Studies should specifically address the following: (1) the role of disturbance (as a natural factor and as a threat); (2) competition, and (3) moisture relations in seed germination and establishment and adult plant growth. (USFWS, 1997)
- 6. Develop and implement a site management strategy for the species. (USFWS, 1997)
- 7. Secure and store viable seeds. This aspect of recovery has been accomplished by the Center for Plant Conservation. (USFWS, 1997)
- 8. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Braun's rockcress could greatly encourage landowner assistance in conservation efforts. However, informational material should not identify the plant's precise locations in order to discourage vandalism to, or collection of, wild populations. Informational materials should stress pragmatic reasons for species conservation as well as intellectual, aesthetic, or moral considerations. Background information about the pharmacological, agricultural, or economic properties of the species, its congeners, or other plant family relatives will help address the questions frequently posed by laypersons. (USFWS, 1997)
- 9. Annually assess the success of recovery efforts for the species. The timely review of new information and the evaluation ofongoing programs are essential to ensure that full recovery occurs as rapidly and efficiently as possible. Monitoring information may reveal new problems or require shifts in the allocation of resources to monitoring, research, and management projects. Population performance should be compared to preestablished targets, and more rigorous or frequent monitoring programs should be implemented ifpopulations decline below the preestablished thresholds. Pilot and full-scale management projects should also be reviewed to ensure their continuing effectiveness. (USFWS, 1997)
- Complete a full status survey of Braun's Rockcress in Kentucky, including evaluations of associated forest quality (2019-2020). (USFWS, 2018)
- Increase survey efforts for new populations in high quality habitat with more mature forest. (USFWS, 2018)
- Conduct studies on garlic mustard management. (USFWS, 2018)
- Increase seed banking efforts. (USFWS, 2018)
- Increase augmentation and introductions to high quality sites containing less invasive plants. (USFWS, 2018)
- Work cooperatively with the Kentucky Department of Fish and Wildlife Resources (KDFWR) and Office of Kentucky Nature Preserves (KNP) to develop management plans and conservation agreements for populations occurring on KDFWR owned properties (e.g., state wildlife management areas). (USFWS, 2018)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities • Continue to pursue permanent protection of occurrences under private ownership through conservation easements or land purchases • Expand the size of extant occurrences through habitat management and augmentation • Establish viable occurrences in areas within the historical range that have suitable habitat and few invasive species • Acquire potentially suitable but currently unoccupied habitat for the species where the species can be introduced and managed • Continue implementation of management actions for

permanently protected occurrences • Work cooperatively with the KDFWR and OKNP to develop management plans and conservation agreements for populations occurring on KDFWR owned properties (e.g., WMAs). Monitoring and Research Activities • Increase survey efforts for new populations in high quality habitat with mature forest • Continue to investigate the life history and ecological requirements of the species (e.g., seedling establishment, seed, and pollen dispersal distances) • Study the species' population genetics • Conduct studies on garlic mustard management (USFWS, 2023).

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SPECIES ACCOUNT: *Arabis serotina* (Shale barren rock cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/13/1989; Northeast Region (R5) (USFWS, 2016)

Physical Description

A facultative biennial herb characterized in its nonreproductive stage by an inconspicuous basal rosette of lobed leaves. Average rosette size ranged from 1.6—3.5 cm. In its reproductive stage, the basal leaves shrivel as the slender stem grows, or "bolts," and the inflorescence develops (USFWS, 1991).

Taxonomy

A member of the mustard family, Brassicaceae. There has been some debate over the taxonomy of the species: A. serotina is not mentioned in some floras and is treated as synonymous with Arabis laevigata var. burkii in others (USFWS, 1991).

Historical Range

First observed in Virginia; extent of historical range is not reported (USFWS, 1991).

Current Range

Ten counties in Virginia and West Virginia (USFWS, 1991).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (EPA, 2016)

Breeding Season

Adult: Flowers from mid-July through September (USFWS, 1991)

Key Resources Needed for Breeding

Adult: Flower flies (USFWS, 1991); possibly bees (NatureServe, 2015).

Reproduction Narrative

Adult: Flowers from mid-July through September (USFWS, 1991); Pollinated by insects (flower flies and butterflies, possibly bees (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 1991)

Habitat Vegetation or Surface Water Classification

Adult: Shale barrens of the Ridge and Valley Province of the Appalachian Highlands (USFWS, 1991)

Geographic or Habitat Restraints or Barriers

Adult: Elevation from 400 to 600 m (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Habitat is shale barrens of the Ridge and Valley Province of the Appalachian Highlands (USFWS, 1991), occurring only on sparsely-vegetated xeric, south or west-facing shale slopes (barrens) at elevations from 400 to 600 meters (NatureServe, 2015). Populations are known from both the shale openings and shale woodlands adjacent to the shale openings. The term "shale barren" is a general reference to certain mid-Appalachian slopes that possess the following features: 1) southern exposures, 2) slopes of 20-70 degrees and 3) a covering of lithologically hard and weather-resistant shale or siltstone fragments (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2023)

Number of Populations:

62 (USFWS, 2023)

Population Narrative:

Since the 2010 status review, VDCR-DNH conducted shale barren rock cress surveys in 2013 (Van Alstine and Heffernan 2013, entire), 2017 (Van Alstine 2017, entire), 2018 (Van Alstine 2019, entire), 2019 (Stanley 2019, entire), and 2020 (Stanley 2021, entire). At the time of the 2010 status review, more than half of the known occurrences in VA had not been revisited since the 1990s. As of this review, approximately 30 (of 34) previously known EOs in VA have been revisited/monitored, and several new EOs and SFs within existing EOs have been identified. Of the 30 EOs that were revisited, 4 were downranked, and the remainder had no change in rank. The four downrankings were a result of either finding lower numbers of SFs than previous counts or finding other site conditions or reproductive conditions that lowered the EO rank. For this status review, VDCR-DNH staff botanist John Townsend reviewed the VA reports written since the 2010 status review to clarify the findings in terms of EOs and SFs. A total of 3 new EOs (comprising a total of 7 new SFs) were recorded during the 2017-2020 surveys, as well as a total of 31 new SFs that were grouped into existing EOs due to proximity to known SFs (J. Townsend, VDCR-DNH, email to S. Hoskin, Service, August 27, 2021). In 2011, WVDNR botanists reduced shale barren rock cress monitoring frequency to every 5 years due to concerns that shale barrens might be negatively impacted by people traversing the barrens during surveys. Depending on funding and staffing, EOs are monitored every 5 years. In 2017, WVDNR botanists clarified that a plant identified as shale barren rock cress was smooth rock cress (Arabis laevigata var. burkii) (WVDNR 2018, unpaginated). In 2019, WVDNR staff assisted in

investigating a report of a new occurrence of shale barren rock cress in the path of a proposed Federal highway. After examining seeds under a dissecting microscope, sharing plant photos and a summary of characteristics with experts in VA and WV, and examining known shale barren rock cress plants, they determined the plants in question were a different species (WVDNR 2019). Overall, the status and trends in WV have been stable, but many of the EOs have fair or worse viability, which increases their risk to stochastic events (A. Silvis, WVDNR, letter to S. Hoskin, Service, January 25, 2021). In summary, the number of known EOs throughout the species range has increased from 34 to 62 in the 34 years since the time of listing, with 1 EO in WV not relocated and 4 EOs in VA not revisited since the 1990s. Twenty-nine EOs in VA and 22 EOs in WV have been assessed since 2010. Of these 51 EOs, 4 have been downranked and 47 have had no change in status since their original discovery (USFWS, 2023).

Threats and Stressors

Stressor: Habitat degradation or modification (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Road, dam, and railroad construction have resulted in the partial destruction and disturbance of shale barrens containing A. serotina (USFWS, 1991).

Stressor: Drought (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Increased reproductive failure was observed among populations in one West Virginia valley that suffered a severe drought in 1987. Additional West Virginia data from 1988 and 1989 -- years of drought and normal rainfall, respectively -- suggested significant negative effects from drought on reproduction in the A. serotina populations studied, including dead terminal and lateral shoot tips and decreased fruit production (USFWS, 1991).

Stressor: Herbivory (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Herbivory by deer has been suggested by some investigators as a significant threat to A. serotina, although the data are mainly circumstantial. Most grazing activity appears to occur in spring, when (if a plant is not otherwise stressed) loss of the terminal bud could increase branching and, possibly, flower and seed production; this makes it difficult to ascertain the degree of threat grazing represents (USFWS, 1991).

Stressor: Other factors that can affect species populations (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Since most of the 34 extant populations consist of less than 100 plants (many with fewer than ten individuals), this rare species may be particularly vulnerable to local extirpation. In general, any other threat that acts on the species is more likely to destroy a small population

than a large one. These small populations may also be susceptible to catastrophic loss by a stochastic event causing reproductive failure such as a tree falling or seed dispersal into an unsuitable habitat (USFWS, 1991).

Stressor: Insects and insect-control measures (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: There has been some concern about possible impacts on A. serotina from gypsy moth (Lymantria dispar) infestation. Escaping in New England, the gypsy moth has moved south, defoliating large forest tracts and causing substantial mortality of trees in some forest types. The moth has entered the northern portion of A. serotina's range and may cover the entire range in the next one to four years. Of more immediate concern are the possible effects on A. serotina caused by treatments to control gypsy moths, which may cause high mortality in certain non-target organisms. These organisms include pollinators of A. serotina such as two rare butterflies (Pvrcrus wyandot and Euchloe olympia), which inhabit shale barrens and adjacent woodlands (USFWS, 1991).

Stressor: Overcollection (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Overcollection of this species by botanists may also pose a threat to some populations of A. serotina, particularly at the more accessible shale barrens (USFWS, 1991).

Stressor: Fire suppression (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: There has been little research conducted on the role of fire in shale barrens. In Illinois, Heikens et al. (1994, p. 279) found no increase in herbaceous understory plants at a shale barren in the short term, 7 months after a prescribed burn. The authors note that more research is necessary to understand the best ways to restore and maintain shale barren habitats. WVDNR reported that prescribed fire may pose a threat to populations, but the impacts of prescribed fire currently are poorly understood, and it is possible that prescribed fire, under certain management prescriptions and implementations, may be beneficial for the species (WVDNR email to Sumalee Hoskin, Service, January 25, 2021). Stanley (2021, p. 7) noted that lack of fire is likely a potential threat to B. serotina, although again noting the role of fire historically in shale barrens is poorly understood. One source indicates that shale barrens were historically prone to regular burning (Aldrich et al. 2010, p. 36). A prescribed burn of a shale barren adjacent to a population of B. serotina resulted in the species occurring in the burned area where it was not previously known to occur (Fred Huber, pers. comm.). Although the 2010 status review referred to prescribed fires as "a newly identified threat to this species" it further stated that there is "limited information in the scientific literature about the impact of fire and/or prescribed burns to shale barrens and specifically to A. serotina." To date there has not been targeted research to understand whether fire is ultimately beneficial or harmful to shale barren rock cress. However, as stated earlier, this species occurs in fire-prone areas that may have a history of fire, which is indicative that it has adapted to periodic fire. Without fire, the woodland landscapes surrounding

the barrens may begin to encroach. While fire may have short-term negative impacts to individuals, it is unclear whether a frequent fire regime may have long-term beneficial impacts to the species (USFWS, 2023).

Stressor: Climate change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Shale barrens and their associated species have a naturally patchy distribution as they occur in spatially isolated outcroppings across the landscape. Shale barrens are also considered xeric (low moisture) habitats, and the species that occur there are adapted to those conditions. There is little available information specific to the potential impacts of climate change to shale barren habitats or associated species. Anderson et al. (1999, p. 95) made the assumption that shale barren endemics are likely to have the capacity to tolerate temperature extremes given the high summer temperatures often experienced on shale barrens. Damschen et al. (2012) conducted a literature review of the responses of plant communities on "special soils," specifically serpentine communities, and found that the limited amount of research available seems to indicate that these communities may be less sensitive to climatic changes than their "normal soil" counterparts (p. 1127); however, they noted that application to other "special soil" communities like shale barrens can be challenging given the differences in specific stressful conditions, functional traits, and stress-tolerance adaptations of the different plant communities (i.e., low moisture vs. acidic soils vs. nutrient limited, etc.; p. 1127). In summary there is high uncertainty associated with the potential effects of future climatic changes to shale barrens in general and B. serotina specifically. However, the currently available information, albeit limited, does not indicate a mechanism for impacts to the species from changing climate (USFWS, 2023).

Recovery

Reclassification Criteria:
1. Twenty demonstrably self-maintaining populations are distributed throughout the species' range (USFWS, 1991).

2. The habitat of these 20 populations is permanently protected (USFWS, 1991).

3. Seeds are stored to prevent extinction in case of disastrous loss of natural populations (USFWS, 1991).

Recovery Priority Number: 11

Delisting Criteria:
1. Twenty demonstrably self-maintaining populations are distributed throughout the species' range (USFWS, 1991).

2. The habitat of these 20 populations is permanently protected (USFWS, 1991).

3. Seeds are stored to prevent extinction in case of disastrous loss of natural populations (USFWS, 1991).

4. Fifteen additional self-maintaining populations and their habitat are permanently protected (USFWS, 1991).

Recovery Actions:

- Seek protection of all extant populations, and secure permanent protection for demonstrably self-maintaining populations and their habitat (USFWS, 1991).
- Monitor extant populations and their habitat on a regular basis (USFWS, 1991).
- Search for additional populations (USFWS, 1991).
- Study life history, ecological, and population parameters and establish guidelines for determining what constitutes a self-maintaining population (USFWS, 1991).
- Store seeds off-site in case of loss of extant populations (USFWS, 1991).
- As needed, manage populations for the maintenance of each population and its habitat (USFWS, 1991).
- Not available.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS x Complete process for removal of ESA protections x Develop post-delisting monitoring plan in collaboration with state agencies While not a requirement for delisting the species, research using prescribed fire to restore the historical fire regime of shale barrens would ascertain its impact on native species including B. serotina. This activity would address an area of uncertainty that has been frequently noted by state biologists and the results would be informative for habitat restoration purposes for species associated with rare and unique shale barren habitats (USFWS, 2023).

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SPECIES ACCOUNT: *Arctomecon humilis* (Dwarf Bear-poppy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/06/1979; Mountain-Prairie Region (Region 6) (USFWS, 2015)

Physical Description

perennial herb with long taproots, woody caudices, and tufts of basal leaves. Short leafy peduncles are only 12-15 cm tall. Due to the short leafy stems, the white flowers appear to float above the cluster of leaves, accentuating the plant's low stature. The flower of A. humilis usually has 4 petals. The genus name is based on the bear paw-like appearance of the shaggy villous leaves while the leaves of are only slightly lannate with deeply 3-toothed leaves at the apex. The abundant white flowers that bloom mid-April through May are showy next to the red soils in which the plant grows. (USFWS, 2015; NatureServe, 2015)

Taxonomy

While three species of bear-poppy share common morphological features, the combination of features is distinctive in each one. The dwarf bear-poppy exhibits similar stamen and pistil structure to A. merriamii and the racemose inflorescence of A. californica rather than the solitary inflorescence of A. merriamii. The clustered pure white flowers of the dwarf bear-poppy and the bright yellow-flowered A. californica make them quite attractive in their arid environment. The dwarf bear-poppy is characterized by several unique features including stature, leaf morphology, and floral parts. Its short leafy peduncles are only 12-15 cm tall. Both other species have tall naked peduncles: A. merriamii, 20-35 cm, and A. californica, up to 60 cm. Due to the short leafy stems, the white flowers appear to float above the clusters of leaves, accentuating the plant's low stature. Although each species may have from 4-6 petals, the dwarf bear-poppy usually have 4 petals (Atwood 1977). (USFWS, 1985); Dwarf bear-poppy (Arctomecon humilis Coville), is one of three species in the genus Arctomecon of the poppy (Papaveraceae) family. The other two species are A. californica and A. merriamii. The dwarf bear-poppy is the only Arctomecon species found in Utah. There are no taxonomic issues with its status as a distinct and clear species (Nelson and Welsh 1993, Welsh et al. 2003). (USFWS, 2016)

Current Range

Endemic to the Dixie Corridor; extant in Washington Co., Utah on the eastern edge of the Mohave desert. (USFWS, 1985); Dwarf bear-poppy is restricted to approximately 9,000 acres (3,642 ha) of habitat in the vicinity of St. George in Washington County, Utah (see Figure 2). The elevation range the species occupies is 823 to 1,006 m (2,700 to 3,300 ft). Approximately 30 percent of the habitat is located on state, private or municipally administered lands; the remaining 70 percent occurs on federal lands managed by the Bureau of Land Management (BLM) (see Table 1) (BLM 2008, Nelson 1989). (USFWS, 2016)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Dwarf bear-poppy reproduces sexually by seeds. The species has a mixed mating system and is thus capable of producing seeds through self-fertilization or crosspollination by pollinators (Tepedino et al. 2014). However, the highest number of seeds and fruits are produced when flowers are cross-pollinated (Tepedino et al. 2014). (USFWS, 2016)

Breeding Season

Adult: Seedling recruitment is episodic and occurs en masse when rainfall is sufficient during the late winter and spring. (USFWS, 2016); Mid-April through May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Seeds are primarily dispersed by wind and animals, mainly ants and rodents, which are also seed predators (Harper and Van Buren 2004; Farrall and Mull 2012; Mull 2012). Seeds are dispersed before they are mature and they need several years to complete development before they germinate (Nelson 1989b; Allphin et al. 1998; Allphin pers. comm. 2014). (USFWS, 2016)

Reproduction Narrative

Adult: The abundant white flowers that bloom mid-April through May are showy next to the red soils in which the plant grows. Seeds are dispersed by ants. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 700 and 1402 m. (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The dwarf bear-poppy grows sympatrically with the Moenkopi endemic Eriogonum thompsonae var. albiflorum. (USFWS, 1985)

Habitat Narrative

Adult: Dwarf bear-poppy habitat is sparsely vegetated, and consists of highly weathered rounded hill and dome formations. Roughly half of the soil surface is bare of vegetation, and the majority of the living cover in the habitat is biological soil crust1 (Nelson 1989a; Nelson and Harper 1991; Simpson 2014). Associated native plants include shadscale (Atriplex confertifolia), Torrey's ephedera (Ephedra torreyana), nodding buckwheat (Eriogonum cernum), desert trumpet (E. inflatum), desert pepperweed (Lepidium fremontii) and burrobush (Ambrosia salsola). Invasive species include red brome (Bromus rubens), cheatgrass (Bromus tectorum), barb-wire Russian thistle (Salsola paulsenii), and African mustard (Malcomia africana) (Harper and Van Buren 2004; Simpson 2014). (USFWS, 2016); Dwarf bear-poppy is found on gypsiferous clay soils derived from the Moenkopi Formation, sometimes on cryptogamic crust. Occurs on

rolling low hills and ridge tops, often on barren, open sites in warm desert shrub communities. Found at elevations between 700 and 1402 m. The dwarf bear-poppy grows sympatrically with the Moenkopi endemic Eriogonum thompsonae var. albiflorum. (USFWS, 1985; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by ants. (NatureServe, 2015)

Population Information and Trends

Population Trends:

A Population Viability Analysis (PVA) for the species indicates a downward population trend within the past 21 years (Meyer et al. 2015) (UWFWS, 2016); Short-term trends indicate a decline of 10 to 30% (NatureServe, 2015)

Number of Populations:

8 (USFWS, 2016)

Population Narrative:

Because of its restricted habitat, it probably never was common. Population numbers fluctuate widely from year to year, based on precipitation, and a large seed bank with long lived seeds is a requirement for the maintenance of this species (Harper and Van Buren 2004). Short-term population trends indicate a decline of 10 to 30%. (NatureServe, 2015)

Threats and Stressors

Stressor: Recreation (including OHV use, hiking, mountain biking, horseback riding, unauthorized recreational use, and vandalism) (USFWS, 2016)
Exposure:
Response:
Consequence: damage and mortality of individuals, destruction and fragmentation of habitat, soil compaction and erosion, destruction of biocrusts, and degradation of vegetative community (Harper et al. 1998; Brooks and Lair 2005; Ouren et al. 2007; Roth 2012). (USFWS, 2016)
Narrative: While OHV use in the habitat has declined significantly since 1999, the impact to the habitat and the species continues into the future. Old OHV trails continue to be used by non-motorized users and the majority of this use is unauthorized. Since enforcement is sporadic, we do not have good reporting of the current level of unauthorized recreational use in the majority of the populations. We anticipate the level of recreational use will increase in poppy habitat with an increase in local population growth, with smaller buffers between residential development and poppy habitat, and with fewer options for recreation as open space is developed in and immediately surrounding the St. George city limits. Therefore, we designated the threat level from recreation as high for dwarf bear poppy. (USFWS, 2016

Stressor: Land development (including residential and industrial development, utility projects, and road development) (USFWS, 2016)
Exposure:

Response:
Consequence: Potential impacts to dwarf bear-poppy from land development include mortality of individuals, habitat loss, degradation and fragmentation, increased soil erosion, increased dust generation, reductions in pollinator populations, reductions in plant reproductive potential, reductions in seed bank quantity and quality, and increasing invasive plant occurrences (Brock and Green 2003). (USFWS, 2016)
Narrative: Land development was considered a threat to dwarf bear-poppy at the time of listing (USFWS 1979). All known populations occur in Washington County, UT, in and around the city of St. George, which is currently one of the fastest growing metro areas in the country (U.S. Census Bureau 2000, 2010, 2014). Projections indicate that the population of Washington County will likely increase by 243 percent by the year 2050 from recorded 2010 levels (Utah Foundation 2014). Todate approximately 50 percent of the dwarf bear-poppy's historic habitat has been lost to urbanization and degradation from off-road vehicles (Harper and Van Buren pers. comm. 2004). Currently, the poppy no longer occurs on private lands in Washington County except for habitat protected by The Nature Conservancy (TNC) (TNC 2015). Roughly 22 percent of known poppy habitat remains under state ownership by Utah School and Institutional Trust Lands Administration (SITLA). The loss of poppy habitat is highly likely in the next twenty years on the majority of State lands. A priority for recovery is the protection of poppy habitat on State and private lands. Protection options include land exchanges between the BLM and the State of Utah, land acquisition by TNC, a conservation agreement with the State of Utah, or additional protections afforded by the State of Utah and private landowners. Due to the high exposure and intensity of development in and around dwarf bearpoppy habitat, the continued and increasing levels of development in Washington County and around St. George, and the severity of the direct and indirect impacts to the species resulting from development, we assign development a high threat level for dwarf bear-poppy. (USFWS, 2016)

Stressor: Livestock Grazing (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: We determine that livestock grazing is a potential threat to dwarf bear-poppy because we do not have evidence of a population level impact to the species. We will continue to assess the potential of livestock grazing to pose a threat to the species. Regular monitoring of livestock grazing in poppy habitat is recommended and research on the direct and indirect impact of livestock grazing to the species is needed. (USFWS, 2016)

Stressor: Invasive Species (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Invasive plants can exclude native plants and alter pollinator behaviors (D'Antonio and Vitousek 1992; DiTomaso 2009; Mooney and Cleland 2001; Levine et al. 2003; Traveset and Richardson 2006). Red brome, an invasive annual grass, was the only non-native plant specifically noted in the species' habitat from the earliest plant community assessment (Nelson and Harper 1991). We determine invasive species are a potential threat to dwarf bear-poppy because they are present at a low level in the habitat and we do not have evidence of a population level impact to the species. We will continue to assess the potential of invasive species to pose a threat to the species. Regular monitoring of invasive species in poppy habitat is recommended

and research on the direct and indirect impact of invasive species to the species is needed.

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: In the absence of the Act's protection, we believe the existing regulatory mechanisms would not provide dwarf bear-poppy with adequate protection from threats. Under the Act's protection, a review of Federal actions potentially impacting the species can be performed. Because the species occurs on Federal land, threats to the species can be addressed by regulatory mechanisms, and some threats (development, recreation) have been addressed. Enforcement of unauthorized recreation is not being addressed on Federal land, but that is not a result of lacking regulatory mechanisms. A newly identified threat to the species, the loss of specialist pollinators, is also not being addressed on Federal land but we need more information about this threat in order to identify adequate regulatory mechanisms. There are no regulatory mechanisms on State and private lands to protect the species from these threats. We assign an overall threat level of high because development and recreation are high threats to the species and are not adequately being addressed by existing State regulatory mechanisms. (USFWS, 2016)

Stressor: Loss of Pollinators and Pollinator Diversity (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: In summary, we have evidence that primary pollinators of dwarf bear-poppy no longer occur within the species' range and that the pollinator assemblage has simplified to generalist pollinators that can only be relied upon to provide adequate pollination services in areas of high plant density. The species' new primary pollinator, the honey bee, is in decline and may not be a reliable pollinator in the future. We also have documented impacts to reproduction that are likely due in part to pollinator limitation. We anticipate the level of development and habitat fragmentation to increase in poppy habitat with an increase in local population growth and it already appears that the species' important specialist pollinators are not able to tolerate and adapt to the current level of development and habitat fragmentation within the species' range. Given these considerations and the critical importance of seed production for the dwarf bear-poppy, we now determine the loss of specialist pollinators is a threat to the species now and in the foreseeable future, and we assign a high threat level. We strongly encourage the synergistic feedback of this threat and other stressors be evaluated and mitigated to prevent extinction (see Brooks et al. 2008 on synergies among extinction drivers).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- 1. Protect occupied and suitable habitat from urban development. (USFWS, 2016)

- 2. Protect occupied and suitable habitat from degradation and additional fragmentation. (USFWS, 2016)
- 3. Support and monitor pollinators in occupied and suitable habitat as well as in adjacent habitat. (USFWS, 2016)
- 4. Perform research on suitable microsites for seedling establishment. (USFWS, 2016)
- 5. Perform propagation research using seeds and plant tissue. (USFWS, 2016)
- 6. Perform a comprehensive census of the medium and large dwarf bear-poppy populations (Red Bluff, Warner Ridge, Webb Hill, White Dome, and Beehive Dome). (USFWS, 2016)
- 7. Update the Recovery Plan. (USFWS, 2016)
- 8. Conduct Census and Monitoring Studies:Comprehensively census all known populations on a regular basis in order to produce an accurate picture of population number and distribution to adequately characterize the species' status. In addition to the populations identified in #6, above: a) Locate and survey the Warner Valley Springs population on foot. b) Survey the Shinob Kibe population on foot. c) Based on census results, develop and implement a range-wide monitoring plan to determine population trends and select monitoring plot locations to regularly monitor recruitment, plant reproduction, and pollinator assemblage. Evaluate population breeding system. d) Monitor crust recovery of land scars periodically. BLM and TNC assistance with this action is essential. e) Regularly monitor and assess recreational use within plant populations. BLM, TNC, and State assistance with this action is essential. (USFWS, 2016)
- 9. Abate Heavy Land Use:a) Identify with GIS all land scars and degradation of habitat within populations and evaluate every 5 years. BLM and State assistance with this action is essential. b) Utilize technical expertise (USGS Las Vegas and Moab or universities) for habitat restoration, trail planning, and assessment of vehicular routes including mountain bikes trails in dwarf bear-poppy habitat. c) Assess and if necessary remove or redirect activities that negatively impact dwarf bear-poppy habitat. d) The Service should be a cooperator on the Washington County Comprehensive Travel and Transportation Management Plan. e) Update ACEC management prescriptions at Red Bluff and Warner Ridge/Fort Pierce to reflect current levels of impact on dwarf bear-poppy: Provide regular, adequate, and responsive monitoring and management at ACECs; Update Implementation Schedule of needed activities; Update ACEC Activity Plans. f) Provide ACEC management protections for the remaining dwarf bear-poppy populations on BLM lands. g) Provide consistent, scientifically based, range-wide management plans for the species. h) Engage and educate recreational user groups that are creating heavy use impacts. (USFWS, 2016)
- 10. Provide Adequate Law Enforcement to address unauthorized recreation use: a) Support law enforcement officials in promoting compliance with off-highway vehicle laws (and regulations) and effective deterrents of abuses of public land. b) Increase patrol of BLM lands to reduce non-compliant land use. c) Seek support and help from the Cities of St. George, Santa Clara, and Washington to manage use within poppy habitat. d) Prioritize and schedule regular land use patrol at high use areas (suggested Red Bluff near Bloomington, Red Bluff near Boomer Hill, Webb Hills at Brigham Road, White Dome at River Run Road, and North Warner Ridge). (USFWS, 2016)
- 11. Conduct Research to Better Understand Species and Species Response to Stressors and Threats: a) Repeat Population Viability modeling using new census and monitoring data on a regular basis. b) Evaluate the synergistic effect or feedback of multiple threats and stressors on the landscape and design a mitigation strategy to prevent extinction. c) Evaluate and implement a human-assisted gene flow pilot study. d) Evaluate and implement a pollinator

rearing or transplant pilot study. (USFWS, 2016)

- 12. Coordinate with State, County, City Officials and Developers: a) Coordinate advance planning of development and infrastructure to avoid, minimize, and mitigate impacts to dwarf bear-poppy habitat. Conservation measures include permanent habitat protections with pollinator buffers to offset impacts, and seed and soil salvage operations to preserve the seedbank and genetic diversity when habitat is lost. b) Evaluate, address and offset habitat impacts from increased land use due to easier access provided by highways. (USFWS, 2016)
- Conservation measures are not available.

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SPECIES ACCOUNT: *Arctostaphylos confertiflora* (Santa Rosa Island manzanita)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

aperennial shrub in the heath (Ericaceae) family that grows 0.1 to 2.0 meters (4 inches to 6.5 feet) high, sometimes reaching as high as 6 meters (20 feet) (Wells 1993; Parker and Vassey in titt. 1998) (Figure 7). Santa Rosa Island manzanita occurs in prostrate and upright forms, the former most likely due to climatic influences and herbivory (McMmnn 1951). The plant has smooth, dark red-purplebark and densely hairy-glandularbranchlets and flower stalks. The leaves are light green, round-ovatewith cupped margins. The flowers occur in dense clusters that mature into flattenedreddish-brownfruits (McMinn 1951). Another manzanita on Santa Rosa Island, Arctostapliytos tomentosa, has three subspecies. These are differentiated from A. confertflora and eachother by variously having long, stiffhairs or no glandularity(A. t. ssp. crustacea - long, nonglandular hairs; A. t. ssp. insuticola - pubescent, nonglandular hairs; A. t. ssp. subcordata - long, glandular hairs) (USFWS, 2000).

Taxonomy

Belongs to the heath family (Ericaceae) (USFWS, 2014). Santa Rosa Island manzanita was described as Arctostaphytos confertflora by Eastwood in 1934 from a collection made by Hoffinann 4 years earlier “in a sheltered dell south of Black Mountain” on Santa Rosa Island (Eastwood 1934). Munz (1958) published the new combination Arctostaphytos subcordata var. confertflora. However, in subsequent treatments of the genus, Wells (1968, 1993) has continued to use the original taxonomy (USFWS, 2000).

Historical Range

See current range.

Current Range

Known from three areas on Santa Rosa Island; the north-east side of Black Mountain (less than 300 plants) combined with the Torrey Pine vicinity (less than 100 plants), the canyons on the south-east side of the island (less than 1,000 plants), and in the vicinity of South Point (approximately 200 plants) (USFWS, 2000).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Possibly sexual and self-pollination, based on closely related species (USFWS, 2014)

Lifespan

Adult: 100+ years (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Fire; insect pollinators, based on closely related species (USFWS, 2014)

Reproduction Narrative

Adult: It has lost this ability to resprout and, as such, reproduce only by seed (obligate seeder) (Tyler and Odion 1996). Obligate seeders produce seeds annually, and a small proportion of the seeds may germinate each year. Dormant seeds are long-lived and accumulate in leaf litter and soil over time creating a long-term seed bank. Often in chaparral, the trigger is a fire; although the Service does not know the exact germination triggers for A. confertiflora, there is no reason to think it is different for this species of Arctostaphylos. Pollination and seed production in Arctostaphylos confertiflora are not well understood. Researchers studying A. pringlei (a closely related obligate seeder) observed that the species was pollinated by solitary bees, bumblebees (Bombus spp.), and syrphid flies (family Syrphidae); and the heaviest visitation was from honey bees (Apis spp.). They also observed successful self-pollination in A. pringlei (Fulton and Carpenter 1979). Arctostaphylos confertiflora is a long-lived perennial (individuals of the species may live 100 years or longer (Schreiner et al. 2006; D. Rodriguez, NPS, in litt. 2013)). Recruitment has been nearly zero at all three population locations for as long as monitoring has occurred (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, mixed woodland, pine woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Scattered on sedimentary substrates (shales, volcanoclastic sediments, and sandstone) in chaparral, mixed woodland, and pine woodland communities. Extant plants are mostly on very steep slopes (NatureServe, 2015). Arctostaphylos confertiflora occurs as a component of mixed chaparral, mixed woodland, and island pine (Pinus torreyana, P. muricata) woodland vegetation types (Service 2000) (USFWS, 2014).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Possibly U. l. santarosae (inferred from USFWS, 2014)

Dispersal/Migration Narrative

Adult: The NPS has observed the Santa Rosa Island fox (Urocyon littoralis santarosae) consuming Arctostaphylos confertiflora seeds, although the seeds appear to pass through the fox digestive system intact (Rodriguez, in litt. 2007). Seed viability testing was conducted on seeds contained in island fox scat; results indicate that there was no loss of viability in these seeds compared to the viability of undigested seeds (Ransom Seed Lab 2007) (USFWS, 2014).

Population Information and Trends

Population Trends:
Unknown (USFWS, 2014)

Number of Populations:
3 (USFWS, 2014)

Population Size:
6,500 - 8,500 (USFWS, 2014)

Adaptability:
Low (inferred from USFWS, 2014)

Population Narrative:
It is found in only three populations. It is not possible to determine population trends (based on recruitment and mortality rates) at this time for Arctostaphylos confertiflora. There are 6,500 to 8,500 individuals on Santa Rosa Island (USFWS, 2014).

Threats and Stressors

Stressor: Erosion (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The listing rule for Arctostaphylos confertiflora identified soil loss (via erosion) and habitat alteration by non-native mammal species as Factor A threats to the species. All non-native ungulates excepting a few deer were removed from Santa Rosa Island in 2011 (Rodriguez pers. comm. 2012), and direct habitat destruction and curtailment by these animals is no longer a threat. However, because the ungulates were removed only recently, their impacts on A. confertiflora have not yet been reversed. Remaining indirect effects of ungulates on A. confertiflora habitat include edge effects from game trails, as well as wind and water erosion continuing to affect the seed bank, seed bed, and leaf litter. Although small increases in litter cover have occurred in some areas since monitoring started in 2001 (Schreiner et al. 2006), the ground underneath arborescent A. confertiflora individuals is exposed and accumulated leaf litter tends to be removed by wind (Rodriguez pers. comm. 2012) (USFWS, 2014).

Stressor: Insect damage (USFWS, 2014)
Exposure:
Response:
Consequence:

Narrative: The 2007 5-year review reported insect damage to individuals of Arctostaphylos confertiflora in all three populations. Damage included fruit and seed predation (Rodriguez, pers. comm. 2006a, 2012) and leaf damage (Dale-Cesmat, in litt. 2005; Rodriguez, pers. comm. 2006b, 2012). The NPS correlated apparently higher levels of "die-back" with insect damage at Black Mountain (Rodriguez, in litt. 2006c). In late 2007, the NPS and USGS observed defoliation of A. confertiflora individuals by tussock moth caterpillars. In the following spring, at least seven individuals appeared to have died as a result (McEachern and Rodriguez 2008). The individual plants killed by the moths were already stressed by other factors, and it is likely that healthy A. confertiflora would be resilient to defoliation by tussock moths (Rodriguez pers. comm. 2012). Tussock moths appear on A. confertiflora in an irregular, multi-annual cycle. The Service is uncertain regarding the extent to which insect damage represents a threat to the species; however, tussock moths can rapidly defoliate plants (Brubaker 1978, Harrison and Maron 1995) and could pose a threat to species such as A. confertiflora that have a restricted range and low reproductive success (USFWS, 2014).

Stressor: Low reproductive success (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: In some locations, the past browsing pressure resulted in plants that never had the opportunity to fruit, flower, and produce seed. In other locations, plants had become arborescent through browsing of the lower portions of the plant; in this case, even if the plants produced seed, the increased erosion under and around stands did not provide suitable conditions for seed retention and germination. These effects compromised the seed bank and reduced the quality of germination sites. The Ransom Seed Lab (2007) found that the germination rate during standard lab testing was zero. These results are not uncommon for Arctostaphylos species (Rodriguez pers. comm. 2012), because members of this genus typically require a specific trigger (such as scarification from a fire event) to break seed dormancy and allow germination to occur (USFWS, 2014).

Stressor: Stochastic events (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Although the extant populations of Arctostaphylos confertiflora are not particularly small, there are only three. Rarity, including a small number of populations, makes a species vulnerable to stochastic events. Arctostaphylos confertiflora is a long-lived species and there are 6,500 to 8,500 individuals on Santa Rosa Island. Therefore, most natural stochastic events are unlikely to extirpate all three populations. One exception is fire. Although the species is an obligate seeder and likely requires fire for large-scale germination, mature plants of this species do not regenerate when damaged by fire as do burl-forming species of Arctostaphylos. In addition, the species' depleted seed bank may preclude large-scale germination required to replace destroyed mature plants. Therefore, a large enough fire could extirpate one or more of the three known A. confertiflora populations (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:

Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, increased summer continental drying, and increased fire frequency (Field et al. 1999; Cayan et al. 2005; Westerling et al. 2006; IPCC 2007). Increased fire frequency could have positive or negative impacts on Arctostaphylos confertiflora. Recently, Loarie et al. (2008) modeled the potential impacts of climate change on the flora of California. They predicted that species' distributions will shift in response to climate-driven habitat changes. Specifically, they predicted that, in general, species will shift northward and to higher elevations, and may experience a reduction in the extent of available habitat. Species will redistribute with shifting habitat, depending on the ability of each species to do so. Species diversity will also shift with a general trend of diversity increasing towards the coast and northwards, with these areas becoming de facto future refugia. Given the narrow geographic range of A. confertiflora, the species will have limited ability to disperse in response to climate change (USFWS, 2014).

Recovery

Reclassification Criteria:
Maintain three stable or increasing populations on Santa Rosa Island with evidence of natural recruitment for a 30-year period including the normal precipitation cycle (USFWS, 2000).

Delisting Criteria:
1. No decline in populations for 10 years after downlisting (USFWS, 2000).

2. All potential habitat surveyed. Santa Rosa Island has been extensively surveyed during vegetation surveys (Reyes et al. 2017 entire), and the distribution of the species on Santa Rosa Island is well understood. This criterion has been met. (USFWS, 2021)

Recovery Actions:
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).
- The Service recommends that the NPS conduct a threats assessment for insect damage to Arctostaphylos confertiflora. If the assessment indicates insect damage is a concern, the NPS

could consider a trial insect control program and additional monitoring to track the extent of insect damage (USFWS, 2014).

- Arctostaphylos confertiflora seeds may require episodic disturbances to stimulate seed germination. These conditions are critical for the establishment and survival of new generations and recovery of the species. Additional research should be done to identify germination cues using methods that are more appropriate for fire-adapted seeds. Once germination cues are better understood, the NPS could explore ways to enhance these conditions in the field through activities such as controlled burns and erosion control (USFWS, 2014).
- Because this species is an obligate seeder and regeneration is sporadic without the presence of disturbance such as fire, an important measure of recovery is the size and viability of the seed bank. The seed bank should be monitored at regular intervals (such as every 3 years) by surveying the amount of seeds in the soil seed bank and conducting seed viability analysis on the seed samples collected during the surveys (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Develop a monitoring plan to track population sizes and distribution. 2. Bolster conservation seed banks with additional maternal lines from all populations. 3. Research seed germination and seedling recruitment requirements. 4. Monitor soil seed bank seed abundance, and develop methods to enhance the soil seed bank. (USFWS, 2021)

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SPECIES ACCOUNT: *Arctostaphylos glandulosa ssp. crassifolia* (Del Mar manzanita)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/7/1996; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial burl-forming shrub; plant height ranges from 1 to 1.2 meters (3.3 to 4 feet) tall. It has thick, leathery leaves that are dark grey-green and a characteristic smooth red bark. It has clusters of urn-shaped flowers (white to pink). The twigs and young stems characteristically lack glandular hairs, but rather are either densely covered with short fine hairs or have scattered longer hairs. The leaves are dark grey-green, sometimes with a reddish margin. The flowers are small, urn-shaped, white to pink in color, and appear between late winter and early spring. Compared to other subspecies, the globose fruits are small and markedly depressed and the twigs lack glandular hairs. The fruits of A. glandulosa produce an average of six seeds embedded in a hard resinous endocarp surrounded by a pulpy pericarp (USFWS, 2010).

Taxonomy

A member of the Ericaceae (heath family). In a recent taxonomic treatment for the species A. glandulosa, a new, narrower distribution for A. g. subsp. crassifolia was proposed. Based on morphologic traits, researchers restricted the distribution to within 3, or possibly 6 miles (mi) (5 to 10 kilometers (km)) from the coast, from Encinitas in San Diego County, south to Baja California (Keeley et al. 2007, p. 57). Carlsbad was not included in this distribution because the research suggests that while some of the plants in Carlsbad are A. g. subsp. crassifolia, many are a different subspecies (A. g. subsp. glandulosa) and that these northern populations comprise a mixture of the two subspecies (Keeley et al. 2007, p. 57). Based on this new treatment, surveys for A. g. subsp. crassifolia by land managers at the Rancho La Costa Habitat Conservation Area in Carlsbad, yielded nine individuals in a population previously thought to be over 1000. The majority of the plants at this site are now considered A. g. subsp. glandulosa (CNLM, unpubl. data 2009) (USFWS, 2010). Also known as Eastwood's Manzanita (NatureServe, 2015).

Historical Range

Historically, Arctostaphylos glandulosa subsp. crassifolia was believed to be restricted to sandstone terraces and bluffs along the immediate coast in San Diego County, California, from Carlsbad south to Torrey Pines State Reserve (USFWS, 2010).

Current Range

Endemic to San Diego County, California and northwestern Baja California, Mexico (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative, sexual (USFWS, 2010)

Breeding Season

Adult: December - April (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, fire (USFWS, 2010)

Reproduction Narrative

Adult: Blooms December-April (NatureServe, 2015). The fruits of A. glandulosa produce an average of six seeds. The flowers of Arctostaphylos glandulosa are self-incompatible and are visited by flies, bees, and bee-flies (Keeley 1977, p. 821; Moldenke 1976, pp. 318-353). Arctostaphylos glandulosa seeds are dependent on fire to germinate. Typically, seedlings are only established in the first year after a fire (Keeley 1991, p. 96). Arctostaphylos glandulosa subsp. crassifolia plants are woody shrubs, which, when mature, can regenerate from burls (lignotubers) and from seeds. The burl at the base of the stem is covered with undeveloped branch buds. Typically, these buds will sprout after the stems are removed or damaged by fire or other means. Occasionally some of these buds will sprout in the absence of fire (Keeley 1992a, p. 1196) (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Maritime chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Coastal fog (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 100 m elevation (NatureServe, 2015); canopy-forming vegetation - shade intolerant; generally occurs within 5 mi of the coast (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Linear (inferred from USFWS, 2010)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Sandstone terraces and bluffs at < 100 m elevation in low, fairly open southern maritime chaparral communities. (NatureServe, 2015). A. glandulosa is shade intolerant and can be replaced by taller stature species (Howard 1992, p. 5). Southern maritime chaparral can be described as a chamise-black sage chaparral that includes rare species such as A. g. subsp. crassifolia and is associated with coastal fog from Carlsbad south to Point Loma. It occurs on weathered sandstone soils including the Carlsbad series, Cesterton series, and Corralitos sandy

loam. It can also be found on loamy alluvium, rough broken land, and terrace escarpments. Southern maritime chaparral is typically found within 5 mi (8 km) of the coast (USFWS, 2010).

Dispersal/Migration

Dispersal

Adult: Low to moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: There does not appear to be any specialized seed dispersal mechanism and the fruits generally fall close to the parent plant in late summer where they may be consumed by rodents (Keeley 1977, pp. 821-826). Some are eaten by foxes or coyotes and may be transported some distance away (Keeley 1977, p. 826; J. Keeley, U.S. Geological Survey, pers. comm. 2009) (USFWS, 2010).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

56 Extant EO's (USFWS, 2023)

Population Narrative:

At the time of the 2010 5-year review for Arctostaphylos glandulosa subsp. crassifolia, there were 51 known occurrences [including 1 relocation and restoration site (EO 15) and 1 transplanted occurrence at San Diego Botanic Garden in Encinitas, California (EO 59)] that were extant or presumed extant (Service 2010, pp. 5, 7) (Appendix A). Six of the 51 occurrences were yet to be included as Element Occurrences (EO) in CNDDB, the database maintained by California Department of Fish and Wildlife (CDFW) (Appendix A). Since then, all occurrences identified in the 2010 5-year review have been assigned EO numbers in CNDDB, EO 53 was subsumed into the nearby EO 47, and 6 new EOs (EOs 61–62, 65–67, and 73; Figure 1; Table 1) have been described (CDFW 2023, database). Thus, there are 56 extant (or presumed extant) EOs that are currently known (CDFW 2023, database). However, the subspecies identity of plants at inland locations such as MCAS Miramar has been questioned; some experts have suggested that plants at these locations are hybrids or belong to a different subspecies of A. glandulosa (USFWS, 2023).

Threats and Stressors

Stressor: Development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: According to the listing rule, the majority of extant populations had been greatly reduced and significantly fragmented due to urban and agricultural development mostly prior to listing (USFWS 1996, p. 52378). The majority of these populations were distributed in highly fragmented habitat along the margins of residential development. At listing, four of the six

largest populations were threatened by proposed or approved development projects. Since listing, completion of these projects resulted in an additional 35 percent being eliminated through direct impacts and 20 percent through indirect impacts to these four populations. In addition, several of the smaller populations were impacted by development (USFWS 1996, pp. 52377- 52378). Impacts of development are rangewide (USFWS, 2010).

Stressor: Fire management (USFWS, 2010).
Exposure:
Response:
Consequence:
Narrative: Fuel modification activities can result in the damaging or removal of plants and their habitats. In addition, these activities can increase the fragmentation of habitat and increase the rate and extent of introduction of nonnative species which could in turn increase both erosion and fire frequency, all of which pose threats to A. g. subsp. crassifolia (see discussion of nonnatives and altered fire regime below) (Longcore 2003, p. 116). Fire history data shows that the majority of Arctostaphylos glandulosa subsp. crassifolia occurrences (mainly located directly adjacent to residential development) have not burned in the last 100 years. Fire suppression activities may have prevented these areas from burning given their proximity to residential development, however, their proximity to residential development also puts them more at risk to be subjected to fire. Given this last assumption, the Service believes that fire suppression activities alone in the order of 100 years may not pose a threat to the habitat of A. g. subsp. crassifolia. However, more information is needed to determine what, if any, the impacts are of fire suppression in cycles greater than 100 years. Fires that occur too frequently may threaten the species because if resprouting plants are burned again before they are able to adequately replenish stores in the burls or sufficient seeds for their seed bank leaving the long term persistence of the plants in doubt. When fires are too frequent, nonnatives (especially grasses) can invade frequently burned areas and outcompete natives. In addition, they can modify the environment in their favor by creating a mass of highly flammable fuels which not only can extend the length of the fire season, but alter the types of fires that occur (USFWS, 2010).

Stressor: Invasive species (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Some invasive nonnative plants can become well established locally and may have profound impacts to the habitat. For example, land managers at the Rancho La Costa Habitat Conservation Area (EO 1) in the City of Carlsbad have noted a nonnative grass, Ehrharta calycina, as a serious problem for the reserve (Appendix 1). This grass is invasive, can cover the ground like a mat, and potentially increase the flammability of the area (J. Vinje, CNLM, pers. comm. 2009). According to the California Invasive Plant Inventory, Ehrharta calycina is considered to have a severe ecological impact on plant and animal communities and are considered to be severely invasive (Cal-IPC 2006, pp. 3-11). Another example is the presence of a woodland Eucalyptus spp. at San Dieguito County Park (EO 17). The canopy is relatively open over the Arctostaphylos glandulosa subsp. crassifolia occurrence but there is a layer of dead, high oil content leaves augmented by park personnel who spread additional leaf litter and wood chips from maintenance operations in the area (Luciani, pers. obs. 2009). If, and when a fire starts at this site, it will likely be intense enough to kill at least some of the burls. In addition, Eucalyptus spp. can have an allelopathic effect on other plants from the compounds found in its bark and leaf

litter. These compounds have been shown to inhibit germination, seedling length, vigor, and nitrogen fixation of certain plant species (Sasikumar et al. 2001, pp. 135-137). Currently, nonnative species likely continue to be a threat to A. g. subsp. crassifolia and its habitat at most occurrences (USFWS, 2010).

Stressor: Residential development
Exposure:
Response:
Consequence:
Narrative: Most A. g. subsp. crassifolia occurrences are directly adjacent to residential development. Use of these lands, whether or not public access is allowed, has proven to be problematic. For example, unwanted public use of lands supporting A. g. subsp. crassifolia have resulted in trail creation, disposal of green waste, dumping of trash, vandalism, and itinerant encampments on the Kelly Ranch and Rancho La Costa Preserves in the City of Carlsbad (CNLM 2008a, p. 22; CNML 2008b, p. 28). The Service has no evidence of direct impacts to A. g. subsp. glandulosa or its habitat; however, these activities generally lead to habitat degradation (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Some of the occurrences of Arctostaphylos glandulosa subsp. crassifolia are potentially threatened by having a small population size. The listing rule estimated a 50 percent decline in the number of stands and individuals since 1982. In addition, the rule stated that over 75 percent of the remaining individuals occurred at 6 of the 25 locations. Four of those populations have been further reduced by development. At one occurrence (the portion of EO 1 at the Rancho La Costa Habitat Conservation Area) there are only nine individuals of A. g. subsp. crassifolia. A commonly accepted principal in conservation biology is that small populations have higher probabilities of extinction than larger populations. Populations with small numbers of individuals are more susceptible to genetic drift, losing variation more readily making them more prone to local extinction. In addition, species whose numbers have been significantly reduced due to habitat destruction may be more susceptible to genetic stresses imposed by small population size (Barrett and Kohn 1991, p. 7). Other factors that can make small populations more susceptible to extinctions than large populations are demographic stochasticity and naturally occurring events such as wildfires, floods, droughts, and disease (Shaffer 1981, p. 131). Because the majority of A. g. subsp. crassifolia occurrences are small, it is reasonable to consider these smaller populations at risk due to these effects of small population size (USFWS, 2010).

Stressor: Military training (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Since listing, populations of A. g. subsp. crassifolia have been found on MCAS Miramar (EO 47, 50, 51, 52, 54, 55, and MCAS Miramar training areas). Potential threats to the plant on MCAS Miramar range from ground training activities including foot traffic, motor vehicle operations, combat engineering support operations, temporary encampments, and fixed or rotary wing aviation operations (MCAS Miramar 2006, p. 2-6). Impacts from these training

activities can result in trampling and destruction of seedlings and plants. However, threats associated with these training activities are thought to be minimal and potentially offset by management considerations described in MCAS Miramar's INRMP (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, p. 1; Cayan et al. 2006, pp. 1, 7-8; IPCC 2007, pp. 8-9). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5 to 6° F (2.7 to 3.3° C) (Morse et al. 1995, p. 393). Whether or not this would include Arctostaphylos glandulosa subsp. crassifolia is unknown (USFWS, 2010).

Stressor: Herbivory and Disease (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: While the health of the Arctostaphylos glandulosa subsp. crassifolia population in the MCAS Miramar post-fire monitoring plots has increased, surveyors also observed signs of herbivory and disease. While monitoring 253 tagged individuals, MCAS Miramar surveyors observed nectarrobbing (i.e., when insects access floral resources from the outside of the flower opening without touching the flowers anthers or stigma) on "many individuals," signs of insect herbivory of leaves on 14 percent of individuals, and black leaf spots (which could be a sign of sun damage or fungal growth) on 32 percent of individuals (Tetra Tech, Inc 2012, p. 15). The report recommended that disease and herbivory continue to be monitored to determine if these factors negatively impact A. g. subsp. crassifolia growth and reproduction over time (Tetra Tech, Inc 2012, p. 18). The Center for Natural Lands Management also mentioned disease as a potential threat to Arctostaphylos glandulosa subsp. crassifolia. In a letter to the U.S. Fish and Wildlife Service, the Center for Natural Lands Management stated that powdery mildew (Podosphaera xanthii), a fungal disease, had been observed affecting the leaves of A. g. subsp. crassifolia at preserves they managed in Carlsbad, California (Center for Natural Lands Management 2021, in litt., p. 2). In 2017, they initiated monitoring to determine presence of powdery mildew on A. g. subsp. crassifolia at the La Costa Glen Habitat Conservation Area, but did not find any (Center for Natural Lands Management 2021, in litt., p. 2–3). (USFWS, 2023)

Stressor: Hybridization (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: A report from MCAS Miramar suggested that hybridization could be a threat to the subspecies, in addition to altered fire regime (including plant canopy encroachment), nonnative invasive plants, erosion with high rainfall events, nectar-robbing and herbivory, and potential

disease (USFWS, 2023)

Recovery

Reclassification Criteria:
Not available - this species does not have a final recovery plan.

Recovery Priority Number: 6C

Delisting Criteria:
Not available - this species does not have a final recovery plan.

Recovery Actions:

- Not available - this species does not have a final recovery plan.
- Determine subspecific identity and densities of plants at occurrences peripheral to the core coastal portion of the range (USFWS, 2010).
- Assess the reproductive output of Arctostaphylos glandulosa subsp. crassifolia occurrences, including seed production and viability (USFWS, 2010).
- Determine causes and likely remedies for apparent low rate of establishment of new plants. This should include establishing the role of fire in the species biology and exploration of an acceptable alternative (USFWS, 2010).
- Evaluate the status of Arctostaphylos glandulosa subsp. crassifolia in Mexico (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will provide a better understanding of Arctostaphylos glandulosa subsp. crassifolia population health, reproductive output, and factors affecting the low rate of establishment. Additional genetic information will also help to better understand relatedness between the listed entity and the other six subspecies and provide more clarity of the geographic distribution of the listed entity. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Work with partners to identify opportunities for conservation or preservation of Arctostaphylos glandulosa subsp. crassifolia occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire A. g. subsp. crassifolia habitat. 2. Assess the taxonomic status of Arctostaphylos glandulosa subspecies (and similar species) in California and Mexico such that the endangered entity (A. g. subsp. crassifolia) can be clearly identified. a. Determine the geographic distribution of the endangered entity and hybridization zones. b. If necessary, revise circumscriptions for Arctostaphylos glandulosa subspecies and related taxa. 3. Evaluate the status of Arctostaphylos glandulosa subsp. crassifolia in Mexico. 4. Assess the reproductive output of Arctostaphylos glandulosa subsp. crassifolia occurrences, including seed production and viability. 5. Determine causes and likely remedies for apparent low rate of establishment of new plants. This should include establishing the role of fire in the subspecies' biology and exploration of an acceptable alternative. 6. Determine the extent to which herbivory or disease may be affecting survival, reproduction, or recruitment of Arctostaphylos glandulosa subsp. crassifolia. (USFWS, 2023).

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SPECIES ACCOUNT: *Arctostaphylos morroensis* (Morro manzanita)

Species Taxonomic and Listing Information

Listing Status: Threatened; 1/17/1995; Pacific Southwest (R8)

Physical Description

This shrub reaches a height of 1.5 to 4.0 meters (5 to 13 feet) and has crowded oblong to ovate grey-green to olive-green leaves, 2.5 to 4.0 centimeters (1 to 1.5 inches) long, with petioles 2 to 6 millimeters (0.08 to 0.20 inch) long. The white to pinkish flowers are 5 to 8 millimeters (0.2 to 0.3 inch) long, and form orange-brown fruits 8 to 13 millimeters (0.3 to 0.5 inch) in diameter with 8 to 10 stones per fruit that are fused but separable. The bark ofthe trunk is a shaggy grey to brown; the leafblades range from wedge-shaped (cuneate) to rounded ornearly straight (truncate) at the base, with the lower surface paler and usually somewhat tomentose (short woolly hairs). Occasional specimens have small projecting lobes at bases of the leaf blades and a short leafstalk or none at all (USFWS, 1998).

Taxonomy

Member of the heath (Ericaceae) family. Morro manzanita (Aretostaphylos morroensis) (Figure 3) was first described by Albert E. Wieslander and Beryl 0. Schreiber in 1939 (Wieslander and Schreiber 1939) based on a specimen collected in Hazard Canyon, south ofMorro Bay, which is now within the boundaries ofMontai'ia de Oro State Park. The species has continued to be recognized by McMmnn (1939), Abrams (1944), Munz(1959), Hoover (1970), and Wells (1993) (USFWS, 1998).

Historical Range

Endemic to San Luis Obispo County, California. The distribution of A. morroensis is correlated with the distribution of Baywood fine sands. Based on the distribution of these sands, the historical distribution of A. morroensis is estimated to have comprised between 2,000 and 2,700 acres (809 and 1,092 hectares (ha)) (USFWS, 2013).

Current Range

Arctostaphylos morroensis ranges from the northeast side of Morro Bay to the southern end of Montaña de Oro State Park, a distance of less than 10 miles (16.1 kilometers) (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2013)

Lifespan

Adult: 47+ years (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: Bombus vosnesenskii (USFWS, 2013)

Breeding Season

Adult: Winter (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators, > 40 year fire intervals (USFWS, 2013)

Reproduction Narrative

Adult: Arctostaphylos morroensis flowers in the winter, with fruit maturation and seed dispersal occurring in the fall. Unlike other species of manzanita, A. morroensis is an obligate seeder, lacking a woody burl from which it can resprout post-fire. Fruits contain 8 to 10 seeds each. Although it is unknown whether the flowers are self-compatible, extensive research revealed that pollination is required for reproduction. In 1998 and 1999, Tyler and Odion found that bumblebees (Bombus vosnesenskii) are the dominant pollinators, though anthophorid bees (Anthophora urbana), several bee flies (Bombylius spp.), and syrphid flies (family Syrphidae) are also known pollinators. The authors also noted surprisingly low pollinator activity for both years surveyed (Tyler et al. 1998 and 2000). Only 10 percent of flowers examined in 1998 produced fruits. For Arctostaphylos morroensis and other obligate-seeding species of manzanita, maintenance and regeneration are dependent upon mass germination triggered by fire (Tyler and Odion 1996). Fire breaks seed dormancy and also creates open areas where seedlings can germinate and individuals establish. Due to very low seed viability in Arctostaphylos morroensis, in combination with high seed mortality in response to fire, Tyler and Odion (1996) suggest that stands burned at cycles greater than 40 years would have sufficient time to accumulate an adequate seed bank (USFWS, 2013). Morro manzanita is a long-lived shrub; studies of stand age based on trunk ring counts and aerial photos of previous disturbance events, including fire and possibly clearing, indicate that the youngest intact stands are some of those south of Highland Drive, which are about 37 years old. Stands west of Pecho Drive are about 47 years old. The remainder are older than 47 years, with stands in the Elfin forest estimated to be the oldest (Tyler and Odion 1996) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dune scrub, maritime chaparral, coast live oak woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2013; see reproduction narrative)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 200 m elevation (NatureServe, 2015); closed-canopy (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2013)

Habitat Narrative

Adult: Inhabits soils derived from ancient sand dunes. Found in nearly pure stands on steep slopes, especially on north exposures. On low-moderate slopes, found in association with coastal dune scrub, maritime chaparral, and coast live oak woodland communities; < 200 m elevation. (NatureServe, 2015). Development of climax, closed-canopy chaparral stands has an adverse effect on populations of A. morroensis by precluding expansion into otherwise suitable habitat. Arctostaphylos morroensis is primarily found on Baywood fine sand soils (ancient wind-blown beach sands), though small stands have also been documented on Santa Lucia shaley clay loam (Soil Conservation Service 1958, McGraw 2005) (USFWS, 2013).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Birds and large mammals (coyote (Canis latrans) and mule deer (Odocoileus hemionus)) are thought to aid Arctostaphylos morroensis in seed dispersal (Keeley and Hays 1976). This secondary dispersal (which occurs after the parent plant initially sets seed) is limited, however, as evidenced by 90 percent fewer seeds present in soil cores 5 feet (1.5 meters) away from A. morroensis compared to samples taken from beneath the canopy (Tyler and Odion 1996) (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (inferred from USFWS, 2013)

Number of Populations:

18 (NatureServe, 2015); Unknown (USFWS, 2013)

Population Size:

Currently unknown; previously 86,500 - 153,000 (USFWS, 2013)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

It is unknown precisely how many populations occur across the range of the species. LSA estimated approximately 153,000 Arctostaphylos morroensis plants occurred across the species' range at the time of listing. McGuire and Morey produced a lower estimate than LSA (using a 15-foot diameter per individual), estimating that the total species population would be closer to 86,500 individuals (McGuire and Morey 1992). An accurate estimate of Arctostaphylos morroensis abundance throughout its range was unavailable at the time of the 5 year review. Tyler and Odion (1996) hypothesized that the low viability may be due to inbreeding as a consequence of small effective population sizes. The current status of Arctostaphylos

morroensis is not markedly different than what was summarized in the final listing rule published in 1994, the final recovery plan completed in 1998, or the most recent 5-year review, released in 2008 (USFWS, 2013). There are 18 occurrences (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction and alteration (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Areas of habitat with high cover of Arctostaphylos morroensis are still at risk on private lands that could be developed in the future. For example, in 2010, a privately owned parcel containing this species in Cabrillo Estates was developed for a private residence. The spread of nonnative species, particularly veldt grass, has altered the composition of the plant communities associated with Arctostaphylos morroensis habitat. This in turn is likely altering the fire cycle, potentially increasing the frequency of fires, and decreasing the viability of existing seed banks. the acquisition of lands reduces the threat of destruction of habitat from development. However, the continued spread of nonnative species throughout Arctostaphylos morroensis' range and the fire cycle needs particular to the species (discussed below in Factor E) necessitate land management that is not currently in place; alteration of habitat from nonnative species is increasing (USFWS, 2013).

Stressor: Altered fire cycles (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Land managers have not planned any prescribed burns for Arctostaphylos morroensis habitat. The U.S. Army Corps of Engineers burned and cleared shrubs in Montaña de Oro State Park in 1958; however, the Service has no knowledge or evidence of prior burns (Odion and Tyler 2003). Montaña de Oro State Park performs controlled burns as needed and when possible, but burning A. morroensis habitat is inhibited by the nature of the landscape. The fuel requirements, steepness of the slopes, limited accessibility, and proximity to residential areas make a prescribed burn for A. morroensis difficult to perform (V. Cicero, California State Parks, in litt. 2012)). The most recent wildfire within the State Park occurred in 1997, but did not burn A. morroensis stands. Wildfires for this maritime chaparral habitat are estimated to occur about every 50 to 200 years (Cicero in litt. 2012). For these reasons, the limited ability to manage fire cycles hinders efforts to reduce the threat of altered fire cycles to A. morroensis (USFWS, 2013).

Stressor: Invasive species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The nonnative veldt grass (Ehrharta calycina) has spread to the Los Osos and Morro Bay region. This species has not only invaded disturbed areas, such as vacant lots, road cuts, and utility corridors, but is becoming naturalized in native plant communities, including conserved lands owned and/or managed by the CDFW and CDPR for Arctostaphylos morroensis (J. Vanderwier, U.S. Fish and Wildlife Service, pers. obs., 2006). Members and volunteers associated with Small Wilderness Area Preservation use manual removal to fight veldt grass in the Elfin

Forest and continue to make progress (Sarafian 2011). Although veldt grass more likely competes for resources with herbaceous species than with established perennials, its presence may also increase the frequency and risk of fire that would negatively affect A. morroensis by reducing the abundance and viability of its seed bank. Veldt grass is not currently invading established A. morroensis stands in Montaña de Oro State Park, although it may prevent recruitment in areas where it has already invaded the habitat (Cicero in litt. 2012). In the final listing rule, the Service recognized that stands of Arctostaphylos morroensis in Montaña de Oro State Park were being overtopped by spreading eucalyptus (Eucalyptus spp.) planted in the early 1900s. The Service noted that A. morroensis is not able to survive such encroachment due to reduction in available soil moisture, increased shading, and the effects of growth-inhibiting terpenes that are released from eucalyptus (California Invasive Plant Council 2006-2011). Although the general plan for Montaña de Oro State Park calls for the removal of exotic species, including eucalyptus, this program has only been partially implemented. In past years, eucalyptus removal efforts generally focused on removing seedlings from outside the bounds of the original groves and not specifically from habitat that supports A. morroensis (Service 1998). Recently, efforts to control eucalyptus have been undertaken and have been successful in preventing further recruitment. However, fluctuations in the park's budget in coming years may hinder these efforts; therefore, the Service still considers competition with eucalyptus to be a threat (Cicero in litt. 2012). Other invasives not mentioned at the time of listing, including narrow-leafed iceplant (Conicosia pugioniformis), are encroaching upon Elfin Forest populations of Arctostaphylos morroensis. Bridal creeper (Asparagus asparagoides) is also posing a threat in the Elfin Forest (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). Arctostaphylos morroensis' small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as those that may result from climate change. Recently, Loarie et al. (2008) discussed the potential impacts of climate change on the flora of California. Based on climate modeling, they predicted that species' distributions will shift in response to climate change and that species will "move" to higher elevations and northward, depending on the ability of each species to do so. Broadly, indirect ecological impacts caused by fog and variation in humidity could alter pollinator activity, soil moisture, and phenology of the species. In general, the scientific community lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species. Small-ranged species, such as A. morroensis, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2013).

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 8

Delisting Criteria:

1. Ninety percent of existing acreage supporting high (75-100 percent) and medium (25-75 percent) cover of Morro manzanita and 85-90 percent of low (1-24 percent) cover supporting Morro manzanita are secured from human-induced threats in preserves in the Northeast Los Osos, South Los Osos and West Pecho Conservation Planning Areas with no greater fragmentation by roads, residences, or other areas of human use than currently exists. (USFWS, 1998)

2. Evidence that the acreage and approximate cover classes of Morro manzanita in preserves can be maintained over time and that preserves are not made unmanageable by small size, proximity to urban development, or fragmentation. (USFWS, 1998)

3. Site-specific management plans have been successfully implemented for the preserves. Because habitat in the Conservation Planning Areas must remain unfragmented to recover this species, habitat attrition must be restricted to isolated or remnant patches of Morro manzanita that are unlikely to be viable over the long term. Highest priority for securing sites should be given to stands where Morro manzanita is the dominant in terms of cover, where large blocks of occupied habitat are still present, and where Morro manzanita habitat can be secured that abuts other protected lands, as in the South Los Osos Conservation Planning Area. (USFWS, 1998)

Recovery Actions:

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS,

1998)

- Recommendation from 2013 5-Year Review: 1. Additional lands with high densities of Arctostaphylos morroensis should be secured from the threat of development in Northeast Los Osos, West Pecho, and South Los Osos conservation planning areas. (USFWS, 2013)
- Recommendation from 2013 5-Year Review: 2. All secured lands should be managed to ensure ecosystem function. Active management is needed to maintain and enhance populations of Arctostaphylos morroensis; therefore, the development and implementation of management plans that identify specific actions for the species are critical to its recovery. At a minimum, these plans need to address: (a) regeneration requirements for the species; and (b) an assessment of the extent of the threat of competition from nonnative invasive plant species. The Service should work with CDPR, CDFW, and other relevant partners to encourage the development and implementation of these management plans. (USFWS, 2013)
- Recommendation from 2013 5-Year Review: 3. Ensure that management actions are implemented and ongoing by securing and using funding sources. Engage partners (State Parks and/or the County of San Luis Obispo) in an effort to work with them toward the common goal of securing the long-term persistence of Arctostaphylos morroensis.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Coordinated conservation and research are needed to better understand the biology and ecology of Morro manzanita, in particular to restore and maintain the existing stands and facilitate recruitment. These efforts should include: • Conduct a more-detailed analysis of the distribution and abundance of and threats to Morro manzanita, with a coordinated team effort including site visits by USFWS and partners. • Conserve and protect habitat in vicinity of and near existing stands of Morro manzanita • Develop and implement site-specific management plans for Morro manzanita habitat within preserves including success criteria for evaluating effectiveness of management. • Conduct modelling to anticipate the effects of climate change on distribution and abundance of Morro manzanita, including changes in temperature, precipitation, extent of marine fog layer, and sea level rise. • Develop protocols for long-term restoration success. 1. Consider using method with seedlings of Sarafian (2011, p. 5), and suggested method for collecting and sowing seeds of Tyler and Odion (2020, p. 164). 2. In light of the threat of climate change with severe drought and increased temperatures, consider using methods for cultivating seeds for propagation and outplanting in arid lands used by Abella et al. (2012, entire), Abella et al. (2015, entire), Abella (2017, entire) and Abella et al. (2020, entire). • Continue studies of the species' relationship with fire. • Collect seeds for conservation seed banking. • Introduce Morro manzanita into living collections at several botanic gardens (USFWS, 2022).

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SPECIES ACCOUNT: *Arctostaphylos myrtifolia* (Ione manzanita)

Species Taxonomic and Listing Information

Listing Status: Threatened: listed in 1999 (64 FR 28403)

Physical Description

Ione manzanita is an evergreen shrub of the heath family (Ericaceae). Reaching a height of generally less than about 4 feet (1.2 meters) and commonly only 2 feet (0.6 meter) tall, plants appear low and spreading. Its bark is red, smooth, and waxy. Olive-green leaves are small 1/4 to 1/2 inch (0.6 to 1.3 centimeters), oval in shape, pointed at the tip, and often pointed at the base as well. The white to pinkish urn-shaped flowers are also small, averaging 1/8 inch (0.3 centimeters) across, and appear from January to February. Its small, rounded, greenish fruits are 1/8 inch (0.3 centimeters) long and 1/16 inch (0.15 centimeter) wide. This manzanita species lacks a basal burl (a basal burl is a swelling at the junction of roots and stems that allows many chaparral shrub species to sprout from the base, and vegetatively regenerate after a fire). After a fire, Ione manzanita must regenerate from seed. Ione manzanita can be distinguished from other species in the same genus by its smaller stature and the color of its leaves (NatureServe 2014; USFWS 2009; USFWS 2010).

Historical Range

Ione manzanita occurs throughout all of its presumed historical range in Amador County, though many populations have been reduced in size due to mining, road construction, development, and diseases. The distribution of Ione manzanita was believed to extend as far east as the Town of San Andreas in Calaveras County. However, efforts to locate and identify the San Andreas populations of Ione manzanita have not been successful. Because of the discontinuous nature of the Ione Formation on which it grows, Ione manzanita was always patchily distributed with other chaparral and oak forest types (USFWS 2010; NatureServe 2014).

Current Range

Ione manzanita occurs in about 100 individual stands, which cover a total of about 1,000 acres (4 square kilometers). It is narrowly endemic to a habitat found only in the central Sierra Nevada foothills of California. At the time of listing, Ione manzanita was known from 17 occurrences covering approximately 1,000 acres (4 square kilometers); currently, the Calflora Occurrence Database (Calflora 2014) contains 94 records for Ione manzanita from Amador and Calaveras Counties, and the CNDDB (2014) recognizes 15 occurrences for this species. Most of the occurrences are on private lands. One occurrence on U.S. Bureau of Land Management (BLM) land is within the Ione Manzanita Area of Critical Environmental Concern. Two additional occurrences are partially on BLM lands. Four small, pure (containing only Ione manzanita) populations and several smaller, mixed populations also occur on the State-owned Apricum Hill Ecological Reserve managed, by the California Department of Fish and Wildlife (USFWS 2010; CNDDB 2014; NatureServe 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: sunlight

Food/Nutrient Narrative

Adult: This species is a plant that aquires its energy from sunlight via photosynthesis.

Reproductive Strategy

Adult: Flowering plant

Lifespan

Adult: unknown

Dependency on Other Individuals or Species

Adult: unknown

Breeding Season

Adult: January and February (Calflora 2014; CNPS 2014).

Key Resources Needed for Breeding

Adult: unknown

Reproduction Narrative

Adult: Flowering occurs from mid-January to early March and fruits are fully developed by late spring or early summer (Gankin and Major 1964, p. 796). Arctostaphylos myrtifolia is an obligate seeder that can be killed by fire and therefore depends entirely on seeds stored in the soil or dispersed to the site for stand regeneration (Gankin and Major 1964, p. 795).

Habitat Type

Adult: barrens, shrubland/chaparral

Dependencies on Specific Environmental Elements

Adult: 190 to 1,900 feet (60 to 580 meters) (CNPS 2014) with soils that are highly acidic, and high levels of aluminum

Geographic or Habitat Restraints or Barriers

Adult: restricted to Ione Formation

Spatial Arrangements of the Population

Adult: clumped according to suitable resources

Environmental Specificity

Adult: special habitat requirements, but not special feeding requirements

Tolerance Ranges/Thresholds

Adult: low

Site Fidelity

Adult: high; plants do not move once they become established

Habitat Narrative

Adult: Ione manzanita occurs on outcrops of the Ione Formation (a remnant Eocence, hard white sandstone formation) in an area of about 22,500 acres (91 square kilometers) in Amador County. A few separate populations occur in Calaveras County. The populations range in elevation from 190 to 1,900 feet (60 to 580 meters) (CNPS 2014), with the largest populations occurring at elevations between 295 and 900 feet (90 and 275 meters) (USFWS 2009; USFWS 2010). Ione manzanita is mostly confined to the unusual soils of the Ione formation. These soils are highly acidic, and contain high levels of aluminum. This soil environment is extremely hostile to the growth of most plants (aluminum in high concentrations can be toxic to plants). Organic matter and nutrient availability is low. Ione manzanita only occupies sites where the extreme conditions described above persist. It commonly grows in pure stands; at the edge of these stands, there may be a transition zone where Ione manzanita and whiteleaf manzanita coexist. It also occurs in transitional zones with surrounding taller chaparral types, but it does not persist if it is shaded (USFWS 2009; USFWS 2010; NatureServe 2014).Some manzanita species have basal burls that can resprout after a fire burns the canopy; Ione manzanita does not have a burl. It is an obligate seeder that can be killed by fire. It depends entirely on seeds stored in the soil or dispersed to the site; seed germination may be promoted by periodic fire (USFWS 2010).

Dispersal/Migration

Motility/Mobility

Adult: not moble

Dispersal

Adult: unknown

Dependency on Other Individuals or Species for Dispersal

Adult: unknown

Dispersal/Migration Narrative

Adult: There is not much information available regarding the dispersal of this species

Population Information and Trends

Population Trends:

Unknown

Species Trends:

Declining

Population Growth Rate:

unknown

Number of Populations:

17

Population Size:
unknown, but likely greater than 100 individuals

Minimum Viable Population Size:
unknown

Resistance to Disease:
low

Adaptability:
low

Population Narrative:
Current status and number of individuals is unknown. At the time of listing Arctostaphylos myrtifolia was known from 17 occurrences covering approximately 404.7 ha (1,000 ac)Individuals occur in stands, with approximately 100 stands documented as still existing. Populations exist in a narrow geographic range that contains the required soil conditions; they occur primarily on private or non-Federal lands. The amount of Ione manzanita habitat lost to mining and has not been quantified, because information regarding the total acreage of land newly disturbed by mining operations is proprietary. However, the loss is believed to be significant. Populations are restricted to a very limited habitat, with much of that population suffering from disease. The ability of populations to recover is limited by poor health and reduction of habitat. There are only about 100 stands, with an unknown number of individuals in a limited area of habitat. A significant portion of those populations are suffering from disease. Populations are restricted to habitat in the Ione Formation soil conditions. Loss of habitat due to mining and other development removes potential area for regrowth.

Threats and Stressors

Stressor: Mining
Exposure:
Response:
Consequence:
Narrative: Nearly all populations of this species occur on private or non-Federal land. The primary threat facing this species is the ongoing and threatened destruction and modification of its habitat by mining for silica sand, clay, lignite, common sand and gravel; and reclamation of mined lands involving establishment of vegetation with which this species cannot co-exist. A lesser degree of threat is posed by commercial or residential development, clearing for agriculture and fire protection, and continued erosion due to previous fireline construction and driver training for California Department of Forestry and Fire Protection (CDFFP) employees. Commercial and residential development also threatens the habitat of Arctostaphylos myrtifolia. In 1993, a 43 ha (106 ac) parcel in the city of Ione reported to have A. myrtifolia was cleared, presumably to facilitate future development (Randy L. Johnsen, Ione City Administrator, in litt. 1994). The Amador County master plan has zoned an area in the northern Ione chaparral near Carbondale for industrial uses. Its habitat occurs in areas that contain valuable minerals. Clay mining began in the Ione area around 1860. Since that time, the Ione area has produced about a third of the fire clay in California (Chapman and Bishop 1975). Lignite, a low-grade coal, also has

been mined in the Ione area since the early 1860s, initially for fuel, but more recently for wax used for industrial purposes. Chapman and Bishop (1975) reported the Ione lignites were the only lignites used commercially in the United States in the production of a specialized wax (montan wax). Quartz sand used in making glass containers, and laterite used for making cement also are commercially mined in the Ione area (Chapman and Bishop 1975). Common sands and gravels are also mined for various uses. Mining of all of these deposits has resulted in the direct removal of habitat for this plant species (Wood and Parker 1988; V. Thomas Parker, Professor of Biology, San Francisco State University, in litt. 1994; M. Wood, in litt. 1994). Strip mining of silica for glass and clay for ceramics and industrial filters has extirpated (caused extinction of) populations of A. myrtifolia north and south of Highway 88 (Roof 1982). mining results in conversion of former habitat to rangeland, pasture, and other agricultural uses; landowners do not restore the original plant community that was lost when the area was mined. Additionally, once the area is mined, the specialized substrate required by the plants may no longer be present. This type of disturbance permanently precludes restoration of habitat suitable for Arctostaphylos myrtifolia. To a lesser extent, land conversion to grazing and agriculture also has degraded or destroyed the habitat for these plants (Wood and Parker 1988; V.T. Parker, in litt. 1994; M. Wood, in litt. 1994). Both activities continue to pose threats to its habitat.

Stressor: Disease
Exposure:
Response:
Consequence:
Narrative: Recent studies by Swiecki and Bernhardt (2003, pp. 1–49) and Swiecki et al. (2005, pp. 1–38) determined that at least three different diseases are affecting the health of Arctostaphylos myrtifolia in the Ione area. First, a branch canker disease caused by a species of Fusicoccum that had previously been identified, and two newly identified pathogens, Phytophthora cinnamomi and P. cambivora. Progressive dieback associated with Fusicoccum spp. cankers likely contributes to and may sometimes cause the death of A. myrtifolia plants. Phytophthora spp. were found to cause contiguous patches of mortality in stands of A. myrtifolia due to root and crown rot (Swiecki and Bernhardt 2003, p. 4; Swiecki et al. 2005, p. 22). While mortality associated with Phytophthora spp. appears to have been noted since the 1980's, Swiecki and Bernhardt (2003, p. 41) believe it was at least partially confused with the branch canker disease because both diseases can occur together in the same area. However, mortality associated with Fusicoccum spp. tends to be patchily distributed within a stand and mortality caused by Phytophthora spp. is continuous. Swiecki and Bernhardt (2003, pp. 41–43) determined that two species of Fusicoccum affect Arctostaphylos myrtifolia plants by killing off branch tips or infecting larger diameter stems where the infection may expand and girdle the stem. The girdling of the stem may result in the death of large portions of the plant or the plant in its entirety. Swiecki and Bernhardt (2003, p. 41) observed that stem cankers associated with Fusicoccum spp. may expand slowly during the months from March to October; however, if the die-back associated with Fusicoccum spp. exceeds new growth, individual plants may eventually be killed. Although advancement of the disease appears to be reduced during the drier months, stem canker severity, and subsequent dieback, appears to be related to plant water stress (Swiecki and Bernhardt 2003, p. 43). Arctostaphylos myrtifolia is highly susceptible to the pathogen Phytophthora cinnamomi. The P. cinnamomi pathogen was first identified as affecting A. myrtifolia by Swiecki and Bernhardt (2003, p. 5). Phytophthora cinnamomi is considered to be a serious pathogen of agricultural crops and native plant communities. In California, it is known to infect avocado trees, orchard trees, ornamental plants and Christmas tree farms (Swiecki and Bernhardt 2003, p. 44). More

recently P. cinnamomi was identified to be partially responsible for mortality in Quercus agrifolia (coast live oak) (Garbelotto et al. 2006, p. 1). Phytophthora cinnamomi is a disease that causes root and crown rot and is responsible for killing off large patches of A. myrtifolia in the Ione area. Once infected by this pathogen, the root system of the plant begins to decay until the loss of roots and/or water-conducting tissues causes the plant to desiccate (Swiecki and Bernhardt 2003, p. 43). Additionally, P. cinnamomi can also infect the leaves and stems of the plant, providing the same symptoms as Fusicoccum infections, making it difficult to determine which disease is affecting a particular plant (Swiecki and Bernhardt 2003, p. 45). Introduction of Phytophthora cinnamomi into Arctostaphylos myrtifolia habitat represents longterm, if not permanent, destruction of habitat due to its long persistence in the soil (Swiecki and Bernhardt 2003, p. 43). Phytophthora cinnamomi can persist in the environment in the absence of susceptible hosts. This pathogen survives in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003, p. 44). There is no known cure or prevention for this A. myrtifolia disease (Swiecki and Bernhardt 2003, pp. 45–47). Swiecki and Bernhardt (2003, pp. 26–27) found that A. myrtifolia regeneration within an older portion of a mortality center was killed off by P. cinnamomi, while Swiecki et al. (2005, p. 25) discovered healthy A. myrtifolia regeneration in other older portions of mortality centers. However, subsequent investigation in 2009 discovered regeneration in these mortality centers displayed extreme dieback, or complete mortality (Karuzas, in litt. 2009, p. 1). Swiecki et al. (2005, p. 330 further noted that although reductions in pathogen populations may occur over time, it is unclear what period of time is needed to allow successful reestablishment of A. myrtifolia. The pathogenic activity of Phytophthora cinnamomi is favored by free moisture and under wet conditions, multiple infection cycles are likely to occur. Phytophthora cinnamomi is primarily spread to new areas through the movement of infested soil by humans, particularly through the use of vehicles (Swiecki and Bernhardt 2003, p. 45). Once the disease has been introduced into an area, the movement of the pathogen is facilitated by water flow. Swiecki et al. (2005, p. 33) noted that the local spread of P. cinnamomi occurs during the wet season at a cross slope and upslope rate of approximately 0.25 m (0.8 ft) per year. Down slope spread has been calculated at 2 m (6.5 ft) per year, presumably due to transport via flowing water, and under stagnant stream conditions P. cinnamomi has been located 10 m (33 ft) from disease-associated mortality centers (Swiecki et al. 2005, p. 34). While it is more likely for P. cinnamomi infected soil to be spread over larger distances during the wet season, movement of infected soils can readily occur during dry months as the result of mining operations and excavation (Swiecki et al. 2005, p. 35). An investigation of the distribution of the Phytophthora cinnamomi pathogen throughout the range of Arctostaphylos myrtifolia found that P. cinnamomi infection is widespread throughout the Ione and Buena Vista area, with a second disease center in the Carbondale area (Swiecki et al. 2005, pp. 1–38). Of the populations located in and around Ione and Buena Vista, over 50 percent have been killed by disease or are at risk of being infected (Swiecki, in litt. 2008, p. 1). DNA microsatellite analysis of P. cinnamomi isolates from Apricum Hill Preserve identified four genetically distinct variants, suggesting multiple introductions of the pathogen at this location. Additionally, two of the four genotypes have been identified elsewhere in California (Swiecki et al. 2005, pp. 28–29). Investigation of the A. myrtifolia mortality on BLM land in the Carbondale area resulted in the discovery of a second soil-borne Phytophthora species, P. cambivora (Swiecki et al. 2005, p. 36). While it is not known what effect P. cambivora has on A. myrtifolia, P. cambivora is closely related to P. cinnamomi and is also an aggressive root pathogen (Swiecki et al. 2005, p. 36). Phytophthora cinnamomi is currently considered to be the greatest threat to Arctostaphylos myrtifolia. As of 2005, P.cinnamomi was documented as occurring in two of the five large A. myrtifolia populations. However, because P. cinnamomi is causing mortality in a

number of native forests and chaparral communities in northern California (Swiecki, in litt. 2008, p. 2), and contaminated soil is readily transported on vehicles and in nursery stock, it is likely that P. cinnamomi will spread throughout the range of A. myrtifolia in the foreseeable future.

Stressor: Inadequate regulations
Exposure:
Response:
Consequence:
Narrative: Regulatory mechanisms thought to be inadequate to protect Arctostaphylos myrtifolia included: (1) the CEQA; (2) the SMARA; and (3) local regulations (see five year review for more information).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
Not available

Recovery Actions:

- Currently there is no approved final or draft recovery plan for Eriogonum apricum (inclusive of vars. apricum and prostratum) or Arctostaphylos myrtifolia, therefore a high priority action should be finalizing a recovery plan for these species. Disease is currently the greatest threat to A. myrtifolia, and as such, a high priority should be placed on identification of the current extent of this pathogen within the range of A. myrtifolia and implementing measures to restrict the movement of infested soil and plant materials from areas affected by Phytophthora cinnamomi. Additional emphasis should be placed on conducting research into how to eliminate this disease from the ecosystem and identify other methods to prevent disease transmission. As part of this effort, the symptomatology, etiology, and impact of P. cambivora on A. myrtifolia and other species should be studied. Additionally, priority should be placed on identifying the status of E. apricum populations and obtaining an accurate representation of the area occupied by this species and the availability of habitat for restoration purposes. These tasks would aid us in better understanding the threats facing these species and to develop methods to help reduce the threats.

References

FEMA species account

five year review

Nature Serve

five year review 2010

final listing rule

SPECIES ACCOUNT: *Arctostaphylos pallida* (Pallid manzanita)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

Pallid manzanita is an upright, evergreen shrub, usually 1.5 to 13 feet (2 to 4 meters) tall, but occasionally much taller. The bark on the main branches is gray to reddish. The leaf blades are 0.75 to 1 inch (2.5 to 4.5 centimeters), and a pale, dull-green color. Flowers are white and urn-shaped, 0.23 to 0.27 inch (6 to 7 millimeters) long, in dense clusters (USFWS 2014; Jepson 2013). Additional detail from 2015b: Arctostaphylos pallida is an upright, evergreen, non-burl-forming, obligate-seeding shrub. It grows up to 4 meters (13 feet) in height, with rough, gray, or reddish bark. The twigs (terminal branches) are bristly and canescent (covered with whitish fine hairs). The pale green leaves surround the stem and are attached by a petiole less than 2 millimeters (0.08 inch). The leaves are closely imbricated (overlap), and are cordate (heart-shaped) and glabrous (hairless). The leaf blade is 2.5 to 4.5 centimeters (1.0 to 1.8 inches) long, 2 to 3 centimeters (0.8 to 1.2 inches) wide, ovate or oblong-ovate, glaucous (covered with a whitish waxy covering), dull, and smooth (Wells 1993). The inflorescences (cluster of flowers) are dense, 3 to 5 per branch; the bracts (leaflike organ subtending an inflorescence) are 5 to 9 millimeters (0.2 to 0.35 inch), widely lanceolate (narrow and tapering at both ends), and acute (sharply pointed) (Wells 1993). The flowers are white, rose, or white-rose in color, urn-shaped, and 6 to 7 millimeters (0.2 to 0.3 inch) long; and flowering occurs from December to March. Fruits are 8 to 10 millimeters (0.3 to 0.4 inch), globe-shaped, and sticky (Wells 1993). (USFWS, 2015b).

Taxonomy

Arctostaphylos pallida was first described by Eastwood (1933), based on a specimen collected by W. W. Carruth in 1902 from the “East Oakland Hills.” Prior to Eastwood (1933), the specimen was included in Arctostaphylos andersonii. Jepson (1922; 1939) did not recognize A. pallida as a separate species and continued to include it in Arctostaphylos andersonii. McMinn (1939) published the combination A. andersonii var. pallida, apparently agreeing with J. E. Adams’ conclusions (first presented in his 1935 dissertation at the University of California at Berkeley) that the Oakland specimen was distinct but related to A. andersonii. This combination was not published until several years later (Adams 1940). In their floristic treatment of California, Munz and Keck (1959) followed McMinn’s treatment. Wells (1969) recognized A. pallida as a species separate from A. andersonii and retained this treatment in the Jepson Manual (Wells 1993). The phylogenetic analysis and relationships outlined in Boykin et al. (2005) do not support A. pallida as being a variety of A. andersonii. Although Parker et al. (2012) revised the taxonomy of several Arctostaphylos species for the second edition of the Jepson Manual; no taxonomic revisions were made to A. pallida. Arctostaphylos pallida is recognized as a full species (Parker et al. 2012).

Historical Range

Pallid manzanita has a historical range in the Contra Costa Hills in the northern Diablo Range in Alameda and Contra Costa counties, California (NatureServe 2014). It was collected on the summit of East Oakland Hills in January of 1902. A second population, which was believed to have been reported in the 1940s or 1950s, was on Sobrante Ridge in Contra Costa County (USFWS 2014). Added in 2015: Based on a personal communication with the late James Roof,

the founding director of East Bay Regional Parks District's (EBRPD) Tilden Regional Park Botanical Garden (Tilden Park; Amme et al. (1987) noted that Mr. Roof planted several dozen A. pallida, in the period between 1939-1940, along Shasta Road and Golf Course Drive in Tilden Park. (USFWS, 2015b).

Current Range

There are 13 documented occurrences where pallid Manzanita currently exists. All extant, naturally occurring populations are in two geographic regions: Huckleberry Ridge in Alameda County, and Sobrante Ridge in Contra Costa County. There are likely dormant seed banks of pallid manzanita in the range of the species, as indicated by the presence of germinated seeds at several sites in Joaquin Miller Park following soil disturbance and/or burning (USFWS 2014). The largest concentration of pallid manzanita occurs on Huckleberry Ridge, with many stands distributed across connected and adjacent ridge tops. The largest stands by number and size occur along the boundary between East Bay Regional Park District's (EBRPD) Huckleberry Botanic Regional Preserve, and private properties to the west, primarily on northeast-facing slopes and extending southwest over the top of the ridge into the urban development of Skyline Boulevard. The second-largest concentration of pallid manzanita occurs at Sobrante Ridge in EBRPD's Sobrante Ridge Ecological Preserve. A 2004 survey indicated the population existed within 1.33 acres at Sobrante Ridge. There also exists a small, naturalized population at Tilden Park that is divided into two stands. One is scattered along the roadside of Wildcat Canyon Road, and the other is along the Selby Trail north of Shasta Road (CNPS 2014, USFWS 2014).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food Source

Adult: sunlight

Competition

Adult: yes (see threats section)

Food/Nutrient Narrative

Adult: This species acquires its energy from sunlight via photosynthesis.

Reproductive Strategy

Adult: diploid, obligate seeding; also capable of reproducing vegetatively by layering

Dependency on Other Individuals or Species

Adult: Depends on bees for pollination; seed caching by seed predators may be important for surviving fires

Key Resources Needed for Breeding

Adult: fire

Reproduction Narrative

Adult: Arctostaphylos pallida is diploid, obligate seeding, and shade-intolerant (Amme and Havlik 1987). Bees and other insects in the superfamily Apoidea, in particular European honeybees (Apis melifera), appear to be important pollinators (Amme and Havlik 1987, B. Solvesky, Service, pers. obs. 2010). Two basic life history patterns are found among species within the genus Arctostaphylos with respect to wildfire; Arctostaphylos plants either survive wildfire and resprout from a basal burl (sprouter) or Arctostaphylos plants are killed by fire and regenerate from seeds stored in the soil (obligate seeder). Obligate seeding Arctostaphylos species, like A. pallida, may require 5 to 25 years before substantial seed crops are produced (Keeley 1986). Seeds typically suffer high rates of predation (Kelly and Parker 1990); however, seed caching by seed predators may be an important mechanism by which seeds are buried to a sufficient depth at which they may survive high-intensity wildfires. Parker (2010) found that while overall seedling density declined with fire intensity, the proportion of seedlings emerging from rodent caches increased. Seeds that are not depredated on are slowly added to the soil seed bank, eventually reaching depths at which they can survive fire (Parker 2007). Obligate seeding Arctostaphylos species tend to have fire-dependent seedling recruitment; and mature stands tend to be even-aged, exhibiting little to no regeneration during fire-free intervals (Safford and Harrison 2004). Mechanical disturbance may be an alternative to fire under certain conditions. The regeneration of seedlings at stands where vegetation management activities disturbed the soil and increased light levels, in the absence of fire, indicates fire is not required for seed germination to occur. However, based on the large number of seedlings that occur at Huckleberry Preserve as the result of a pile burn, compared to other stands with seedlings where fire has not occurred, fire is likely a more effective means of stimulating germination. In addition to being an obligate seeder, A. pallida can reproduce vegetatively by layering. Layering occurs when branches become partially or fully buried in soil or litter and produce roots. Some extensive clones of A. pallida have developed in this manner within the Sobrante Ridge population (Amme and Havlik 1987).The understory of mature Arctostaphylos pallida stands and chaparral vegetation in general is typically free of vegetation, including regeneration. The cause of the lack of vegetation beneath chaparral species has been attributed to allelopathy (inhibitory biochemical interactions between plants), small mammal herbivory, and/or fire dependant seed banks. Keeley and Keeley (1989) concluded that in nature, a substantial proportion of the seed pool of some chaparral species is unlikely to germinate in the absence of fire and that dormancy mechanisms minimize seed germination during periods of low-survival probability. However, they also note that a portion of the seed pool is potentially capable of germinating in the absence of fire. A study comparing the regeneration and recolonization of obligate-seeding to sprouting Arctostaphylos after fire found that the seedlings of obligate seeders did not compete well against sprouters post-fire; thus, seedlings are adapted to openings in chaparral after fire (Keeley and Zelder 1978). Based on this observation, Keeley and Zelder (1978) hypothesized that longer fire-free periods favor obligate seeders by creating more and larger openings in chaparral post-fire, because: (1) longer fire-free periods result in higher fuel loads and more intense fires, thereby reducing the number of sprouters that survive fire; and (2) long fire-free periods allow for increased stem-exclusion, thereby reducing the density of potential sprouters after a fire. In support of this hypothesis, Odion and Davis (2000) found that chaparral with dense canopy cover prior to fire tended to be barren after fire, where heating was relatively high, except for the occasional obligate seeding Arctostaphylos and obligate seeding Ceanothus. The authors also noted that obligate seeders tended to have deeply buried seeds, allowing them to withstand prolonged soil heating. A study of the effects of prescribed fire on A. morroensis (Morro manzanita), a closely related species to A. pallida (Boykin et al. 2005) and a federally

endangered obligate-seeding species from Morro Bay, California, found that A. morroensis may require considerably longer than 40 years between fires to establish a deeply buried seed bank with enough viable seed to adequately compensate for mortality and prevent population decrease or local extinction (Odion and Tyler 2002). However, it is not clear how long it takes to produce a persistent soil seed bank in which seeds are buried deep enough to withstand fire (Parker 2007).

Habitat Type

Adult: maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees

Dependencies on Specific Environmental Elements

Adult: cool air temperatures that experience maritime fog

Geographic or Habitat Restraints or Barriers

Adult: likely restricted to the northwestern extremity of the Diablo Range (see Misc. Section)

Spatial Arrangements of the Population

Adult: clumped according to suitable resources

Environmental Specificity

Adult: Narrow; special habitat requirements

Tolerance Ranges/Thresholds

Adult: shade intolerant

Site Fidelity

Adult: very high

Habitat Narrative

Adult: The primary soil series Arctostaphylos pallida occurs on, including the large stands and satellite stands along Huckleberry Ridge and portions of Sobrante Ridge and Tilden Park, is Millsholm loam (NRCS 2013). The Millsholm soil series consists of shallow, well-drained soils that formed in material weathered from sandstone, mudstone, and shale. In addition to Millsholm loam, A. pallida occurs on other shallow well-drained soils series, rock formations, and soil complexes with parent materials that include shale, schist, greenstone, sandstone, silty clay loam, or conglomerate. The Huckleberry Preserve and the Sobrante Ridge stands grow on soil composed of Middle Miocene cherts and shales of the Monterey Group (Amme and Havlik 1987). These soils are thin, well drained at the surface, and deficient in many essential plant nutrients. However, the fractured and bedded rocks below hold water that is accessible to deep roots. Satellite stands along Skyline Boulevard occur on Pinehurst Shale and the Joaquin Miller Formation; both substrates are mixtures of shale, sandstone, and minor conglomerate. The stand along Exeter Drive occurs on soft sandstone. Arctostaphylos pallida appears to only grow on these soils in areas that experience maritime summer fog, and have not been found on the same substrates where summer air and soil temperatures are higher (Johnson 1983). Arctostaphylos pallida is a component of the maritime chaparral vegetation type and appears to be co-dominant with other woody shrubs and shrub-form trees, including A. crustacea subsp. crustacea (brittle leaf manzanita), Vaccinium ovatum (California huckleberry), Chrysolepis

chrysophylla var. minor (golden chinquapin), and several shrub-form Quercus species. Maritime chaparral represents a plant community of special concern because of the high density of narrowly distributed endemic species, its patchy distribution, and its association with forest edges or odd soils (Parker 2007). Arctostaphylos pallida is shade intolerant and will slowly die when shaded by larger trees and shrubs. However, based on the results of vegetation management activities conducted in the mid-1980s at Huckleberry Preserve, Chabot, and Big Trees Trail and in the mid-2000s at Redwood Regional Park and Big Trees Trail, A. pallida responds positively to activities that reduce light competition and disturb the soil. Four vegetation types exist on Sobrante Ridge: maritime chaparral, oak woodland, coastal scrub, and grassland (Amme and Havlik 1987). The area outside of the shale soil formation is dominated by open park-like coast live oak woodland, interspersed with grassland and coastal scrub; while the area within the shale soil formation is dominated by maritime chaparral, including A. pallida and A. crustacea subsp. crustacea. Within the approximately 3.6-hectare (9-acre) shale soil formation, primarily along the edges, are A. custacea subsp. crustacea; within the center of the formation is the largest concentration of A. pallida, occurring on both east- and southwest-facing slopes. There are two vegetation types within the Huckleberry Preserve stand: maritime chaparral and oak/California bay laurel (Quercus species/Umbellularia californica) woodland. As is the case at Sobrante Ridge, the most barren soils at Huckleberry Preserve are occupied by the largest concentrations of Arctostaphylos pallida. Unlike the large stand at Huckleberry Preserve and the Sobrante Ridge, the soils of the satellite stands of the Huckleberry Ridge population are more developed and less nutrient deficient, capable of supporting redwood and coast live oak vegetation types. As such, the A. pallida at these sites occur mainly on roadcuts and within forest gaps.

Dispersal/Migration

Motility/Mobility

Adult: not mobile

Dispersal

Adult: only the seeds can disperse

Dispersal/Migration Narrative

Adult: There is not a lot of available dispersal information on this species.

Population Information and Trends

Population Trends:

some declining and some with unknown status

Species Trends:

unknown

Population Growth Rate:

unknown

Number of Populations:

3 (2 Naturally occurring. 1 Naturalized) (USFWS, 2023)

Population Size:

The most recent counts have estimated the population to be 2,444 mature plants and 133 seedlings (USFWS, 2023).

Minimum Viable Population Size:

unknown

Resistance to Disease:

low

Adaptability:

low

Population Narrative:

Distribution: At the time of listing, the pallid manzanita was known to be distributed between two naturally occurring populations and a single naturalized population. The distribution of the three populations have not significantly changed. The Huckleberry Ridge population is the largest known population and exists as a large colony with several satellite colonies. The population at Huckleberry Ridge occurs within East Bay Regional Park District's (EBRPD) Huckleberry Botanic Regional Preserve (Huckleberry Preserve), East Bay Municipal Utility District (EBMUD) managed areas, City of Oakland owned land, Pacific Gas and Electric power line easements, and on private property. Since listing, two colonies have been extirpated (Table 1). The second population occurs at Sobrante Ridge, within EBRPD's Sobrante Ridge Ecological Preserve. The third population was planted in the 1930s–1940s and occurs near the Tilden Park Botanical Garden (Tilden Park) in Contra Costa County (USFWS, 2023). Abundance: At the time of listing, the total population size was determined to be around 4,385 plants (Service 2011, p. 3). During the 2011 status review, the total population size was determined to be around 1,350 mature plants and 295 seedlings (Service 2011, p. 3). The most recent counts have estimated the population to be 2,444 mature plants and 133 seedlings. Table 1 below details most recent survey years for the different colonies within the three populations, and their most recent counts. Some of the increases may be explained by habitat management; at Chabot in Joaquin Miller Park, 125 seedlings germinated following extensive tree removal – with scarification from raking suspected to have assisted seed germination (Ella Matsuda, Friends of Sausal Creek, pers. comm. 2023). Similarly, on EBMUD managed lands, the number of pallid manzanitas more than tripled after the removal of over-shading trees (East Bay Municipal Utility District 2020, p. 12). Other increases can be linked to the discovery of new individuals and potential differences in counting of individuals from previous survey years; at the Huckleberry Preserve, surveys were completed in previously unmonitored areas where new mature plants were discovered (Californian Environmental Services 2018, p. 196). Lastly, a small colony of 10 outplanted individuals was propagated from cuttings taken by Friends of Sausal Creek between 2018 – 2023 (Ella Matsuda, Friends of Sausal Creek, pers. comm. 2023); limited information is available on the outplanted colony (USFWS, 2023).

Threats and Stressors

Stressor: Disease
Exposure:

Response:
Consequence:
Narrative: Recently, Phytophthora cinnamomi has been confirmed infecting and killing A. pallida plants at Huckleberry Preserve and the Big Trees Trail stands. In contrast to the unidentified fungal pathogen, A. pallida infected with P cinnamomi die within several months of signs of infection and do not experience branch or stem dieback while maintaining healthy branches and meristems. To our knowledge, the extent of the infestation within stands of A. pallida has not been quantified and the potential for widespread population decline is still unknown. The pathogenic activity of Phytophthora cinnamomi is favored by free moisture, and under wet conditions multiple infection cycles are likely to occur. Phytophthora cinnamomi is primarily spread to new areas through the movement of infested soil by humans, particularly on vehicle tires, but also on shoes, tools and equipment that become contaminated with infested soil (Swiecki and Bernhardt 2003). In addition, P. cinnamomi has been isolated from container stock purchased from several native plant nurseries, suggesting nursery stock used for restoration projects or planted within the Wildland Urban-Interface (WUI) can provide a vector for this disease (Swiecki et al. 2011). In addition, a high percentage of woody plant materials from commercial nurseries are infested with various root-rotting Phytophthora species, including P. cinnamomi. This not only increases the likelihood that remnant plants in landscapes will be killed by this pathogen, but further increases the risk to stands in the vicinity of landscaped parcels, especially where landscaped parcels are located upslope of A. pallida stands (e.g., Manzanita Drive area) (T. Swiecki pers. comm. 2012).Human transport of contaminated soil is the primary vector for introducing Phytophthora cinnamomi into new areas. Most Arctostaphylos pallida stands occur along ridge tops, adjacent to unpaved maintenance roads and trails, increasing the likelihood contaminated soils will be spread throughout the East Bay Hills on shoes, bicycles, and vehicles. Once Phytophthora cinnamomi has been introduced into an area, its movement is facilitated by water flow, especially downhill. Swiecki et al. (2005) noted that the local spread of P. cinnamomi in A. myrtifolia occurs during the wet season at a cross-slope and upslope rate of approximately 0.25 meter (0.8 foot) per year. Down slope spread has been calculated at 2 meters (6.5 feet) per year, presumably due to transport via flowing water (Swiecki et al. 2005). Over a longer time interval, Swiecki and Bernhardt (2012) have documented that P. cinnamomi has spread at average rates about 1 meter (3.3 feet) per year in relatively level sites within A. myrtifolia stands.Introduction of Phytophthora cinnamomi into Arctostaphylos pallida habitat represents a long-term and substantial threat. Phytophthora cinnamomi can persist in the environment in the absence of susceptible hosts, surviving in the soil in infected roots, or as long-lived resident spores (Swiecki and Bernhardt 2003). There is no known cure for plants that have been infected. Prevention of this disease depends on the exclusion of the pathogen from areas that contain host plants.

Stressor: Fire frequency
Exposure:
Response:
Consequence:
Narrative: A lack of frequent small fires to stimulate regeneration and reduce fuel loads within stands of chaparral represented one of the greatest threats to the species. There has been considerable debate about the effects of decades of fire suppression on chaparral ecosystems (Moritz 2003). One side of the debate argues that fire suppression has increased fuel loads which lead to fewer, but larger wildlfires. This theory is supported by studies contrasting shrubland fire regimes north and south of the U.S.-Mexican border (Minnich 1983, 1995, 2001), suggesting that

the pattern of frequent small fires south of the boarder is a model of what fire regimes were like north of the boarder prior to fire suppression policy. Based on this assumption, proponents of this theory suggested that California-shrubland WUI management should de-emphasize fire suppression and reestablish an age mosaic of shrublands to return the landscape to a condition in which fire size is constrained by discontinuities in fuels due to smaller, more frequent fires.In contrast, others contend that relatively large stand-replacing crown fires are a natural part of these ecosystems and that urban expansion into these ecosystems has increased the rate of fire incidence through human ignition sources, resulting in more destructive (that is, expensive due loss the of human structures) fires. This is supported by research that has shown that frequency and area burned have not declined as a result of fire suppression (Keeley 1999), extremely large, stand replacing crown fires in California shrubland ecosystems predate fire suppression policy (Keeley and Fotheringham 2001, Keeley and Zedler 2009); over the last 130 years there has been no significant change in the incidence of large fires greater than 10,000 hectares (24,710 acres); fire suppression has not reduced the area burned (Conrad and Weise 1998, Keeley et al. 1999); large extensive fires are not dependent on stand age (Keeley et al. 1999, Moritz 2003); and when wildfires occur under severe fire conditions they burn through all but the youngest age-class of chaparral and coastal scrub (Keeley et al. 1999, Keeley 2002). Keeley and Fotheringham (2001) question the use of current fire regimes south of the border as a model of what fire regimes were like north of the border prior to fire suppression for the following reasons: (1) fire frequency from human ignition sources is five times greater south of the boarder; (2) most fires in northern Baja California, Mexico are driven by on-shore northwestern breezes, which have a different capacity for fire spread than fires driven by foëhn winds; (3) areas south of the border tend to receive less precipitation and soils tend to be less fertile, both of which affect fuel production; (4) much of the chaparral-dominated landscape south of the boarder is a plateau, lacking topographic heterogeneity, which affects the rate of fire spread and increases solar evaporation and reduced fuel production; and (5) few, if any, contiguous chaparral stands south of the boarder reach the sizes of those north of boarder. In a study of relative frequency of human-caused and lightning-caused fires in the coast range east of San Francisco Bay, Keeley (2005) found that most years were without any lightning-ignited fires: in Contra Costa County 86 percent of the years had no lightning-ignited fires and in Alameda County the figure was 74 percent. Wildfire in Alameda and Contra Costa counties is most often human caused; thus, the fire return interval is likely no longer within the evolutionary bounds of the species. Odion and Tyler's (2002) study of Arctostaphylos morroensis indicates that a fire return interval of 40 years or less would likely result in the extirpation of the species, and other studies on obligate seeding Arctostaphylos similarly found that long fire-free intervals (with an interval greater than one fire every 100 years) likely do not represent a significant threat (Keeley and Zelder 1978, Odion and Davis 2000). Consequently, a relatively short fire-return interval, one that depletes the soil seed bank before it can be replenished, is likely a greater threat to A. pallida than a relatively long fire-return interval.Still, because fire is essential to the natural regeneration of Arctostaphylos pallida and regeneration can be difficult in the absence of fire, fire suppression remains a threat. The Huckleberry Preserve site has likely not experienced a stand-replacing fire for more than 80 years and would benefit from fire or other management activities that stimulated regeneration and reduced competition with native and non-native species. The Sobrante Ridge site likely experienced a stand-replacing fire 30 to 40 years ago (Service 1998) and appears to be healthy and vigorous. EBRPD does not typically conduct broadcast burning in the WUI due to the threat of fire escape and liability; however, EBRPD is proposing to burn slash piles at Huckleberry Preserve as part of their Wildfire Hazard Reduction and Resource Management Plan (LSA Associates, Inc. 2009) (WHRRMP). The limited opportunities to use fire to stimulate regeneration

of A. pallida represents a threat to the species, because the effectiveness of mechanical soil disturbance to stimulate regeneration has not been proven to provide adequate regeneration.

Stressor: Goat grazing
Exposure:
Response:
Consequence:
Narrative: Both EBRPD and the City of Oakland have used domestic goat (Capra aegagrus) grazing as a tool to reduce fuel loads and wildfire hazard within the WUI of the East Bay Hills. Due to the relatively indiscriminant food selection preferences of the domestic goat, this practice poses a serious, yet easily avoidable, threat to Arctostaphylos pallida. According to Kanz (2004) goat grazing by the City of Oakland is responsible for the extirpation of the Manzanita Flat stand and has caused damage to A. pallida plants at the Big Trees Trail site. The WHRRMP specifically excludes the use of goat grazing near stands of A. pallida. Goat grazing is a minor threat in areas other than City of Oakland properties, but is a significant threat to A. pallida occurring on City of Oakland properties.

Stressor: Succession and invasive species
Exposure:
Response:
Consequence:
Narrative: Succession of maritime chaparral to oak/California bay laurel (Quercus species/Umbellularia californica) woodland and shading by non-native invasive species such as Eucalyptus species and Pinus radiata were cited as significant threats to Arctostaphylos pallida at the time of listing and continue to represent one of the most significant threats to the species. Mosaics of grassland, oak woodland, coastal scrub, and chaparral, in some locations, have been reported to correlate with geological substrate (Cole 1980, Davis et al. 1988) and soil characteristics (Harrison et al. 1971). However, Callaway and Davis (1993) found each of these vegetation types represented abundantly on most soil depths, slope aspects, and all geological substrates. Cyclical changes between chaparral, oak woodland, grassland, and coastal scrub do occur. However, the interactions between variables responsible for vegetation type conversion and the rate of conversion are complex and site-specific. Callaway and Davis (1993) found that transition rates varied with substrate and topographic position, indicating fire, grazing, and the physical environment interacted to determine direction and rate of conversion. Variation in transition on different substrates suggests that only portions of the vegetation on the landscape may be dynamic, with some patches in certain combinations of environment and disturbance that change rapidly, and other patches that remain static as edaphic or topographic climax communities. As a broad generalization, in the absence of disturbance and on sites with environmental factors that allow for transition from one vegetation type to another, grasslands tend to transition to coastal scrub, coastal scrub to chaparral or oak woodland, chaparral to oak woodland, and oak woodland to grassland (Callaway and Davis 1993). Arctostaphylos pallida is highly shade intolerant and the invasion of tree-form plant species creates shade that causes A. pallida shrubs to slowly die over several years if management action is not taken. All of the stands of A. pallida, to some degree, show signs of succession to oak/ California bay laurel woodland and/or are being shaded by non-native trees. The Huckleberry Preserve stands and all of the satellite stands of the Huckleberry Ridge population are in severe decline due to shading via native species and non-native invasive species. For example, the Chabot stand will likely be extirpated within a decade if action is not taken that addresses this issue. Shading lowers seed

production, reduces vegetative growth, causes branch dieback and ultimately results in plant death. However, A. pallida stands that experience 100 percent mortality will likely have a viable, although declining, seed bank for many decades.

Stressor: Nitrogen Deposition
Exposure:
Response:
Consequence:
Narrative: Atmospheric nitrogen deposition is a complex process by which reactive chemical species of nitrogen (N), nitrogen oxides (NOX), ammonia (NH3), and their reaction products are deposited onto surfaces and enter ecosystems as N-fertilizer. As a consequence of anthropogenic inputs, the global nitrogen cycle has been significantly altered over the past century (Weiss 2006). The added N has been shown to allow nutrient-deficient soils, such as serpentine, to be invaded by both native and non-native species that require added nutrients to survive (Weiss 2006). Although it has been posited that the succession of maritime chaparral to oak/bay (Quercus species/Umbellularia californica) woodland in the East San Francisco Bay is due to fire exclusion or is a natural process, it is also possible N-deposition has created conditions that have allowed vegetation-type conversion, from maritime chaparral to oak-bay woodland, to occur on the nutrient deficient soils that are typical of Arctostaphylos pallida.

Stressor: Hybridization
Exposure:
Response:
Consequence:
Narrative: Hybridization between Arctostaphylos pallida and other Arctostaphylos species was cited as a threat at the time of listing and continues to threaten the species today. Hybridization is known to occur naturally between A. pallida and A. crustacean. However, several species of Arctostaphylos not known to co-occur with A. pallida have been used for landscaping on private lands within the urban development adjacent to Huckleberry Preserve and threaten nearby A. pallida individuals through pollen swamping and hybridization leading to genetic assimilation. While most Arctostaphylos are diploid, about 30 percent are tetraploid. Differences in ploidy level are not a complete barrier to hybridization, and several diploid-tetraploid crosses have been observed in the field (e.g., A. crustacea X A. pallida) (Wahlert et al. 2006). From examination of populations of co-occurring diploid Arctostaphylos species in the field, in which the co-occurring Arctostaphylos species are from different genetic clades as defined in Boykin et al. (2005), there is very little or no hybridization (V.T. Parker and M.C. Vasey, unpublished data). However, A. glauca, A. pajaroensis and A. pallida are from the same genetic clade (Boykin et al. 2005) and are all diploid (Parker et al. 2012). Furthermore, hybrids have been observed between A. pallida and A. glauca (bigberry manzanita) and hybridization may be occurring in areas where residents have planted A. pajaroensis (Pajaro manzanita). This calls into question the genetic integrity of the seed bank within the City of Oakland residential development along Huckleberry Ridge and, to some extent, within the adjacent Huckleberry Preserve stands. If the seed bank in this area, including that of the Huckleberry Preserve stands, has been genetically compromised though hybridization with non-native Arctostaphylos species, regeneration in the area could result in a hybrid swarm and a blurring of the genetic integrity of all future stands of A. pallida in the area. At this time, the extent to which hybridization has occurred and the extent to which hybridization threatens A. pallida is not known.

Stressor: Landscaping
Exposure:
Response:
Consequence:
Narrative: Arctostaphylos pallida plants that occur within the yards of private residences (less than 57 plants) in City of Oakland residential neighborhoods are highly susceptible to mortality from landscaping activities. The majority of these plants will likely be lost in the foreseeable future due to these activities and a lack of regeneration. In addition, the genetic integrity of the soil seed bank is questionable due to hybridization with non-native Arctostaphylos species (see Factor D, Hybridization above). Due to the susceptibility of these plants to mortality from landscaping and home improvement projects, and ongoing hybridization with non-native Arctostaphylos species, these plants and the associated seed bank will not contribute to meeting any of the recovery criteria for this species.

Stressor: Herbicide Use
Exposure:
Response:
Consequence:
Narrative: At the time of listing, herbicide use for the purpose of controlling roadside vegetation in the residential development adjacent Huckleberry Preserve was cited as a threat to Arctostaphylos pallida. Kanz (2004) indicated that A. pallida plants below the Pacific Gas and Electric Company power lines, between Manzanita Drive and Skyline Boulevard, exhibited evidence of herbicide use. Herbicide use continues to be a minor threat to A. pallida, particularly within the urban development and associated A. pallida stands adjacent to Huckleberry Preserve.

Stressor: Small Population Size and Stochasticity
Exposure:
Response:
Consequence:
Narrative: Because Arctostaphylos pallida exists as three populations with only two large stands and several small satellite stands, inbreeding depression and stochastic events represent significant threats to the species. Inbreeding depression can result in reduced fitness, which, coupled with small population size may result in a higher susceptibility to stochastic events, such as excessive rain, drought, and landslides, that further increase the likelihood of loss of genetic variability. Stochastic events, such as prolonged rainy periods, can also increase susceptibility to other threats, such as fungal pathogens and Phytophthora cinnamomi.

Stressor: Climate Change
Exposure:
Response:
Consequence:
Narrative: Effects to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and to what degree climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. The most recent literature

on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007).A modeling study by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, large numbers of plant species will tend to move to higher elevations, towards the coast, or northwards. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, Arctostaphylos pallida plants would likely be unable to shift their range naturally because of their dependence on specific soil types and a maritime climate and due to the presumably low dispersal potential of the species. Climate change may also affect summer fog frequency and have a substantial impact on Arctostaphylos pallida, which is dependent on a fog-influenced maritime climate. According to M. Vasey (personal communication 2010), coastal endemic Arctostaphylos species are more vulnerable to summer drought stress than interior species, and if the frequency of coastal fog declines, the hydrologic regime of coastal Arctostaphylos species will likely become more challenging as they are not well-adapted to water stress. In addition, summer fog increases plant, soil, and atmospheric moisture, which decreases fire hazard and decreases the threat of too-frequent fire. Based on observational (Bakun 1990, Lebassi et al. 2009) and modeling studies (Diffenbaugh et al. 2004, Snyder et al. 2003) climate change may intensify upwelling, an important process in fog production off the coast of California, suggesting increases in fog in response to increased carbon emissions. However, Johnstone and Dawson (2010) found empirical evidence for moderate fog reductions since 1951, with interannual and multidecadal variations governed largely by ocean-atmosphere circulation and temperature anomalies.

Recovery

Reclassification Criteria:
Not applicable

Recovery Priority Number: 5

Delisting Criteria:
To delist Arctostaphylos pallida, threats to the species habitat must be reduced. This will be accomplished when the following has occurred: The 6,700 mature Arctostaphylos pallida plants counted toward recovery in delisting criterion E/2 are protected from incompatible uses through long-term conservation agreements with landowners. To delist A. pallida, the threat of disease must be controlled or eliminated. This will be accomplished when the following have occurred: Tools or treatments have been developed and are effectively being utilized that have stopped the spread of Phytophthora cinnamomi and any individual mortality. Treatments have been developed that allow Arctostaphylos pallida plants infected with Phytophthora cinnamomi to produce viable seed during or after treatment in quantities similar to uninfected healthy A. pallida plants. A Phytophthora cinnamomi monitoring plan has been developed and implemented for all Arctostaphylos pallida stands and areas within watersheds of stands, to determine if stands are infected, the extent of infection, and to identify potential sources of future infection. Other natural or manmade factors believed to affect the continued existence of Arctostaphylos pallida include: fire frequency, wildfire fuel reduction treatments, succession and non-native invasive species, and small population size and stochasticity. To delist A. pallida, these threats must be reduced. This will have been accomplished when the following have

occurred: There are at least three separate populations of mature Arctostaphylos pallida plants: at least one population south of California State Route 24 (SR24) and at least two populations north of SR24, each with at least 1,700 genetically pure mature A. pallida plants.1 For the purpose of recovery, a population is considered to be separate as long as it is more than 3.0 kilometers (1.9 miles) from the nearest A. pallida stand, and a mature plant is defined as being 25 years of age or greater. There are at least 6,700 genetically pure mature Arctostaphylos pallida plants. Competing native and non-native vegetation is controlled to a level whereby Arctostaphylos pallida vigor is not negatively affected and landowners have committed to provide long-term vegetation control that will conserve resident A. pallida. Stand regeneration methods (mechanical or fire) result in an increasing trend in the number of mature Arctostaphylos pallida over a 25-year period. Seed, representative of the breadth of the species' genetic diversity, is stored at a seed storage facility.

Recovery Actions:

- In 2009, as part of a Low Effect Habitat Conservation Plan for EBMUD lands in the San Francisco East Bay, a large Pinus radiata that shaded the Pinehurst Road stand was removed. Prior to the removal of this tree, the stand had declined from 25 to 11 mature Arctostaphylos pallida plants. Apparently, the increased light not only invigorated the plants that had been shaded, but the mild disturbance to the site, caused by horse logging activities, stimulated a portion of the soil seed bank and over 52 A. pallida seedlings germinated. EBMUD continues to survey the Pinehurst Road stand on an annual basis.
- In the summers of 2004 and 2005, approximately 500 square feet (152 square meters) were cleared by EBRPD at Huckleberry Preserve, leaving only Arctostaphylos pallida plants. Cut material and dead wood were placed into piles. In late February and early March of 2007, the piles were burned. In 2008, 176 seedlings had sprouted within the burned area.
- The Big Trees Trail stand is likely to have sustained greater mortality if not for vegetation management activities conducted by a local volunteer watershed restoration organization, the Friends of Sausal Creek (FOSC). The FOSC conducts surveys of the site and occasionally removes both native and non-native plants that shade Arctostaphylos pallida plants. The management of the Big Trees Trail stand was included in the Chabot management plan to allow for a memorandum of understanding between FOSC and CDFG to permit FOSC to conduct restoration activities at both sites. A small number of A. pallida seeds have again germinated at the Big Trees Trail site in the absence of fire. Seed germination is likely due to soil disturbance caused by vegetation removal activities that scarified the seed coats.
- A 1995 Environmental Impact Report (EIR) prepared for the construction of the Science Center in Oakland California required that an A. pallida management plan be created and implemented. The plan was finalized in September 2009, and proposes to restore habitat and maintain a minimum of 21 plants at the site (Nomad Ecology 2009). According to the management plan, restoration activities were to begin in October 2009; however, the A. pallid at the Science Center have continued to decline and management activities did not begin until 2013.
- Recovery Strategy: Because Arctostaphylos pallida is an obligate-seeding species naturally occurring as even-aged stands with a long-lived soil seed bank, the primary management goal, at the stand level, should be to maximize seed production and to ensure the soil seed bank is adequate to replace all mature plants within a stand in the event of fire. At this time, the most significant long-term threats to seed production and stand regeneration, and in effect, the continued existence of the species, are: 1) the fungal pathogen Phytophthora cinnamomi which directly kills A. pallida plants and results in perpetual soil contamination;

2) competition, via succession, with native and non-native vegetation for light and space; 3) an altered fire regime that may prematurely deplete soil seed banks; 4) fire fuels management; and 5) small population and stand sizes that increase the likelihood stochastic events will extirpate a stand or population. In addition to ensuring habitat loss does not occur as a result of development, these threats can be minimized or ameliorated through the implementation of management plans that include and prioritize the control of P. cinnamomi at the stand level, P. cinnamomi spread abatement at the landscape level, management of competing native and non-native vegetation, perpetual stand regeneration, maintenance of genetic diversity, stand expansion, establishment of additional stands, and compatible fuel reduction treatments and methods.

- Phosphite (neutralized phosphorous acid), is a biodegradable systemic fungicide that, in part, potentiates plant defense mechanisms so that there is a more rapid and robust response to the pathogen. Phosphite stresses Phytophthora cinnamomi, causing it to release chemical signals that trigger the natural defense mechanisms of the host plant, thereby reducing the ability of P. cinnamomi to colonize and reproduce within the host (Suddaby and Liew 2008). Phosphite can be applied as a low volume aerial spray, high volume foliar spray, or by trunk injection of individual plants. The dosage of phosphite required to protect individual plant species is not universal. Applications that are too high for a particular plant species will have side-effects, such as leaf burning and a reduction in pollen viability, however, these effects may be temporary (Suddaby and Liew 2008). The efficacy of phosphite is not permanent and reapplication is required. The appropriate treatment regime (including an understanding of season, dose, application type, frequency, etc.) for Arctostaphylos pallida is not known at this time, but treatment frequency could be as often as once every 2 years. Low volume aerial application rates in Western Australia have ranged from 12 to 24 kilograms per hectare (11 to 21 pounds per acre) with disease control anticipated for approximately 2 years post-spray (Barrett et al. 2001). A study is currently underway to assess the efficacy of phosphite for limiting the spread of root disease caused by P. cinnamomi in native A. myrtifolia stands (Swiecki and Bernhardt, 2012).
- EBRPD's Wildfire Hazard Reduction and Resource Management Plan: According to EBRPD's Wildfire Hazard Reduction and Resource Management Plan (WHRRMP) the maritime chaparral vegetation type represents an extreme wildfire hazard. To reduce the hazard, the WHRRMP aims to focus mechanical fuel treatment efforts on key locations, including almost all stands of Arctostaphylos pallida. To minimize the effects of the WHRRMP, the Service is working with the Federal Emergency Management Agency and EBRPD to complete a long-term A. pallida management plan. Although the WHRRMP threatens A. pallida, the WHRRMP includes the removal of both native and non-native vegetation that grows within and adjacent to stands of A. pallida to reduce wildfire hazard. Shading by native and non-native species poses a significant threat to the existence of A. pallida (see Factor E section on Succession and Non-native Invasive Species); thus, the WHRRMP, if implemented in conjunction with an A. pallida management plan, may benefit the species.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct frequent surveys for Phytophthora cinnamomi infection to understand risk of infection and rate of mortality once infected. 2. Develop tools and treatments to control the spread and impact of Phytophthora cinnamomi. 3. Continue to use mechanical methods to clear over-shading trees, especially at the Big Trees Trail in Joaquin Miller Park colony and the Sobrante Ridge population. 4. Collect and store seeds from Tilden Park and Huckleberry Ridge populations, including accessions from each colony in the Huckleberry

population. 5. At the Tilden Park, outplant seedling pallid manzanitas and scarify the ground to increase germination of latent seeds. 6. Partners and stakeholders should continue to promote Phytophthora cinnamomi education to the public to promote reduction of disease spread within and among the colonies (USFWS, 2023).

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draft Recovery Plan

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draft recovery plan

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SPECIES ACCOUNT: *Arenaria paludicola* (Marsh Sandwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/3/1993; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A herbaceous green perennial often supported by surrounding vegetation, with angled or grooved stems, which are glabrous (without hair) except at the nodes (points of leaf attachment) (Figure 1, Figure 3). The trailing stems often root at the nodes, and can be up to 1 meter (3 feet) long. The opposite leaves of the plant are lanceolate (lance-shaped) and narrowly acute (sharp-pointed), with a solitary mid-vein. The species blooms from May to August. At Oso Flaco Lake, it was flowering with some green fruit in early June (John Chesnut, in litt. 1998). Flowers are small, white, and borne singly on long stalks arising from the leaf axils (point of leaf attachment to the stem); capsules (fruits) contain 15 to 20 seeds. The solitary axillary flower and smooth, angled stem distinguish this species from others in the genus. Hitchcock (1964) speculated that this plant was "very seldom collected, possibly because it is mistaken for sterile plants of Galium aparine," a common species. As reported by Bonilla (1992, in litt. 1998) from Zempoala Lakes in the state of Morelos in central Mexico, this species is an annual, flowering April to September and producing seeds from June to October. (USFWS, 1998)

Taxonomy

Marsh sandwort (Arenariapaludicola) is a dicotyledonous plant belonging to the pink family (Caryophyllaceae). Pertinent synonyms for the scientific name are Minuartia paludicola House; Alsinopsispaludicola A. Heller; Arenariapalustris S. Watson not of Gay 1845; and Alsine palustre Kellogg. The species first was described as Alsine palustre by Albert Kellogg in 1863, from specimens collected by Bolander near Fort Point (now within Golden Gate National Recreation Area), San Francisco, California. The plant was then "very abundant in swamps" in the area (Kellogg 1863). In 1876, Sereno Watson reassigned the species to the genus Arenaria. The resulting name, Arenaria palustris, inadvertently duplicated the name that Gay had published earlier, in 1845, for another species. This duplication of names was corrected by B.L. Robinson (1894), who substituted the currently used scientific name, Arenaria paludicola. (USFWS,1998)

Historical Range

Historically collected by botanists from scattered locations near the Pacific coast in southern and central California and Washington. California locations were recorded in 1899 in San Francisco and San Bernardino counties, in 1947 in Santa Cruz and San Luis Obispo counties, and in 1950 and 1964 in San Luis Obispo County. The southern range limit is given as Los Angeles County by Hitchcock (1964), and as the Santa Ana River (Orange County) by Hartman (1993). In a sequence of regional floras starting with Abrams and Ferris (1944), and continuing through Mason (1957), Munz and Keck (1968), Hoover (1970), Munz (1974), Smith (1976), and Hartman (1993), the earlier floras report the species as widespread within its historical range. Later floras report it as more localized and restricted, becoming "occasional," "scarce" in swamps and marshes, and most recently, "rare." (USFWS, 1998)

Current Range

In California, in San Luis Obispo County. One extant wild population at Oso Flaco Lake; one introduced population at Sweet Springs Marsh on the southern edge of Morro Bay. (USFWS,

2008)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 2008)

Breeding Season

Adult: May - August (USFWS, 2008)

Reproduction Narrative

Adult: It generally blooms from May to August. This plant can also reproduce asexually. It can produce adventitious roots on the trailing stems that come in contact with suitable conditions (USFWS, 2008).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Freshwater marshes (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 450 m elevation (NatureServe, 2015); possibly shade (USFWS, 1998)

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 1998)

Habitat Narrative

Adult: Inhabits freshwater marshes from close to sea level to 450 m elevation. Plants have been found in areas with shallow standing water and with no standing water. Substrates are saturated, acidic, organic bog soils. Sensitive to disturbance; specialized habitat and wetlands are vanishing (NatureServe, 2015). Shady or filtered light conditions may inhibit the growth of Arenaria paludicola (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining (most populations extirpated) (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

2 (USFWS, 2020)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Marsh sandwort was once a wide ranging species with a historic range that extended along the west coast from Washington State to Mexico (Service 2008, p. 5-6). The species distribution is now reduced to three isolated occurrences, with two populations at GGNRA in Marin County and two populations in San Luis Obispo County; at the Sweet Springs Nature Preserve on Morro Bay and Oso Flaco Lake on ODSVRA (Figure 1). Threats identified at the time of listing, in the 1998 Recovery Plan, and in the 2008 5-year review remain largely unchanged (Service 1993, 58 FR 41378; Service 1998, p. 8 and 18-21; Service 2008, p. 10-13). Climate change effects, especially those resulting in hydrological changes to marsh and other wetland habitats, are a new primary threat to the species. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2008).
Exposure:
Response:
Consequence:
Narrative: There continues to be both a loss and degradation of habitat due to development/urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development/urbanization. Some of this habitat loss occurs in watersheds that are classified as impaired by the Regional Water Quality Control Board for excessive amounts of nitrogen and other nutrients (California State Water Resources Control Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (a state in which the total nitrogen is >1.5 milligrams/liter and/or the total phosphorus is >0.075 milligrams/liter within an aquatic system) (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998) (USFWS, 2008).

Stressor: Herbivory (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Herbivory has been documented in some locations. While this plant may be able to withstand some herbivory, herbivory may cause a reduction in its reproductive success due to the loss of flowers and the correlated reduction in the production of seeds. The extent of this threat is not known, but the herbivory of even a few flowers may have a significant effect on the long-term survival of Arenaria paludicola because there are so few individuals and only one known population remaining in the wild (USFWS, 2008).

Stressor: Small population size (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). An increase in urban development has reduced the range of this species considerably. Increasing development in the area will likely increase threats from stochastic events. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. The effects of competition with nonnative species is most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of A. paludicola independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of A. paludicola (USFWS, 2008).

Recovery

Reclassification Criteria:
1. When new plants are established so that there are at least 5 populations of at least 500 individuals each (USFWS, 1998)

2. When some of the populations occur in permanently protected habitats within the Black Lake Canyon and the dune lakes area (USFWS, 1998)

3. When some of the populations are in other areas of suitable habitat with the species' historical range in the United States (USFWS, 1998)

4. When the populations remain viable for at least 5 years. Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation(USFWS, 1998)

Delisting Criteria:
1. If threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management 5 necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) controlling competition with nonnative species, and b) managing water conditions, particularly flow and salinity, that the species depends on. (USFWS, 2019)

2. If protected populations are established across the species ecological settings (in addition to Black Lake Canyon and the Dune Lakes area), including San Mateo Creek in San Onofre State Park in Orange County or comparable site(s) in that region; the San Antonio Creek drainage on Vandenberg Air Force Base in Santa Barbara County or comparable site(s) in that region; and wetlands in Golden Gate National Recreation Area in San Francisco County or comparable site(s) in that region. (USFWS, 2019)

3) the populations remain viable for at least 10 years. Because this species has narrow microhabitat conditions that it will tolerate, particularly with respect to soil moisture and salinity, and in light of fluctuations that can occur with climatic conditions, local groundwater table levels, and saltwater intrusion events, the persistence of populations with these varying conditions over time needs to be confirmed. (USFWS, 2019)

Recovery Actions:

- 1. Protect, maintain, and enhance species habitats. The most important immediate objective in the recovery plan for and Marsh sandwort is the protection of its habitat. - Coordinate among agencies involved in recovery activities. - Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon. - . Establish protection agreements. - Acquire key land parcels and conservation easements. Enhance existing habitat at Black Lake Canyon. - Continue to protect, maintain, and enhance habitat in the Dune Lakes area. - . Communicate species and habitat protection information to all concerned parties. (USFWS, 1998)
- 2. Document and monitor population and habitat characteristics. - Conduct plant surveys. - Protect newly discovered populations. - Monitor all populations and habitats. (USFWS, 1998)
- 3. Conduct research on the ecology and biology of the species. - Identify potential impacts of conducting research. - Determine population characteristics and life history of the species. - valuate species' tolerances. - Investigate the effects of genetic diversity. (USFWS, 1998)
- 4. Augment existing populations. In addition to protecting existing and newly discovered habitats of Marsh sandwort , monitoring these populations and their habitats, and conducting research on the biology and ecology of the species, attempts should be made to augment existing populations. (USFWS, 1998)
- 5. Establish new populations. Because Marsh sandwort currently has very restricted distribution in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a catastrophic event could result in the extinction of the species with its current restricted distribution. (USFWS, 1998)
- 6. Evaluate Progress and Update Management and Recovery Guidelines. Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed. (USFWS, 1998)
- Work with the California Department of Parks and Recreation and other stakeholders to implement site-specific management activities in the immediate future to alleviate threats and prevent the loss of the last, known remaining wild population (at Oso Flaco Lake) (USFWS, 2008).
- Work with others to establish several new populations in the near future to reduce the risk of extinction to Arenaria paludicola and maintain ex situ stock at two or more institutions (USFWS, 2008).
- Assemble a scientific recovery implementation team to assist us in determining a scientifically sound plan to reintroduce and introduce Arenaria paludicola to sites within its historical range in California (USFWS, 2008).

- Work with the Regional Water Quality Control Board to determine nutrient levels in the watersheds which have supported Arenaria paludicola in the recent past (particularly Black Lake Canyon and Oso Flaco), and work with local landowners and stakeholders to alleviate (and remove) any threats to A. paludicola that are associated with water quality (USFWS, 2008).
- Conduct a genetic analysis to determine the extent of variation within and between Arenaria paludicola populations to help determine an appropriate recovery and reintroduction strategy (USFWS, 2008).
- Survey historical Arenaria paludicola sites for potential extant occurrences and to identify suitable sites for reintroductions and survey areas in southern and central California and near Tacoma in Washington State for potential new A. paludicola occurrences and to identify suitable sites for introductions (USFWS, 2008).
- Modify downlisting criterion number 4 ("[T]he [introduced] populations remain viable for at least 5 years") to viable onsite reproduction for more than one generation (i.e., a second, or "f2" generation) has been confirmed (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following actions are recommended based on the current 5-year review: 1. Implement annual monitoring programs and develop comprehensive management plans to ameliorate the threats at extant populations. 2. Conduct surveys within suitable marsh habitats throughout the historic range and in extirpated sites previously known to have supported the species. 3. Conduct introductions at suitable sites that include long-term management strategies to ensure success and persistence of the species at introduced locations. 4. Continue to collect seed to expand the ex situ conservation seed bank collection. 5. Conduct research to evaluate site-specific effects of climate change, the role of sexual reproduction, the seed bank, and genetics of the species to inform management and introduction efforts. (USFWS, 2020)

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SPECIES ACCOUNT: *Arenaria ursina* (Bear Valley sandwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

This species is a low, tufted perennial herb with stems from 2 to 6 inches (in) (5 to 15 centimeters (cm)) long. The leaves are opposite and 0.16 to 0.5 in (0.41 to 1.3 cm) long. The flowers are white, five-parted and arranged in open cymes 1.5-6 in (3.8-15 cm) high. The petals are 0.16 to 0.2 in (0.41 to 0.51 cm) long, and the sepals are up to 0.16 in (0.41 cm) long (63 FR 49006). Bear Valley sandwort is distinguished from other members of the genus within its range by its glabrous, filiform, nerveless leaves that are less than 0.08 in (0.2 cm) wide and its rounded 0.12 to 0.16 in (0.3 to 0.41 cm) long sepals (63 FR 49006). (USFWS, 2008)

Taxonomy

Member of the pink family (Caryophyllaceae). The Service made a technical correction to the List of Endangered and Threatened Plants at 50 CFR 17.12(h) to reflect acceptance of the change in scientific name for Bear Valley sandwort to Eremogone ursina (B.L. Rob.) Ikonn. (Ikonnikov 1973, p. 140) from Arenaria ursina B.L Rob. (Robinson 1894, p. 294). Recent phylogenetic analysis of three chloroplast gene regions has confirmed the polyphyletic nature of Arenaria, and supports recognition of Eremogone as a separate genus (Harbaugh et al. 2010, p. 195) (USFWS, 2015).

Historical Range

Eremogone ursina was known from pebble plain complexes in the vicinity of Big Bear and Baldwin lakes in San Bernadino County, California. (USFWS, 2015)

Current Range

Eremogone ursina was known from pebble plain complexes in the vicinity of Big Bear and Baldwin lakes in San Bernadino County, California. (USFWS, 2015)

Critical Habitat Designated

Yes; 1/25/2008.

Legal Description

On December 26, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 25, 2008) for Arenaria ursina (Bear Valley sandwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation for this species includes 17 critical habitat units (CHUs) in California (72 FR 73092-73178).

Critical Habitat Designation

The critical habitat designation for Arenaria ursina includes 17 CHUs in San Bernardino County, California. Approximately 1,412 ac (571 ha) of Federal and and private land are being designated as critical habitat for A. ursina (72 FR 73092-73178). Units are grouped by pebble plain complexes (e.g., Arrastre/Union Flat) as identified in the USFS's 2002 Management Guide. Detailed coordinates and maps are provided in the Final Rule.

Units ARUR 1 and ARUR 2, Arrastre/Union Flat, San Bernardino County, California. ARUR 1 contains 69 ac (28 ha); ARUR 2 contains 229 ac (93 ha). The landowner is the U.S. Forest Service. ARUR 1 is USFS Pebble Plain Number 100; ARUR 2 is USFS Pebble Plain Number 87.

Units ARUR 3 and ARUR 4. Big Bear Lake, San Bernardino County, California. ARUR 3 contains 21 ac (9 ha); ARUR 4 contains 6 ac (2 ha); the landowner is the U.S. Forest Service. ARUR 3 is USFS Pebble Plain Number 248; ARUR 4 is USFS Pebble Plain Number 254.

Unit ARUR 5. Broom Flat, San Bernardino County, California. ARUR 5 contains 326 ac (132 ha). The landowners are the U.S. Forest Service (255 ac) and a private landowner (71 ac). ARUR 5 is USFS Pebble Plain Numbers 285 and 309.

Unit ARUR 6 and ARUR 7. Fawnskin, San Bernardino County, California. ARUR 6 contains 15 ac (6 ha); ARUR 7 contains 24 ac (10 ha). The landowner is the U.S. Forest Service. ARUR 6 is USFS Pebble Plain Number 301; ARUR 7 is USFS Pebble Plain Number 302.

Units ARUR 8, ARUR 9, and ARUR 12. Gold Mountain and North Baldwin Lake, San Bernardino County, California. ARUR 8 contains 62 ac (25ha); ARUR 9 contains 43 ac (17 ha); ARUR 12 contains 320 ac (129 ha). The landowner is the U.S. Forest Service. ARUR 8 is USFS Pebble Plain Number 188; ARUR 9 is USFS Pebble Plain Number 192; ARUR 12 is USFS Pebble Plain Number 128.

Units ARUR 10 and ARUR 11. Holcomb Valley, San Bernardino County, California. ARUR 10 contains 28 ac (11 ha); ARUR 11 contains 44 ac (18 ha). The ARUR 10 landowners are is the U.S. Forest Service (22 ac) and a private landowner (6 ac). ARUR 11 is owned by the U.S. Forest Service. ARUR 10 is USFS Pebble Plain Numbers 98 and 109; ARUR 11 is USFS Pebble Plain Number 153.

Units ARUR 13 and ARUR 14. Sawmill, San Bernardino County, California. ARUR 13 contains 36 ac (15 ha); ARUR 14 contains 5 ac (2 ha). The ARUR 13 landowners are the U.S. Forest Service (15 ac) and a private landowner (21 ac). ARUR 13 is USFS Pebble Plain Number 236; ARUR 14 is USFS Pebble Plain Number 224.

Unit ARUR 15. South Baldwin Ridge/Erwin Lake, San Bernardino County, California. ARUR 15 contains 23 ac (9 ha). The landowner is the U.S. Forest Service. ARUR 15 is USFS Pebble Plain Number 212.

Unites ARUR 16 and ARUR 17. Sugarloaf Ridge. San Bernardino County, California. ARUR 16 contains 127 ac (51 ha); ARUR 17 contains 34 ac (14 ha). The landowner is the U.S. Forest Service. ARUR 16 is USFS Pebble Plain Number 294; ARUR 17 is USFS Pebble Plain Number 289.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of critical habitat for Arenaria ursin are the habitat components that provide (72 FR 73092-73178):

(i) Pebble plains in dry meadow-like openings within upper montane coniferous forest, pinyon-juniper woodlands, or Great Basin sagebrush in the San Bernardino Mountains of San Bernardino

County, California; at elevations between 5,900 to 9,800 ft (1,830 to 2,990 m) that provide space for individual and population growth, reproduction and dispersal.

(ii) Seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles, that provide space for individual and population growth, reproduction and dispersal, adequate water, air, minerals, and other nutritional or physiological requirements to the species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Threats to listed pebble plains plants throughout their range include land development, off-highway vehicle (OHV) use off of designated routes, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, and nonnative plant species (63 FR 49006; September 14, 1998). Pebble plain habitat is also threatened by vegetation and fuels management, hazard tree removal, and wildfire suppression activities (Eliason 2006). However, of the above threats, land development remains the primary cause of habitat loss on private lands; while on Federal lands, OHV use off of designated routes has historically been, and continues to be, the most significant threat to pebble plains habitat. Increasing residential populations adjacent to pebble plains habitat on private and Federal lands has also resulted in degradation of habitat, as dispersed recreation and unauthorized OHV use increases (Eliason 2006). Also, while forest system road use and maintenance, mining activities, and dispersed recreation continue to have adverse ongoing effects to pebble plain habitat and the species it supports, the magnitude and severity of effects caused by these activities are relatively small compared to the effects of unauthorized motorized vehicle use (Eliason 2006). The primary constituent elements for the listed pebble plains plants may require special management considerations or protection to minimize impacts associated with, (1) vehicle use and road maintenance; (2) recreational activities; and (3) the presence of nonnative species (63 FR 49006, September 14, 1998; USFS 2002, p. 17; USFS 2005, pp. 207, 249, 293).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing), self-pollination (USFWS, 2015)

Breeding Season

Adult: May - June (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2015)

Reproduction Narrative

Adult: Plants flower between May and June. Eremogone ursina produces seeds by selfing (self-pollinating) and entomophilous (insect-mediated) outcrossing (O'Brien 1979, p. 80). Small syrphid flies, sphecid wasps, and bees appear to be the primary insect pollinators for this species (O'Brien 1979, p. 82; Freas and Murphy 1990, p. 6). O'Brien (1980, p. 217) observed that E. ursina flowers with their open cup morphology were heavily visited by insects, in contrast to pebble plain plants with specialized flower morphology. Additionally, this species was dependent on insects for maximum seed set, as bagged individuals had approximately half of the seed production of those that were not bagged (O'Brien 1980, p. 214). (USFWS, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon and juniper woodland (NatureServe, 2015); pebble plain (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Surface water flow (USFWS, 2015); freeze-thaw cycles (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: 1800 - 2300 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 2007)

Habitat Narrative

Adult: Grows on pebble plains and dry slopes in pinyon and juniper woodland. Pebble plains: dense clay soils, usually covered with a cobble pavement of quartzite. These are sparsely vegetated; they occur as openings in the surrounding forest at 1800 - 2300 m elevation. They support several endemic plant species and disjunct occurrences of plants that are more common elsewhere. Occurs with Eriogonum kennedyi ssp. austromontanum. Eremogone ursina tolerates more shaded sites than other pebble plains associated species. Habitat does not recover well from disturbance. This species has a very narrow environmental specificity (NatureServe, 2015). This species is restricted to specific habitats (i.e., specialized niche) found within a narrow range of the San Bernardino Mountains and dependent upon undisturbed surface water flows and associated physical features that are easily and permanently altered by human activities. This species requires pebble plains in dry meadow-like openings within upper montane coniferous forest, pinyon-juniper woodlands, or Great Basin sagebrush, and seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles (USFWS, 2007).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2015)

Dispersal/Migration Narrative

Adult: The seeds of E. ursina are flat, reticulate, measure 2 millimeters (mm) (0.079 in) long, remain in open erect capsules for up to 2 months, and can bounce out of the capsule in a strong wind (O'Brien 1979, pp. 81–82) (USFWS, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

10 - 50% decline (NatureServe, 2015)

Number of Populations:

33 (8 extant and 25 presumed extant) (USFWS, 2021)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

Since the 2015 5-year review, we have received new information about seven Eremogone ursina occurrences. Five were not included in our 2015 5-year review but are in CNDDB [Element Occurrence (EO) numbers 19, 38, 46, 53, 54], and two (0512MT-KAD-E020 and 0512MTMBC-E395) are in the USFS occurrence database. These new occurrences increase the total number of E. ursina occurrences to 36 (Tables 1, 2; Figure 1). Of the 29 occurrences considered in the 2015 5-year review, 22 have had a change in status. Three occurrences that were extant in 2015 (EOs 10, 17, and 34) are possibly extirpated, because portions of the occurrences have been developed and there have been no observations for over 20 years. The remaining 19 occurrences that were extant in 2015 are now presumed extant, because they have not been observed for over 10 years. The seven new occurrences that were not discussed in the 2015 review are all presumed extant, except for 0512MT-MBC-E395, which is considered extant. (USFWS, 2021)

Threats and Stressors

Stressor: Urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Much of the habitat historically occupied by Eremogone ursina on private lands was lost to residential and commercial development (USFS 2012a, p. 31). Urban development (primarily residences) and related recreational development on city, county, or private lands within the Big Bear Lake and Baldwin Lake areas continue to represent an ongoing threat to Eremogone ursina at six of the pebble plain complexes. Several utilities operating within the San

Bernardino Mountains provide either direct services to urbanized areas in the region or related infrastructure, and their operation and maintenance activities can affect populations of Eremogone ursina or its critical habitat. The primary threats to E. ursina from these utilities include ground disturbance and localized trampling of habitat related to operation and maintenance activities, such as pole replacements (USFWS, 2015).

Stressor: Road and trail use (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: An estimated 9.6 mi (15.4 km) or 223 ac (90 ha) (using 100 foot (30 meters) of centerline) of roads and trails affect Eremogone ursina occurrences within an estimated 1,591 ac (642 ha) of E. ursina occupied habitat located on lands owned and managed by the USFS (USFS 2012b, p. 22). Threats to Eremogone ursina from roads and trails include both direct effects, such as habitat alteration, and indirect effects, including alteration of water flow and drainage patterns, sedimentation, deposition of particulates (dust), and effects related to wildfire (USFS 2012b, pp. 21–24). Roads, road construction, and road maintenance can also facilitate the introduction and establishment of nonnative plants by creating open, continually disturbed habitat as well as disrupt hydrological processes within pebble plains habitats. Nonnative plants can be transported along these road corridors by equipment and vehicles, and are often more easily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005b, Vol. 1, p. 114). Ongoing use and maintenance of USFS trails likely subjects Eremogone ursina to occasional localized crushing, uprooting, or burial of habitat and individuals in the Big Bear Lake, Baldwin Lake, and Sugarloaf–Onyx areas (USFS 2012b, pp. 59, 76–77, 82). Unauthorized OHV use has impacted all pebble plain complexes to varying degrees (USFS 2002, p. 25). Impacts also result from the effects of non-motorized trails and mountain biking due to the proximity of E. ursina and its habitat to urban areas (USFS 2012b, pp. 60–61). Along with soil compaction, soil erosion resulting from OHV use could significantly alter Eremogone ursine habitat. Vehicle traffic during the wet season is of particular concern, as this activity directly disturbs or destroys vegetation and creates deep ruts that change the hydrological patterns over the pebble plain (USFS 2002, p. 20). (Threats from alteration of hydrological conditions is discussed below). Vehicle traffic also increases breakdown in natural soil aggregates (structure) (Sadler 1989, pers. comm., cited in USFS 2002, p. 23). Associated with OHV activity is unauthorized collection of wood for fuel including removal of downed vegetation or trees (USFWS, 2015).

Stressor: Alteration of hydrology (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Alteration of hydrology can also result from land disturbance due to mining and fire suppression activities. Normally, surface water flows evenly across the relatively impervious pebble plains (Odell 1988, p. 19). However, changes in the hydrological pattern associated with a disturbed pebble plain could alter the soil composition by allowing for erosion of clay sediments during rainfall events, leaving only large cobbles and pebbles (Neel and Chaney 1992, p. 1). These potential changes to soil morphology and composition could theoretically result in invasion of both native and nonnative plant species that then out-compete Eremogone ursina for space and resources. Once established, native trees and shrubs alter the surrounding microhabitat by shading, increasing leaf litter, and probably by reducing temperature extremes (Derby 1979, pp.

72–73; USFS 2002, p. 15) (USFWS, 2015).

Stressor: Trampling by ungulates (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: At present, the threat of trampling to pebble plain habitat and to individual plants, including Eremogone ursina, due to burro activity is estimated to be very minor. However, if soils within pebble plain habitats are wet, trampling effects may be more significant to both habitat and individual plants (Eliason 2013b, pers. comm.). Hitchcock Ranch, a private inholding in the Holcomb Valley area, grazes approximately 30 to 40 horses in the Hitchcock Meadow (located within the Holcomb Valley pebble plain complex), which is occupied by Eremogone ursina and other federally listed plants (USFS 2012b, p. 74). The extent and severity of effects of trampling by horses in this portion of the Holcomb Valley to E. ursina habitat and individual plants is currently unknown (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The presence of B. tectorum within pebble plain habitat can provide a continuous "flashy" fuel load and the potential to increase the fire return interval (USFS 2005a, p. 101); though it is unclear to what extent fire has affected pebble plain communities, its presence represents an increasing concern for fire management (USFS 2005a, p. 101). Bromus tectorum, as well as Erodium cicutarium (filaree), represent very old invasions in the San Bernardino Mountains and are persistent threats within these complexes (Eliason 2012b, pers. comm.). More recent invasions of nonnative plant species within some of these pebble plain complexes include Linaria dalmatica (dalmatian toadflax), Ranunculus testiculatus (bur buttercup), and Lepidium perfoliatum (clasping pepperweeed) (Eliason 2012b, pers. comm.) (USFWS, 2015).

Stressor: Mining (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Unpatented mining claims on USFS lands were previously reported for five pebble plain complexes occupied by Eremogone ursina: (1) Holcomb Valley (83 ac (33.6 ha)), (2) Fawnskin (24 ac (9.7 ha)), (3) Arrastre Flats (69 ac (28 ha)), (4) North Baldwin Lake (62 ac (25 ha)), and (5) Broom Flat (0.2 ac (0.08 ha)) (USFS 2002, pp. 42, 46, 48, 57, 65). These claims continue to represent a potential threat of ground disturbance for E. ursina, specifically, gold prospecting activities or mining operations related to the ownership of mineral rights. Some of these mining activities may fall under the Notice of Intent submission exceptions of 36 CFR § 228.4 (regulations that govern locatable minerals on USFS lands) and are therefore not reviewed by the USFS, which could result in the uprooting, burying, or crushing of meadow plants (USFS 2012b, p. 33). The Holcomb Valley area, which includes the Holcomb Valley and Arrastre Flats pebble plain complexes, is a particularly active area for small-scale mining activities (e.g., prospecting by clubs and individuals) and represents an area of concern for pebble plain plants and their habitats (USFS 2012b, p. 74). Small-scale mining activities around Doble in the North Baldwin Lake pebble plain complex could affect a small portion of occupied habitat (USFS 2012b, p. 80) (USFWS,

2015).

Stressor: Fire suppression (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Fire suppression activities typically include fire line construction, fire retardant and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation (USFWS 2005, p. 27). Each of these activities can have negative impacts to E. ursina and its habitat. For example, safety zone and fire line construction can involve using bulldozers to clear vegetation and parking areas, and fire camps result in heavy trampling and soil compaction from equipment and vehicles. Additionally, fire lines that cut through habitat can alter hydrological patterns as well as destroy individual plants or encourage the establishment of nonnative species (USFWS 2005, p. 27) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Climate change has already altered, and will continue to alter, the water cycle. Changes in the water cycle, which are consistent with the warming observed over the past several decades, include, but are not limited to: (1) changes in precipitation patterns and intensity; (2) changes in the incidence of drought; (3) widespread melting of snow and ice; (4) increasing evaporation; and (5) changes in soil moisture and runoff (USGCRP 2009, p. 41). Although the effects of climate change on Eremogone ursina and its habitat have not been measured and there is uncertainty in future predictions of downscaled climate change models, projected climate change effects mentioned above could significantly alter the hydrology that sustain and characterize pebble plain habitat occupied by E. ursina. Freas and Murphy (1990, p. 8) reported reproductive failure of four pebble plain plant taxa—including Eremogone ursina—and significantly reduced vigor of adult plants in 1989 following several years of drought, particularly in the easternmost (i.e., driest) pebble plains. Thus, an increased number high temperature events due to the effects of climate change could create conditions that exceed the drought tolerance of E. ursina, causing direct mortality of individuals and decreased reproduction (USFWS, 2015).

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Recommendation for Future Action from 2015 5-Year Review: Work with biologists at the SBNF to reduce impacts from recreational use of roads and trails through uncontrolled access to pebble plain habitat occupied by Eremogone ursina. Prioritize protective measures being implemented (or planned) for controlling access to areas occupied by E. ursina. This

should include providing comment on biological assessments for proposed activities to support SBNF program of road closures and/or assistance in securing resources for placement of more effective barriers in the areas that receive the highest recreational uses from motorized vehicles (USFWS, 2015).

- Recommendation for Future Action from 2015 5-Year Review: Conserve or preserve Eremogone ursina occurrences on private lands. Continue to work with the State and local groups to purchase E. ursina habitat from willing sellers, particularly within the Sawmill pebble plain complex (USFWS, 2015).
- Recommendation for Future Action from 2015 5-Year Review: Develop a monitoring plan to provide early detection of downward trends in the populations of pebble plain plants, such as Eremogone ursina, and quality of pebble plain habitat (adapted from USFS 2005a, p. 125). This monitoring plan should identify and prioritize surveys of plant populations, including abundance, and habitat conditions, in those areas most vulnerable to threats (e.g., pebble plain complexes with high levels of recreational activity) and should include remote sensing and mapping of unauthorized OHV trails (USFWS, 2015).
- Recommendation for Future Action from 2015 5-Year Review: Evaluate reproductive life history characteristics of Eremogone ursina, such as seed germination requirements, mechanism of seed dispersal, and seed viability (USFWS, 2015).
- Recommendation for Future Action from 2015 5-Year Review: Determine the distribution of genetic diversity in Eremogone ursina occurrences and identify the most appropriate means to preserve the diversity (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Eremogone ursina and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Work with USFS land managers to reduce impacts to E. ursina and its habitat from recreational and unauthorized OHV use. Coordinate with USFS on implementation of the Pebble Plains Habitat Management Guide. 2. Reach out to private landowners to identify opportunities for conservation on private lands. Work with private landowners, local governments, and conservation organizations to conserve and manage habitat. 3. Continue to monitor E. ursina occurrences to provide early detection of downward trends in population numbers or quality of pebble plain habitat, or both. Regular monitoring of pebble plain complexes can also help with early detection of increasing threats to specific areas (e.g. unauthorized OHV trails). 4. Study E. ursina population genetics, including levels of genetic diversity and differentiation among and within occurrences. Determine levels of inbreeding, relatedness, and ploidy. This information will help us assess current levels of genetic diversity and gene flow and determine if genetic management is needed and assess appropriate seed sources for potential future reintroduction or augmentation activities. 5. Collect E. ursina seed and conserve seed in an ex situ (off-site) conservation seed bank, to preserve the genetic diversity in the species. (USFWS, 2021)

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SPECIES ACCOUNT: *Argemone pleiacantha* (Sacramento prickly poppy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1989; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Sacramento prickly poppy is a robust, short-lived perennial, 0.5-1.5 m (1.5-5.0 ft) tall with 3-12 branching stems and striking, blue-green colored leaves. The leaves are about 10.0-15.0 cm (4.0-6.0 in) long, with rectangular sinuses and spine-tipped lobes extending almost to the midrib. The veins and midrib are armored with stout, yellow spines. The large and showy white flowers have 6 petals 3.0-4.0 cm (1.2—1.6 in) long and 8.0-9.0 cm (3.5 in) wide, with numerous orange stamens and a purple stigma. Capsule spines are simple. The small, round, black seeds are 2.5 mm (0.1 in) in diameter and dispersed by wind, water and possibly animals (R. Galeano-Popp, U.S. Forest Service (USFS), pers. comm., 1992; R. Sivinski, New Mexico Energy Minerals and Natural Resources Department (NMEMNRD), in litt., 1992). In addition to the deeply divided leaves and simple capsule spines, Sacramento prickly poppy has white—colored stem sap. (USFWS, 1994)

Taxonomy

Recent molecular and geographic data (Cervantes et al., 2010) support a scientific name change for the Sacramento prickly poppy from Argemone pleiacantha spp. pinnatisecta to Argemone pinnatisecta, which was documented in the previous 5-year review for the poppy (USFWS, 2013). However, the scientific name has yet to be changed in the List of Endangered and Threatened Wildlife and Plants (50 CFR 17.12) and associated recovery documents (USFWS, 2022).

Historical Range

The species' known historical range covered 13 canyons in 8 canyon systems of the Lincoln National Forest (LNF). Populations existed in Fresnal Canyon, including Salado and La Luz canyons; Dry Canyon; Marble Canyon; Alamo Canyon, including Caballero, Gordon, and Deadman canyons; Mule Canyon; San Andres Canyon; Dog Canyon; and Escondido Canyon (USFWS, 2022).

Current Range

Currently, poppies are known to be extant in 11 of these canyons. The species is also known to occur on Bureau of Land Management lands, private lands, Oliver Lee State Park, and on State of New Mexico and City of Alamogordo rights-of-way (USFWS, 2022).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The flowers have a variety of pollinators that include carpenter bees (Xylocopa californica arizonensis), honey bees (Apis mellifera), bumblebees (Bombus ssp.), soldier beetles (Cantharidae), lizard beetles (Liguriidae), flies (Diptera), and butterflies (Lepidoptera) (U.S. Forest Service 2004). (USFWS, 2013)

Breeding Season

Adult: May through summer (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Germination can only occur after cold stratification and is further enhanced if the seed coat is also scarified. (USFWS, 1994)

Reproduction Narrative

Adult: Generally, plants bloom during the second year, if moisture availability has allowed for sufficient growth. Flowering begins in May and continues throughout the summer depending on elevation and moisture conditions. The flowers have a variety of pollinators that include carpenter bees (Xylocopa californica arizonensis), honey bees (Apis mellifera), bumblebees (Bombus ssp.), soldier beetles (Cantharidae), lizard beetles (Liguriidae), flies (Diptera), and butterflies (Lepidoptera) (U.S. Forest Service 2004). Studies of pollination biology and subsequent fruit set and seed production show that prickly poppy will set little or no fruit unless visited by pollinators. Self pollination, either within one flower or among flowers of the same plant, results in significantly fewer fruits and fewer seeds per fruit (Tepedino 1992). Seed output for mid- sized plants in Alamo and Dog canyons averaged about 2,000 seeds per plant (Malaby 1988). However, based on nursery results, seed germination is low (approximately 3 percent in 1989) and seedling mortality is high (Malaby 1988). Germination can only occur after cold stratification and is further enhanced if the seed coat is also scarified. (USFWS, 1994; USFWS, 2013)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, desert, forest/woodland, woodland- conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 4,200 and 7,120 feet (USFWS, 1994)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1994)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1994)

Habitat Narrative

Adult: Sacramento prickly poppy is found in the dry hills, pinyon-juniper zone (Flora of North America Editorial Committee 1997) on loose, gravelly soils of open disturbed sites, canyon bottoms and slopes (McDonald 2010). Usually in areas of enhanced soil moisture such as north-facing slopes, canyon bottoms, along drainages, and near leaks in water pipelines. Sacramento

prickly poppy occurs in rocky canyons on the western slope of the Sacramento Mountains. It ranges from 4,200 feet elevation in the lower Dog Canyon area to 7,120 feet elevation in upper Alamo Canyon area (Malaby 1987). The topography of the area is characterized by steep, rocky hillsides. Soils are primarily derived from limestone and may also contain sandstone and gypsum (USFS 1992). Numerous large canyons and arroyos drain westward into the Tularosa Basin. Annual precipitation in the Sacramento Mountains averages about 38 cm (15 in) per year, most of which occurs from July through October, during brief but heavy thundershowers (U.S. Soil Conservation Service (SCS) 1981). All canyons on the west side of the Sacramento Mountains experience periodic and severe flash floods (USFS 1992). Wide fluctuation in diurnal and seasonal temperatures is characteristic of the western slope of the Sacramento Mountains. Temperatures average above 90 degrees Fahrenheit from mid—May to mid— September and may go as low as 16 degrees Fahrenheit during the winter (SCS 1981). High temperatures combined with high insolation and high evaporation rates create xeric conditions in the western foothills of the Sacramento Mountains (NMNP PAC 1984). Unlike seedlings, established poppy plants appear to be capable of weathering periods of drought by becoming dormant. (USFWS, 1994; USFWS, 2013)

Dispersal/Migration

Dispersal

Adult: Medium (USFWS, 1994)

Dispersal/Migration Narrative

Adult: The small, round, black seeds are 2.5 mm (0.1 in) in diameter and dispersed by wind, water and possibly animals (R. Galeano—Popp, U.S. Forest Service (USFS), pers. comm., 1992; R. Sivinski, New Mexico Energy Minerals and Natural Resources Department (NMEMNRD), in litt., 1992). The majority of Sacramento prickly poppy seeds do not travel far from the parent plant and would remain there if flash floods did not move these large and heavy seeds downslope through the canyon drainage channels. This large endosperm could be a potential source of food for various rodents, birds, and insects. Dispersal by animals to upland sites may account for the occasional presence of prickly poppy plants in areas away from drainages. Soreng (1982) observed ants transporting seeds. (USFWS, 1994)

Population Information and Trends

Population Trends:

Decline of 62% over 23 years (USFWS, 2022)

Number of Populations:

9 (NatureServe, 2015)

Population Size:

~1,000 (NatureServe, 2015)

Population Narrative:

Long-term population trends suggest a decline of 30 to 50%. Approximately 1,286 total plants of Sacramento prickly poppy occupy 10 canyons on the western slope of the Sacramento Mountains in south—central New Mexico. In the late 1980's, there were approximately 1300

plants (McDonald 2010). More recently, the total number of plants is estimated to be below 1000 (Sivinski 1999; Tonne 2008 cited by Cervantes et al. 2010). (USFWS, 1994; NatureServe, 2015) Little new information is available on this species' population trend since the previous 5-year review was completed in 2013 (USFWS, 2013). New data on the poppy was provided by the LNF and included survey data that were collected from 2013 to 2019. These data show that counts of adult prickly poppy in Alamo and Caballero canyons have fluctuated each year but remained relatively static between 2016 and 2019. While the most current survey data do not show as steep of a decline as was documented in the last 5-year review (62 percent over 23 years; USFWS, 2013), the species still appears to be declining in the number of adults at sites that were surveyed. The surveys conducted did not document many seedling or sub-adult poppies, which may indicate that recruitment is not occurring or some unknown threat is affecting adult poppy reproduction ability. Alternatively, the apparent lack of recruitment could be associated with difficulties in locating seedlings, especially in areas that other vegetation is dense, resulting in under reporting of seedling and sub-adult poppies. Since the last 5-year review, survey efforts have occurred sporadically and advantageously across known poppy sites rather than systematically across all poppy sites. Inconsistent survey of poppy sites makes it difficult to determine if poppies are persisting at all previously known sites, if these populations are remaining relatively static as seen in Alamo and Caballero canyons, or if a population may have been extirpated from some sites. In 2018, data were collected in 6 canyons, indicating that the species continues to persist at these locations, though two sites had less than 5 individuals and no documentation of recruitment. Only Alamo and Caballero canyons were re-surveyed in 2019 (USFWS, 2022).

Threats and Stressors

Stressor: Flooding (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Flooding and erosion are known threats to the poppy (Soreng 1982; U.S. Fish and Wildlife Service 1989, 1994, 2004, 2012; Sivinski 1992; Forest Service 2004; Tonne 2008). In 1977, severe floods were observed to remove up to 100 plants from lower Alamo Canyon (Fletcher 1978; Soreng 1982). Two years later, when Fletcher found only six plants in this location in 1979, he speculated that the population might be in jeopardy of extirpation. Observations since this time have shown that plants in and along arroyos are subject to periodic damage and loss of mature plants from floods, and numbers fluctuate considerably in response to flooding. Some plants are completely removed or buried by floods, and others re-sprout from roots (Tonne 2008). Recent floods have had severe, damaging effects to individual poppy plants, but long-term impacts to populations are unknown (U.S. Forest Service 2008). (USFWS, 2013)

Stressor: Livestock (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Grazing and trampling by livestock can destroy young seedlings and can potentially degrade the quality of poppy habitat. Livestock grazing can affect vegetation species composition, plant density, and plant vigor. Cattle tend to occupy canyon bottoms, where poppy seedlings are most likely to occur, because the steep sides of the canyon render most of the

acreage in the pasture inaccessible. Out of the approximately 11,000 acres on the Alamo winter pasture, only about 3,000 acres are usable and accessible to livestock. Livestock may avoid eating most mature poppy plants due to their bitter-tasting latex; however, early season basal rosettes with spines have been grazed to the ground (Forest Service 2005). Detrimental effects to the poppy depend on the timing, intensity, and duration of livestock use. Trampling by cattle has been more frequently observed than herbivory, especially of adult plants. Herbivory by livestock appears to occur mostly during periods of drought, but trampling by livestock can impact the poppy at any time (Salas and Barker 2003; Tonne 2008). Healthy mature plants appear to be capable of re-sprouting after livestock tread on them, but mortality appears likely to occur in young plants or in stressed mature plants suffering from drought or disease. At higher stocking rates, the threat of seedling mortality is greatly increased because livestock have a direct negative impact on the poppy when their presence coincides with the emergence of seedlings (Soreng 1982; Wagner and Sabo 1982; U.S. Fish and Wildlife Service 1989, 1994, 2005, 2008, 2012; Wood 1992; Salas 2003). The period between germination and establishment of the mature poppy is the most vulnerable time in this plant's life cycle. This developmental stage is the main impediment to increased abundance in any colony or population of this taxon. Germination has been documented throughout the range of the poppy, sometimes in great abundance. However, as with many plants, few of these seedlings survive to become reproductive adults. Some are killed almost immediately through trampling by livestock, while others face periods of dry weather, flooding, or other disturbance. Rotation dates have sometimes been violated, and cattle have remained in poppy habitat year-round, causing damage to poppy seedlings and likely contributing to poor watershed condition through the reduction of herbaceous and riparian vegetation (Tonne 2008, U.S. Forest Service 2008). (USFWS, 2013)

Stressor: Herbicide spraying (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: In 2007, herbicide was sprayed by the New Mexico Department of Transportation on U.S. Highway 82 near High Rolls, New Mexico, to reduce vegetation in the right-of-way. The herbicide was applied directly to at least five adult poppies, killing three of these. The Forest Service flagged areas that should not be sprayed, but this did not successfully protect the plants. The use of flagging does not appear to be adequate because, at best, it protects only adults known to the Forest Service employee deploying the flagging. It does not protect seedlings or young plants, or adults that are hidden from view (Tonne 2008). Due to this event, the New Mexico Department of Transportation has not sprayed herbicide in poppy habitat again. An agreement to improve protection of poppies from this activity has been discussed among the New Mexico Department of Transportation, U.S. Forest Service, and U.S. Fish and Wildlife Service. (USFWS, 2013)

Stressor: Road maintenance (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: During spring 2008, the City of Alamogordo cleared a maintenance road in upper Alamo Canyon, destroying many mature poppies (U.S. Forest Service 2008). During a survey in June 2008, only a few poppies had re-sprouted in this area. Some poppies that were previously

located in or adjacent to the roadway were missing and presumed dead, but a few had re-sprouted in the road (U.S. Fish and Wildlife Service 2008). (USFWS, 2013)

Stressor: Water extraction (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The City of Alamogordo captures water at the head of Alamo, Caballero, Fresnal, and La Luz canyons, potentially reducing the amount of water available to the poppy. Because poppy seedlings are delicate and sensitive to drying until they establish their taproot, any factor that increases soil dryness is likely to affect seedling establishment and recruitment. This permanent removal of water at headwater springs under State water rights by local communities, combined with livestock presence, drought, and climatic fluctuations have degraded riparian and spring habitat (U.S. Forest Service 2003, 2008; Tonne 2008). These relatively mesic areas within the range of the poppy may have historically served as important reserves during periods of drought. (USFWS, 2013)

Stressor: Road and pipeline construction, maintenance (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Road and pipeline construction and maintenance activities sometimes destroy poppy plants. The Lincoln National Forest performs road maintenance on approximately 523 km (325 mi) of roads per year. Additional maintenance is conducted on Federal, State, and county non-National Forest System roads (U.S. Forest Service 2004). In Fresnal Canyon, road maintenance by the Otero County Road Maintenance Department resulted in the loss of poppy plants along an unpaved National Forest System road. In Fresnal Canyon, road maintenance by the Otero County Road Maintenance Department resulted in the loss of poppy plants along an unpaved National Forest System road. During spring 2008, the City of Alamogordo cleared a maintenance road in upper Alamo Canyon, destroying many mature poppies (U.S. Forest Service 2008). Surveys in June 2008, reported that only a few poppies had re-sprouted. Many poppies that were previously located in or adjacent to the road were missing and presumed dead (U.S. Forest Service 2008). The loss of plants in the upper reaches of occupied habitat leads to reductions in seed dispersal from this area to existing colonies and potential new habitat downstream. The City of Alamogordo maintains water pipelines that tap large springs on the upper western slope of the Sacramento Mountains. These pipelines occur in La Luz, Fresnal, Alamo, and Caballero Canyons. The water rights for these systems pre-date the Lincoln National Forest. The pipelines in Alamo, Caballero, and Fresnal Canyons, canyons occupied by poppy, have been replaced over time as the pipes become cemented in with calcium carbonate. The new pipelines no longer leak water along their route through the canyon bottoms, as they historically have, and, consequently, no longer provide water to limited areas that may have supported poppies in the past (U.S. Forest Service 2004). Municipal use of canyon water has changed the natural hydrology, making upland areas and canyons much drier, perhaps reducing poppy habitat. Pipeline repair, replacement, and maintenance are ongoing in four canyons. These pipelines and associated activities continue to impact the suitability of poppy habitat. Heavy equipment used to transport, excavate, position, and remove large sections of steel pipe may damage or destroy plants if not carefully controlled and monitored. The Forest Service has surveyed, consulted upon, and monitored these activities when informed of them in advance (U.S. Fish and Wildlife

Service 2008). (USFWS, 2013)

Stressor: Mowing and herbicide application along roadways (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Roadway maintenance, including herbicide use and mowing, may threaten the poppy. Although the poppy is adapted to disturbed habitats, and, therefore, could benefit from some ground-disturbing activities, blading along drainage ditches and the shoulders of unpaved roads has destroyed some poppy plants (U.S. Forest Service 2004). Invasive plants such as Russian thistle, tamarisk, spotted knapweed, and Russian knapweed occur in poppy habitat. At present, the Forest Service and New Mexico State Highway and Transportation Department coordinate efforts at weed control and implement spraying of infested sites along the highways. Because plant competition may be a limiting factor to the distribution of the poppy based on the poppy's preference for sites that are more open and less densely vegetated, eliminating invasive plants may be beneficial for the poppy (U.S. Fish and Wildlife Service 1994). However, any spraying performed near poppy individuals still may pose a threat to the survival of this species. Direct and indirect application of herbicides on poppies in 2007 resulted in loss of plants occurring along the Highway 82 corridor (Tonne 2008). Since this occurrence, the New Mexico State Highway and Transportation Department has ceased spraying herbicides in proximity to poppy plants. In addition, the Lincoln National Forest has completed consultation on their Noxious Weed Control Plan for treatments of noxious weeds in the vicinity of the poppy. (USFWS, 2013)

Stressor: Off-highway vehicles (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Off-highway vehicles are recognized to be a potential threat to the poppy. Off-highway use of motorized vehicles on established trails is permitted in Alamo, Caballero, and Dry canyons on the Lincoln National Forest. Dry Canyon is not currently occupied by the poppy, and the mouth and only western access route into Alamo and Caballero canyons through City of Alamogordo land is closed to motorized traffic. Unauthorized off-highway vehicles can crush individual poppy plants and threaten the health of poppy habitat. Off-highway vehicles can destabilize or compact soils, which affect seed germination and plant growth. Motorized travel is prohibited on the Forest beyond 91 meters (m) (300 feet [ft]) from a road, except for purposes of camping or parking. This excludes use in the channels of Fresnal and La Luz canyons on National Forest System lands. Offhighway vehicles can crush or disturb poppy individuals and may modify the soils, local hydrology, and microclimates associated with seed germination and plant growth (U.S. Forest Service 2004). Furthermore, the creation of trails through poppy habitat can promote the spread of noxious weeds already present in the area (U.S. Forest Service 2004) into these areas which may threaten the poppy's establishment through competition. As an indication of increased interest in off-road riding in poppy habitat, a website exists that provides advice on how to circumvent Lincoln National Forest closures and lists detours to take in the vicinity of Alamo Canyon. Off-highway vehicles present a moderate threat to the poppy at this time. (USFWS, 2013)

Stressor: Fungal mold (USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: The presence of Alternaria sp., a fungal mold that can be a plant pathogen, has been observed to be an intermittent problem throughout the distribution of the poppy (Tonne 2005). For example, this fungal stem canker caused 7 of 18 plants to fail to set fruit and subsequently die in Dog Canyon (Sivinski 1999). It appears to be most common and damaging in drought years (Tonne 2008). A link between decreased water availability and increased cases of disease may exist, as drying may weaken a plant's resistance to disease. (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Global climate change may be a threat to the poppy in the foreseeable future. The global average temperature has risen by approximately 0.6 degrees Celsius during the 20th Century, according to the Intergovernmental Panel on Climate Change (Intergovernmental Panel on Climate Change 2001, 2007). Warming temperatures have been documented in recent decades in the southwestern United States. In New Mexico, mean annual temperature has increased by 0.6 degree per decade beginning in 1970, and warming is greatest in spring (Lenart 2005). Higher temperatures lead to higher evaporation rates which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge (Stewart et al. 2004). Temperature changes and seasonal shifts may stimulate earlier growth in the spring or extend the growing season into the fall that is out of phase with available moisture, possibly leading to increased water stress and decreased survival for the poppy. Flowering phenology may also be affected by temperature shifts, potentially causing asynchronous relationships with pollinators and reducing chances of sexual reproduction for the plant. In recent years, the area occupied by the poppy has been under severe drought. These precipitation levels led to low soil moisture conditions that severely curtailed recruitment of poppies into the population (U.S. Fish and Wildlife Service 2004a; Tonne 2008). From 2008 continuing through to the present, the Palmer long-term drought severity index for Otero County has been primarily in the severe to extreme range (National Oceanographic and Atmospheric Administration 2008-2013). Thus climate change presents a significant threat to the poppy, with impacts likely from not only precipitation and temperature changes, but also from possible interactive effects with grazing, water extraction, and disease. (USFWS, 2013)

Stressor: Small population size and low genetic diversity (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Decreasing genetic diversity is an indirect threat capable of extirpating the limited populations of poppies. Populations composed of smaller numbers of plants with narrow distributions are more susceptible to elimination from stochastic events, such as flooding or drought, or demographic fluctuations, such as reduced numbers of adults or diminished seed banks, than are larger, more widely distributed populations. A loss of populations or individuals may contribute significantly to a reduction in the gene pool and the ability of the species to adapt to environmental changes. With fewer, more widely spaced plants, out-crossing may become more difficult, which Tepedino (1992) has shown reduces fruit and seed set and could preclude population recovery. At this time, the small population size and limited genetic diversity present

a minor threat to the Sacramento prickly poppy. (USFWS, 2013)

Recovery

Reclassification Criteria:
The Sacramento prickly poppy will be considered for downlisting when: 1. The Alamo-Caballero Canyon population is shown to be stable or improving over a 20- year period with at least 1,000 individuals (flowering adults) according to the following measures: a) The Alamo-Caballero Canyon population has been designated as the core recovery population. The Alamo-Caballero Canyon population includes all individuals (flowering adults) located with these two canyon systems. This core population will be monitored yearly using annual demographic trend monitoring at representative sites to provide a population estimate based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. b) Approximately every 5 years, range wide and peripheral counts within Alamo and Caballero Canyons will be conducted using standardized methods peer-reviewed by species experts and approved by the Service. c) Species presence and abundance is maintained at the aforementioned level within the core Alamo-Caballero Canyon population. The population shall be considered stable when a linear regression analysis (or other method which has been peer-reviewed by species experts and approved by the Service) of the population numbers estimated from the results of annual demographic monitoring reveals no significant decline in numbers. d) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain a resilient population. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. (USFWS, 2019)

2. The 7 additional canyon systems (outside of Alamo-Caballero Canyon), which represent the currently-known occupied habitat for the Sacramento prickly poppy, are shown to maintain stable or improving occupancy over a 20-year period with at least 50% of the canyons demonstrating an average of 75% probability of occupancy over this time frame, according to the following measures: a) Maintain or increase occupied and high probability of occupancy habitat within these canyon systems. b) These additional canyon systems will be surveyed at least once every 2 years utilizing annual occupancy monitoring at representative sites within each canyon to provide a probability of occupancy for the canyon based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. c) Occupancy is maintained at 75% probability of occupancy within at least 50% of the additional canyon systems. The canyon systems shall be considered stable when occupancy analysis based on methodology peer-reviewed by species experts and approved by the Service reveals no significant decline in occupancy. d) As well as demonstrating no significant decline in occupancy, each canyon system should maintain functionality over the 20-year period with appropriate demonstrated population dynamics as defined by methodology peer-reviewed by species experts and approved by the Service. e) Approximately every 5 years, efforts to characterize occupied and high probability of occupancy habitat throughout the canyon systems

should be conducted based on methodology peer-reviewed by species experts and approved by the Service. f) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain resiliency across these additional populations. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. (USFWS, 2019)

3. The genetic corridors between populations are maintained through patterns of occupancy within different canyon systems to promote gene transfer as defined by methodology peer-reviewed by species experts and approved by the Service. (USFWS, 2019)

4. The Alamo/Caballero Canyon populations, as well as populations within additional canyon systems considered occupied habitat, must be protected through the development and implementation of species-specific management recommendations that protect the species from identified threats (e.g., livestock grazing and water extraction). a. These management recommendations should be developed in coordination with the Service and implemented by the appropriate land management entity (entities). b. These management recommendations should be periodically evaluated (i.e., at least every 2 years) to ensure effectiveness and success in protecting the species from identified threats. (USFWS, 2019)

Recovery Priority Number: 5C

Delisting Criteria:
1. The Alamo-Caballero Canyon population is shown to be stable or improving over a 20- year period with at least 1,500 individuals (flowering adults) according to the following measures: a) The Alamo-Caballero Canyon population has been designated as the core recovery population. The Alamo-Caballero Canyon population includes all individuals (flowering adults) located with these two canyon systems. This core population will be monitored yearly using annual demographic trend monitoring at representative sites to provide a population estimate based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. b) Approximately every 5 years, range wide and peripheral counts within Alamo and Caballero Canyons will be conducted using standardized methods peer-reviewed by species experts and approved by the Service. c) Species presence and abundance is maintained at the aforementioned level within the core Alamo-Caballero Canyon population. The population shall be considered stable when a linear regression analysis (or other method which has been peerreviewed by species experts and approved by the Service) of the population numbers estimated from the results of annual demographic monitoring reveals no significant decline in numbers. d) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain a resilient population. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve

a resilient population, if necessary. The recovery criteria would be reassessed to establish more appropriate population numbers, if necessary. (USFWS, 2019)

2. The 7 additional canyon systems (outside of Alamo-Caballero canyon) which represent occupied habitat for the Sacramento prickly poppy are shown to maintain stable or improving occupancy over a 20-year period with at least 75% of the canyons demonstrating an average of 75% probability of occupancy over this time frame, according to the following measures: a) Maintain or increase occupied and high probability of occupancy habitat within these canyon systems. b) These additional canyon systems will be surveyed at least once every 2 years utilizing annual occupancy monitoring at representative sites within each canyon to provide a probability of occupancy for the canyon based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible. c) Occupancy is maintained at the aforementioned levels within the additional canyon systems. The canyon system shall be considered stable when occupancy analysis based on methodology peer-reviewed by species experts and approved by the Service reveals no significant decline in occupancy. d) As well as demonstrating no significant decline in occupancy, each canyon system should maintain functionality over the 20-year period with appropriate demonstrated population dynamics as defined by methodology peer-reviewed by species experts and approved by the Service. e) Approximately every 5 years, efforts to characterize occupied and high probability of occupancy habitat throughout the canyon systems should be conducted based on methodology peer-reviewed by species experts and approved by the Service. f) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain resiliency across these populations. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. (USFWS, 2019)

3. Genetic diversity is maintained within the core Alamo/Caballero canyon population, and throughout populations within canyon systems which are considered occupied habitat, according to the following measures: a) The weak genetic divergence that has been observed between populations found in different canyon systems is maintained at a sufficient level to avoid any potential outbreeding depression as defined by methodology peer-reviewed by species experts and approved by the Service. b) The genetic corridors between populations are maintained through patterns of occupancy within different canyon systems to promote gene transfer as defined by methodology peer-reviewed by species experts and approved by the Service. (USFWS, 2019)

4. The existing species-specific management recommendations (developed in coordination with the Service and implemented by the appropriate land management entity/entities) have been effective and successful in protecting the species over the 20-year period required to reach the delisting criteria described above. In addition, all land managing agencies have developed a Post-Delisting Monitoring Plan (which has been approved by the Service's Southwest Regional Director) to cover a minimum of 5 years post-delisting of the species and are prepared to implement this plan prior to delisting to ensure the ongoing conservation of the listed species

and the continuing effectiveness of management actions. a) In addition to this criterion, monitoring and research have been completed to conclude with a high degree of certainty that population sizes, quality, configuration, and management are adequate to provide a high probability of species survival (greater than 90 percent over 100 years). (USFWS, 2019)

Recovery Actions:

- Study biological and habitat requirements of the species. (USFWS, 1994)
- Develop a management plan for the City of Alamogordo's water pipeline project in the Alamo and Fresnal Canyon systems with measures to avoid or reduce impacts to populations. (USFWS, 1994)
- Develop a management plan with the Lincoln National Forest and the Bureau of Land Management for Sacramento prickly poppy plants located on lands under their jurisdiction. Conduct long-term monitoring studies to evaluate the impacts of livestock grazing and trampling, and off-road vehicles on these populations. (USFWS, 1994)
- Develop a management plan with the New Mexico State Highways and Transportation Department for populations occurring in the Highway 82 right-of-way and any other plants affected by their management. (USFWS, 1994)
- Develop a conservation agreement with private landowners to protect plants on private property. (USFWS, 1994)
- Conduct surveys in potential habitat. (USFWS, 1994)
- Study biological and habitat requirements of the species. (USFWS, 2013)
- Develop a management plan for the City of Alamogordo's water pipeline project in the Alamo and Fresnal Canyon systems with measures to avoid or reduce impacts to populations. (USFWS, 2013)
- Develop a management plan with the Lincoln National Forest and the Bureau of Land Management for Sacramento prickly poppy plants located on lands under their jurisdiction. Conduct long-term monitoring studies to evaluate the impacts of livestock grazing and trampling, and off-road vehicles on these populations. (USFWS, 2013)
- Develop a management plan with the New Mexico State Highways and Transportation Department for populations occurring in the Highway 82 right-of-way and any other plants affected by their management. (USFWS, 2013)
- Develop a conservation agreement with private landowners to protect plants on private property. (USFWS, 2013)
- Conduct surveys in potential habitat. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Establishing a specific survey protocol, methodology, and monitoring schedule to document population trends and gain an accurate assessment of population size and extent would be beneficial for the poppy. Additionally, threats that could be managed through landowner action such as livestock herbivory and water development/diversion should be reduced to the maximum extent practical and monitored to determine existing and on-going impacts to the Sacramento prickly poppy and its habitat. A species status assessment to inform a recovery plan revision should, when workload permits, be conducted to incorporate new information on the species. Research is needed to better understand best practices that would support restoring the poppy throughout its range and to identify habitat requirements of the species. This research should include analyzing the long-term viability of the poppy to determine if inbreeding depression or other factors may exist that are limiting poppy fecundity and recruitment

and develop management recommendations that could prevent the continued decline in poppy population size and resilience. Investigation is also needed to determine if the acquisition of water rights under the existing water rights law established by the state of New Mexico is possible to protect habitat for the Sacramento prickly poppy (USFWS, 2022).

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SPECIES ACCOUNT: *Argyroxiphium kauense* (Mauna Loa (=Ka'u) silversword)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/07/1993; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

The Ka'u silversword is an erect rosette shrub, primarily with a single rosette, but occasionally branched. Leaves are pointed, 20 to 40 cm (8 to 16 in) long, 3 to 7 mm (0.1 to 0.3 in) wide at midpoint, and triangular in cross-section. The leaves are covered with a grayish-silver pubescence (downy hairs). Plants grow vegetatively for many years before flowering. Mature plants may be up to 1.3 m (4.25 ft) tall and 40 to 80 cm (16 to 31 in) in rosette diameter. Flowering generally occurs in July and August. The inflorescence (flowering stem) elongates from the apical meristem (growth tip) of the rosette and is 1 to 2 m (about 3.3 to 6.5 ft) tall and 15 to 30 cm (6 to 12 in) wide. The inflorescence usually has 100 to 350 capitula (flowering heads), each of which has between 50 to 200 florets (densely clustered small flowers). Ray florets usually number 3 to 11. Flowers are pale yellow, yellow with a rose tinge, rose, or sometimes wine-red. Fruits are dry, black, single-seeded achenes (thin-walled fruits) that are up to 1 cm (0.4 in) long and 1.5 mm (0.06 in) wide (Carr 1985, Meyrat 1982, Powell, unpublished data). (USFWS, 1995)

Taxonomy

The silverswords of Mauna Kea and Mauna Loa were considered the same taxon (Argvroxiphium sandwicense) by Hillebrand (1888), Skottsberg (1926), and Keck (1936a). Rock and Neal (1957) determined that the silverswords from the Ka'u district of Mauna Loa were different from those of Mauna Kea and Haleakala and named the silversword from Ka'u Argyroxiphium sandwicense var. kauense Rock and Neal. Meyrat (1982) found that the silverswords from Kahuku Ranch, Ka'u District, and those from Upper Waiakea Forest Reserve, South Hio District, of Mauna Loa differed significantly in five characters (plant length, leaf width, inflorescence length, number of capitula per raceme, and involucral bract length). The Ka'u silversword differs from the Mauna Kea silversword (Argyroxiphium sandwicense DC subspecies sandwicense and the Haleakala silversword (Argyroxiphium sandwicense subspecies macrocephalum (A. Gray) Meyrat), primarily by having the vegetative rosette of leaves elevated on an erect stem. The leaves ofthe Ka'u silversword are longer and thinner than those of the Mauna Kea or Haleakala silverswords and are triangular rather than flat in cross-section. Leaf pubescence (hairiness) is somewhat sparser than that of the Mauna Kea or Haleakala silverswords; therefore, leaves of the Ka'u silversword appear silvery-grey rather than silver-white. (USFWS, 1995)

Historical Range

The Ka'u silversword has been frequently sighted and collected on Mauna Loa, but may have also existed on Hualalai in historic times (Carr 1985). (USFWS, 1995)

Current Range

The current range is restricted slopes of Mauna Loa, Island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description
On July 2, 2003, the U.S. Fish and Wildlife Service designated critical habitat for Argyroxiphium kauense.

Critical Habitat Designation
Four critical habitat units are designated for Argyroxiphium kauense. Of the four units, only ''Hawaii 10— Argyroxiphium kauense—a'' is currently unoccupied by the species.

Hawaii 10—Argyroxiphium kauense—a: This unit, which contains no named natural features, lies in the Kiholo watershed and is completely within the Puuwaawaa Wildlife Sanctuary. This unoccupied unit, in combination with adjacent Kamehameha Schools land, provides habitat for one population of 2,000 individuals. This unit provides the northwesternmost critical habitat within the species' historical range.

Hawaii 24—Argyroxiphium kauense—b: This unit contains the upper portions of Hionamoa, Kauhuula, Moaula, Pikea, and Waihaka gulches, Makaka Ravine, Puu Kinikini summit, and Maunaanu Waterhole. The southern portion lies in the Hilea watershed, the northern portion in Kapapala watershed, and the central portion in the Pahala watershed. The northeast portion is in the Kapapala Forest Reserve. This unit provides habitat for four populations of 2,000 individuals and is currently occupied by about 1,130 individuals of A. kauense in three locations. This unit provides the southernmost critical habitat within the species' historical range.

Hawaii 25—Argyroxiphium kauense—c: This unit contains a portion of Kipuka Kulalio and Kipuka Maunaiu in the Kapapala watershed. This unit provides habitat for one population of 2,000 individuals and currently is occupied by about 1,000 outplanted individuals of A. kauense.

Hawaii 30—Argyroxiphium kauense—d: This unit contains portions of the lava flows of 1852 and 1942 and lies mostly in the Wailoa watershed, with the southern tip in the Kaahakini watershed. The upper area of the unit lies in portions of Upper Waiakea Forest Reserve and Mauna Loa Forest Reserve. The southern portion is part of the OlaaKilauea Partnership. This unit provides habitat for two populations of 2,000 individuals of A. kauense and is currently occupied by fewer than 500 individuals. This unit provides the easternmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features
The habitat features contained in these four units that are essential for this species include, but are not limited to:

(i) subalpine forests,

(ii) bogs, and

(iii) mountain parkland.

Special Management Considerations or Protections
Not available

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1995)

Lifespan

Adult: While it is a long-lived species, it is monocarpic (i.e., flowering only once before dying) (USFWS 1995). Therefore, for these purposes, it will be treated effectively as an annual that grows, flowers once, and dies, although over a longer period of time than an annual. The species does not behave biologically as a long-lived perennial, which could grow and flower annually and repeatedly for over 10 years prior to dying. (USFWS, 2019)

Dependency on Other Individuals or Species

Adult: Flying insects, including native bees (Nesoprosopis sp.), non-native flies, and native moths (Agrotis sp.), are typical pollinators of the Mauna Kea silversword (Powell 1992a) and may also be pollinators of the Ka'u silversword. (USFWS, 1995)

Reproduction Narrative

Adult: The species is monocarpic, that is, the single, non-flowering rosette grows for a number of years, and then produces a tall inflorescence; after fruit set, the entire plant dies. The life trait of this monocarpic (only flowering once before dying) species suggests it can take 10 to 50 years to first flower (Carr 1985; Carlquist et al. 2003). The Ka'u silversword probably reproduces only by seed; there is no evidence of vegetative reproduction. The low seed set found for certain individuals of the Ka'u silversword also indicates that this species is at least partially self-incompatible. Flying insects, including native bees (Nesoprosopis sp.), non-native flies, and native moths (Agrotis sp.), are typical pollinators of the Mauna Kea silversword (Powell 1992a) and may also be pollinators of the Ka'u silversword. (USFWS, 1995; USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1995)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 1995)

Habitat Narrative

Adult: This species grows in boggy patches within wet forests or, in drier areas, in subalpine moist forests on old lava flows. The Keapohina population occurs in moist open forest with short stature o'hia trees and an understory of shrubs, grasses, and herbs. The substrate is a'a (rough) lava with well-developed soil. The annual mean rainfall in the Keapohina area is about 10 to 15 cm (3.9 to 5.9 in), but moisture is also available to the silverswords as condensation from frequent afternoon fogs. The silverswords found in the Kapapala Forest Reserve in the past were on weathered, old pahoehoc (smooth) lava with pockets of soil, in subalpine mountain parkland vegetation dominated by shrubby o'hia and scattered shrubs. The historic range of the Ka'u silversword may have corresponded with a mean annual rainfall of about 100 to 300 cm (39 to 118 in). Rainfall of about 100 to 150 cm (39 to 59 in) currently occurs on the south slope of Mauna Loa in the Ka'u district from 1,500 to 2,100 m (5,000 to 7,000 ft) elevation (Giambella et al. 1986). On the east slope of Mauna Loa in South Hio District from 1,500 to 2,500 m (about 5,000 to 8,000 ft) elevation, mean annual rainfall is between 150 and 300 cm (59 and 118 in) (Giambella et al. 1986). Argyroxiphium kauense remains to be found in three geographically separated wild populations scattered across the species' former range on Mauna Loa. (USFWS, 1995; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

3 (USFWS, 2020)

Population Size:

~1,000 individuals and 24,000+ outplanted (USFWS, 2020)

Population Narrative:

At the time of Federal listing, Argyroxiphium kauense consisted of two wild populations: Powerline Road in Upper Waiakea Forest Reserve and Ke a Pohina on Kahuku Ranch, with an estimated total of 540 individuals (USFWS 1993). As of 2007, A. kauense is found in three geographically separated wild populations consisting of about 1,000 individuals scattered across the species' former range on Mauna Loa, island of Hawaii. The three populations exhibit differential adaptation to the habitats in which they are found: Kahuku (approximately 700 individuals in mesic to wet forest), Kapapala (approximately 20 individuals in mesic shrubland and open forest) and Waiakea (approximately 150 individuals in montane bog) (Perry 2007). No recruitment has been observed in the remnant Kapapala population, but some recruitment has been observed at the remnant Kahuku and Waiakea populations (R. Robichaux, Hawaiian Silversword Foundation, pers. comm. 2007, 2008a). Approximately 24,000 seedlings have been reintroduced into fenced exclosures within the historical range of the species (Perry 2007; R. Robichaux, pers. comm. 2008a). However, the life trait of this monocarpic (only flowering once before dying) species suggests it can take 10 to 50 years to first flower (Carr 1985; Carlquist et

al. 2003). Only a handful of the reintroduced seedlings have produced flowers, but none have yet to produce seedlings (R. Robichaux, pers. comm. 2007, 2008a). (USFWS, 2020)

Threats and Stressors

Stressor: Herbivory (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Browsing by feral and domesticated ungulates has been identified as the primary reason for the decline of the Ka'u silversword. Mouflon sheep were introduced to Kahuku Ranch in 1968 (J. Canfield, personal communication 1992) and have steadily increased in numbers there (Mitchell 1981; Cuddihy and Stone 1990). Severe browse damage to Ka'u silverswords was noted in 1984 (E. Powell, personal observation 1984). Although a 1 hectare (2.5 acre) area of the Keapohina population was fenced by Kahuku Ranch personnel in 1982 to protect the silverswords, mouflon were able to gain entry to the fenced area. The mouflon apparently preferred the silversword and Machaerina mariscoides plants as browse species, as these two species were the only plants in the area that were severely browsed in 1984 (E. Powell, personal observation 1984). In 1991, browse damage to Astehia sp. was noted (J. Canfield, personal communication 1992). Feral pigs are currently a major threat to the Ka'u silversword both at Keapohina and in the Upper Waiakea Forest Reserve. Rooting by feral pigs disrupts natural vegetation and uproots and damages small silversword plants. Rooting by pigs is particularly destructive in bogs (Medeiros et al. 1991). Insects (including fruit parasites), drought, human disturbance, alien plants and disease have all been suggested as probable threats to the Ka'u silversword (U.S. Fish and Wildlife Service, 1990). Ungulate damage to the species has been so severe and population numbers have declined so rapidly that other possible threats are currently of lesser importance, but may become more significant if population sizes continue to drop. The single most serious threat to the immediate survival of the Ka'u silversword is that posed by feral and domestic ungulates, including cattle, goats, pigs, and mouflon sheep. (USFWS, 1995)

Stressor: Lava flows (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Populations of the Ka'u silversword may have been eliminated by lava flows from Mauna Loa in historic times (Keck 1936b). Lava flows and the damage caused by feral ungulates may have combined to hasten the endangerment of the Ka'u silversword. However, the fact that the Ka'u silversword is endemic to Mauna Loa, an active volcano, indicates that the species was able to survive thousands of years of eruptive activity. Before feral and domestic ungulates arrived on Mauna Loa, the silversword apparently sustained a widespread population in dynamic equilibrium between chance extinctions of some populations from lava flows and founding of new populations in developing kipukas. (USFWS, 1995)

Stressor: Small population size (USFWS, 1995)
Exposure:
Response:
Consequence:

Narrative: Small population size and localization are major threats to the survival of a species. In 1984, a lava flow from Mauna Loa came within about 2 kilometers (1.2 miles) of the silversword bog in the Upper Waiakea Forest Reserve. Because that silversword population is confined to a single bog, the population is vulnerable to chance lava flows, fires, or other natural disasters. Even an extended drought could drive the population to extinction. The Keapohina population is also threatened by lava flows from Mauna Loa, or potentially by fire, hurricane damage, or earthquakes. A widespread species is less likely to become extinct due to lava flows, other natural disasters, or even human disturbance. It is almost certain that this species was historically widespread. (USFWS, 1995)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Argyroxiphium kauense is minimally vulnerable to the impacts of climate change. (USFWS, 2015)

Recovery

Reclassification Criteria:
1) There are 5 to 10 populations in suitable, protected habitat with 2,000 mature individuals per population; (USFWS, 2019)

2) All major threats are controlled around the target populations; (USFWS, 2019)

3) Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed; (USFWS, 2019)

4) All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary. (USFWS, 2019)

Delisting Criteria:
1) All of the downlisting criteria have been met; (USFWS, 2019)

2) All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management. (USFWS, 2019)

Recovery Actions:
- Securing habitat and stabilizing the current populations through negotiations with the Damon Estate, the State of Hawai'i and the National Park Service. (USFWS, 1995)
- Control of ungulates through improved fencing and hunting programs and monitoring of populations are of utmost importance. (USFWS, 1995)

- Reduction of human related disturbance and an investigation of the effects of alien plants on growth and reproduction are also important recovery activities. (USFWS, 1995)
- A research program should also be initiated to determine the physiological and environmental factors influencing habitat preferences; assess the factors limiting germination and seedling establishment and those influencing reproductive biology; determine the need for genetic management; study associated insects and causes of mortality; and to develop methods to reduce other threats that may be discovered. (USFWS, 1995)
- An effort to re-establish the Ka'u Silversword in its former range should also be initiated, including the selection and protection of sites for re-establishment, cross-pollination of existing plants, collection and storage of seed, nursery propagation, seeding and/or transplantation of nursery grown plants, and monitoring and refinement of the program. (USFWS, 1995)
- Continue maintenance of exclosure fencing. Establish new and expand existing exclosures within historical range. (USFWS, 2009)
- Continue reintroduction of new maternal lines into existing exclosures, and new exclosures as available, as additional wild individuals flower. (USFWS, 2009)
- Continue to work with the Tri-Mountain Alliance and Hawaii Volcanoes National Park to implement ecosystem-level restoration and management to benefit this species on Mauna Loa. (USFWS, 2009)
- Assess the pollination and natural recruitment of wild and reintroduced plants. (USFWS, 2009)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2015)
- Augment current natural populations to increase numbers of individuals. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Continue control and maintenance of invasive plants within fenced exclosures. (USFWS, 2015)
- Continue monitoring wild and outplanted individuals for a thorough current assessment of the species' status. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue maintenance of exclosure fencing. Establish new and expand existing exclosures within historical range. • Continue reintroduction of new maternal lines into existing exclosures, and new exclosures as available, as additional wild individuals flower. • Continue to work with the Tri-Mountain Alliance and Hawaii Volcanoes National Park to implement ecosystem-level restoration and management to benefit this species on Mauna Loa. • Assess the pollination and natural recruitment of wild and reintroduced plants. (USFWS, 2020)

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SPECIES ACCOUNT: *Argyroxiphium sandwicense ssp. sandwicense* (`ahinahina (Mauna Kea silversword))

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/21/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

The Mauna Kea silversword is a giant rosette plant. The plant grows as a ball-shaped basal rosette composed of narrow lance-shaped leaves that may be up to 39 cm (15.35 ins) long and up to 1.5 cm (.59 in) wide at the midpoint. Leaves are coated with silvery hairs. Branched (polycarpic) individuals produce a tight cluster of rosettes of various sizes. The entire cluster may be up to 150 cm (59.06 in) in diameter. Unbranched (monocarpic) individuals produce a single large rosette, of up to 75 cm (29.53 in) in diameter. At flowering, monocarpic individuals produce a single large raceme, up to 300 cm (118.11 in) in height, and have numerous short branches, each terminating in a single capitula of flowers. The inflorescence stalk, the bracts that subtend the pedicels, and the involucre bracts are all covered with sticky glandular hairs that emit a faint sweet odor. Flower heads (capitula) are 2 cm (.79 in) in diameter, and have white to pink ray florets and pink to maroon disk florets. Each floret produces a single fruit, an achene, which may or may not contain a single seed. Achenes are black, 1 cm (.39 in) long, and have a pappus of 1 to 6 short scales (USFWS, 1993).

Taxonomy

The Mauna Kea silversword is the type species for the genus Argyroxiphium, which includes the Hawaiian silverswords and greenswords. The genus consists of four extant and one extinct species of silverswords and greenswords endemic to the islands of Maui and Hawai'i of the Hawaiian Islands (Carr 1985). The Hawaiian name for the silverswords is 'Ahinahina, which means "very gray" and is used for a number of unrelated plant species with silvery leaves. The similarity in vegetative features between Mauna Kea silversword and the Haleakala silversword has led several authors to consider these taxa as the same species. Keck (1936) placed both silverswords under Argvroxiphium sandwicense DC. St. John (1973) also considered the two taxa to be the same. Based on a morphometric analysis, Meyrat et al. (1984) designated Mauna Kea silversword and the Haleakala silverswords as subspecies of Argvroxiphium sandwicense. Carr (1985) followed this nomenclature in his monograph of the Hawaiian Madiinae. This nomenclature was also accepted by Wagner et al. (1990). The Service accepts the designation of Mauna Kea silversword at the subspecies level. The Mauna Kea silversword is distinguished from the Haleakala silversword by a high frequency of branching; taller, thinner inflorescences; green bracts subtending flower heads; fewer ray florets; and obvious pappus on disk achenes. (USFWS, 1993)

Historical Range

The Mauna Kea silversword probably only occurred on Mauna Kea, Hawaii. (USFWS, 1993)

Current Range

The Mauna Kea silversword is only found in Mauna Kea, Hawaii (USFWS, 2012)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2012)

Lifespan

Adult: 50 years or more (inferred from USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Pollinators such as insects (USFWS, 2012)

Breeding Season

Adult: June to September (USFWS, 2012)

Reproduction Narrative

Adult: Flowering of Argyroxiphium sandwicense subsp. sandwicense, which may be entirely absent in some years (R. Robichaux, Professor of Biology, University of Arizona, pers. comm. 2001), occurs between June and September (USFWS 1993; Bishop Museum 2011; National Tropical Botanical Garden 2011). An individual typically flowers only once during its life (monocarpic), or more infrequently it can form branches from near the base, each of which flowers and subsequently dies back (polycarpic) (Wagner et al. 1999; USFWS 1993). Argyroxiphium sandwicense subsp. sandwicense is mostly self-incompatible, which means it is dependent on insects or other vectors to pollinate its flowers. Observed and recorded hybridization events appear to be generally rare in the wild for Argyroxiphium sandwicense subsp. sandwicense. Individuals may live from 3 to 50 years before flowering (USFWS 1993). (USFWS, 2012)

Habitat Type

Adult: Terrestrial (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Alpine cinder deserts, alpine shrublands, lava outcrops, rocky gulches, cinder cones, and subalpine forests. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 2,600 to 3,800 meters (USFWS, 1993)

Spatial Arrangements of the Population

Adult: Widely scattered (USFWS, 1993)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1993)

Site Fidelity

Adult: High (USFWS, 1993)

Habitat Narrative

Adult: The area of the probable original range of the Mauna Kea silversword includes several distinct vegetational and climatic zones of Mauna Kea. The upper region from 3400 to 3800 meters (11,152 to 12,464 feet) elevation is barren alpine cinder desert. The surface is covered with glaciated and unglaciated block lava and cinders. Mosses, lichens, and grasses (Trisetum glomeratum and Agrostis sandwicensis) grow in widely scattered patches in the shelter of or on the sheltered surface of rocks. The region between 3200 and 3400 meters (10,496 to 11,152 feet) elevation is scrub desert. The substrate is also block lava and cinders. The region between 2900 and 3200 meters (9512 and 10,496 feet) elevation may have been the area of the original treeline of Mauna Kea. This area is now alpine scrub and the substrate is lava outcrops and ash. Open mamane forest begins between 2600 and 2900 meters (8528 and 9512 feet) elevation. The soil in this region is mostly ash with lava outcrops. (USFWS, 1993)

Dispersal/Migration

Dispersal

Adult: Abiotic (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Dispersal of the seeds occurs by wind and water (USFWS, 2012).

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

2 wild populations; number of outplanting populations uncertain (USFWS, 2012)

Population Size:

15-16 (USFWS, 2020)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

Low seed set, self-incompatible, monocarpic. Recent summaries suggest that two wild populations of Argyroxiphium sandwicense subsp. sandwicense currently exist, comprising only approximately 27 individuals (Plant Extinction Prevention Program 2010; USFWS 2010). Several outplantings presently exist that collectively harbor at least 10,000 individuals (USFWS 2010; J. Hatayama, Protection Forester, Hawaii Department of Land and Natural Resources, Division of Forestry and Wildlife, pers. comms. 2011a,b,c), but details concerning the number of outplanted populations and number of individuals within each outplanted population have not been confirmed with certainty. Data are not available that summarize what proportion of individuals flowered (and presumably die) each year (J. Hatayama, pers. comm. 2011a,b). What is certain, however, is that most individuals are on the east and north slopes of Mauna Kea between

Kanakaleonui and the road accessing the summit, and most of these are in the Wailuku exclosure; smaller populations (numbers unknown) persist in the skyline and Puu Nanana exclosures; nearly all surviving individuals were reintroduced; seedling survival in the wild is nearly non-existent; and the subspecies is not sustaining itself naturally due to high seedling mortality (J. Hatayama, pers. comm. 2011a,b,c). (USFWS, 2012; NatureServe, 2015) Currently there are 15 to 16 wild individuals of Argyroxiphium sandwicense subsp. sandwicense on Mauna Kea on the island of Hawai'i. A landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that A. sandwicense is highly vulnerable to the effects of climate change. All populations of A. sandwicense subsp. sandwicense are provided protection from feral ungulates by fencing; however, ungulate pressure on fencing is high. Hand pollination, seed collection, propagation, and reintroduction are ongoing for this subspecies. (USFWS, 2020)

Threats and Stressors

Stressor: Herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Feral sheep (Ovis aries) and other ungulates readily eat the relatively succulent leaves of Argyroxiphium sandwicense subsp. sandwicense. Human-mediated declines in the overall population size, indirectly due to the intentional introduction of ungulate species such as cattle (Bos taurus), goats (Capra hircus), and sheep, may have occurred as much as 186 years ago, given that an early collector of specimens, James Macrae, observed a dead sheep near the summit of Mauna Kea in 1825 (USFWS 1993). Sheep may have been driven to the highest portions of Mauna Kea due to hunting pressure from humans and feral dogs, and the succulent leaves of Argyroxiphium sandwicense subsp. sandwicense likely were preferentially browsed by sheep in the arid, alpine habitat of Maua Kea. The grazing pressure may have been enormous, given one estimate of approximately 40,000 sheep on Mauna Kea in the late 1930s. Goats also damage the subspecies (USFWS 1993). Feral pigs (Sus scrofa) up root and damage the species (USFWS 1993). Invertebrate predation or herbivory – Kobayashi (1974) reported that Argyroxiphium sandwicense is largely unaffected by insect predation in the seedling stage, and that such predation mostly commences after the terminal inflorescence forms. The predators most affecting this subspecies are Rhynchephestia rhabdotis and Tephritis cratericola, which feed on developing seeds. However, this study focused on subspecies macrocephalum (Kobayashi 1974), so it is uncertain whether these finding also apply to subspecies sandwicense. Rodent herbivory and predation may also occur. (USFWS, 2012)

Stressor: Collection (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Collection of silversword plants by humans has been, and is currently, a potential threat to the Mauna Kea silversword. The paucity of herbarium specimens of the Mauna Kea silversword, however, suggests that the species was never heavily collected for scientific purposes. Plants were occasionally removed from Mauna Kea for ornamental purposes in the 1920's, but these removals were probably not performed on a large scale. In areas where the

silversword populations had already declined to a few individuals, removals may have represented a large reduction or the final elimination of a population. Between September 1987 and July 1988, three adult plants were removed from the Skyline population. This removal may affect the survival potential of this already small population (USFWS, 1993).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Invasive species (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: There are established invasive plant species competition by the following species: Anthoxanthum odoratum (sweet vernal grass), Rytidosperma pilosum (hairy oat grass), and Verbascum thapsus (mullein) (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: There is an increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (J. Hatayama, pers. comm. 2011c; Plant Extinction Prevention Program 2010) (USFWS, 2012).

Stressor: Climate change loss or degradation of habitat (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) was conducted at the species level, and concluded that Argyroxiphium sandwicense is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.536 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). However, the two subspecies, macrocephalum and sandwicense, are endemic to separate islands (Maui and Hawai‘i, respectively) Therefore, additional management actions are needed to conserve A. sandwicense subsp. sandwicense into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2020)

Recovery

Reclassification Criteria:
1) There are 5 to 10 populations in suitable, protected habitat with 2,000 mature individuals per population; (USFWS, 2019)

2) All major threats are controlled around the target populations; (USFWS, 2019)

3) Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed; (USFWS, 2019)

4) All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary. (USFWS, 2019)

Delisting Criteria:
1) All of the downlisting criteria have been met; (USFWS, 2019)

2) All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Subspecies-specific management actions must no longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management. (USFWS, 2019)

Recovery Actions:
- Protect all extant individuals from feral ungulates, fire and human-related disturbances. (USFWS, 1993)
- Monitor and research existing populations. (USFWS, 1993)
- Develop and implement a program to enhance regeneration within existing populations. (USFWS, 1993)
- Reestablish the silversword within areas of historic abundance, and verify recovery objectives. (USFWS, 1993)
- Protect existing populations of Mauna Kea silversword (USFWS, 1993).
- Monitor and research existing populations (USFWS, 1993).
- Develop and implement a program to enhance regeneration within existing populations (USFWS, 1993).
- Reestablish Mauna Kea silversword within areas of historic abundance (USFWS, 1993).
- Verify recovery objectives (USFWS, 1993).
- Captive propagation for genetic storage and reintroduction: Collect seed from all wild individuals that may be found for use in propagation, to increase the genetic variability of breeding stock. Continue to collect seed material from all populations. Attach tags to individuals to record which individuals have served as maternal parents in propagation efforts ex situ. (USFWS, 2012)
- Reintroduction / translocation implementation: Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Ungulate enclosure: Construct large-scale fences around all existing and any new populations. Monitor fenced exclosures for evidence of breaching by feral ungulates. (USFWS, 2012)

- Ungulate control: Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Surveys / inventories: Resurvey the historical range of Argyroxiphium sandwicense subsp. sandwicense for additional individuals or populations and to determine the current status of the species. (USFWS, 2012)
- Reintroduction / translocation site identification: Conduct surveys to determine which areas would be most appropriate for additional reintroductions. In particular, focus on the northern and western slopes of Mauna Kea, where reintroduction sites are less common. (USFWS, 2012)
- Competitive invasive plant species control: Remove invasive introduced plant species around all known populations, especially within fenced exclosures. (USFWS, 2012)
- Predator / herbivore control: Control rodents around existing populations. (USFWS, 2012)
- Threats research: Develop and implement effective measures to reduce the impact of collection. Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Invertebrate control research: Research the effects of invertebrates around existing and reintroduced populations. If research deemed an immediate threat, determine and implement effective control measures. (USFWS, 2012)
- Reintroduced / translocation population management and monitoring: Continue to monitor reintroduced populations twice annually for signs of significant population decreases and for other signs of distress, such as insect damage or evidence of plant disease. (USFWS, 2012)
- Alliance and partnership development: Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or other significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Surveys and inventories— o Continue to survey historical range for a thorough assessment of the subspecies' status. o Continue to monitor reintroduced populations for signs of significant population decreases and other signs of distress. • Ungulate monitoring and control—Continue to monitor and modify exclosures to prevent ungulate ingress. Control ungulates if present in fenced areas. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species at all populations, especially within exclosures. • Climate change adaptation strategy—Assess the modeled effects of climate change on this subspecies and use to determine future landscape needed for its recovery. • Collection—Develop and implement effective measures to reduce the impact of collection. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents. o Continue to research the effects of nonnative invertebrates on A. sandwicense subsp. sandwicense. Determine and implement effective control methods is needed. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o Continue hand-pollination efforts to establish representation of genetic diversity. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to these species to build resiliency and redundancy to reduce impacts of loss of viability. • Population biology research— o Continue to investigate techniques to improve seed and seedling viability to improve natural recruitment. o Continue to research which

sites are most suitable for reintroduction efforts with climate change effects taken into consideration. • Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit these species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—The Plant Extinction Prevention Program (PEPP) monitors wild and reintroduced populations of A. sandwicense subsp. sandwicense (PEPP 2010, 2011, 2012, 2015). • Ungulate monitoring and control—A 2.4-hectare (ha) (6-acre (ac)) fence was constructed to protect the core A. sandwicense subsp. sandwicense reintroduced population at Waipāhoehoe on Mauna Kea in September and October 2015. The fence was constructed with assistance from Mauna Kea Forest Restoration Project, Mauna Kea Watershed Alliance, and Hawai‘i State Natural Area Reserve System staff. This fence protects the core area of the reintroduced population that represents the greatest genetic diversity of the entire species and is the site of the best natural recruitment seen thus far. This population was threatened in September 2015 by ingress of mouflon and feral pigs into the existing 20-ha (50- ac) exclosure. The old exclosure included a 1.2 meter (m) (4-foot (ft) hogwire fence and new unit, which is a smaller 2.4 ha (6-ac) fence within the larger unit, includes 1.8 m (6-ft) hogwire (PEPP 2016). Since construction of that unit in late 2015, the larger unit has experienced substantial ingress by feral pigs and widespread damage to the reintroduced population. The 20-ha (50-ac) fence is not adequately skirted and pigs continue to find areas of weakness (PEPP 2018). In response to this continuing problem and to insure that pigs do not get into the smaller “core” unit, PEPP organized an effort to skirt the entire core unit, recruiting help from the State’s Natural Areas Reserve program, the Mauna Kea Forest Reserve program, Hawai‘i Volcanoes National Park-Resource Management, and the Hawai‘i Silversword Foundation. Skirting on the south side of the fencing unit was completed (PEPP 2018). • Captive propagation for genetic storage and reintroduction— o The Volcano Rare Plant Facility (VRPF) reports collection and storage of 24,000 seeds from the Pōhakuloa Gulch population, and 52,000 seeds from the Waipāhoehoe population (VRPF 2019). o Hawai‘i Island PEPP staff continued to collaborate with conservation partner Rob Robichaux of the Hawai‘i Silversword Alliance and facilitated pollen exchange between the known founders of A. sandwicense subsp. sandwicense at Waipāhoehoe with the flowering founders at Pōhakuloa Gulch on Mauna Kea (PEPP 2015). This effort has been conducted over the last several years. The plants were marked and are monitored for seed set. In 2016, collections were made from six crosspollinated founders from two separate populations (PEPP 2016). • Reintroduction and translocation—PEPP reports reintroduction and survival of 35 immature plants of A. sandwicense subsp. sandwicense at Mauna Kea (Ice Age site) in 2014 and more than 12,000 reintroduced individuals at a second population at Mauna Kea, and nine mature individuals at Waipāhoehoe Gulch with a second reintroduced population there of 1,000 individuals in 2017. In 2018, PEPP reintroduced an additional 425 plants at the Mauna Kea reintroduction site from a mix of founders (PEPP 2017, 2019). (USFWS, 2020)

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SPECIES ACCOUNT: *Argythamnia blodgettii* (Blodgett's silverbush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/31/2016; Southeast Region (R4)

Physical Description

Argythamnia blodgettii, in the Euphorbia family, is an erect, perennial shrub or herb, 10 to 60 cm (4 to 24 in) tall, with a woody base and small, green flowers. The stems and leaves are covered with small hairs. The leaves, arranged alternately along the stems, are 1.5 to 4.0 cm (0.6 to 1.6 in) long, have smooth (or rarely toothed) edges, are oval or elliptic in shape, and often are colored a distinctive, metallic bluish green. The plants have separate male and female flowers. Staminate (male) flowers have a calyx 7 to 8 mm (0.27 to 0.31 in) wide, consisting of 4 to 5 lanceshaped sepals that are larger than the petals. The petals are broadly elliptic and shorter than the sepals. There are 10 stamens. Pistillate (female) flowers have 4 to 5 sepals that are 5 to 6 mm (0.19 to 0.24 in) long, lance-shaped, and often more narrow than those of male flowers. The petals are broadly elliptic, shorter than the sepals. The fruit is a woody capsule 4 to 5 mm (0.16 to 0.19 in) wide, which contains the seeds (Adapted from Small 1933, pp. 784–785; Bradley and Gann 1999, p. 2). (USFWS, 2015)

Taxonomy

Botanist John Torrey first described the species in Chapman (1884, p. 100) as Aphora blodgettii, reporting it for South Florida. In an 1896 (p. 100) revision of the genus, Pax placed it in the genus Ditaxis. In 1897 (p. 100), Chapman placed it in the genus Argythamnia. In 1903, Small placed it again in the genus Ditaxis. In 1914, Pax (p. 100) placed it in synonymy under Ditaxis fendleri, a plant of Colombia, Venezuela, Curacao, and Trinidad. Small (1933, pp. 784–785) retained it as Ditaxis blodgettii, treating it as a southern Florida endemic. Subsequent authors (Webster 1967, p. 100; Long and Lakela 1971, p. 558; Wunderlin 1998, p. 100; Wunderlin and Hansen 2003, p. 100) have retained it as a southern Florida endemic Argythamnia blodgettii (from Hodges and Bradley 2006, p. 10). The Integrated Taxonomic Information System (2015, p. 1) uses the name Argythamnia blodgettii and indicates that this species' taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name A. blodgettii. In summary, there is consensus that A. blodgettii is a distinct taxon. We have carefully reviewed the available taxonomic information to r each the conclusion that the species is a valid taxon. Synonyms include Aphora blodgettii Torr. ex Chapm.; Ditaxis blodgettii (Torr. ex Chapm.) Pax; Argyrothamnia blodgettii (Torr. ex Chapm.) Chapm.; and Ditaxis fendleri Pax, not (Mull. Arg.) Pax and K. Hoof. (USFWS, 2015)

Historical Range

U.S., Florida, Miami-Dade and Monroe counties. Argythamnia blodgettii historically occurred from central and southern Miami-Dade County from Brickell Hammock to Long Pine Key in Everglades National Park, and in Monroe County throughout the Florida Keys from Totten Key south to Key West (Bradley and Gann 1999, p. 2) (USFWS, 2015).

Current Range

U.S., Florida, Miami-Dade County. Argythamnia blodgettii is currently known from central Miami-Dade County from Coral Gables and southern MiamiDade County to Long Pine Key in Everglades National Park, and the Florida Keys from nine islands, from Windley Key (Bradley and

Gann 1999, p. 3) southwest to Boca Chica Key (Hodges and Bradley 2006, pp. 10, 43) (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2015)

Breeding Season

Adult: Flowering and fruiting take place throughout the year (USFWS, 2015).

Other Reproductive Information

Adult: Perennial (USFWS, 2015)

Reproduction Narrative

Adult: Reproduction is sexual; flowering and fruiting apparently takes place throughout the year (Bradley and Gann 1999, p. 3) (USFWS, 2015).

Habitat Type

Adult: Low, moist limestone areas near margins of pine rocklands. Sunny edges and gaps in pine rocklands, rockland hammocks, and coastal berm (USFWS, 2013).

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Woodland - Conifer (USFWS, 2013)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2015)

Habitat Narrative

Adult: Argythamnia blodgettii grows in pine rocklands, in sunny gaps or edges of rockland hammock and coastal berm, and on roadsides (Bradley and Gann 1999, p. 3). It grows from crevices on oolitic limestone or on sand. The pine rocklands habitat where it occurs requires periodic fire to maintain an open, sunny understory with a minimum amount of hardwoods. Bradley and Gann (1999, p. 3) indicated that this species does tolerate some degree of human-induced disturbance. It can often be found along disturbed edges of pine rocklands, rockland hammock, and coastal berm, or in completely scarified pine rocklands (Bradley and Gann, 1999, p. 3) (USFWS, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Number of Populations:

55 Populations (26 extant, 15 uncertain, and 14 extirpated) (USFWS, 2023)

Population Size:

~21,000 total (USFWS, 2023)

Population Narrative:

At the time of listing, Blodgett's silverbush had been documented in 50 populations (20 extant, 15 uncertain, and 15 extirpated) in Miami-Dade and Monroe Counties (Service 2016). However, several of these populations are near each other, within NatureServe's (2020) 0.62-mile (1.0-kilometer [km]) distance to differentiate populations but occur on separate parcels or lands with different ownership and were thus treated as separate populations in the listing rule. The Service now uses NatureServe's (2020) 0.62-mile (1.0-km) distance to delineate populations. Therefore, populations in the listing rule (Service 2016) that are within 0.62 miles (1.0 km) of each other are now combined into single populations with subpopulations (Appendix A). Also, the Big Pine Key/National Key Deer Refuge population reported in the listing rule (Service 2016) has been split into three separate populations based on their distances of over 0.62 miles (1.0 km) apart. In the listing rule (Service 2016), we considered a population to have an uncertain status if it had not been surveyed in 15 or more years and extirpated if the plants were not seen during a survey or if the habitat had been destroyed. However, we have no quantitative information on how long Blodgett's silverbush seeds may persist in the soil seed bank (Service 2015), and observations from Fairchild botanists indicate they may form persistent soil seed banks (Wintergerst 2023). Therefore, in this review, we are considering a population or subpopulation extirpated if the habitat is developed or there is a negative survey more than five years old with a small (>100) or unreported number plants in the previous survey. A population or subpopulation is considered to have uncertain status if it has a negative survey within five years with presence recorded previously and habitat remaining or has not been observed in more than 15 years with presence recorded previously and habitat remaining. A population or subpopulation is considered extant if it has been observed on site in the previous 15 years. Using this new population delineation and updated status categorization, we recognize 55 populations (26 extant, 15 uncertain, and 14 extirpated) in MiamiDade and Monroe Counties (Table 1; Appendix A). This difference in population delineation reflects a reduction in the number of populations due to combining several from the listing rule, but also an increase from splitting the Big Pine Key/National Key Deer Refuge population into three separate populations. In addition to these delineation changes, the number of populations has increased due to five newly discovered populations, five population introductions, and four populations that were not reported in the listing rule (Appendix A). Additionally, the status of some populations has changed since the listing rule with six populations declining and one improving in status (USFWS, 2023). The current population size of extant Blodgett's silverbush populations in MiamiDade County is approximately 9,152 plants, which is close to the estimated population size at the time of listing (8,985 plants; Service 2016). Notably, 8 of the 11 extant populations consist of fewer than 100 plants and only 3 (Larry and Penny Thompson Memorial Park, Camp Owaissa Bauer Area, and Long Pine Key in Everglades National Park) have over 1,000 plants. The current population size of extant Blodgett's silverbush populations in Monroe County is approximately 11,885 plants, which is approximately 1,300 fewer plants than the estimated population size reported at the time of listing (13,200 plants; Service 2015 based on the Hodges and Bradley

2006 report). The difference is mostly attributed to the decline in the species at the two Naval Air Station Key West populations, between which over 1,400 plants were estimated to occur at the time of listing (Bradley and Hodges 2006; FNAI 2011, 2022; Service 2016), but only 106 plants were documented in early 2022 (Texas A & M University [TAMU] 2022). However, since the population on Big Munson Island is by far the largest with 8,000 to 9,000 plants according to Hodges and Bradley (2006) and there is no recent population estimate, the total number of plants in Monroe County could change considerably depending on the current size of the Big Munson Island population. Additionally, many of the populations in Monroe County may have experienced impacts from Hurricane Ian in October of 2022, which passed over the Keys with tropical storm force winds after the most recent surveys occurred for this review. Notably, as of April 2022, 12 of the 15 extant populations consist of fewer than 100 plants and only 3 (Lignumvitae Key Botanical State Park - Island, Cactus Hammock/Long Beach Area in National Key Deer Refuge, and Big Munson Island) have over 1,000 plants (USFWS, 2023)

Threats and Stressors

Stressor: Agricultural and residential development (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Pine rocklands in Miami-Dade and Monroe Counties have lost nearly 90 percent of their area due to agricultural and residential development (OBrien 1998, p. 208). Development has reduced the coverage of pine rocklands from 130,358 acres (52,754 ha) to 15,256 acres (6,174 ha) (OBrien 1998, p. 208). Most of the ecosystems on the Keys have been impacted by humans, through widespread clearing of rockland hammocks in the 19th century for farming, or building of homes and businesses (Hodges and Bradley 2006, p. 6). Habitat loss continues to occur in its range, and most remaining suitable habitat has been negatively altered by human activity. Outside of ENP, only about one percent of the Miami Rock Ridge pinelands have escaped clearing, and much of what is left is in small remnant blocks isolated from other natural areas (Herndon 1998, p. 1) (USFWS, 2016).

Stressor: Habitat Fragmentation/Fire suppression (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Habitat fragmentation leads to the possibility of fire suppression in and around these isolated fragments. While this plant is not entirely limited to fire-maintained pine rocklands, fire suppression threatens the survival of Blodgett's silverbush. Pine rocklands need regular fires to prevent hardwood encroachment and excessive accumulations of litter. Under natural conditions, lightning fires typically occurred at 3- to 7-year intervals. With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like Blodgett's silverbush. Fire suppression has reduced the size of the areas that burn and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Thus, many pine rocklands are gradually becoming tropical hardwood hammocks. Fire suppression threatens the Blodgett's silverbush at more than half of its remaining sites (Bradley and Gann 1999, p. 6; K. Bradley, pers. comm. 2007). The staff at NKDR is beginning to monitor the response of rare plants, including Blodgetts silverbush, to prescribed fire after years of fire suppression on the Refuge (Anderson 2010, slide 20). They have noted an increase in Blodgett's silverbush post fire.

Approximately 20 plants were recorded in the monitored area prior to the burn, and 342 plants were detected 4 months post-fire (Anderson 2010, slide 20) (USFWS, 2016).

Stressor: Nonnative plants (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Nonnative (exotic) plant taxa have significantly affected pine rocklands. As a result of human activities, at least 277 taxa of exotic plants are now known to have invaded pine rocklands throughout south Florida (Service 1999, p. 3-175). A few of these exotic plants include the Schinus terebinthifolius (Brazilian pepper), Neyraudia reynaudiana (Burma reed) and Melaleuca quinquenervia (melaleuca). Lygodium microphyllum (Old World climbing fern) is rapidly spreading and may become a serious problem (Volin et al. 2004, p. 445). Nearly all of the extant occurrences are threatened by exotic plant species (Bradley and Gann 1999, p. 6; Hodges and Bradley 2006, p. 43; K. Bradley, pers. comm. 2007). Exotic species have altered the type of fire that occurs in pine rocklands. Historically, pine rocklands had an open, low understory where natural fires remained patchy with low temperature intensity, thus sparing many native plants such as Blodgett's silverbush. The current density of exotic plant overgrowth throughout the range of Blodgett's silverbush may no longer allow the species to be conserved through fire. Dense growth can create intense fire temperatures and longer burning periods. Pine rockland plants cannot tolerate these extreme conditions. Given the current conditions, exotic plant control may require an alternate method, such as hand chopping followed by spot herbicide treatment, which requires extensive labor and is very costly. This method may not be feasible for publicly owned lands, because of the acreage and staffing and budget constraints (USFWS, 2016).

Stressor: Road maintenance (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Several occurrences exist near roads and road maintenance is a particular concern to each of these occurrences (Bradley and Gann 1999, p. 6; Hodges and Bradley 2006, pp. 11-15; K. Bradley, pers. comm. 2007). Clearing of vegetation along roads and the use of herbicides could impact populations; coordination needs to exist with road maintenance crews to prevent impacts (Hodges and Bradley 2006, pp. 11-15). Road enhancements (e.g., paving) or other infrastructure projects (e.g., underground cable, sewer and water lines) may also threaten some roadside populations (Hodges and Bradley 2006, pp. 11, 15). Illegal dumping is identified as a problem at two sites (Hodges and Bradley 2006, pp. 11, 13). Since Blodgetts silverbush (and 10 other rare species) are included in an Important Rare Plant Area (IRPA) on Big Pine Key, management along this FDOT right-of-way could improve (Gordon et al. 2007, pp. 2, 68) (USFWS, 2016).

Stressor: Natural disturbances (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Given the species narrow range and the small number of individuals at many sites, Blodgett's silverbush is vulnerable to natural disturbances, such as hurricanes. Storm surges associated with hurricanes result in inundation of habitat with saltwater for varying durations. In 2005, the Keys were impacted by three hurricanes (Katrina, Rita, and Wilma), and vegetation in

many areas was top-killed due to salt water inundation (Hodges and Bradley 2006, p. 9). Storm surges may pose a threat to the population at Cactus Hammock on National Key Deer Refuge; however, hurricanes may also ultimately help this species by creating canopy gaps where this species thrives (Hodges and Bradley 2006, p. 12). According to the National Oceanographic and Atmospheric Administration, Miami-Dade County, the Keys, and western Cuba are the most storm-prone areas in the Caribbean so this threat is expected to continue (USFWS, 2016).

Stressor: Inbreeding depression (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The species occurs in a restricted range, and many occurrences are small and isolated. As a result, threats associated with small population size ensue. These include potential vulnerabilities from environmental (catastrophic hurricanes), demographic (potential episodes of poor reproduction), and genetic (potential inbreeding depression) threats (USFWS, 2016).

Stressor: Pesticide effects on pollinators (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Critical habitat regulations for Bartram's scrubhairstreak butterfly and Florida leafwing have extended benefits to populations of these four plants and their pollinator guild by limiting mosquito insecticide activity in pine rocklands habitat in the Florida Keys. Nevertheless, we are proceeding cautiously and have initiated a multi-year research project to further investigate the level of impact pesticides have on these four plants and their pollinators throughout their ranges (USFWS, 2016).

Stressor: Fire suppression (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Fire suppression is a primary cause of habitat degradation in pine rockland preserves and is likely to suppress Blodgett's silverbush seed germination (Possley et al. 2019). Fragmentation has also impacted the management of pine rockland habitat, as urbanization has encroached into native areas, leaving small habitat fragments that are increasingly difficult to burn. Habitat management with use of controlled burns remains a vital way to maintain pine rockland habitat. Without proper fire management, cover of hardwoods increase, along with invasion by non-native exotic plants, causing deterioration of ideal habitat for Blodgett's silverbush. Hardwoods and non-native invasive plants directly compete with Blodgett's silverbush for space, light, water, and nutrients. Although the species can tolerate some human disturbance and sometimes even seems to benefit from it if these disturbances create canopy openings (e.g., trails in within preserves or mowing along roadsides), five populations and four subpopulations are now extirpated due to development or significant disturbance of its habitat. Other populations growing on private property remain at high risk of extirpation due to development or disturbance and roadside populations in Monroe County are vulnerable to impacts from road maintenance projects such as herbicide application, grading, and resurfacing (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023)

Exposure:
Response:
Consequence:
Narrative: Climate Change. Climate change presents a variety of threats to Blodgett's silverbush and its habitat. Florida's average annual temperature has risen more than 2˚F since 1900 and estimates project further increases between 2.3-11.4˚F by 2100, depending on the greenhouse gas emission rates and the region in Florida (Runkle et al. 2022). In addition, it is predicted that south Florida will experience drier summers (Sun et al. 2015; Runkle et al. 2022). Higher temperatures and changes in precipitation patterns could alter relative humidity levels and evapotranspiration rates, leading to the potential for more frequent and intense droughts and wildfire events. Although Blodgett's silverbush has evolved to grow in habitats that experience frequent fire, prolonged periods of record high temperatures associated with droughts contribute to dry conditions that are driving hotter, more intense wildfires than would naturally occur. Intense wildfires can cause drastic changes in species composition, changes in tree density, and potentially kill Blodgett's silverbush (Possley et al. 2022a). Sea Level Rise. Sea level rise, saltwater intrusion, and storm intensification are also anticipated impacts of climate change and increasing threats to south Florida and Blodgett's silverbush. By 2100, it is predicted that sea levels in south Florida and the Keys will rise between 2.13 ft (0.64 m) and 7.12 ft (2.17 m) (Sweet et al. 2022). Based on this, areas supporting Blodgett's silverbush (e.g., coastal Miami, Florida Keys) will likely become partially or completely inundated by 2100. For example, approximately 75 percent of land mass in the Florida Keys is predicted to be inundated at 1.9 ft (0.59 m) of sea level rise (The Nature Conservancy 2011) and 94 percent of the Keys would be inundated at 5.9 ft (1.8 m) of sea level rise (Zhang et al. 2011). Sea level rise and saltwater intrusion have been found to reduce pine rockland acreage in the lower Keys (Ross et al. 1994) and will have impacts on other habitats as well. Prior to surface inundation, Blodgett's silverbush habitats may undergo vegetation shifts triggered by changes to hydrology, increased salinity, and more frequent storm surge and king tide events (S. Saha et al. 2011). Even if high tide or surge flooding is infrequent, most pine rocklands, rockland hammocks, and coastal berms in the Florida Keys will still slowly degrade and shift to buttonwood/mangrove or marsh habitats (Ross et al. 2009; A. Saha et al. 2011), making some sites unsuitable for Blodgett's silverbush. Hurricanes and Extreme Weather Events. Hurricane rainfall and intensity are expected to increase as the climate warms (Runkle et al. 2022). Given the small, isolated populations and restricted range of Blodgett's silverbush in locations prone to storm influences, nearly all known populations are at substantial risk from hurricanes and storm surges. Although this species naturally occurs in an area historically affected by hurricanes and has evolved to persist under such disturbances, an increase in storm intensity and its impacts could negatively affect populations. Hurricane winds and debris can cause mortality by defoliation, mechanical injury, or uprooting of individuals, leading to irreversible desiccation. Storm surge physically washes away plants and substrate and leads to salinization of soils. These pulses of salinization will exacerbate saltwater intrusion and accelerate habitat modification and loss. Blodgett's silverbush may have experienced these disturbances historically but had the benefit of more abundant and contiguous habitat to buffer populations from extirpation. With much of the historical habitat having been destroyed or modified, smaller populations are particularly vulnerable to local extirpations due to these events. The impacts of Hurricane Ian, which passed over the Keys with tropical storm force winds in October of 2022, have not yet been assessed and may have negatively impacted Blodgett's silverbush populations, especially in the Lower Keys (USFWS, 2023).

Recovery

Reclassification Criteria:
Not relevant.

Recovery Priority Number: 8

Delisting Criteria:
Not defined; a Recovery Plan has not been issued as of December 2019.

Recovery Actions:

- Not defined; a Recovery Plan has not been issued as of December 2019.
- Prevent further destruction or degradation of existing pine rocklands and hammocks (Service 1999, p. 3-191).
- Acquire available fragments, promote conservation easements and landowner agreements, work with private landowners, and enforce regulatory protection of pine rocklands (Service 1999, p. 3-191).
- Prevent further degradation of existing preserves from exotic plant species, fire exclusion, anthropogenic fires, unauthorized site uses, illegal dumping, improper siting of facilities (including interpretive trails), collecting of plants, hydrologic modifications including drainage, flooding and salt-water intrusion, and herbicides by working with Federal, State, county, and municipal agencies and non-governmental organizations (Service 1999, p. 3-192).
- Restore existing degraded pine rocklands through active management (e.g., where possible restore natural connections, natural fire regimes, and areas impacted by anthropogenic fires, unauthorized site uses, illegal dumping) (Service 1999, p. 3-192).
- Monitor populations on a regular basis to track trends within the population and changes in management needs (Hodges and Bradley 2006, p. 19).
- Design and implement a coordinated system of informing maintenance crews about populations of Blodgett's silverbush occurring along roads and rights-of-way (Hodges and Bradley 2006, p. 19). Raise awareness among maintenance workers and contractors.
- Evaluate the use of herbicide application along roadside populations.
- Conduct studies involving reproductive biology or life history (Hodges and Bradley 2005, p. 19). Ephemeral populations of this species present challenges; little is known about long-term continuity of population sizes (Hodges and Bradley 2005, p. 19). Reproductive biology studies would provide information on effects of unnatural disturbance and mosquito spraying on pollinators (Hodges and Bradley 2006, p. 19).
- Use prescribed fire and incorporate monitoring into plans to determine the effectiveness of the prescription; monitor the health of the community and species that occur with Blodgett's silverbush (Bradley and Gann 1999, p. 4).
- Consider a plan of action to establish a Florida Keys pine rockland core conservation area and ex-situ conservation of this species (Ross et al. 2009, p. 477)
- • For populations in pine rockland habitat (all populations in Miami-Dade County, except Fuchs Hammock Preserve, and the National Key Deer Refuge populations in Monroe County), ensure that prescribed fire is frequent enough to maintain the open, sunny habitat required by Blodgett’s silverbush and to promote seed germination. • For populations in hammock or other areas where fire is not feasible (Fuchs Hammock Preserve and most of the Monroe County populations), clear dense undergrowth regularly. • Continue invasive

species removal at conservation areas with Blodgett's silverbush. • Acquire or pursue conservation agreements for populations or subpopulations on nonconservation private lands that are extant (Ludlam Florida Power and Light Easement and Marathon International Airport) and uncertain (Camp Choee, Country Ridge Estates, Epmore Drive Pineland, Boot Key, Big Munson Island, and Stock Island Golf Course), if it is determined that Blodgett's silverbush is extant. • Bank seeds from wild populations, with a focus on those that are not yet represented or are under-represented in storage (see section II.C.1.g., above for which populations are represented). Efforts should be especially concentrated on collecting seeds from populations of the Florida Keys, which are currently not represented in any seed banks. • Consider augmenting known extant natural and introduced populations or subpopulations with fewer than 10 individuals (George N. Avery Pineland, Pine Ridge Sanctuary, John Kunkel Small Pineland, Tavernier Roadside, Green Turtle Hammock, Key Tree Cactus Preserve, National Key Deer Refuge – Watson Hammock Area, and Key West Tropical Forest and Botanical Garden) (USFWS, 2023).

Conservation Measures and Best Management Practices:

- Monitoring/Research Activities • Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, rockland hammock, coastal berm, and disturbed areas. • Conduct range-wide surveys at uncertain and extirpated populations and adjacent parcels with potential habitat to determine the status of populations and/or to fine-tune population size estimates. Repeat every 5-10 years. • Survey Blodgett's silverbush populations after storms since population sizes could change substantially due to more open habitat. • Re-test seeds that Fairchild has banked at 5 years, to determine how long viability is retained in storage and repeat tests every 5 years thereafter. • Conduct germination experiments with seeds collected in the Florida Keys to determine if germination requirements are different to mainland populations and populations in the Florida Keys. • Further research on the reproductive biology and life history of Blodgett's silverbush (e.g., pollinators). • Conduct genetic research to determine the amount of genetic variation between populations from the mainland and the Florida Keys, and between Florida populations and those of Argythamnia argothamnoides populations across the Caribbean and northern South America (USFWS, 2023).

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SPECIES ACCOUNT: *Asclepias meadii* (Mead's milkweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/1/1988; Midwest Region (R3) (USFWS, 2016)

Physical Description

A perennial herb with a single slender unbranched stalk, 8-16 inches (20-40 centimeters) high without hairs but with a whitish waxy covering. The hairless leaves are opposite, broadly ovate, 2-3 inches (5-7.5 centimeters) long, 3/8-2 inches (1-5 centimeters) wide, with a whitish waxy covering. A solitary umbel at the top of the stalk has 6-15 greenish ivory/cream colored flowers. Young green fruit pods appear by late June and darken as they mature, reaching 1.5-4 inches (4-8 centimeters) by late August or early September. Seeds are mature by mid-October (USFWS, 2003).

Taxonomy

Mead (1846) originally identified the plant as Asclepias cordata, but it was later described as a separate species by Torrey as Asclepias meadii (Gray 1856) (USFWS, 2003).

Historical Range

Indiana, Kansas, Missouri, Iowa, Illinois, and Wisconsin (USFWS, 2012)

Current Range

Extant populations are present in eastern Kansas, Missouri, south-central Iowa, and southern Illinois. Populations have been introduced into Indiana and Wisconsin; natural populations are considered extirpated (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, Asexual (USFWS, 2003)

Lifespan

Adult: 15 years or more (USFWS, 2003)

Dependency on Other Individuals or Species

Adult: Bumblebees and miner bees for pollination (USFWS, 2003)

Breeding Season

Adult: Flowers in late May and early June; fruits from June to October (USFWS, 2003)

Reproduction Narrative

Adult: Flowers in late May and early June; fruits from June to October. This species has low reproductive rate; research suggests that Mead's milkweed will require 15 years or more to mature from a germinating seed to a flowering plant. Species is long-lived and may persist indefinitely or until destroyed by chance impacts from animals or pathogens (USFWS, 2003). Reproduction is apparently rare. In an 11 year study, Kettle et al. (2000) found that only 15% of flowering stems produced mature fruit (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 2003)

Habitat Vegetation or Surface Water Classification

Adult: Tallgrass prairie, hay meadows, thin soil glades or barrens (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: Mead's milkweed usually occurs between 800-1200 feet above sea level on middle and upper portions of slopes less than 20 percent (Freeman 1988) (USFWS, 2003).

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Mead's milkweed usually occurs between 800-1200 feet above sea level on middle and upper portions of slopes less than 20 percent (Freeman 1988). Such habitats are often described as drymesic and represent a wide range of landtypes and substrates. The southern part of this species' range is unglaciated, and soils are developed in loess or residual material from underlying sandstone, chert, dolomite, shale, and igneous bedrock. These soils are acidic and nutrient poor in comparison to the soils found in northern populations. In the northern part of its range, soils are developed in glacial drift often with a deep mantle of loess. A single population found in the driftless area of Wisconsin probably occurred in loess over dolomite. These soils are calcareous and high in nutrients and organic matter. Soils in Kansas habitats have intermediate pH levels, nutrients, and organic matter. In general, Missouri and southern Illinois sites are acid and nutrient poor, Kansas sites are intermediate, and Iowa and northern Illinois sites are calcareous and nutrient-rich (Table 2) (USFWS, 2003). Restricted to sites that have never been plowed and only lightly grazed, and hay meadows that are cropped annually for hay (USFWS, 2003).

Dispersal/Migration

Motility/Mobility

Adult: Abiotic, Bird, Mammal (EPA, 2016)

Dispersal/Migration Narrative

Adult: Seeds are wind dispersed from follicles (USFWS, 2003)

Population Information and Trends

Population Trends:

Decline of 70-80% (NatureServe, 2015)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Number of Populations:

346 (USFWS, 2021)

Population Size:

Uncertain (NatureServe, 2015)

Population Narrative:

As of February, 2015, there are approximately 212 occurrences observed since 1994: 177 in Kansas, 30 in Missouri, 3 in Iowa, and 2 in Illinois. The clone-forming nature of the species makes it difficult to determine number of individuals at each site. In addition, non-flowering stems are difficult to detect in tall grass (Alexander et al. 1997). There are 22 occurrences with good viability/integrity (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Mead's milkweed habitat is threatened by urbanization, conversion to agricultural land, and habitat fragmentation. Many Mead's milkweed populations are also experiencing habitat loss due to the lack of appropriate prairie management such as prescribed fire. Fire suppression provides opportunities for subsequent woody vegetation encroachment, and invasion by exotic cool season grasses. Habitat destruction from feral hogs has also reduced Mead's milkweed habitat (USFWS, 2012).

Stressor: Disease or predation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Weevil damage to stems and developing fruits can affect seed viability. Other milkweed species may act as reservoirs for weevil populations, which then migrate to the rarer Mead's milkweed. Herbivory of Mead's milkweed from white-tailed deer has been observed at many sites across the species range and contributes to a lack of fruit production. Grazing by cattle and to a lesser degree by bison can adversely affect Mead's milkweed populations, especially when grazing occurs during flowering and fruiting periods from April to September. In Missouri, some Mead's milkweed populations are also experiencing fungal attacks (USFWS, 2012).

Stressor: Hay mowing (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Over 50% of Mead's milkweed sites are usually mowed annually for hay. Haying during the growing season prevents seed production of Mead's milkweed and results in reduced genetic diversity. Although haying and grazing occur on a large scale and may be a much more serious threat to the species, off-road vehicle use, in some cases associated with oil wells on a site, and trampling by researchers and school groups also adversely affects Mead's milkweed through excessive disturbance to its habitat. A proposed pipeline replacement project and highway construction project could potentially affect several Mead's milkweed populations in Kansas, however project sponsors are discussing alternatives with the USFWS Kansas Field Office (USFWS, 2012).

Stressor: Herbicide application (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: In the Osage Plains physiographic region, reference to herbicide damaged Mead's milkweed plants was specifically made in occurrence records for three populations (Doering Place, Mount Hope Prairie, and Nodding Polytaenia Prairie). Constant herbicide application has been reported as a contributing factor in the decline of Mead's milkweed in railroad prairies (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The protection of federally threatened plants on privately-owned lands is extremely limited in all states throughout the Mead's milkweed range, leaving those populations vulnerable to habitat destruction and eventual extirpation. Currently, only about 11% of Mead's milkweed sites have legal protection. Most Mead's milkweed populations occur on private land, most of these are hay meadows, and most are, therefore, not protected from habitat destruction, the primary threat to this species (USFWS, 2012).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change will be a particular challenge for endangered, threatened and other at-risk-species because the interaction of additional stresses associated with climate change and current stressors may push them beyond their ability to survive. In addition, populations of some species that are near the southern end of the range may be at particular risk. There is uncertainty about the exact nature and severity of climate change related impacts that may be anticipated to occur within the Mead's milkweed's range. A number of scientific studies project that there will be increased duration and intensity of heat waves in summer, higher levels of humidity and evaporation, changing patterns of precipitation with fewer rain events of greater intensity, increased frequency and more severe dry spells, and more flooding from heavy rains. Research has suggested that climate change may also negatively impact pollinator species if plants and their pollinators respond differently to climate change. These climatic changes may threaten the Mead's milkweed in a variety of direct and indirect ways including: changes in the timing of blooming, loss of suitable habitat, loss of inter-specific relationships with pollinators, and

increased threats from invasive species (USFWS, 2012).

Stressor: Feral Swine (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Feral swine were originally introduced to the southeastern United States and California in the early 1500s, but their range has increased substantially over the last several decades across the United States. The distribution and abundance of feral swine varies with habitat type but is highly correlated with the presence of public lands. Feral swine damage natural resources by destroying native vegetation, causing soil erosion, degrading water quality, and acting as a vector for many diseases. Feral swine have contributed to substantial habitat destruction in Missouri including severe damage to Mead's milkweed plants at some locations (Mark Twain National Forest 2009, USFWS 2012). Feral swine have been reported in all states of the Mead's milkweed distribution; however, swine are believed to be eradicated from Wisconsin and Iowa, with near eradication achieved in Illinois and Indiana (USDA-APHIS 2020). Historically, feral swine have overlapped in the Mead's milkweed distribution in 4 counties in Kansas (accounting for 138 Mead's milkweed sites), 11 counties in Missouri (58 sites) and 1 county in Illinois (1 site; Figure 2). (USFWS, 2022)

Stressor: Climate Change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Long-term changes in environmental conditions (e.g., patterns of temperature and precipitation) have had observable impacts on plants, wildlife, ecosystems, and the ecosystem services they provide to society (Groffman et al. 2014, USGCRP 2018). Mead's milkweed may be directly impacted by the changes to water quality, drought and flooding, and the spread of invasive species. Such changes are projected to continue. Without substantial and sustained reductions in global greenhouse gas emissions, extinctions and transformative impacts on some ecosystems cannot be avoided in the long term. More frequent and intense extreme weather and climate related events, as well as changes in average climate conditions, are expected to continue to damage infrastructure, ecosystems, and social systems that provide essential benefits to communities (USGCRP 2018). The frequency of flood events has increased across the southeastern region and across most of the Midwestern U.S. over the past two or more decades (Neri et al. 2019). Climate change projections predict warming average temperatures, more days with extreme heat, increased extreme precipitation events, and longer periods of drought (IPCC 2014, USGCRP 2018) (USFWS, 2022)

Stressor: Pollinator Declines (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Mead's milkweed are primarily pollinated by large bees, including the species European honeybee (Apis melifera), rusty patched bumblebee (Bombus affinis), brown-belted bumblebee (B. griseocollis), Southern Plains bumblebee (B. fraternus) and the chimney bee (Anthrophora abrupta), (Betz et al. 1994, Edens-Meier et al. 2017). Hallmann (2017) reported severe losses of flying insects across the globe, with several taxa of pollinators (e.g., butterflies,

wild bees, and moths) experiencing large declines. In most ecosystems, bees are the dominant pollinators; however, compounding stressors (e.g. habitat loss, food stress, exposure to pesticides, pathogens, and climate change-related impacts) have led to wide scale declines (Rhodes 2018). In North America, losses of bees in grasslands commenced in the early 19th century (Samson and Knopf 1994), while a largescale bee decline in the U.S. Midwest occurred as agriculture practices intensified between the 1940s and 1960s (Grixti et al. 2009). Mead's milkweed pollinators, particularly bumblebees, have declined throughout the United States. (USFWS, 2022)

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
1. Twenty-one populations are distributed across plant communities and physiographic regions within the historic range of the species (USFWS, 2003).

2. Each of these 21 populations is highly viable. A highly viable population is defined as follows: more than 50 mature plants; seed production is occurring and the population is increasing in size and maturity; the population is genetically diverse with more than 50 genotypes; the available habitat size is at least 125 acres (50 hectares); the habitat is in a late-successional stage; the site is protected through long-term conservation easements, legal dedication as nature preserves, or other means; and the site is managed by fire in order to maintain a late-successional graminoid-vegetation structure free of woody vegetation (USFWS, 2003).

3. Monitoring data indicates that these populations have had a stable or increasing trend for 15 years (USFWS, 2003).

Recovery Actions:
- Assess the viability of populations and protect habitat. Assess the viability of each population. Contact landowners and encourage conservation. Seek legal dedication. Increase number of sites managed or owned for the conservation of plant communities associated with Mead's milkweed in perpetuity (USFWS, 2003).
- Manage habitat. Conduct management assessment of public and private lands. Perform prescribed burns on a regular basis in Mead's milkweed habitat. Control invasive species in habitat with extant populations of Mead's milkweed (USFWS, 2003).
- Increase size and number of populations. Assess genetic condition of extant populations. Estimate the number of ramets and genotypes by collecting morphological data. Determine if genetic lineages occur among populations. Increase genetic diversity by introducing seeds or plants. Select sites for introduction and restoration. Select sites for augmentation based on variables in population viability index. Introduce or restore new populations in historic sites and newly identified habitat. Establish new populations using seeds or plants (USFWS, 2003).
- Conduct field surveys for new population occurrences or potential habitat for introduction
- Conduct research on restoration, management, and introduction techniques

- Maintain conservation populations. Collect and store seeds. Grow and maintain plants (USFWS, 2003).
- Promote public understanding. Produce a fact sheet and make it available on Service website. Hold workshops on managing Mead's milkweed sites. Create a traveling display. Promote news reports and press releases (USFWS, 2003).
- Review and track recovery progress. Reassess the viability of each population. Develop a post-delisting monitoring plan (USFWS, 2003).
- It is recommended that a plan be developed and implemented to collect information required to complete a thorough Population Viability Index for each population of Mead's milkweed. Data that is currently missing for most populations include population trend, number of genotypes, habitat size, and management condition. Regular population monitoring will be required in order to establish a population trend. A prioritization of sites based on the population's potential to become highly viable and contribute to recovery should be considered, however, this prioritization cannot be completed without the data that is currently missing from most populations. At the time a prioritization of sites is possible, this information should be provided to all recovery partners (state, federal, and non-government organizations) to provide guidance on where recovery should best be targeted. Protection through conservation easement, acquisition and dedication, or other protection should be sought for Mead's milkweed populations within each physiographic region that have high viability or that have the potential to become highly viable. Land acquisition funding sources should be explored including the U.S. Fish and Wildlife Service's Non-Traditional Section 6 Recovery Land Acquisition Grant Program (USFWS, 2012).
- The number of populations managed with prescribed burns and removal of invasive species should be increased. Over 50% of sites continue to be mowed for hay. This activity prevents seed production and results in reduced genetic diversity. Increasing the number of hay meadows that are managed to allow reproduction of Mead's milkweed through a reduction in haying and grazing, especially on public lands, would be beneficial to Mead's milkweed populations. The exploration of incentives offered by the U.S. Department of Agriculture, Natural Resource Conservation Service's (NRCS) Conservation Programs, whereby landowners are encouraged to manage their lands for the conservation of natural resources, may be beneficial in recovering Mead's milkweed. Some populations are also experiencing herbivory by deer or habitat destruction by feral hogs. Grazing, in general, adversely affects Mead's milkweed and patch/burn/graze management appears to be reducing the quality of Mead's milkweed habitat. In addition, information on habitat size and management condition may already be available but needs to be compiled. Management condition can also be assessed during population monitoring (USFWS, 2012).
- Although management efforts to improve habitat and remove threats have occurred in some populations, actual increase in population size has been rare. Seven high priority recovery populations have been targeted in Missouri for intense recovery efforts. Introductions are underway in Illinois, Indiana and Wisconsin and planned in Missouri. Augmentation occurred in Illinois, Missouri, and Kansas (Kindscher et al. 2008; Menard 2012), in order to increase genetic diversity and promote successful reproduction. These introductions are not always located in the physiographic regions or community types indicated in the recovery criteria. For this reason, surveys are needed to locate suitable locations for the introduction and establishment of new populations in the physiographic regions and community types listed in the recovery criteria. Because Mead's milkweed grows slowly and rarely reproduces, it may be decades before the already introduced

populations become viable (USFWS, 2012).

- There is a need for greater understanding of the species' life history requirements, specifically: phenology, pollination biology, and information on the species' reproduction in natural populations. Research indicates that introduction by transplanting juveniles reared in nurseries or greenhouses reduces time to reproduction and therefore should increase the potential viability of introductions (Bowles et al. 2003). Further research on restoration, management, introduction techniques, and the lack of reproduction in natural populations of Mead's milkweed will assist in the recovery of the Mead's milkweed. Establishing long-term seed collection of representative populations as well as establishing new, and maintaining current, propagation nurseries will also assist in the recovery of Mead's milkweed. Although a genetically diverse nursery population of Mead's milkweed is being maintained at the Morton Arboretum for introduction and augmentation purposes, a long-term seed collection protocol focused on representing populations throughout the range has not been established and would contribute to recovery of Mead's milkweed (USFWS, 2012).
- Statewide recovery groups have been developed in Missouri and Kansas. It is recommended that the states of Illinois, Iowa, and Wisconsin also develop recovery groups, which can be defined as either one recovery group for each state or one recovery group for all three states (WI, IA, and IL) that would include representatives from each state (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct surveys and monitoring. The PVI analysis conducted for Mead's milkweed was originally implemented as a preliminary calculation, and likely overestimates viability. It is important that more accurate analyses are conducted; however, to do so the current status of each population is needed with regular monitoring following. 2. Complete a Species Status Assessment. Since listing, many populations have not been monitored and their status remains unknown. Threats from feral swine, climate change, and a lack of appropriate management compound the risks to Mead's. Once sufficient data is gathered for a more accurate viability analysis, a species status assessment (SSA) may be helpful to determine if the species should remain the same or reclassified under the ESA. 3. Coordinate with partners on monitoring and management needs. Coordination among Federal, State, and private entities on monitoring and management needs to be enhanced and improved. As noted in Moore et al. (2011), an adaptive decision/management framework is recommended to assess various management actions, as well as augmentations to increase genetic diversity. The proliferation of virtual meeting platforms (e.g., Zoom, and Microsoft Teams) allows for collaboration at a distance, which can facilitate meetings and conservation planning. Federal, State, private conservation groups, species experts, geneticists, management experts, university researchers, expert ecologists, and invertebrate specialists (especially pollination experts) should be included in these discussions. 4. Prioritize populations for restoration efforts. After site surveys are updated, sites that are considered optimal habitat with low genetic diversity or ramet counts should be identified for future reintroductions. 5. Manage sites to improve fecundity in Mead's milkweed. Generally, high fruit set was found when populations had >50 ramets flowering at once. Therefore, populations with fewer than 50 flowering ramets should be augmented, though sites left fallow for several years and then burned may show a large increase in flowering ramets. Synchronous flowering among populations of Mead's milkweed may also improve fecundity. Coordinating the timing of controlled burns across multiple sites is one way to accomplish this (Wagenius et al. 2020). A study investigating the effects of fire return interval and seasonality on flowering is needed to test this hypothesis. 6. Conduct studies on the impacts of climate change. Climate change will likely alter future viability of many Mead's

milkweed populations, and future viability analyses should adjust for changing environmental conditions. Studies like Molano-Flores et al. (2019) should be conducted throughout the range of the species. 7. Conduct pollination research studies to assess limitations. To test for pollen limitation, a pollen supplementation study is needed that compares fecundity in open and hand□pollinated treatments across populations with varying numbers of flowering ramets. Additionally, studies are needed to test for pollinator limitation. 8. Conduct genetic analysis to facilitate augmentations. Promote widespread gene flow across the range of Mead's milkweed. Future augmentations should focus on adding seedlings sourced from multiple different maternal plants to maintain levels of genetic diversity in populations. Additional genetic analyses of small populations are needed to test mate limitation and the presence of the Allee effect in Mead's milkweed. 9. Encourage voluntary management. Because the protection status of many populations is either unknown or the sites are unprotected, conservation organizations should encourage voluntary management strategies with landowners. 10. Evaluate the impacts of imperiled insect management. In managing Mead's milkweed habitat, we should also evaluate various management prescriptions on other listed and candidate species that co-occur with Mead's, especially invertebrates such as Rattlesnake master borer moth (Papaipema eryngii) and Monarch butterflies (Danaus plexippus). (USFWS, 2022)

- CONSERVATION MEASURES: Iowa: Powell Prairie in Taylor County and Woodside Prairie in Adair County are sites where Mead's milkweed has been reliably located. After approximately 20 years without surveys, both sites were surveyed in 2020 with only 1 sterile plant observed at Woodside Prairie. While both sites are small, these highly diverse prairie remnants located on private property recently underwent active conservation management for Mead's milkweed. These sites were burned, and habitat improvements also included removal of red cedar (Juniperus virginiana) trees. Indiana: The Indiana Plant Conservation Alliance (INPCA) has recently identified rare plants for conservation prioritization, including Mead's milkweed. A Mead's milkweed conservation team has been formed, and conservation planning includes future monitoring, conducting a literature review, and identifying appropriate habitat for potential future reintroductions (V. Witting – Indiana Plant Conservation Alliance, pers. comm. 2022). Monitoring of reintroduced populations is ongoing and continues to be managed for prairie species including Mead's milkweed recovery (S. Namestnik – Indiana DNR, pers. comm. 2022). Kansas: The Grassland Heritage Foundation has purchased a 15-acre prairie in Anderson County with a small population of Mead's milkweed. In 2018, a conservation easement was placed on a privately-owned, 80-acre prairie in Anderson County with a large Mead's population (M. McNulty - USFWS, pers. comm. 2022). Managing agencies have initiated burns at the formerly hayed Lexington Lake Park site in Johnson County, Kansas (C. Edwards – Missouri Botanical Garden, pers. comm. 2022). Missouri: Missouri Department of Conservation (MDC) acquired Berrier (formerly known as South Fork upland and Winn's Prairie) in 2020 and has initiated burns on the site (C. Edwards – Missouri Botanical Garden, pers. comm. 2022). Together with Missouri Botanical Garden (MoBOT), MDC conducted an augmentation at Berrier in 2020 (C. Edwards – Missouri Botanical Garden, pers. comm. 2022). Plantings occurred in 2011 and 2012, and these sites were monitored annually 2015-2017 to estimate establishment success and persistence. They continue to be monitored during the flowering season immediately after a prescribed burn. Remnant populations that are regularly managed and easily accessible are also surveyed immediately following a prescribed burn. Prescribed burns are predominately occurring during the dormant season. Seed pods were collected in 2013, and used to establish a propagation plot in 2015 at Powell Gardens. As of 2022, there are approximately 50 individuals within the plot. A seed pod was produced in 2019 but succumbed to insect damage. There have been a few flowering individuals in recent years and the plot is expected to serve as a seed source for future propagation efforts. Following recent studies that have provided better understanding of

genetic diversity, future propagation efforts are expected, along with follow up studies to investigate the lack of seed production that is observed at several locations. Management activities (e.g., haying and burning) likely affect the height of individual plants and the number of observable plants, possibly contributing to low rates of fecundity (USFWS 2012). Another potential cause of low fecundity is a resource limitation. Upcoming research funded by MDC and conducted by the Missouri Botanical Garden is expected to evaluate these possibilities. Wisconsin: Three populations have been surveyed in the last 10 years and continued monitoring of these locations is planned. Interest has been expressed in identifying optimal habitat for future reintroductions (R. Henderson, pers. comm. 2022). (USFWS, 2022)

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SPECIES ACCOUNT: *Asclepias welshii* (Welsh's milkweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/28/1987; Mountain-Prairie Region (Region 6) (USFWS, 2015a)

Physical Description

Asclepias welshii is a tall, herbaceous plant in the milkweed family (Asclepiadaceae). The species stems are about 1 m (40 in) tall at maturity arising singularly or in clusters of about 10 stems from vertical taproots with horizontal runners connecting stem clusters. The leaves are displayed in opposite pairs along the stems. The upper leaves are broadly ovate shaped with a short petiole, about 8 cm (3 in) long and 5 cm (2 in) broad. The lower leaves are smaller, have acuminate tips and are borne directly on the stem without a petiole. The foliage and stems are covered with a very dense white-wooly pubescence (tomentum) early in the growing season. About 30 flowers are borne in a spherical inflorescence about 7 cm (3 in) in diameter at the end of a pedicel about 10 mm (0.4 in) long arising from the plant's upper leaf nodes. Individual flowers have the characteristic milkweed form. The reflexed calyx has individual lobes about 6 mm (0.25 in) long. The corolla, with the characteristic milkweed hoods and horns, is about 6 mm long, cream colored with a rose-tinged center. (USFWS, 1992)

Taxonomy

It is distinguished morphologically from other members of the large (approximately 140 species) genus, Asclepias, by the shape and size of the anther wings, the outer texture of its fruit, and its seed, which is the largest in the genus (Holmgren and Holmgren 1979; Service 1992). (USFWS, 2015b)

Historical Range

Not known from locations other than current (inferred from USFWS, 2015)

Current Range

Welsh's milkweed is endemic to active sand dunes of south central Utah (Kane County), northern Arizona (Coconino County) and the Navajo Indian Reservation in Arizona. (USFWS, 2015b)+H4

Critical Habitat Designated

Yes; 10/28/1987.

Legal Description

On October 28, 1987, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Asclepias welshii (Welsh's milkweed) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Utah (52 FR 41435-41441).

Critical Habitat Designation

The critical habitat designation for Asclepias welshii includes one CHU in Kane County, Utah. This species critical habitat encompasses approximately 4,000 acres (ac) (52 FR 41435-41441).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Asclepias welshii critical habitat consists of one component (52 FR 41435-41441):

The constituent elements of this critical habitat are the sand dunes themselves.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (seeds) and asexual (rhizomatous) (USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Milkweed species are known to be insect pollinated, primarily by bees, wasps, and butterflies (Struven et al. 1994). (USFWS, 2015)

Breeding Season

Adult: May to June (USFWS, 2015)

Reproduction Narrative

Adult: Reproduction can occur by asexual (rhizomatous) and sexual (seeds) means. Welsh's milkweed flowers from May to June; fruits develop and seeds disperse from July through September (Service 1992). Flowers in the genus, Asclepias cannot self-pollinate; they require pollinators to produce fruits and seeds. Milkweed species are known to be insect pollinated, primarily by bees, wasps, and butterflies (Struven et al. 1994). (USFWS, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Sand/dune, Shrubland/chaparral, Woodland - Conifer (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Heavy rainfall events (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found on coral pink sand dunes in sagebrush, juniper, and ponderosa pine communities at 1700 to 1900 meters. Occupies both the crest and lee slopes of dunes, adjusting readily to changes in depth of the sand. (Welsh et al. 1993). (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2015)

Habitat Narrative

Adult: The soil supporting A. welshii is unconsolidated aeolian sand on active dunes while the surrounding habitat is either vegetated, stabilized sands, sandstone slickrock, or various exposed shales and other fine grained exposed geologic rock types or their finer grained developed soils. Found on coral pink sand dunes in sagebrush, juniper, and ponderosa pine communities at 1700 to 1900 meters. Occupies both the crest and lee slopes of dunes, adjusting readily to changes in depth of the sand. (Welsh et al. 1993). Widespread germination in the wild appears to be triggered by multiple heavy rainfall events in a season. Germination and survival of seedlings grown under greenhouse conditions were negatively affected by low moisture conditions. However, established plants are considered drought tolerant because of their deep taproot and extensive rhizome structure (Palmer 1999). Populations of A. welshii occur in a plant community dominated by sand mulesears (Wvethia scabrida var. attenuata) with prominent groves of ponderosa pine (Pinus Donderosa) and clumps of Gambel oak (Quercus gambelii). (USFWS, 1992; USFWS, 2015; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: High (USFWS, 2015)

Dispersal/Migration Narrative

Adult: After seeds mature, they drop and are buried near the fruits from which they fall or are dispersed along the surface of the dune by wind (Palmer 2001, Esplin 2007). Wind dispersal also allows for long-distance seed dispersal (Esplin 2007), as populations of Welsh's milkweed tend to be isolated with some of the known populations more than 70 miles apart (although un-surveyed, suitable habitat may exist between those points). Welsh's milkweed seeds have a pappus (a sometimes feathery or bristly modification to a flower) that is suitable for wind dispersal and the CPSD is subject to high winds. Seed dispersal may also be facilitated by birds or other animals. (USFWS, 2015)

Population Information and Trends

Population Trends:

Increasing (USFWS, 2021)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

9 (USFWS, 2021)

Population Size:

~74,007 (USFWS, 2021)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

Since the previous review, we have received survey or monitoring information for seven populations (CPSD, Sand Hills, State Line, Sand Cove, Tuba City, Comb Ridge, Standing Rock Dune) (Robinson 2014, 2015, 2016, 2017, 2018, and 2019; BLM 2020; Talkington 2021; Willey 2021). We received annual Bureau of Land Management (BLM) monitoring reports for the CPSD and Sand Hills populations in Utah (Table 2; Robinson 2014, 2015, 2016, 2017, 2018, and 2019). As of this writing, the BLM report for 2020 was in development (Gubler 2021, pers. comm.). As OHVs were identified as the primary threat to Welsh's milkweed, monitoring plots were placed in areas both open and closed to OHVs at CPSD; the Sand Hills population is closed to OHVs. Since 2011, the monitoring plots have been centered on colonies (or groupings) of Welsh's milkweed stems and follow colonies as they move with the dunes. This was done because stationary plots do not accurately capture population changes and often record false declines as the colony moves out of the study area (RMER 2011). The monitoring includes the number of stems at each development stage, the area encompassed by the colony, the number of fruits present, and the amount of insect damage observed. Overall, the annual fluctuation of stems at CPSD and Sand Hills appear to be relatively stable around a mean of 4,044 during the study period (Table 2). The CPSD monitoring plots have an overall increasing trend in both OHV open and closed areas while the Sand Hills monitoring plots show a decreasing trend. For more detailed information on number of stems by life stage, number of fruits, movement of the dunes, condition of the plots, and insect activity, see the 2019 monitoring report (Robinson 2019). We received monitoring data for the State Line population (at the Coyote Buttes BLM site) and the Sand Cove population on BLM lands in Arizona (Table 1; BLM 2020). Successful fruit set was reported at both populations in 2014 (BLM 2020). The State Line population has a declining trend while the Sand Cove population has an increasing trend. Both populations are on BLM designated wilderness and OHV use is prohibited. We also received survey information for the Tuba City, Comb Ridge, and Standing Rock Dune populations on the Navajo Nation in Arizona (Table 1; Talkington 2021; Talkington 2021, pers. comm.; Willey 2021). In 2016, surveyors located the new population at Standing Rock Dune (Talkington 2021; Talkington 2021 pers. comm.). Recent surveys improved the total population estimates for the Tuba City and Comb Ridge populations and the surveys also recorded successful reproduction and seedling recruitment at the Tuba City and Standing Rock dune populations (Talkington 2021; Talkington 2021, pers. comm.). All three populations are remote and relatively inaccessible to OHV use. (USFWS, 2021)

Threats and Stressors

Stressor: Recreation (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: In Utah, thousands of people visit the state park area for OHV, camping, hiking, etc. (NatureServe, 2015)

Stressor: Off highway vehicle use (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Off highway vehicles (OHVs) are also known as off road vehicles (ORVs) and include dune buggies and all-terrain vehicles. Five populations are protected from OHV use: Coyote

Buttes, State Line, Thousand Pockets, Sand Cove and Sand Hills. OHV use is prohibited in Coyote Buttes, State Line, Thousand Pockets, and Sand Cove because they are in the Paria Canyon-Vermilion Cliffs Wilderness, while the Sand Hills population is located entirely within an OHV closure area for Welsh's milkweed designated critical habitat. The surrounding suitable habitat permits OHV use on designated trails only, and the compliance is high (BLM 2008; Church 2014 pers. comm.). The CPSD population is heavily used by OHVs. While a total of 27% of Welsh's milkweed designated critical habitat in CPSD is closed to OHV use, the majority of the dunes are open to cross country OHV use. The effects of OHV use on Welsh's milkweed are not fully understood and are complicated by our lack of basic biological information on the species and limited monitoring. The deep root and rhizome system of established stands or individuals likely offers some protection from OHV damage, although it is reasonable to assume that seedlings are more vulnerable than juvenile and adult plants. Repeated damage to stems in high traffic areas may result in the mortality of individual plants or plant stands within the population, but this type of data has not been documented within the monitoring plots (Kneller 2003). OHV use physically damages Welsh's milkweed plants by either crushing or removing portions of the plants. OHVs can damage all above ground portions of the plants including vegetative stems, flowers and fruits (Esplin 2007; Kneller 2003). Of great concern is the damage and destruction of seed pods and flowers, which decreases the reproductive success of individual plants (Esplin 2007; Kneller 2003). Plants with damaged stems will likely spend more energy on new vegetative growth than reproduction, thereby indirectly reducing sexual and asexual reproductive output. (USFWS, 2015)

Stressor: Grazing (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: All populations of Welsh's milkweed are on land that is open to grazing. Livestock (cattle) grazing is known to occur at three populations, CPSD, Sand Hills, and Comb Ridge. No evidence of grazing or livestock impact has been documented at the remaining five populations, although none of these are frequently visited or surveyed. Some trampling of plants was noted at CPSD, Sand Hills, and Comb Ridge, and at Comb Ridge evidence of grazing on Welsh's milkweed stems was also observed (Hazelton 2013, pers. comm.; Roth 2013, pers. comm.). Aside from these observations, there are no data on livestock impacts on Welsh's milkweed. However, the impact of grazing on the species is likely limited because livestock do not typically walk on the dunes where Welsh's milkweed grows unless they need to cross a dune field to reach new grazing areas (Roth 2013; Palmer 1993). We consider livestock grazing to not be a threat at this time, as any stress to the plants from grazing appears to be extremely low. This would only be re-evaluated if there was an increase in grazing pressure on Welsh's milkweed habitat, or if additional evidence of livestock herbivory was documented in one or more of the populations. (USFWS, 2015)

Stressor: Insect predation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Milkweed bugs (Lygaeus spp.) and milkweed beetles (Tetraopes spp.) have been observed feeding on plants within four Welsh's milkweed populations, CPSD, Sand Hills, Comb Ridge and Tuba City. Milkweed aphids (Aphis nerii) have also been observed feeding on Welsh's

milkweed (Hazelton 2013, pers. comm.). These are all native insects that are common predators of other milkweed species and were likely historic predators of Welsh's milkweed. Damage to Welsh's milkweed plants from insect predation, primarily milkweed bug nymphs, includes damage to seedpods resulting in fruit desiccation and aborted or unviable seeds (Esplin 2006). (USFWS, 2015)

Stressor: Small population size (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Four of the eight populations of Welsh's milkweed are small in size and consist of 100 stems or less. These populations likely consist of far fewer genetically distinct individuals than 100. Population size is likely the best predictor of extinction rate for isolated populations (Fischer and Stöcklin 1997; Pimm et al. 1988). Small plant populations are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002), and are more likely to succumb to natural catastrophes (e.g., drought, fire, and flood) and environmental stochasticity (Fisher and Stocklin 1997). (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In the southwestern United States, including Utah, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960 – 1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the southwest (Karl et al. 2009). Much of the Southwest remains in a drought, recently assessed as the most severe western drought of the last 110 years (Karl et al. 2009). Water resources in the western United States are predicted to be sensitive to climate change (Karl et al. 2009). The levels of aridity of recent drought conditions are predicted to become the new climatology for the southwestern United States, and the most recent projections show the drought risk in this area for the remainder of the 21st century likely to reach unprecedented levels (Cook et al. 2015; Seager et al. 2007). Utah is expected to see longer periods between precipitation events, while those precipitation events become more intense (Steenburgh et al. 2007). Severe climate conditions have the potential to profoundly impact individuals, populations, and plant communities (Levine and Paige 2004). We do not have enough data to accurately assess the threat level to this species from climate change at this time. We have no immediate evidence of a negative impact on Welsh's milkweed populations from climate change but this has not been studied so we do not fully understand it. (USFWS, 2015)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. The species known populations have been demonstrated to be at viable population levels. (USFWS, 1992)

2. Formal land management designations, which would provide long-term habitat protection for A. welshii, are established for the known populations. (USFWS, 1992)

Recovery Actions:

- Control activities which adversely affect the habitat of A. welshii. (USFWS, 1992)
- Inventory suitable habitat for A. welshii and determine abundance and distribution of the species. (USFWS, 1992)
- Determine the biological and ecological factors critical to the species conservation, and conduct minimum viable population studies in each of the species known populations. (USFWS, 1992)
- Develop public awareness and appreciation for the conservation of the species. (USFWS, 1992)
- The Service recommends continued monitoring of the existing plots at Coral Pink Sand Dunes, with a focus on refining a protocol that takes into account the changing location of dunes and monitored stands and meaningfully measures the impact of OHV use, while returning consistent results that can be compared across years. (USFWS, 2015)
- Data on the presence and intensity of OHV activity in the plots and any damage should continue to be collected and recorded in a standardized, quantifiable form, and monitoring protocols should be expanded to more fully capture the total OHV usage over a season in monitored plots as opposed to only the most recent usage once per season. (USFWS, 2015)
- The Service recommends that targeted surveys of previously un-surveyed likely suitable habitat be conducted for Welsh's milkweed in, and detailed records kept of what locations have been surveyed. (USFWS, 2015)
- The Service recommends that all known populations be surveyed regularly with standardized and accurate methodology in order to obtain baseline population data, and that a targeted, scientifically-meaningful, range-wide monitoring scheme be developed and implemented. (USFWS, 2015)
- The Service recommends that monitoring protocol include provisions to distinguish new rhizomatous growth from true seedlings, and that the delineation of stem classes (particularly between secondary and mature stems) be made clear and consistently applied, including consideration of whether classifying stems as secondary is scientifically useful – a categorization such as seedling, primary stem, nonreproductive stem, reproductive stem may hold more value and be easier to apply. (USFWS, 2015)
- The Service recommends that monitoring data collected be expanded to include the presence of predatory insects on plants, damage observed, number of first year seedlings, and the number of desiccated or abortive seedpods vs healthy seed pods. (USFWS, 2015)
- The Service recommends that the Navajo Nation develop a monitoring plan for the Welsh's milkweed populations at Tuba City and Comb Ridge, to ensure that those populations are adequately surveyed and to assess what threats they face currently or may face in the future. (USFWS, 2015)
- The Service recommends that GIS data from the 2002 census at CPSD showing milkweed stand number and location in 1992 and 2002 be located and used to guide future surveying or censusing efforts at CPSD. If this data cannot be located, we recommend it be reconstructed by hand and digitized using existing maps from the 2002 census. (USFWS, 2015)

- The Service recommends that a census of the CPSD similar to the one performed in 2002 be completed to determine locations of stands, amount of occupied habitat, and what level of protection current closure areas are providing for that population. (USFWS, 2015)
- Determine the current level of OHV use in and on existing stands and how that use relates to species response and impacts on individual mortality, reproductive success, and population demographics, particularly during high traffic times of the season. Monitoring should evaluate plant and reproductive damage in low, medium, and high OHV use areas and ultimately determine the overall detriment to the species from OHV use. This should be weighed against any benefit from OHV disturbance in the form of habitat creation, with the purpose of creating science-based OHV regulations within CPSD that are adequate for the protection of Welsh's milkweed. (USFWS, 2015)
- Assess the genetic variability of the species across the range and within populations in order to understand the population genetics of Welsh's milkweed. (USFWS, 2015)
- Genetic or other research should identify individual plants within a stand and develop protocols to distinguish individuals so monitoring methods follow individuals through time and so actual population size can be determined. (USFWS, 2015)
- Determine the mechanisms of species population dynamics including why certain populations appear to have declining stem counts, and whether those which appear to be increasing are actually increasing in number of individuals or only in stem counts. (USFWS, 2015)
- Gain a more complete understanding of the life history of Welsh's milkweed, particularly as it pertains to sexual reproduction, seedling recruitment, life span, and stem demographics, in order to be able to monitor the health and status of the populations effectively. (USFWS, 2015)
- Study the breeding biology, pollinators of the species and pollinator requirements for the species. Identify other community associates that may be important for the species (i.e. those species that support pollinators and provide corridors for pollinators). (USFWS, 2015)
- Study how and when Welsh's milkweed reproduces sexually and asexually. (USFWS, 2015)
- Determine the species' vulnerability to prolonged drought, temperature change, and the potential impacts of climate change, including impact on pollinators of Welsh's milkweed. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Recommended future actions: The suite of recommended future actions identified in the previous five-year review still provides the full list of recommendations until more species-specific life history information is identified (USFWS 2015). Specifically, (in order of priority) we recommend 1) range wide drone surveys to census populations; 2) a range wide genetic study to determine the number of individuals (genets) within populations and development of long-term monitoring plots based on that information; 3) an evaluation of the effects of OHV use on Welsh's milkweed at CPSD on a population-level; 4) a longterm study to evaluate the effects insect predation and climate change; and 5) establishing more stringent protections to Welsh's milkweed from OHV use where appropriate at CPSD. (USFWS, 2021)

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SPECIES ACCOUNT: *Asimina tetramera* (Four-petal pawpaw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

Asimina tetramera is a 1 to 3 m tall aromatic shrub that has one to several stems arising from a deep taproot. Leaves are oblong to oblanceolate, 5 to 10 cm long, arranged alternately on the stem, and are yellow-green to deep green. The leaves are narrow at the base (A. Cox, Florida International University, personal communication 1995), have broadly acute or blunt tips, and lack stipules. The flowers are maroon and fetid. They occur singly in the leaf axil; however, if the plant is burned or damaged, two or three flowers may develop. Perianth parts are typically in whorls of three, but may vary. The petals usually form whorls. The stamens are spirally arranged on an elevated torus or ballshaped receptacle, surrounding one to many separate carpels. After fertilization, the receptacle expands as fruit develops. The fruit is an aggregate of developing carpels, or monocarps, on the expanding receptacle. The monocarps are indehiscent and berry-like. An individual flower may produce from one to eight monocarps with one to nine seeds each (A. Cox, Florida International University, personal communication 1995). The fruit are oblong and greenish-yellow, emitting a banana-like aroma when ripe (A. Cox, Florida International University, personal communication 1995). The laterally flattened seeds are dark brown and shiny (Austin and Tatje 1979, Kral 1983). (USFWS, 1999)

Taxonomy

The four-petal pawpaw was discovered at Rio, Florida, in 1924 and subsequently named ityothamnus tetramerus (Small 1926, 1933). However, the new genus was rejected by other taxonomists (Kral 1960). According to Kral (1960), Asimina tetramera is grouped with A. pygmaea, A. longifolia, and A. nashii. These species have several common characteristics, including flower development on new growth, sparsely and omentulose young shoots, and glabrous petioles, peduncles and leaf surfaces. Kral (1960) concluded A. tetramera more closely related to A. pygmaea than to the other Asimina species based on floral similarities. Both species have strongly recurved inner petals, are maroon, have a pungent aroma and flower between April and July. However, several differences separate these two species: the gynoecium of A. tetramera is larger than A. pygmaea, adult plants of A. tetramera are larger than adult plants of A. pygmaea, and A. tetramera is limited to sand pine scrub ridges in Martin and Palm Beach counties, while A. pygmaea occurs in mesic slash pine or long leaf pine habitats and savannas. (USFWS, 1999)

Historical Range

Historically, A. tetramera occurred in sand pine scrub habitat on the coastal dune system in Martin and northern Palm Beach counties, Florida (USFWS, 1999)

Current Range

15 sites in Martin and northern Palm Beach Counties, Florida, along a 30-mile stretch of sand pine scrub. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1999)

Breeding Season

Adult: Flowering peaks in April and May, and continues throughout the summer. (USFWS, 1999)

Other Reproductive Information

Adult: Beetles are the most likely pollinators, although Dipterans (flies), Hymenopterans (wasps), and other insects have been observed visiting flowers. Gopher tortoises (Gopherus polyphemus), and small mammals such as the Florida mouse (Podomys floridanus) (Jones 1989) eat the fleshy fruit and may disperse seeds. Ingestion by animals is not necessary for seed germination. Asimina tetramera seeds germinate from September to March. Old, stored, or dried seeds will not germinate. Germination may take from 1 to 8 months after the seed is planted. The root system establishes several months before shoot emergence, and two to seven leaves are produced the first year. Asimina tetramera plants are deciduous, or partly so, with new leaves emerging in April and continuing to develop into summer. Buds are borne in the axils of the leaves as shoots develop. Flowers occur on new growth, and flower maturation proceeds from the base of the shoot toward the tip. Damaged stems sprout, producing new growth and may flower as late as September. Flowering peaks in April and May, and continues throughout the summer, with fruit ripening in 2 to 3 months. (USFWS, 1999)

Reproduction Narrative

Adult: Reproduction in A. tetramera is sexual. The perfect flowers open before all the parts are fully developed, and mature from the base of the stem toward the developing tip. They are protogynous, meaning that the stigmatic surface becomes receptive before anther maturation and pollen release. The petals fall from the flowers within one day of pollen release, and carpel development and receptacle enlargement follow successful pollination and fertilization. Flowers that are not pollinated fall soon after pollen release. (USFWS, 1999)

Habitat Type

Adult: sand pine scrub vegetation (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: Asimina tetramera is found only in sand pine scrub vegetation on old, coastal dunes (Austin and Tatje 1979). The species grows in excessively-drained, quartz sand of both the Paola and the St. Lucie soil series (Austin et al. 1980; A. Cox, Florida International University, personal communication 1995); however, it shows a preference for the Paola soils (Farnsworth, 1988).

Asimina tetramera is found in various seral stages of sand pine scrub, ranging from open [no canopy] to mature [closed canopy] (A. Cox, Florida International University, personal communication 1997). A. tetramera is adapted to infrequent, intense fires, perhaps every 20 to 80 years (FWS 1988). Abundant flowering and fruitset occur in years following fire and diminish with maturation of the community and subsequent canopy closure (A. Cox, Florida International University, personal communication 1996b). (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Gopher tortoises, and small mammals such as the Florida mouse (Podomys floridanus) (Jones 1989) eat the fleshy fruit and may disperse seeds.

Population Information and Trends

Population Trends:

Approximately half of the extant populations appear to be stable or increasing, while the rest are decreasing, or their status is unknown. (USFWS, 2022)

Number of Populations:

15 (USFWS, 2019)

Population Narrative:

The four-petal pawpaw can be found in sand pine scrub habitat in the coastal dune system of limited areas of Martin and Palm Beach Counties in southeast Florida (Kral 1960; Austin and Tatje 1979; Service 1999). The remaining four-petal pawpaw populations are declining due to further loss of habitat and may be characterized as existing on fragmented parcels within the historical range. While the four-petal pawpaw was historically documented in sand pine scrub areas of the south-central Atlantic Coastal Ridge of coastal Martin and northern Palm Beach counties, much habitat for the species has been destroyed or converted (Kral 1960; Service 1999; Florida Natural Areas Inventory (FNAI) 2000), and it is now found in a much smaller area from north of Palm Beach Gardens to the Savannas Preserve State Park in Martin County (Cox pers. comm. 1996a; Service 1999; Gann et al. 2002). The remaining populations of four-petal pawpaw occur within a narrow region of sand pine scrub habitat fragments that in 2018 included 15 sites — 11 public and 4 private sites (Service 1999; Gann et al. 2002; Cox pers. comm. 2018). Current information in 2018 shows four (4) of the 15 existing sites (27 percent) exist on private lands: three (3) in Martin County and one (1) in Palm Beach County (Cox pers. comm. 2018). Four-petal pawpaw occurred on approximately 26-27 historically known sites (Peterson 2008; Service 2009). (USFWS, 2019). Four-petal pawpaw is a long-lived shrub that occurs in coastal sand pine scrub within a limited range in Martin and Palm Beach counties, Florida. Remaining occurrences are fragmented and isolated within this range, and the species is estimated to occur in only 9 populations made up of 14 natural and augmented sub-populations with approximately 1,400 plants (Table 1). The previous status review (Service 2009) reported 16 populations made up of 21 sub-populations with approximately 1,800 plants. The status of some populations has been well documented while others remain in question due to accessibility issues. Approximately half of the extant populations appear to be stable or increasing, while the rest are decreasing, or their status is unknown. (USFWS, 2022)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of four-petal pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. Even though 68 percent of the sites containing four-petal pawpaw are publicly owned and not at risk of being developed, the plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Degradation to habitat can also occur from damage by feral hogs . Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in sand pine scrub habitat and the encroachment of exotic plants will continue to threaten four-petal pawpaw. (USFWS, 2009)

Stressor: Inadequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: The ESA provides limited protection for the species and its habitat. Existing federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The four-petal pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. Existing regulatory mechanisms do not appear to be adequate, as several properties with pawpaws on private lands have been developed. Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. (USFWS, 2009)

Stressor: Inadequate fire management
Exposure:
Response:
Consequence:
Narrative: This species occurs in scrub habitat, which is typically maintained by fire. On many privately owned sites, fire has historically been suppressed and habitat has not received regular maintenance. Because fragmented habitat is interspersed on a developed landscape, burning may also be unlikely due to proximity to neighbors (Peterson 2008). If sites are not regularly maintained through fire or mechanical treatment, the overall health of the scrub system may be compromised and flowering and fruit set of fourpetal pawpaws may be reduced. (USFWS, 2009)

Stressor: Invasive nonnative plants
Exposure:
Response:
Consequence:
Narrative: Another major threat to pawpaws is the establishment of exotic plant species such as Brazilian pepper, rosary pea (Abrus precatorius), guinea grass (Panicum maximum), and natal grass (Rhynchelytrum repens) in the absence of maintenance, especially where native soil is disturbed. However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the four-petal pawpaw. Broad application of herbicide to remove Brazilian pepper and tall grasses can be especially damaging (Cox in litt. 2009). It is thought that plants on at least two sites have been affected by herbicide treatments (Cox 2006). (USFWS, 2009)

Stressor: Limited distribution and specialized habitat
Exposure:
Response:
Consequence:
Narrative: The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. Although the species faired well through the 2004 and 2005 hurricanes, specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction. Unfortunately, long-term seed storage does not seem to be a viable option for this species, as the seed does not persist (Peterson et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When sites within the historic range of A. tetramera are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the coastal sand pine scrub communities to support A. tetramera (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Delisting Criteria:
1. At least 25 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)

2. Populations (as defined in criterion 1) occur in coastal sand pine scrub and are distributed across the historical range of the species. (Factor A, E) (USFWS, 2019)

3. Populations (as defined in criterion 1) must be protected via a conservation mechanism and/or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factor A, D, E) (USFWS, 2019)

Recovery Actions:

- Determine current distribution of A. tetramera. Some portions of A. tetramera's range have been well surveyed yet a total distribution has not been ascertained for this pecies. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Atlantic Coastal Ridge has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Continue research on life history characteristics of A. tetramera. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of A. tetramera. Develop monitoring protocol to assess population trends for A. tetramera. Develop a quantitative description of the population structure of A. tetramera. Monitor introduced plants. (USFWS, 1999)
- Provide public information about A. tetramera. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of A. tetramera and other rare species requires self-sustaining, secure, natural populations in existing native scrub habitat. S6. Establish delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about xeric vegetative communities and their unique biota. (USFWS, 1999)
- Surveys: - Continue to survey potential habitat and pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage scrub for ecosystem health and listed species. - Conduct additional surveys for four-petal pawpaw on all known and potentially suitable sites in the two counties of occurrence and provide updated information to FNAI for consistent tracking. - Continue monitoring for plants on both reintroduced and natural sites. - Monitor sites of special interest, such as those with altered water tables or in ecotonal areas at lower elevations. (USFWS, 2009)
- Management: - Continue management actions to include removal of debris and exotics through careful herbicide application, controlling public access, and the reintroduction of prescribed fire into the ecosystem. - Portions of sites with four-petal pawpaw and dense sand pines should be burned on a regular basis to prevent accumulation of large fuel loads. - Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species. - Identify additional reintroduction sites and establish reintroduced populations; population augmentations should also be implemented. (USFWS, 2009)

- Research: - Conduct research on the response of four-petal pawpaw to fire and fire prescriptions necessary to benefit the species. - Conduct additional research on the biology, ecology, genetics, and management needs of the species. - Continue demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages. - Compare the viability of the small sites in the northern portion of the range to the much larger southern site. - Conduct additional life history studies to enhance our understanding of observed genetic variance. - Continue to evaluate insect pollinators associated with the species over a longer term, and evaluate impacts to pollinators from aerial mosquito spraying, especially in the small, isolated sites in the northern portion of the species' range. - Continue seed germination studies and make efforts to develop additional outplanting techniques. - Continue genetic characterizations on sites that have not yet been studied, and apply this knowledge to future introductions and population augmentations. - Continue to collect germ plasm from the remaining sites not currently represented in the Center for Plant Conservation's National Collection of Endangered Plants. - Continue propagation efforts. - Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2009)
- Other: - Partnerships should be promoted to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. - Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize five- and ten-year goals. - Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities: • Collect germplasm from the remaining sites not currently represented in the Center for Plant Conservation's National Collection of Endangered Plants for ex situ safeguarding. • As informed by research on best methods and site characteristics (see Research/Monitoring below), continue seed collection, propagation, and direct planting for both augmentations and introductions. • Identify the most suitable introduction sites and carefully monitor any plants translocated or seeds planted. Use irrigation to help increase plant survival the first year. • If suitable habitat remains on publicly owned sites with extirpated populations, consider re-introducing four-petal pawpaw. Where habitat has degraded in areas of historical populations, perform restoration to return to suitable scrub pine habitat. • Carefully apply herbicide to invasive plant species in pawpaw habitat as needed and avoid pawpaw plants by ensuring all applicators know exactly where it is safe to spray. • Conduct prescribed fires, preferably in the spring lightning season, within appropriate fire return intervals to prevent accumulation of large fuel loads and create more favorable conditions for pawpaw reproduction. • If habitat/landscape level burns are not feasible because of wildland-urban interface or other challenges, experiment with conducting micro-burns around pawpaw plants. • As informed by additional genetic analysis (see Research/Monitoring below), focus conservation efforts on marginal and small sites to preserve genetic diversity. • As landowners are willing, acquire private sites with remaining pawpaw populations to ensure their protection or alternatively, enact conservation easements. • As a last resort and where needed, perform rescues of plants on private sites to be developed and

translocate to protected land with suitable habitat. Research/Monitoring: • Investigate methods and site characteristics that lead to long-term introduction success. • Continue to survey potential coastal sand pine scrub habitat for new occurrences and provide updated information to FNAI. • Continue demographic monitoring on sites where populations have been followed and begin demographic monitoring on those sites where populations only have been periodically observed. Data on population size, reproductive rates, age class structure, and habitat conditions should all be documented. • Closely monitor for recruitment and determine the conditions required for growth. • Obtain permission from private landowners with historical pawpaw occurrences to survey and determine the status of these populations. If present, foster partnerships/working relationships with these landowners to protect plants. • Complete genetic analysis of populations to determine the amount and spatial distribution of diversity remaining to help inform further conservation actions, such as appropriate translocation material and locations. • Collect and analyze RAPD data on leaf samples from unsampled populations and create an updated dendrogram. • Continue to evaluate insect pollinators associated with the species and determine the status of these insect populations. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. Outreach/Collaboration Activities: • Promote partnerships between county, state, and federal agencies to share information and conduct collaborative research on coastal scrub habitat conservation. • Convene another ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize five- and ten-year goals. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public. • Continue educating landowners with properties near pawpaw-occupied protected lands on the benefits of prescribed fire. • Continue using volunteer assistance (e.g., Florida Native Plant Society) and engaging youth in the monitoring and recovery of this species. (USFWS, 2022)

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SPECIES ACCOUNT: *Astragalus albens* (Cushenbury milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/24/1994; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A winter annual or short-lived perennial herb, silvery-white with a covering of dense, appressed silvery hairs. Stems (several) are slender, decumbent, up to 3 dm in length, together forming a loose mat. Leaves have 5-9 leaflets. Purple flowers are borne in clusters of 5-14 towards the tips of the stems (NatureServe, 2015).

Taxonomy

Member of the Fabaceae (pea family) (USFWS, 2009).

Historical Range

Cushenbury milk-vetch is endemic to the San Bernardino Mountains, San Bernardino County, California (USFWS, 2009).

Current Range

Restricted to a carbonate belt in the northeastern San Bernardino Mountains (east slope of the Transverse Range) extending from Dry Canyon southeastward to the head of Lone Valley (approximately 24 km) in and adjacent to San Bernardino National Forest; San Bernardino County, California. Using GIS tools, range extent was calculated to be approximately 82 square km (NatureServe, 2015). Cushenbury milk-vetch occurs from Furnace Canyon southeast to the head of Lone Valley (USFWS 1994, p. 43654) (USFWS, 2009). The species is endemic to the northeastern San Bernardino Mountains, San Bernardino County, California (USFWS, 2022).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus albens (Cushenbury milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for Astragalus albens includes one CHU (39 subunits) in San Bernardino County, California (67 FR 78570-78610).

Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin, Big Bear City, Rattlesnake Canyon, and Cougar Buttes, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus albens critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from the upper and middle members of the Bird Spring Formation and Undivided Cambrian parent materials that occur on hillsides or along rocky washes with limestone outwash/ deposits at elevations between 1,171 and 2,013 m (3,864 and 6,604 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Breeding Season

Adult: March - May (USFWS, 1997)

Key Resources Needed for Breeding

Adult: Probably bee pollinators (USFWS, 2009)

Reproduction Narrative

Adult: Plants have a taproot and show no evidence of vegetative reproduction (Neel 2008) (NatureServe, 2015). Pollinators are probably small bees (USFS 2008) (USFWS, 2009). Flowers bloom from March to May (USFWS, 1997).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodland, pinyon woodland, Joshua tree woodland, blackbrush scrub, creosote bush-blackbrush scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Generally 5,000 - 6,600 ft. elevation (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Patchy (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Primarily found on soils derived directly from decomposing limestone bedrock, especially on ridgetops and on open, very rocky, relatively gentle slopes at 1500-2000 m elevation. Also known from lower elevations (down to about 1170 m) in rocky washes that receive limestone outwash and from granite and granite-quartzite substrates. Plant communities are pinyon-juniper woodland, pinyon woodland, Joshua tree woodland, blackbrush scrub, and creosote bush-blackbrush scrub. Occupied sites tend to have low overstory and shrub canopy cover, high soil pH, and a high percentage of soil calcium. Associated species include Fremontodendron californicum (California Flannelbush), Coleogyne ramosissima (Blackbrush), Echinocereus triglochidiatus var. mojavensis (King-Cup Cactus), Prunus fasciculata (Desert Almond), and Yucca schidigera (Mojave Yucca). This species has a narrow environmental specificity, indicated by a restricted and patchy distribution in a highly specialized habitat (NatureServe, 2015). Cushenbury milk-vetch generally occurs with soils derived from limestone, dolomite, or a mixture of limestone and dolomite (Tierra Madre Consultants 1992, p. 33). Most occurrences are found between elevations of 5,000 and 6,600 feet (1,524 and 2,012 meters). Three occurrences are found below 5,000 feet (1,524 meters). Other habitat characteristics include an open canopy cover with little accumulation of organic material, rock cover exceeding 75 percent, and gentle to moderate slopes (5 to 30 percent) (USFWS 1997, p. 8). The primary constituent elements of Cushenbury milk-vetch designated critical habitat include: 1) soils derived primarily from the upper and middle members of the Bird Spring Formation and Undivided Cambrian parent materials that occur on dry flats and slopes or along rocky washes with limestone outwash/deposits at elevations between 3,864 and 6,604 feet (1,171 and 2,013 meters); 2) soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, re-contoured, or otherwise altered by ground-disturbing equipment); and 3) associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Fruits and seeds have no specialized dispersal mechanism (Neel 2008) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Declining (NatureServe, 2015)

Number of Populations:

23 (7 extant, 16 presumed extant, 1 is unknown (USFWS, 2022)

Population Narrative:

In summary, we consider there to be 24 known occurrences of Astragalus albens. Of the 24 occurrences, 7 are extant (i.e., the species was observed during the past 10 years), 16 are presumed extant (i.e., the species was not observed during the past 10 years, but suitable habitat is present), and one is unknown because habitat suitability may have been impacted by mining (Table 1). One occurrence is fully protected and eight are partially protected as part of the Carbonate Strategy's Habitat Reserve (Figure 2; Table 1). Portions of four occurrences are known to be under active mining (i.e., are being actively mined or have approved plans to be mined) (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Mining activity remains the primary threat for Cushenbury milk-vetch (USFWS 2005a, p. 246). Mining activities can impact habitat for the plants through the removal of mined materials, disposal of overburden, and road construction. Other impacts to the plants are associated with dust and artificial lighting (USFWS 1997, pp. 13, 15–18). Dust can affect Cushenbury milkvetch's habitat by altering soil chemistry and light penetration into seedbanks (USFWS 1997, pp. 17-18). Artificial lighting may affect Cushenbury milk-vetch's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18). Off-road vehicle use and energy development projects could impact the species' habitat though ground disturbance or dust creation. Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities were also identified since listing. However, the magnitude of these threats has been reduced through regulatory mechanisms, including implementation of the Act and actions taken by the U.S. Forest Service (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Cushenbury milk-vetch is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the

species, poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the species into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction (USFWS, 2009).

Recovery

Reclassification Criteria:
1. Sufficient habitat has been protected for existing populations of the plants to persist in their ecological contexts. The system of permanent biological reserves for the habitat will be designed to protect the largest populations, the best habitat, and to be manageable (USFWS, 1999).

2. Potential buffer zones for these reserve lands shall have been identified, albeit not necessarily secured, to meet this criterion. The interim estimate of additional lands needed for habitat connectivity, buffers, and natural community context is 1,860 hectares (USFWS, 1997).

3. Early detection of population instability or other problems in the reserve system is assured through population monitoring/habitat management programs (USFWS, 1997).

4. The chance that the most narrowly-distributed species might go extinct due to random naturally occurring events has been reduced through reintroductions or expansions of existing populations (USFWS, 1997).

Recovery Priority Number: 8C

Delisting Criteria:
Not available

Recovery Actions:
- Protect significant extant populations by developing a system of reserves on Federally owned land. Initially, preserves covering about 2,000 hectares are needed, based on known areas occupied by the plants. The reserve system includes buffer zones and maintenance of selected habitat connections. The land managing agencies will conserve these plants in the context of applicable laws and regulations (USFWS, 1997).
- Restore habitat and conduct reintroductions and/or population enhancements where appropriate and feasible (USFWS, 1997).
- Identify and implement appropriate management measures (USFWS, 1997).
- Monitor populations (USFWS, 1997).
- Conduct limited surveys and taxonomic assessment to find new populations and resolve questions about the identity of several populations identified in the text (USFWS, 1997).
- Prepare a new threats-based recovery plan specific to Cushenbury milk-vetch that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Cushenbury milk-vetch (USFWS, 2009).

- Work with the San Bernardino National Forest to conduct systematic monitoring of Cushenbury milk-vetch throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change (USFWS, 2009).
- Work with partners, such as the San Bernardino National Forest, to help conserve Cushenbury milk-vetch by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Cushenbury milk-vetch from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Cushenbury milk-vetch habitat (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to Astragalus albens and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Continue implementation of the Carbonate Habitat Management Strategy, particularly additions of A. albens habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value. 2. Research the species' susceptibility to climate change by determining climate tolerances (e.g., temperature, drought duration) and identify climate refugia to protect within carbonate habitat. 3. Determine appropriate monitoring frequency and implement a range-wide monitoring strategy that provides useful information about population health. 4. Continue managing the threat of roads, off-road vehicle activity, or other recreational activities to carbonate habitat. This may be achieved through road decommissioning, installation and maintenance of signs and barriers, or other management. 5. Research the efficacy of restoring populations on reclaimed lands that have been restored after mining. 6. Finalize the establishment of the proposed Blackhawk Research Natural Area. 7. Collect additional seeds, as needed, to maintain a viable and genetically diverse conservation seed bank (USFWS, 2022).

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SPECIES ACCOUNT: *Astragalus ampullarioides* (Shivwits milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/28/2001; Mountain-Prairie Region (Region 6) (USFWS, 2015)

Physical Description

Stems may grow along the ground or to a height of 8-20 in. (20-50 cm), although ungrazed flowering stems may attain a height of 40 in. (1 m). The leaves are pinnately (arranged opposite) compound, 1.6-7.1 in. (4-18 cm) long, and have 11 to 23 elliptical leaflets. Each plant produces approximately 45 small cream-colored flowers about 0.8 in. (2.0 cm) long on a single stalk in the spring. Seeds are produced in small pods, and the plant dies back to its root crown after the flowering season. The fruit is a short, broad pod between 0.3-0.6 in. (0.8-1.5 cm) long and 0.2-0.5 in. (0.6-1.2 cm) wide. (USFWS, 2006)

Taxonomy

Kartesz (1999), Isely (1998), and Barneby (1989) do not recognize this entity, at either the species or infraspecific levels, instead including Astragalus ampullarioides (also known as A. eremiticus var. ampullarioides) in A. eremiticus, with no varieties recognized. USFWS and Welsh (1998) recognize at the full species level: A. ampullarioides (Great Basin Naturalist 58(1):51). Barneby (1989) questioned the taxonomic significance of the variety and submerged A. eremiticus var. ampullarioides within typical A. eremiticus. Later research by Harper and Van Buren (1998) and Stubben (1997) demonstrated significant ecological and genetic differences between typical A. eremiticus and A. eremiticus var. ampullarioides. These differences are summarized as follows-(1) A. ampullarioides has more flowers per stem, (2) A. ampullarioides has longer flower stalks (from last leaf to flower), (3) A. ampullarioides has wider pods, (4) A. ampullarioides has taller stems, (5) A. ampullarioides has hollow stems while A. eremiticus stems are solid, and (6) A. ampullarioides plants are highly palatable to grazing animals while typical A. eremiticus is seldom if ever eaten (Barneby 1989; Welsh 1986, 1998; Welsh et al. 1987; Van Buren 1992; Harper and Van Buren 1998). (USFWS, 2006)

Historical Range

Historical distribution is not known for either species, that is, records are not available to ascertain whether the current distribution of A. holmgreniorum and A. ampullarioides populations represents either a loss of individual populations or a range contraction for either species. (USFWS, 2006)

Current Range

All known locations of A. ampullarioides occur within Washington County, Utah. Known populations of A. holmgreniorum occur within approximately 10 miles (mi) (16 kilometers (km)) of St. George in Washington County, Utah, and Mohave County, Arizona. (USFWS, 2006)

Critical Habitat Designated

Yes; 12/27/2006.

Legal Description

On December 27, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus ampullarioide (Shivwits milk-vetch) under the Endangered Species Act of 1973, as

amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Utah (71 FR 77972-78012).

Critical Habitat Designation

The critical habitat designation for Astragalus ampullarioide includes four CHUs in Washington County, Utah. This species critical habitat encompasses approximately 2,181 acres (2,545 ha) (71 FR 77972-78012).

Unit 1—Pahcoon Spring Wash This unit includes 134 ac (54 ha), all on BLM UT lands adjacent to the Shivwits Indian Reservation. Astragalus ampullarioides was known to occupy this area at the time of listing. This population occurs in a small area where the density of A. ampullarioides is high (Van Buren and Harper 2004b, p. 3). In 2005, this population was estimated to contain approximately 300 to 350 individuals (Van Buren 2005). Unit 1 is determined to be critical habitat because it contains features essential to conservation of A. ampullarioides, is occupied by the species, and represents the northwestern-most occurrence of the species. Resources within this unit support the identified PCEs associated with outcroppings of the Chinle Formation. Special management may be required to minimize disturbance to the surface and subsurface structure within this unit, to control invasive species, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. Cattle grazing activities are present within this unit. The Chinle soils are soft and easily susceptible to erosion. A cost-share agreement between BLM UT and The Nature Conservancy (TNC) provides funding for signs and protective fencing; contracting for the fence is in process. As a part of the agreement, BLM UT and TNC will compare past plant survey data with population surveys to be completed in 2007 and 2009 to evaluate the effectiveness of the fence in eliminating habitat degradation.

Unit 3—Coral Canyon This unit, known to be occupied at the time of listing, is located adjacent to a golf course near Harrisburg Junction, and was estimated to contain 100 individuals in 2005 (Van Buren 2005). Land ownership for the 87 ac (35 ha) is 87 percent SITLA, 12 percent BLM UT, and 1 percent private. We included occupied habitats and adjacent areas of suitable soils and vegetation to allow for maintenance of the seed bank, seed dispersal, and pollinator services. This unit is determined to be critical habitat because it contains features essential to conservation of the taxon, is occupied by the taxon, is centrally located and may provide connectivity between populations, and contains a persistent occupied site of Astragalus ampullarioides. Plants within this subunit face threats from urban development. Special management may be required to minimize disturbance to the surface and subsurface structure within this subunit, maintain the identified soil and vegetation types, and control invasive weeds.

Unit 4—Harrisburg Junction In 2001, the final listing rule (66 FR 49560; September 28, 2001) referred to a population near Harrisburg Junction that contained four separate sites. Unit 4 is comprised of two subunits encompassing 759 ac (307 ha) that are spatially separated based on geography (Harrisburg Bench/Cottonwood and Silver Reef). Each of these subunits contains two of the plant occurrence sites that were known to be occupied at the time of the final listing rule (66 FR 49560; September 28, 2001). In 1999, the 4 sites contained approximately 300 plants (England 1999; Utah Natural Heritage Program 1999; Van Buren 2000). In the area of Harrisburg Junction, Astragalus ampullarioides populations or subpopulations are restricted to outcroppings of the Chinle soil. Each area may be relatively self-sustaining; however, their long-term persistence and stability relies on a balance of site extinctions and colonization of suitable, unoccupied outcroppings through dispersal events (Hanski 1985, p. 341; Olivieri et al. 1990, pp.

207–209; Hastings and Harrison 1994, pp. 175– 176, 180). Subunit 4a—Harrisburg Bench and Cottonwood This 297–ac (120–ha) subunit is 88 percent BLM land and 12 percent private land. Approximately 100 individual plants were located in this subunit during 2005 surveys (Van Buren 2005). This subunit contains PCEs necessary to support Astragalus ampullarioides growth, reproduction, and establishment. Land found between the northbound and southbound lanes of I–15 contains an occupied site. This intervening area within the highway right-of-way may allow pollinator flow between occupied sites (Douglas 2005). Habitat areas between known occupied sites are included in the critical habitat designation to support pollinators and seed dispersal between sites. Pollinator habitat and seed dispersal are considered important for the species' long-term survival (Steffan-Dewenter and Tscharntke 1999, pp. 437–438; Steffan-Dewenter 2003, pp. 1039–1040; Greenleaf 2005, pp. 72–74; Van Buren and Harper 2003a, p. 242). This subunit is determined to be critical habitat because it contains features essential to conservation of Astragalus ampullarioides, is occupied by the species, and contains a persistent occupied site for A. ampullarioides that is centrally located and may provide connectivity between other units. At the Harrisburg site, Bromus tectorum (cheatgrass) is a closely associated species (Van Buren 2005, p. 14). Part of this unit, east of I–15, burned during a wildfire in 2005; however, no suppression occurred in areas of occupied habitat. The status of seeds within the seed bank is unknown. Also unknown, but likely, is that most of the above-ground stems and foliage died back at the time of the fire (Van Buren 2005, p. 14). Revisits in 2006 indicated that Astragalus ampullarioides occupies the site and was not adversely affected by the fire (Van Buren 2006). Plants within this subunit may be threatened by urban development, recreation, and invasive plant species. Special management may be required to control invasive plant species, minimize disturbance to the surface and subsurface structure, and maintain the identified soil and vegetation types. BLM UT and TNC have entered into a cost-share agreement to provide signs and protective fencing to minimize human use at one occupied area within this subunit. Subunit 4b—Silver Reef The 462 ac (187 ha) in this subunit are composed of 90 percent BLM lands and 10 percent private lands. Astragalus ampullarioides individuals are found along intermittent outcroppings of the Chinle Formation. Approximately 150 individuals were identified in a partial survey in 2005 (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of A. ampullarioides, is occupied by the species, contains a thriving population, and maintains a prevalence of soil substrate necessary for future expansion to maintain metapopulation dynamics. Special management may be required to minimize recreational use and disturbance to the soil surface and subsurface structure, control invasive plant species and domestic animals, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Quantitative information on impacts from cattle grazing or recreational use is unknown. One occupied area within this subunit is under a cost-share agreement for protective fencing, which is to begin in the near future. Monitoring will be used to evaluate the effectiveness of the fences in eliminating habitat degradation from cattle and recreational use. Additional areas in this subunit remain unfenced, and special management may still be necessary to reduce impacts to habitat.

Unit 5—Zion The 1,201 ac (486 ha) in Unit 5 occur entirely on lands managed by Zion National Park. The population consisted of approximately 300 to 500 individuals in 2000 (66 FR 49560; September 28, 2001). More recent surveys document almost 4,200 individuals in the unit (Miller 2006). This unit is determined to be critical habitat because it contains features essential to conservation of Astragalus ampullarioides, is occupied by the species, is one of five known populations, represents the northeastern-most range of the species, and contains the largest known population of the species. The land within this unit supports the PCEs necessary for

growth, reproduction, and establishment. Special management is necessary in this unit to minimize recreation disturbance to the soil surface and subsurface structure, control invasive weedy species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Recreational use of Zion National Park and disturbance from park visitors and horses may affect Astragalus ampullarioides. An established hiking and horse trail that is used infrequently from November through April occurs near populations of Astragalus ampullarioides. Plants and habitat within this unit also are threatened by invasive nonnative plants, including Moluccella laevis (bells of Ireland), an introduced species not found at other sites. Although this unit is in a sparsely vegetated habitat that in the past did not carry fire, the invasions of exotic grasses are creating more continuous fuels. No management plan exists specific to Astragalus ampullarioides in Zion National Park; however, the current Zion National Park Fire Management Plan includes restrictions on fire management within a 0.75-mi (1.2-km) buffer zone of the area where A. ampullarioides is found. Zion National Park worked with us to complete a recovery plan for the species (71 FR 57557, September 29, 2006), and is partnering with the USGS to investigate biotic soil conditions and invasive weed interactions with A. ampullarioides.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus ampullarioide critical habitat consists of three components (71 FR 77972-78012):

(i) Outcroppings of soft clay soil, which is often purplish red, within the Chinle Formation and the Dinosaur Canyon Member of the Moenave Formation, at elevations from 920 to 1,330 m (3,018 to 4,367 ft);

(ii) Topographic features/relief, including alluvial fans and fan terraces, and gently rolling to steep swales with little to moderate slope (3 to 24 percent), that are often markedly dissected by water flow pathways from seasonal precipitation; and

(iii) The presence of insect visitors or pollinators, such as Anthophora captognatha, A. damnersi, A. porterae, other Anthophora species, Eucera quadricincta, Bombus morrissonis, Hoplitis grinnelli, Osmia clarescens, O. marginata, O. titus, O. clavescens, and two types of Dialictus species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

The features essential to the conservation of A. holmgreniorum and A. ampullarioides, in all areas we are designating, may require special management considerations and protections, including measures necessary to alleviate the effects of urban development, retaining plants and their habitat on Federal lands, fencing small populations, removing or limiting access routes, ensuring vehicles and pedestrians stay on designated routes, reducing land use practices that disturb the hydrologic regime, minimizing the effects of grazing and recreation use, managing invasive nonnative plant species, evaluating revegetation and restoration with native plant species, developing adequate fire management buffers for these plant species and their habitat,

and educating fire management staff on the location of the plants. Additionally these areas may require special management considerations and protections for ground-nesting and local pollinator communities.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2006)

Lifespan

Adult: Unknown; >9 years (USFWS, 2007)

Dependency on Other Individuals or Species

Adult: Primary pollinators of A. ampullarioides include the native bees Anthophora coptognatha, A. dammersi, Anthophora spp., Eucera quadricincta, Bombus morrisoni, Hoplitis grnnellei, Osmia clarescens, O. marginata, and O. titusi, as well as the nonnative honeybee Apis mellifera (Tepedino 2005). A. ampullarioides relies solely on the production of seeds for reproduction, and pollination is thus highly linked to the survival of the species. (USFWS, 2007)

Breeding Season

Adult: April to May (USFWS, 2007)

Reproduction Narrative

Adult: Collection of demographic and life history data for A. ampullarioides began in 1992. A. ampullarioides, a perennial herb, has an unknown lifespan, although tracking of seedlings from 1995 indicates a lifespan of at least 9 years (Van Buren and Harper 2003b). A. ampullarioides does not reproduce through vegetative methods, and their sexual reproduction is contingent on pollen reaching receptive stigmas for seed production. Flowering occurs between April and late May; by the end of June plants dry up, although vestiges of dried plants may persist for several months. Each A. ampullarioides plant is capable of bearing up to 45 flowers per flower stalk (Welsh et al. 2003, 66 FR 49560), and plants frequently have several stalks. From 1992 to 2000, Van Buren and Harper (2003a) documented an average of 86.7 flowers per plant. The number of seeds per pod ranges from 2 to 17, with 7 to 80% of all ovules producing seed (Tepedino 2005). (USFWS, 2006; USFWS, 2007)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Great Basin Pinyon-Juniper Woodland, Colorado Plateau Blackbrush-Mormon-tea Shrubland, Mojave Mid-Elevation Mixed Desert Scrub, Intermountain Basins Mixed Salt Desert Scrub, Sonora Mojave Creosote-Whitebursage Desert Scrub, Intermountain Basins Semi-Desert Shrub Steppe, and North American Warm Desert Lower Montane Riparian Woodland and Shrubland (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Adequate rainfall (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: A. ampullaroides populations are found at elevations between 3,018-4,367 ft (920-1,330 m); sparsely vegetated habitat with an average of 12% cover (USFWS, 2007)

Environmental Specificity

Adult: Narrow / specialist (USFWS, 2007)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2007)

Habitat Narrative

Adult: A. ampullaroides populations are found at elevations between 3,018-4,367 ft (920-1,330 m), typically on purple-hued patches of soft clay soil of which 99% are associated with isolated outcrops of the Petrified Forest member of the Chinle Formation (Armstrong and Harper 1991; Harper and Van Buren 1997; M. Miller, pers. comm. 2006). This substrate, which is light, airy, and unstable when dry (Van Buren and Harper 2003a), expands greatly with precipitation, becoming slick and glue-like and forming mounds (Harper 1997). Equal contraction upon drying often results in the formation of deep, wide fissures, constricting root systems so that few perennial plants persist on Chinle soils (Harper 1997). A. ampullarioides is documented from the following soil map units described by USDA et al. (1977) C Stony colluvial land; Naplene silt loam, 2-6% slope; Eroded land-Shalet complex; Badland, very steep; Mathis-Rock outcrop complex, 20-50% slope; Rock land, stony; Bond sandy loam, 1-10%; Clovis fine sandy loam, 1-5% slope; Badland; and Rock land Hobog association (USFWS unpubl. data 2005). Soil texture by weight is 48.9% clay, 25.1% silt, and 26.0% sand, with an undetermined depth (Van Buren and Harper 2001). Percentage of gravel and rock on site is much lower than A. holmgreniorum and measures 13.8% (Van Buren and Harper 2003a). A. ampullarioides habitat is sparsely vegetated, with an average 12% cover (Van Buren and Harper 2003a). Due to soil shrinkage and expansion, native plant species found with A ampullarioides are generally herbaceous forbs and grasses including Calochortus flexuosus (sego lily), Dichelostemma pulchellum (bluedicks), Hilaria rigida (galleta), H. jamesii (James' galleta), Sporobolus airoides (alkali dropseed), and Lotus humistratus (hill lotus) (Van Buren and Harper 2003a; M. Miller, pers. comm. 2006). The perennial rootstock allows A. ampullarioides to survive dry years, and in a drought year plants may not emerge (Van Buren and Harper 2003b). Dormancy is one strategy by which longer-lived plant species can survive changing climatic conditions, particularly in relation to rainfall (Epling and Lewis 1952). (USFWS, 2007)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Methods of A. ampullarioides seed dispersal have not been researched. However, water patterns, landscape erosion, and soil slumping likely contribute to the development of appropriate habitat sites and may transport seeds within sites (Van Buren and Harper 2003a). The disjunct populations of A. ampullarioides also could imply bird dispersal (S.L. Welsh, pers. comm. 2005). (USFWS, 2007)

Population Information and Trends

Population Trends:
Stable (USFWS, 2021)

Number of Populations:
6 (USFWS, 2021)

Population Size:
4,000-5,000 (USFWS, 2021)

Population Narrative:
The latest range-wide estimate for Shivwits milkvetch is 4,000 – 5,000 individuals in six populations; approximately 83 percent of known individuals occur in the Zion population (USFWS, 2021).

Threats and Stressors

Stressor: Habitat loss (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Habitat loss due to the growing development pressures in the vicinity of St. George and associated infrastructure also threaten A. ampullarioides populations. (USFWS, 2007)

Stressor: Recreation (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Within the Zion population, a recreational trail poses a potential threat to individuals and habitat, albeit the frequency of habitat disturbance and/or direct plant loss is unknown. Research on user impact has been suggested so that Zion National Park can better manage and assess continuing threats of this species on its lands. (USFWS, 2007)

Stressor: Electric power transmission line (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: In the final listing rule, an electric power transmission line was projected to pass through the Pahcoon Spring Wash and Shivwits A. ampullarioides populations at the western edge of the species' range, as well as through the easternmost population within Zion National Park. Prior to these projects, surveys conducted for this species did not result in any new A. ampullarioides sites being found (L. England, pers. comm. 2006). In response to potential adjacent utility corridor activities, the Shivwits band of the Paiutes fenced the main area of plant occupancy. (USFWS, 2007)

Stressor: Silver mining (USFWS, 2007)
Exposure:
Response:

Consequence:
Narrative: Silver mining diminished by the early 1900s (R. Douglas, pers. comm. 2005) and is not believed to be a future threat for A. ampullarioides. Other mining, such as removal of landscaping rock, exists at a distance to the Pahcoon Springs Wash population but does not appear to constitute a threat. (USFWS, 2007)

Stressor: Off-road vehicles (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, habitat degradation from ORV use was identified as a threat for A. ampullarioide,s and it continues to be a serious threat, given the increasing popularity of ORV activities in Washington County (see A. holmgreniorum above for more details). The ORV activities in A. ampullarioides habitat are particularly damaging, as the localized clay substrate lacks soil stability and is easily disturbed. The ORV activities lead to associated plant loss, habitat degradation, and changes in native plant communities. Although fencing will not abate all ORV use within A. ampullarioides habitat, fencing at the Pahcoon Spring Wash, Harrisburg Bench and Cottonwood, and Silver Reef population, which is expected to be completed in October 2006, will reduce direct ORV impacts to sites on BLM lands. The Silver Reef population currently experiences the highest levels of ORV use, but a portion of this population has been incorporated into the Red Cliffs Desert Reserve (Washington County Habitat Conservation Plan (HCP), 1995) due to a boundary adjustment (J. Crisp, pers. comm. 2006) and thus will be afforded better protection through site-specific planning for recreational management, recreation use monitoring, and law enforcement. (USFWS, 2007)

Stressor: Trampling (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Milk-vetch habitat degradation is caused by cattle trampling, which disturbs the soil surface and seedbanks for these species. This is an issue for the Pahcoon Spring Wash, Shivwits, and Silver Reef A. ampullarioides populations. In particular, the Pahcoon Spring Wash habitat has recently experienced severe cattle trampling (Van Buren 2005), disturbing the fragile clay soils found on the Chinle and Moenave formations and crushing individual plants. Supporting soils are especially susceptible to disturbance and compaction caused by trampling and overuse (R. Van Buren, pers. comm. 2006). In addition to cattle trampling, A. ampullarioides may incur damage during survey efforts if these activities are conducted without sufficient caution. Cattle or human trampling is expected to diminish in the future in light of recently funded fencing projects expected to be completed in October 2006. (USFWS, 2007)

Stressor: Fires (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Finally, as described for A. holmgreniorum, St. George, Utah, and surrounding areas are experiencing an increase in fires due to exotic, nonnative grasses such as cheatgrass and red brome. In 2005, fire ran through the Harrisburg Bench site of the Harrisburg Bench and Cottonwood population. Site visits in 2006 documented species presence and indicated a

healthy return. Timing of the 2005 fire coincided with annual plant dormancy patterns, which appears to have reduced detrimental effects (R. Van Buren, pers. comm. 2006). Fires in past years and in 2006 occurred close to the Pahcoon Springs Wash and Shivwits populations on the eastern slopes of the Beaver Dam Mountains. Both BLM and the Tribe are aware of A. ampullarioides population locations and efforts will be made to protect the plants. (USFWS, 2007)

Stressor: Development (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Residential and commercial development, which indirectly affects known occupied areas, is occurring at the Coral Canyon population and, to a lesser degree, at the Harrisburg Bench and Cottonwood and Silver Reef populations. (USFWS, 2007)

Stressor: Roads (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: New roads, highways, electric power transmission lines, and pipelines were constructed in A. ampullarioides areas prior to the final listing rule and probably caused past impacts on A. ampullarioides populations. For example, the construction of highway I-15 altered the Cottonwood site within the Harrisburg Bench and Cottonwood population areas. not known if additional utility or transportation corridors will be constructed in the future. Current and future highway maintenance (see A. holmgreniorum above for description of projected activities) is a potential threat. (USFWS, 2007)

Stressor: Herbivory (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: In terms of predation, A. holmgreniorum may be occasionally susceptible to herbivory, while A. ampullarioides is extremely palatable to both wildlife and domestic livestock. Tepedino (2005) indicates losses to herbivores, including cattle for research done at the State Line (A. holmgreniorum) and Coral Canyon (A. ampullarioides) populations; however, this information was not quantified. At the time of listing, livestock grazing at the two western A. ampullarioides populations, Pahcoon Spring Wash and Shivwits, was of concern. However, protective fencing at the Shivwits population has greatly reduced the threat at that site, as will fencing slated to be installed at the Pahcoon Spring Wash in October 2006. (USFWS, 2007)

Stressor: Overgrazing (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Overgrazing by livestock can eventually cause a shift in the plant communities, favoring invasive plants to the detriment of both A. holmgreniorum and A. ampullarioides (see Factor E). Recent herbivory at the A. ampullarioides demography study site at Pahcoon Spring Wash population is tentatively attributed to rabbits (Van Buren 2005), although it is not known if

the level of herbivory negatively affects the plants at the population level. Some degree of natural herbivory occurs every year in A. ampullarioides populations (Van Buren 2005). High herbivory was seen in preliminary research conducted in 2006 at Zion National Park, where 90% reduction in fruit production was attributed to vertebrate herbivores. (USFWS, 2007)

Stressor: Parasitism and insect infestations (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: One additional factor that warrants further research is the potential for parasitism and insect infestations, particularly in regard to potential effects on A. ampullarioides populations. Past monitoring documented aphid infestations associated with A. ampullarioides. Also, an outbreak of white moths, which visited flowers in April 2005, may have restricted production of seeds. By May, flowers dropped off the stem, inhibiting fruit development, and these symptoms could either be related to white moth predation or to a coincidental lack of pollination. If this reoccurs, it will become a priority for further investigation. (USFWS, 2007)

Stressor: Invasive species (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Past habitat disturbance has caused the proliferation of invasive annual weeds into both species' occupied habitat (Harper 1997 and Van Buren and Harper 2000a, 2000b in 66 FR 49560). In fact, all populations of both A. holmgreniorum and A. ampullariodes have been affected to some degree by invasive nonnative annuals, which make up the highest percentage of living cover in the habitat of both species (Van Buren 2004). Because invasive annuals tend to emerge prior to the milk-vetches, competition for soil moisture and nutrients and displacement of the milk-vetches is an emerging threat. (USFWS, 2007)

Stressor: Fragmented habitats (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: A. holmgreniorum and A. ampullarioides are pollinated by native solitary ground-dwelling bees (Tepedino 2005). Fragmented, disjunct habitats hamper pollinator exchange between populations, which could cause genetic isolation and potentially lead to inbreeding and local extirpation of isolated populations (Heschel and Paige 1995). Urban expansion and associated impacts may directly and indirectly affect pollinators through loss of pollinator habitat (Tepedino 2005). For both species, lack of pollinators would result in a gradual decrease in the number of seeds in the seedbank (Tepedino 2005). Additionally, small and restricted sites of other rare Astragalus were found to receive lower levels of pollinator vistors (Karron 1987). The Gardner Well, Stucki Spring, South Hills, and Purgatory Flat A. holmgreniorum sites are small and disjunct. Similarly, all A. ampullarioides sites, except for Zion, are small and disjunct. (USFWS, 2007)

Stressor: Climate change (USFWS, 2007)
Exposure:
Response:

Consequence:
Narrative: Climate change has emerged as a significant concern, particularly in regard to the potential for increasingly prolonged drought cycles (Miller 2005; R. Van Buren, pers. comm. 2006). Both A. holmgreniorum and A. ampullarioides have higher germination and survivorship rates during and following years of increased precipitation (Van Buren and Harper 2003a), and if consecutive years of low reproductive output caused by drought conditions outlast seedbank longevity, the affected populations could become extirpated (R. Van Buren, pers. comm. 2006). Given that drought events occur at a regional scale (Miller 2005), this could prove to be a serious limiting factor for both species. Frost kill also affects both species and could become a more prevalent problem with long-term seasonal changes (R. Van Buren, pers. comm. 2006). (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Additionally, some A. holmgreniorum and A. ampullarioides are small-sized and could be threatened by stochastic events. (USFWS, 2007)

Recovery

Reclassification Criteria:
1. Species presence is maintained at all recovery populations. (USFWS, 2006)

2. Population trends for four out of six recovery populations of each species are primarily stable or improving, as indicated by occupied habitat, density of occupied habitat, and predictive modeling. (USFWS, 2006)

3. The habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations. (USFWS, 2006)

4. Population and habitat management is implemented for all recovery populations of each species in accordance with site-specific management plans. (USFWS, 2006)

5. Permanent land protection is achieved for at least four recovery populations of each species. (USFWS, 2006)

6. Site-specific conservation agreements are in place for all recovery populations and their habitat to protect these milk-vetches within existing State laws. (USFWS, 2006)

7. The conservation of these species is included in a long-term State plant conservation agreement. (USFWS, 2006)

8. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within A. ampullarioides and A. holmgreniorum recovery populations. (USFWS, 2006)

9. For at least four recovery populations of each species, effective measures are in place to control potential negative effects on invasive nonnative species that could harm these milk-vetches and/or their habitats. (USFWS, 2006)

10. The protected habitat base for at least four recovery populations of each species is large enough to offset loss or restriction of the species' pollinators. (USFWS, 2006)

11. Use of pesticides or herbicides detrimental to either of the milk-vetches or their pollinators is prohibited in the vicinity of all recovery populations. (USFWS, 2006)

12. Research indicates genetic fitness, alleviating concern about inbreeding or outbreeding depression. (USFWS, 2006)

13. Seed collection/storage is underway for all extant A. holmgreniorum and A. ampullarioides populations. (USFWS, 2006)

Delisting Criteria:
1. Two additional populations of each species are either located or successfully introduced to habitat in proximity to extant populations. Thus, a minimum of eight recovery populations will be needed to delist each species. (USFWS, 2006)

2. The available habitat base for each newly discovered or introduced recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and among populations. (USFWS, 2006)

3. Population trends for all A. holmgreniorum and A. ampullarioides recovery populations are primarily stable or improving, as indicated as indicated by species presence, occupied habitat, density of occupied habitat, and demographic modeling. (USFWS, 2006)

4. Each of the eight A. holmgreniorum and eight A. ampullarioides recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective. (USFWS, 2006)

5. Permanent land conservation is achieved for all recovery populations whether extant or introduced (a minimum of 8 populations), such that Endangered Species Act (ESA) protection is no longer needed to compensate for regulatory inadequacies. (USFWS, 2006)

6. Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within all A. ampullarioides and A. holmgreniorum recovery populations. (USFWS, 2006)

7. A long-term offsite conservation program is ongoing for all milk-vetch recovery populations. (USFWS, 2006)

Recovery Actions:
- Conserve known extant A. holmgreniorum and A. ampullarioides populations and their habitat. (USFWS, 2006)

- Locate and conserve additional extant populations, if any. (USFWS, 2006)
- Monitor A. holmgreniorum and A. ampullarioides sites for population information and trends. (USFWS, 2006)
- Establish a set of need-based research priorities aimed at abating or reducing threats and increasing population health and numbers. (USFWS, 2006)
- Develop and implement a rangewide strategy for augmentation and/or introduction of milk-vetch populations. (USFWS, 2006)
- Augment extant populations and/or establish new populations of each species in accordance with the rangewide strategy. (USFWS, 2006)
- Promote effective communications with partners and stakeholders regarding the milk-vetches' recovery needs and progress. (USFWS, 2006)
- Develop and implement educational and outreach programs. (USFWS, 2006)
- Develop and implement educational and outreach programs. (USFWS, 2006)
- Establish a technical working group to regularly review the status of the species and track the effectiveness of recovery actions. (USFWS, 2006)
- Revise the recovery program when indicated by new information and recovery progress. (USFWS, 2006)
- In collaboration with interested local, State, and Federal agencies, institutions, and Indian Tribes, BLM will prepare conservation agreements and strategies designed to stabilize declining populations, and will promote protective management to ensure survival of the species. (USFWS, 2007)
- To reduce conflicts and additional disturbance, habitat areas will be designated as rights-of-way avoidance areas and closed to fuelwood and mineral material sales. Plants will be protected by restricting mountain bike use and off-road vehicle travel to designated roads and trails. (USFWS, 2007)
- Prior to surface-disturbing exploration or development associated with fluid mineral leasing, botanical surveys will be completed and known populations avoided to eliminate the taking of plants. (USFWS, 2007)
- Habitat areas will be kept free from use of chemical pesticides and herbicides. (USFWS, 2007)
- Where necessary to protect small isolated populations of Hermit's milk-vetch (aka Shivwits milk-vetch) under 10 ac (4 ha) in size, BLM will fence areas to prevent inadvertent destruction of plants. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- Recommendations on species status: After reviewing available scientific information and recovery criteria, we conclude that Shivwits milkvetch remains an endangered species. Our review of new information compiled since 2007 does not change our evaluation of the species status and threats affecting the species under the factors in 4(a)(1) of the Act from our most recent 5-year review (Service 2007). The downlisting and delisting criteria for Shivwits milkvetch are not met (Service 2006a). Therefore, we recommend no change in status. (USFWS, 2021)

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SPECIES ACCOUNT: *Astragalus applegatei* (Applegate's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/27/1993; Pacific Southwest (R8)

Physical Description

A tap-rooted, herbaceous, perennial plant. The numerous tufted or trailing stems are 2.5-8 decimeters (10-33 inches) long, simple or branching, and may be smooth or have sparse stiff, short hairs. Leaves are 3.5-12 centimeters (1.5-5 inches) long, are on petioles, and have 7-1 1 linear to linear-elliptic flat leaflets, the terminal one usually the longest. Racemes typically bear 5-20 pea-like flowers with lavender-tipped white petals. The 8-13 millimeters (0.4-0.6 inches) long, stalked fruit pods are oblong, compressed, have short hairs and frequently have green or purple speckled valves. Pods split apart from the top (dehisce apically)then downward through the ventral suture, and contain up to 10 (but usually fewer than 3) dark brown minutely dotted seeds with depressions. (USFWS, 1998)

Taxonomy

Member of the Fabaceae (pea family). First discovered near Klanlath Falls, Oregon, in 1927 by Morton Peck. Peck subsequently collected the species 2 miles (3.2 kilometers) east of Keno, Oregon, in 1931 and then described It (Peck 1936). It was thought to be extinct until its rediscovery in 1983 by James Kagan of theOregon Natural Heritage Program (Kagan 1983).(USFWS, 2009).

Historical Range

Endemic to the Lower Klamath Basin, in Klamath County, Oregon, about fifteen miles north of the Oregon-California border. (USFWS, 1998)

Current Range

Lower Klamath Basin, in Klamath County, Oregon (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; self-fertilization and crossing occur (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Plebejus melissa (USFWS, 2009)

Breeding Season

Adult: June - September (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Possibly other insect pollinators (USFWS, 1998)

Reproduction Narrative

Adult: Reproduction is sexual; self-fertilization and crossing occur (4/98 Recovery Plan) (NatureServe, 2015). Flowers are present from June to September. The Melissa blue butterfly (Plebejus melissa) is a specific known pollinator (58 FR 40548). Despite ample production of viable seeds, very few Applegate's milk-vetch seedlings have been observed in native populations. Applegate's milk-vetch plants have eight to ten ovules per pod that can mature into seeds; however, it is rare that more than three do so (USFWS 1998) (USFWS, 2009). Applegate's milk-vetch is visited by numerous insects, with prominent visitors including bumble bees (Apidae: Bombus spp.), other polylectic bees (Megachilidae: Osmia spp.; Andrenidae: Andrena spp.), bee-flies (Bombylidae), and the butterflies Lycaedes argyrognomon (Yamamoto 1985) and Plebejus melissa (ODA, unpublished) (USFWS, 1998).

Habitat Type

Adult: Terrestrial, wetland, riparian (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Floodplain grasslands (NatureServe, 2015); interior alkali grassland (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Probably periodic flooding (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~1250 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (USFWS, 2009)

Habitat Narrative

Adult: Inhabits flat seasonally moist remnants of alkaline floodplain grasslands of the Klamath Basin, at about 1250 meters. The substrate is poorly drained fine silt loam (an underlying hardpan impedes drainage). Prior to irrigation and water control along the Klamath River, periodic flooding probably limited the dominance of other species and provided openings for establishment of Astragalus applegatei (NatureServe, 2015). This species is limited to a very specific soil regime resulting in a very specific habitat type. The vegetative community in which Applegate's milk-vetch sites occurs is classified as interior alkali grassland (TNC 1999). Soils in typical Applegate's milk-vetch habitats are characterized as being gray in color, slightly alkaline, with a shallow water table and groundwater with a relatively high salinity due to periodic flooding and evaporation (TNC 1999). The soils on these sites belong to the Henley, Laki, and Poe series with inclusions in the Calimus series, and are very deep, coarse-loamy, mixed superlative, mesic Haplic Durixeroll (TNC 1999). A weakly developed duripan at 127 to 254 inches is usually present and accounts for the pooled surface water during the spring at most sites (TNC 1999) (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 1998)

Dispersal/Migration Narrative

Adult: Fruits shed their seed shortly after flowering and exhibit no specialized mechanisms for long-distance seed dispersal. Some seed dispersal may take place through ingestion by rodents or jackrabbits, although this has not been documented. Localized seed dispersal is supported by field observations, which document that the majority of seedling establishment is immediately adjacent to mature plants (Yamamoto 1985, Oregon Department of Agriculture [ODA]unpublished) (USFWS, 1998).

Population Information and Trends

Number of Populations:

8 (USFWS, 2019a)

Population Size:

!80,000 individuals (USFWS, 2019a)

Population Narrative:

Ongoing demographic monitoring of naturally occurring populations is providing data related to life stages and survival rates (Byrnes 2017b). The discovery of additional occupied sites through opportunistic observation increased the total number of known sites from two in 1993 to the current number of eight, although the current status of two smaller sites is uncertain (USFWS 2019a). Based on previous survey results, populations at four of the eight known sites appear to suggest population stability or growth. Population of a fifth site appears to be declining while the status of the remaining three populations is uncertain due to lack of data (USFWS 2019a). 2019 preliminary survey results from the Collins site also suggest site population stability and growth (J. Spaur, personal communication 7/17/19). Three of the sites are privately owned, two are state owned, one is city owned, and one is owned by an environmental organization for the purpose of Applegate's milk-vetch conservation. (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The final rule states that irrigation and water control along the Klamath River have eliminated the seasonal flooding that once occurred along floodplains supporting the species. While some adverse affects cannot be ruled out from this hydrologic alteration, declines appear to be mostly due to declines appear to be mostly due to other factors. Agricultural and urban development has resulted in widespread depletion, fragmentation, and modification of Applegate's milk-vetch habitat, to the extent that even small (an acre or less) parcels of truly undisturbed habitat are uncommon (USFWS 1998). Habitat loss and modification from both urban and commercial development and expansion are still the most significant threats to the species within its historic range. At the Klamath Falls Airport, there are plans to expand and develop the area where the largest occurrence of Applegate's milk-vetch is currently found. The airport is currently filling in wetlands around the perimeter of the property to reduce bird

collisions with the air traffic where milk-vetch occurs. Additionally, the airport has plans to expand runways, build more hangers, and is looking to alter areas to provide better drainage along runways (USFWS, 2009).

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In 1991 and 1992, ORNHIC (2007b) noted that the Miller Island population was struggling due to rabbit grazing. In 2007, ORNHIC reported observations of jack rabbit pellets at several Applegate's milk-vetch sites at Miller Island (ORNHIC 2007a). Jack rabbits are plentiful at the Klamath Falls Airport site as well (Hancock, pers. comm. 2007). As a result of seed collection efforts, Oregon Department of Agriculture reported that the reduced seed output of Applegate's milk-vetch in 2002 appeared to be caused by predispersal seed predation by insects. Most seed pods showed damage by insects and the seed collection bags were littered with the bodies of seed weevils and beetles (Gisler 2002a). Limited seed production coupled with seed predation may be significantly affecting the reproductive opportunities of Applegate's milk-vetch occurrences but additional studies are needed to determine population-level effects. Cattle are currently grazed at the Collins site and it has been documented that cattle do consume this species. Herbivory from insects includes the larvae of the Melissa blue butterfly. The larvae of the Melissa blue butterfly have been observed defoliating Applegate's milk-vetch plants and chewing through large plant stems near their bases (Gisler and Meinke 2001). Herbivory is not likely a major threat to the species, but when combined with the limited distribution and population size of Applegate's milk-vetch, habitat loss or modification due to herbivory and seed predation on this species could have a negative impact on its reproductive output and therefore recovery (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Habitat colonization by non-natives could indirectly limit Applegate's milk-vetch by increasing input of plant litter and nitrogen fixation by introduced legumes, and creating conditions favorable to secondary succession by shrubs and other herbaceous species historically restricted by harsh, bare soils (USFWS 1998). Likewise, habitat colonization by weeds, especially thatch-forming grasses, could promote greater densities of voles and other potential plant herbivores and granivores through increased cover and protection from predators (USFWS 1998). Thatch-forming grasses are also problematic for this species because it's difficult for seedlings to germinate and penetrate the thatch layer. All of the extant occurrences of Applegate's milk-vetch have some non-native weeds present. Elitrigia or Elytrigia repens (creeping quackgrass), Lactuca serriola (prickly lettuce) and Apera interrupta (dense silky bent) are just a few of the weed species found at Applegate's milk-vetch sites. Creeping quackgrass is present at the Ewauna Flat Preserve, Miller Island and Washburn Way-Railroad sites. The Miller Island and Klamath Falls Airport sites are mostly dominated by planted Thinopyrum intermedium (intermediate wheatgrass) (ORNHIC 2007a). Non-native plants at the Klamath Falls Airport site include: Agropyron cristatum (crested wheatgrass), intermediate wheatgrass, Poa bulbosa (bulbous bluegrass) and Holosteum umbellatum (jagged chickweed) (ORNHIC 2007a), although these species do not occur in high densities. Low densities of weedy species have also been observed at

the Collins Tract site, but of particular concern at this site is Hordeum murinum (mouse barley) and Cirsium spp. (thistles) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The final rule for Applegate's milk-vetch states that with the small number of occurrences, and small number of individual plants for each occurrence, there is an increased potential for extinction from stochastic events such as flood or fire. The limited gene pool may depress reproductive vigor or a single human-caused or natural environmental disturbance could destroy many of the individuals of this species. There is no information available about the genetic diversity of the few occurrences of this species (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: State-level protections do not apply to private lands. Federal protections under the Clean Water Act may not be protective. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. A minimum of four self-sustaining populations/sites are under protected management3 for the benefit of the species. Includes the development of an Applegate's milk-vetch management plan addressing the mitigation and prevention of stressors and threats including agricultural and urban development (Factor A); wildlife and cattle grazing (Factor C); lack of regulatory protection (Factor D); and poor reproduction, competition with exotic weeds, seed predation, and low population viability (Factor E). (USFWS, 2019)

2. For a site to contribute as a self-sustaining population/site, a minimum of 2,200 reproductive plants need to be present at the site over five consecutive years of monitoring. (USFWS, 2019)

Delisting Criteria:
1. A minimum of four self-sustaining populations/sites are under secured management7 for the benefit of the species or six self-sustaining recovery populations/sites are under protected management for the benefit of the species. Habitat being managed for Applegate's milk-vetch under the oversight of long-term land ownership that is not expected to change (e.g., the Miller Island recovery area that is owned by the State and managed as a Wildlife Management Area or the Airport property owned and managed by the City). (USFWS, 2019)

2. A minimum of 2,200 reproductive plants occurring over five consecutive years of monitoring at each site that contributes toward the delisting threshold. (USFWS, 2019)

Recovery Actions:
- Conserve natural and introduced Applegate's milk-vetch populations. The heart of recovery efforts for Applegate's milk-vetch will be to: 1) increase the species' representation from the

current three areas to at least six areas with a minimum of two populations occurring at each of the recovery areas; and 2) develop management strategies that provide for long-term stability. (USFWS, 1998)

- Long-term, off-site seed storage. Banking (long-term cryogenic storage) of Applegate's milk-vetch seeds will provide an additional level of security to the recovery and survival of the species, by creating a demographic and genetic reserve of plant propagules. Off-site seed storage may be particularly vital in instances when natural soil seed banks are depleted due to poor seed production and pre- and post-dispersal seed mortality, or destroyed by natural or anthropogenic catastrophe. Stored seeds may be useful in establishing and augmenting Applegate's milk-vetch populations, mitigation of future population losses, and potential sources of genetic variability in the event populations suffer from inbreeding depression and/or allele fixation through drift. (USFWS, 1998)
- Conduct further research. The following areas of research must be addressed to increase our knowledge about the nature and extent of Applegate's milk-vetch threats, and improve the species' prospects of recovery. Define population self-sustainability. Perfect population establishment and augmentation techniques. Assess efficacy of habitat management strategies. Edaphic and hydrologic requirements. (USFWS, 1998)
- Develop and implement an outreach program. Increasing public awareness of Applegate's milkvetch will facilitate efforts to preserve this plant and restore its habitat. Prepare informational brochures, audiovisual, and sign programs on habitat restoration and recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities such as National Wildlife Refuge interpretive programs and school programs. (USFWS, 1998)
- Recommended Future Action: While our Applegate's milk-vetch knowledge has increased substantially since its listing, much remains unknown regarding the species' life stages and resource requirements. Demographic monitoring efforts are currently ongoing for both naturally occurring populations and outsourced plants, including the collection of survivorship and life stage data. Data analysis for the first three years of the natural population survival study returned results for seedling survival at 11.5% for year one and 8.5% for year two. Work is needed to determine methods to increase seedling survival rates. (USFWS, 2019a)
- Recommended Future Action: Another key remaining research question is the identification of the species or group of species of mycorrhizae that are necessary for Applegate's milk-vetch survival. Once we know how to identify the species/group of species, we'll be able to more successfully determine where future transplanting should occur, as we'll be able to test if the mycorrhizae/other potentially important soil microbiota are present in the soil. The Service will also gain a better understanding of how and when it colonizes milk-vetch roots. Preliminary efforts have been initiated but additional study is needed. (USFWS, 2019a)
- Recommended Future Action: The Service believes that the highest priority actions during the next five years are to determine methods to increase seedling survival rates and to identify the species/group of species of mycorrhizae that are necessary for Applegate's milk-vetch survival. The next highest research priorities are those focusing on genetic or pollinator studies. Therefore, the Service recommends that current efforts continue and that additional methods are developed and implemented toward answering these highest priority research questions. (USFWS, 2019a)

- Recommended Future Action: The Service also periodically receives new information about potential sites where Applegate's milk-vetch may have been seen. It is recommended that the Service survey these sites, to the extent that there is access. (USFWS, 2019a)

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SPECIES ACCOUNT: *Astragalus bibullatus* (Guthrie's (=Pyne's) ground-plum)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/26/1991; Southeast Region (R4) (USFWS, 2015)

Physical Description

A low perennial herb with a stout taproot bearing 5-10 simple, glabrous, slender stems, 5-15 cm long. Leaves are alternate and pinnately compound with small leaflets. Flowering stems are 5-8 cm long, ascending with purple, pea-shaped flowers in compact clusters of 10-16 and blooming in April and May. Fruits are plump, fleshy globe shaped pods that ripen in May and lie on the ground, becoming red on the side facing the sun and yellow on the bottom. In the summer, the pods dry to stiff, 2-valved papery pods with flattened small dull black seeds (Somers and Gunn 1990). (NatureServe, 2015)

Taxonomy

Specimens that are now assigned to A. bibullatus were apparently first collected as early as 1881 by the Tennessee botanist, Augustin Gattinger. For over 100 years, this material was assigned to A. crassicarpus, a related but morphologically and geographically distinct species that occurs approximately 750 kilometers (466 miles) to the west. Milo Pyne discovered the Rutherford County, Tennessee, site in 1979, which later became the type locality for the species. Botanists familiar with the genus Astragalus determined that the plants found by Pyne might represent a new species. In 1985, flowering and fruiting material from the type locality was sent by Jerry Baskin to Rupert Barneby, a monographer of the genus at the New York Botanical Garden. Barneby concluded that this was a new species, A. bibullatus, and described it with Edwin Bridges (Barneby and Bridges 1987). Kartez (1994) recognizes A. bibullatus as the correct name for plants in Tennessee (USFWS, 2011a).

Historical Range

Astragalus bibullatus is endemic to the cedar glades of middle Tennessee (USFWS, 2011a).

Current Range

Extant occurrences are located in the Stones River watershed in the vicinity of Murfreesboro, Rutherford County, Tennessee (USFWS, 2011a).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 2011b)

Breeding Season

Adult: April - May (USFWS, 2011b)

Reproduction Narrative

Adult: Flowering occurs April to May and fruiting occurs May to June. Obligate sexual reproduction most likely occurs via insect pollination (USFWS, 2011b).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone cedar glade ecosystems; barrens, forest edge, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Partial shade (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 500 - 700 ft. elevation (USFWS, 2011b)

Spatial Arrangements of the Population

Adult: Clumped (see population narrative)

Environmental Specificity

Adult: Narrow to moderate (inferred from USFWS, 2011a)

Habitat Narrative

Adult: Limestone cedar glade ecosystems in the Middle Tennessee Central Basin. The plants are associated with Lebanon limestone and occur in transitional areas or glade margins where the soils are deeper (5-15 cm) and there is partial shade from shrubs and small trees. Environmental conditions in limestone glades are extreme - wet in the spring and very dry in the summer (NatureServe, 2015). Occurs between 500 to 700 ft. elevation. Soil types generally associated with rock outcrops in Rutherford County are the Gladeville and Talbott series (USFWS, 2011b). It should be noted that the most recently discovered occurrence was found in a small opening in a closed cedar forest, suggesting the potential for long-term persistence of A. bibullatus in less than ideal conditions provided that habitat is not destroyed (USFWS, 2011).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by gravity and water (USFWS, 2011b).

Population Information and Trends

Population Trends:

Decline of 10-90% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2011a)

Number of Populations:

12 (USFWS, 2019)

Population Size:

The number of individuals at most of these occurrences ranges in the tens to hundreds; only one occurrence has been observed to consist of greater than 1,000 individuals (USFWS, 2019)

Adaptability:

Low (inferred from USFWS, 2011a)

Population Narrative:

It is known from three extant populations. Two populations of Astragalus bibullatus (collected in 1901 and 1948 respectively) are believed to have been extirpated (USFWS 1991). This species has experienced a long-term decline of 10-90% (NatureServe, 2015). The species status is stable based on the 2011 Recovery Data Call. It is presently known from 8 extant occurrences. The extant occurrences of A. bibullatus are typically small, consisting of tens to hundreds of individuals (Table 1). Only one occurrence has ever been estimated to include greater than 1,000 individuals. Morris et al. (2002) surmised that, because of environmental changes, A. bibullatus populations were reduced in size and gene flow among them was likely restricted, leaving them vulnerable to effects of genetic drift and inbreeding. An occurrence that TVA biologists discovered during a 2006 survey of a powerline right-of-way extended the currently known range approximately 16 km (10 mi) to the southwest and expanded the area encompassing the species' current range to approximately 235 km2 (90 mi2) (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011a)
Exposure:
Response:
Consequence:
Narrative: All the occurrences of Astragalus bibullatus are within a short distance of the rapidly growing middle Tennessee city of Murfreesboro. Five of the occurrences are located on public lands and as such are protected from development threats. However, the three remaining occurrences are located on private lands where development pressures are great. Limestone cedar glades are relatively flat and clear areas that often attract developers. One occurrence (population 2 in the listing rule) has been either destroyed or significantly altered by commercial development since A. bibullatus was listed and is now believed to be extirpated. Habitat degradation due to ORV use of sites on private lands remains a potential threat, as does illegal ORV use on sites protected by public ownership (USFWS, 2011a).

Stressor: Invasive species (USFWS, 2011a)
Exposure:
Response:
Consequence:

Narrative: All the known Astragalus bibullatus occurrences are threatened by the encroachment of more competitive herbaceous vegetation and/or woody plants, such as eastern red cedar, that produce shade and compete for limited water and nutrients. Invasive exotic species that currently are either being managed or have been noted as potential threats at A. bibullatus occurrences include spotted knapweed (Centaurea biebersteinii), Japanese honeysuckle (Lonicera japonica), privet (Ligustrum spp.), and sericea lespedeza (Lespedeza cuneata), among others. Active management to reduce or eliminate vegetation encroachment is required to ensure that the species continues to survive at all the sites (USFWS, 2011a).

Stressor: Herbivory (USFWS, 2011a)
Exposure:
Response:
Consequence:
Narrative: Herbivory has been observed to varying degrees during monitoring of A. bibullatus occurrences. Albrecht and McCue (2010) observed that some spring transplants were browsed, and Walck (2007) observed herbivory or signs of it at three sites (USFWS, 2011a).

Stressor: Climate change (USFWS, 2011a)
Exposure:
Response:
Consequence:
Narrative: The Service identified extended drought conditions as a threat to Astragalus bibullatus, because of the likely reduced resilience of the three small populations that were known at the time of listing to endure such stochastic environmental events (56 FR 48750, Service 1991). The occurrence of severe drought in middle Tennessee, during the summers of 2007 and 2008, provides an opportunity to assess effects of drought to populations that are periodically monitored. It is possible that alterations in precipitation and drought frequency or severity that might accompany climate change could pose a growing threat to A. bibullatus in the future. Estimates of the effects of climate change using available climate models lack the geographic precision needed to predict the magnitude of effects at a scale small enough to discretely apply to the range of Astragalus bibullatus. However, data on recent trends and predicted changes for the Southeast United States (Karl et al. 2009) provide some insight for evaluating the potential threat of climate change to A. bibullatus. Since 1970, the average annual temperature of the region has increased by about 2o F, with the greatest increases occurring during winter months. The geographic extent of areas in the Southeast region affected by moderate to severe spring and summer drought has increased over the past three decades by 12 and 14 percent, respectively (Karl et al. 2009). These trends are expected to increase. Rates of warming are predicted to more than double in comparison to what the Southeast has experienced since 1975, with the greatest increases projected for summer months. Depending on the emissions scenario used for modeling change, average temperatures are expected to increase by 4.5o F to 9o F by the 2080s (Karl et al. 2009). While there is considerable variability in rainfall predictions throughout the region, increases in evaporation of moisture from soils and loss of water by plants in response to warmer temperatures are expected to contribute to increased frequency, duration, and intensity of droughts (Karl et al. 2009) (USFWS, 2011a).

Stressor: Population fragmentation (USFWS, 2011a)
Exposure:
Response:

Consequence:
Narrative: Small population sizes and fragmentation of cedar glade habitats could influence genetic structure of Astragalus bibullatus populations. As noted above, Morris et al. (2002) concluded that the among-site genetic structure they detected within the youngest soil seed layers of A. bibullatus occurrences was likely attributable to an increased incidence of inbreeding over time, due to the isolation of populations caused by fragmentation. They surmised that, because of increased fragmentation of cedar glade habitats and increased shading due to vegetation encroachment in those that remain, A. bibullatus populations were reduced in size and gene flow among them was likely restricted, leaving them vulnerable to effects of genetic drift and inbreeding (USFWS, 2011a).

Recovery

Reclassification Criteria:
There are 11 viable, protected occurrences distributed throughout the cedar glade ecosystem of the Stones River Basin within Davidson, Rutherford, or Wilson counties (USFWS, 2011a).

Delisting Criteria:
There are 16 viable, protected occurrences that are distributed throughout the cedar glade ecosystem of the Stones River Basin within Davidson, Rutherford, and Wilson counties (USFWS, 2011a).

Recovery Actions:
- Protect and manage existing occurrences and habitats (USFWS, 2011b).
- Search for new occurrences (USFWS, 2011b).
- Conduct long-term monitoring and assess population growth rates and viability (USFWS, 2011b).
- Conduct biological and ecological research (USFWS, 2011b).
- Develop protocols for establishing new occurrences or augmenting existing ones (USFWS, 2011b).
- Communicate with local officials to coordinate city and county planning (USFWS, 2011b).
- Develop and implement public education materials (USFWS, 2011b).
- Periodically assess the success of recovery efforts for the species (USFWS, 2011b).
- Federal and state regulatory protection (USFWS, 2011b).
- Investigating the species' biology, ecology, and life history (USFWS, 2011b).
- Preserving germplasm and establishing or augmenting occurrences (USFWS, 2011b).
- Site protection and management (USFWS, 2011b).
- Surveys and monitoring (USFWS, 2011b).

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS A. Continue to pursue protection and/or cooperative management for occurrences located on privately owned lands. Highest priority should be given to protecting or managing the Rockvale site (EO 18), due to its genetic distinctiveness relative to other occurrences throughout the species range. Demographic monitoring also should be conducted for EO 18. B. Coordinate with private landowners to gain permission for collecting seed to preserve germplasm representing currently unprotected occurrences. Collect seed from these sites to add to existing accessions held at MBG. C. Determine whether redundant seed accessions are needed, in

order to eliminate potential for losing all germplasm currently held in ex situ collections. If they are not currently established, coordinate with MBG to establish redundant accessions at another facility. D. Implement site-specific management recommendations listed below. Note that recommended timing for prescribed burns is November through mid-February. When prescribed burns are conducted late in this timeframe, pre-burn inspections should be conducted to determine whether spring growth has been initiated in A. bibullatus. If plants are found to be actively growing, measures should be taken to remove fuels from the immediate vicinity of A. bibullatus plants to prevent damaging them. Site-specific Recommendations Davis site (EO 5) – This small population, semi-protected on private land, has low viability but apparently contains some unique alleles. Albrecht and Dell (2019) recommended applying judicious and light manual thinning of eastern red cedar trees staggered over several years to avoid potential impacts of drought. They also recommend the collection of seeds and seed banking for possible use in augmentation at the adjacent Overbridge DSNA. Augmentation attempts should be staggered over several years. Overbridge DSNA (EO 4) – As of 2018, this is a very small population with only six non-reproductive individuals and is not likely to have positive population growth without augmentation. In recent years, thinning of eastern red cedar and prescribed burning have been conducted on the natural area; however, tree canopy cover remains >50% (Albrecht and Dell 2019). MBG recommends augmentation of this population using material from the adjacent Davis site to increase population size. Genetic material from Flat Rock Cedar Glades and Barrens DSNA could also be used if needed. Manus Road Glade DSNA (EO 9) – Population dynamics are more variable at this site; however, the long-term trend is projecting a population decline. It is possible that the low population growth rate is in response to multiple interacting variables such as herbivory, drought, and untimely application of a spring prescribed burn (Albrecht and Dell 2019). Management at this site has been more active over the last six years especially with thinning woody encroachment and use of prescribed fire. Albrecht and Dell (2019) recommended that no management occur for a period of 2-3 years to see how the population recovers. Herbivore exclusion plots were established here in 2018. Prescribed fires should be conducted during the dormant season (November to mid-February) at an interval of > 5 years. Recent fires were too close together (March 2016-Fall 2017) and likely resulted in high mortality for seedling and small juvenile plants (Albrecht and Dell 2019). Flat Rock Cedar Glades and Barrens DSNA – • Airport site (EO 1a) – This site contains the largest population of A. bibullatus and the highest population growth rates. The population is near demographic equilibrium (i.e., population growth models indicate that demographic structure is sufficient to maintain a stable population, $\lambda \approx 1$) and has high survival rates for both small and large plants, and Albrecht and Dell (2019) recommended continuing to mow this site with a bush hog every 5-10 years from late June to December. This site has less woody canopy cover than other sites and experienced the lowest population growth rates during drought years when most other sites showed higher growth rates (Albrecht and Dell 2019). • Alexander site (EO 1b) – This site is across the road from the Airport site and has similar characteristics. Woody encroachment has been steadily increasing at this site and, therefore, Albrecht and Dell (2019) recommended continued mowing every 5-10 years from late June to December. • Davenport East site (EO 3a) – This small population is completely surrounded by forest despite thinning of woody vegetation and management with prescribed burning. It is near demographic equilibrium but expected to slowly decline. Albrecht and Dell (2019) recommended creating a large canopy gap around the A. bibullatus population through selective removal of canopy trees like eastern red cedar and non-oak species. Dormant season burning of the surrounding woodland may also promote population expansion. Because an herbivore exclusion plot was established here in 2018, Albrecht and Dell (2019) recommended delaying management for 2-3 years. • Davenport West site (EO 3b) – This site has been managed with woody encroachment thinning and prescribed burning. Despite its small size, the population is near demographic

equilibrium. Albrecht and Dell (2019) recommended management to expand the size and spatial extent of the suitable habitat to increase population resilience to environmental change. This may be accomplished with dormant season prescribed burning every 6- 10 years. Small population augmentations may also be needed to hedge against the loss of large adult plants, which currently dominate the population. (USFWS, 2019)

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SPECIES ACCOUNT: *Astragalus brauntonii* (Braunton's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/28/1997; Pacific Southwest (R8)

Physical Description

A robust, short-lived perennial in the pea family (Fabaceae) (Hickman 1993). It is one of the tallest members of the genus, reaching a height of 1.5 meters (5 feet) and is covered with fine, entangled hairs throughout. The stems are white, the leaves pale to greenish. A thick taproot and woody basal stem gives rise to several stems. The 4 to 16 centimeters (1.5 to 6.5 inches) long leaves are pinnately compound with 25 to 33 oblong-ovate, abruptly pointed leaflets. The light purple flowers are clustered in 35 to 60 flowered racemes (flowers are borne on stalks) 4 to 14 centimeters (1.5 to 5.5 inches) long. The beaked, slightly curved pods are oblong-ovoid, 6.5 to 9 millimeters (2.5 to 3.5 inches) long and two-celled, front to back, with three to six seeds. Astraga/us brauntonii is readily distinguished from the only other perennial species ofAstraga/us in the area, A. trichopodus, by being woolly tomentose (covered with densely matted hairs) as opposed to strigose (covered with sharp, stiff-appressed hairs) or glabrous (without hairs), and by the twochambered, rather than one-chambered pods (Barneby 1964). (USFWS, 1999)

Taxonomy

Member of the pea family (Fabaceae) (USFWS, 2009). Astragalus brauntonii was described by Samuel Parish (1903) based on a specimen collected by Dr. H. E. Hasse in 1899 above Santa Monica. It was named for Ernest Braunton. Per Axel Rydberg published the name Brachyphragma brauntonii in his revision of the genus. However, Rydberg's fragmentation of the genus Astraga/us has not been accepted by other botanists. Systematic treatments (Bameby 1964) and floristic treatments (Munz 1974, Spellenberg 1993) recognized Parish's original treatment of this taxon (USFWS, 1999).

Historical Range

See Current Range.

Current Range

Occurs in five disjunct geographic areas in Ventura, Los Angeles, and Orange Counties, California (USFWS, 2009). The occurrences can be grouped into four areas: the Santa Monica Mountains, the south slope of the Simi Hills, the San Gabriel Mountains near Monrovia, and the Santa Ana Mountains. At the time of listing in 1997 (Service 1997), A. brauntonii was described as being found in the same four general areas, with 6 occurrences distributed among those areas. The recovery plan identified 20 occurrences (it combined EO# 15 and EO# 17, and listed an EO# 21 which is not currently recognized; Service 1999 pp. 8–10). The critical habitat designation (Service 2006) did not list occurrences, and the 2009 5-year review did not add any new occurrences (USFWS, 2023).

Critical Habitat Designated

Yes; 12/14/2006.

Legal Description

On November 14, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 14, 2006) for Astragalus brauntonii (Braunton's milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (71 FR 66374-66423).

Critical Habitat Designation

The critical habitat designation for Astragalus brauntonii includes six CHUs (including 10 subunits) in Ventura, Orange and Los Angeles Counties, California. Approximately 3,300 acres (ac) (1,337 hectares (ha)) fall within the boundaries of the critical habitat designation. The critical habitat is located in Ventura, Los Angeles, and Orange Counties, California. Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule. (USFWS, 2006).

Unit 1: Northern Simi Hills Unit: This unit is located south of Simi Valley in the northern Simi Hills in Ventura County and consists of 21 ac (9 ha) of local agency land (Rancho Simi Recreation and Parks District) and 413 ac (166 ha) of private lands. It is divided into four subunits mapped from occurrences identified after the time of listing but currently occupied; all occur within 1.5 mi (2.5 km) of each other. Unit 1, inclusive of the four subunits, is located within the same physiographic area (the Simi Hills) as Unit 2.

Unit 2: Southern Simi Hills Unit: This unit is located along the southern Simi Hills in Ventura and Los Angeles Counties and consists of 196 ac (80 ha) of Federal lands, 118 ac (48 ha) of State land, 427 ac (173 ha) of local agency lands (Conejo Open Space Conservation Authority (COSCA), City of Thousand Oaks, Santa Monica Mountains Conservancy, and Rancho Simi Recreation and District), and 278 ac (113 ha) of private land. This unit is divided into six subunits mapped from records known at the time of listing and occurrences identified after listing. These subunits are all within 3.2 mi (5.2 km) of each other and occur along the southern perimeter of the geologic Chatsworth Formation.

Unit 3: Santa Monica Mountains Unit: This unit is located in the eastern Santa Monica Mountains in upper Zuma Canyon, north of Point Dume in Los Angeles County. It consists of 172 ac (70 ha) of Federal land within the Santa Monica Mountains National Recreation Area, and 56 ac (23 ha) of private land. It includes an area where more than 300 plants were found in 1999 after a prescribed burn, and the entire unit is mapped from an occurrence identified after listing.

Unit 4: Pacific Palisades Unit This unit is located in the Santa Ynez Canyon north of Pacific Palisades in Los Angeles County and consists of 439 ac (178 ha) of State lands within Topanga State Park and 66 ac (27 ha) of private land. It includes plants found in three separate locations that are part of a single population complex, and is mapped from occurrences known at the time of listing.

Unit 5: Monrovia Unit This unit is located in the San Gabriel Mountains in the City of Monrovia in Los Angeles County and consists of 218 ac (88 ha) of local agency land owned by the City of Monrovia and managed as open space (Monrovia Wilderness Preserve) and 64 ac (26 ha) of private land. It includes plants found in several locations that are part of a single population complex, and is mapped from an occurrence known at the time of listing.

Unit 6: Coal Canyon Unit This unit is located south of the City of Yorba Linda in Coal Canyon and Gypsum Canyon in Orange County and consists of 589 ac (238 ha) of State land (Chino Hills State

Park and California Department of Fish and Game—Coal Canyon Ecological Reserve) and 243 ac (98 ha) of private land. This unit includes plants found in several locations that are part of a large population complex, and is mapped from occurrences known at the time of listing.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus brauntonii critical habitat consists of three components (71 FR 66374-66423):

(i) Calcium carbonate soils derived from marine sediment;

(ii) Low proportion (less than 10 percent) of shrub cover directly around the plant; and

(iii) Chaparral and coastal sage scrub communities characterized by periodic disturbances that stimulate seed germination (e.g., fire, flooding, erosion) and reduce vegetative cover.

Special Management Considerations or Protections

Threats that may require special management are specified in the Final Rule for each Critical Habitat Unit: Unit 1. Road maintenance, which could result in disturbances that are too frequent and prevent replenishment of the seed bank, invasion of nonnative plants which could crowd out A. brauntonii, cattle grazing, and recreation activities such as equestrian and foot traffic, which could result in trampling of plants. Unit 2: Road and trail maintenance that could result in disturbances that are too frequent and prevent replenishment of the seed bank, invasion of nonnative plants that could crowd out Astragalus brauntonii, edge effects from urban development, and recreation activities such as off-road vehicles and equestrian and foot traffic, which could result in trampling of plants. Subunit 1c is threated by additional part development. Unit 3: Road maintenance that could result in disturbances that are too frequent, preventing establishment or replenishment of the seed bank. Unit 4: Road maintenance that could result in disturbances that are too frequent, preventing establishment or replenishment of the seed bank, and growth of nonnative plants that could crowd out Astragalus brauntonii. Unit 5: Maintenance of fire roads, the growth of nonnative plants that could crowd out Astragalus brauntonii, and recreation activities such as foot and bicycle traffic, which could result in trampling of plants. Unit 6: Maintenance of fire roads and the growth of shrubs and nonnative plants, which could crowd out Astragalus brauntonii. (USFWS, 2006)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-fertilization, cross-pollination (USFWS, 2009)

Lifespan

Adult: 2 - 3 years (NatureServe, 2015); possibly 5+ years in favorable conditions (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Fire/disturbance (NatureServe, 2015); insect pollinators (bees known), soil seed bank (USFWS, 2009)

Reproduction Narrative

Adult: The seeds germinate after fire or other disturbance and the plants live only 2-3 years before senescing (NatureServe, 2015). A. brauntonii is self-fertile, but also produces seed through cross-pollination (Fotheringham and Keeley 1998). Known pollinators include megachilid bees (Ashmeadiella spp.) and bumblebees (Bombus spp.) (Fotheringham and Keeley 1998). Disturbances such as fire, erosion, and mechanical scraping of soil (e.g., during road or trail maintenance) are known to stimulate germination (Fotheringham and Keeley 1998). Each plant may support upwards of several hundred flowers, and each seed pod produces three to six seeds (Barneby 1964), therefore, each plant can produce a large number of seeds which are deposited in the soil (seed bank). Individual plants have a lifespan of two to three years, although some individuals may live five years or more if conditions are favorable, and then plants are not visible again until the next disturbance (Fotheringham and Keeley 1998) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Brush/chaparral (NatureServe, 2015); coastal sage scrub (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Periodic fire; interval unknown (possibly 20 - 100+ years) (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~800 - 2,100 ft. elevation, shade-intolerant (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Habitat Narrative

Adult: Brush/chaparral communities. The natural frequency of fire in the species' habitat is unknown. The plants may be restricted to limestone substrates (NatureServe, 2015). The species appears to be limited to shallow calcium carbonate soils derived from marine substrates; it occasionally occurs on non-carbonate soils at down-wash sites near other known occurrences, although survivorship of plants may be reduced on noncarbonate soils (Mistretta 1992, Fotheringham and Keeley 1998, Landis 2005). Astragalus brauntonii is associated with chaparral and coastal sage scrub plant communities and generally occurs along the tops of knolls ranging from 800 to 2,100 ft. (244 to 640 m) in elevation (Fotheringham and Keeley 1998, CNDDB 2007, Landis 2005). The habitat has been described as scrub dominated by chaparral with a high overall percentage (>80 percent) of vegetative cover, however, the species does not tolerate shading and is associated with surrounding bare ground (Carroll 1987, Fotheringham and Keeley 1998). It requires a low proportion (<10 percent) of shrub cover directly around the plant. Many of the plant species that comprise chaparral and coastal sage scrub communities regenerate after fire, either through the release of a dormant seed bank whose germination is stimulated

by fire, or through basal burl sprouting (Hanes 1971, Keeley and Zedler 1978). The above-ground expression of A. brauntonii populations are patchy over time and space as a result of the dormant seed bank and are subject to the dynamic habitat conditions and physical processes where it occurs (USFWS, 2009). The natural fire interval in the habitat of. brauntonii is unknown. Estimates range from 20 to more than 100 years, with an average of 70 year intervals (Minnich 1989; O'Leary 1990) (USFWS, 1999).

Dispersal/Migration

Dispersal

Adult: Low to moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Neither the fruits or the seeds have specialized adaptations to facilitate seed dispersal by wind; therefore, it is likely that most seeds fall within a short distance of the parent plant (Cain et al. 2000). Long-distance dispersal, however, is likely achieved by water (during rainstorms), and by transport of seeds by wildlife. Small mammals facilitate seed dispersal through consumption and elimination of undigested seed and through seed caching (Cain et al. 2000, Sieg 1987) (USFWS, 2009)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

57 EOs. 52 extant (USFWS, 2023)

Population Size:

Variable; tens to thousands per population, depending on disturbance cycle (USFWS, 2009)

Population Narrative:

This plant is only visible for a short time following disturbance such as a fire (NatureServe, 2015). There are currently 20 known occurrences. In most cases, the number of plants within a population is in the hundreds to thousands following a disturbance, and declines to fewer than ten plants within a few years (CNDDB 2007). (USFWS, 2009). Currently, the California Natural Diversity Database (CNDDB) recognizes 57 Element Occurrences (EOs, Table 1, CDFW 2023) of A. brauntonii. An EO is a group of plants separated by at least 400 meters (1/4 mile) from the closest group of plants of the same species (CNDDB 2018 entire). The occurrences can be grouped into four areas: the Santa Monica Mountains, the south slope of the Simi Hills, the San Gabriel Mountains near Monrovia, and the Santa Ana Mountains. At the time of listing in 1997 (Service 1997), A. brauntonii was described as being found in the same four general areas, with 6 occurrences distributed among those areas. The recovery plan identified 20 occurrences (it combined EO# 15 and EO# 17, and listed an EO# 21 which is not currently recognized; Service 1999 pp. 8–10). The critical habitat designation (Service 2006) did not list occurrences, and the 2009 5-year review did not add any new occurrences (Service 2009). Most of the occurrences (52 of 57, Table 1) are presumed by CNDDB to be extant, and most of the presumed extant occurrences (39 of 52) may be at least partly on land managed for resource conservation. Most

of the occurrences are in the Santa Monica Mountains and Simi Hills (22 and 24 respectively), with only 4 in the San Gabriel Mountains and 7 in the Santa Ana Mountains (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Land management actions that result in frequent disturbances, such as yearly road maintenance where Astragalus brauntonii occurs, may be contributing to the decline of populations by mowing and removing plants before seeds mature and replenish the seed bank. This has been known to occur for plants along unpaved fire access roads and utility corridors. Other land management activities such as herbicide application, cattle grazing, and recreational activities such as off-road vehicle and equestrian use that results in trampling of plants may be affecting A. brauntonii. Of the currently known 20 occurrences, the Service is unaware of protections for the 6 occurrences on private lands and for 4 of the 8 occurrences on local agency lands, and therefore presumes they could be threatened by indirect or direct effects from existing or future urban development, recreational activities, or other land management activities. Since the time of listing, one occurrence in Oak Park on lands owned by Rancho Simi Recreation and Parks District was extirpated due to park expansion. Another occurrence was partially removed by the Ventura County Public Works Agency for creation of a detention basin, and the remaining portion of this occurrence has been proposed for development into the Lang Ranch Community Park by Conejo Recreation and Park District (USFWS, 2009).

Stressor: Altered fire cycles (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: One threat to Astragalus brauntonii discussed in the listing rule is the impact of fire management policies over the last 200 years on southern California ecosystems. The listing rule stated that fire exclusion has resulted in an accumulation of fuels in woody vegetation, making fire intensity and duration more severe. However, wildlands near urban areas have been experiencing increased fire frequencies, resulting in vegetation changes from shrub to grass and facilitating the spread of non-native, invasive annual plants. Despite efforts to suppress fires in coastal southern California, the current fire frequency of every 15 years or less, is substantially higher than it was historically, which is thought to be every 50 to 100 years (Keeley 2006). The impacts of fire suppression and/or increased fire frequencies near urban areas on Astragalus brauntonii are unclear. As of 1997, the Service believed that fire suppression activities resulted in the extirpation of A. brauntonii during the Old Topanga fire of 1993 (Service 1997); however, more recent surveys have revealed plants growing in that area (CNDDB 2007). Extirpation of populations is unlikely as long as habitat remains, although above-ground plants may cease to grow for many years until a disturbance stimulates dormant seeds to germinate. Therefore, A. brauntonii habitat that has undergone succession and is dominated by dense woody shrubs may not be harmful to the long-term persistence of the plant as long as periodic disturbances are allowed to occur (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: Astragalus brauntonii may be vulnerable to extirpation by stochastic factors including demographic stochasticity, environmental stochasticity, and genetic stochasticity (Shaffer 1981). Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of A. brauntonii. In most cases, the number of plants within a population is in the hundreds to thousands following a disturbance, and declines to fewer than ten plants within a few years (CNDDB 2007). The disjunct distribution of A. brauntonii decreases genetic exchange between populations, which could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The Service recognizes that climate change is an important issue with potential effects to listed species and their habitats. While the Service lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Astragalus brauntonii, small ranged species, such as Astragalus brauntonii, may be more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2009).

Stressor: Trampling (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Occurrences on both private and public lands are subject to damage from trampling of plants from activities including hiking, mountain biking, off-highway vehicle use, equestrian use, and, in a few cases, grazing. In some situations, the disturbance of these activities can stimulate germination of an existing soil seed bank, with the resulting plants succumbing to trampling before being able to produce seeds. Trampling by recreational use remains a threat to the species when trails cross through occurrences (USFWS, 2023).

Stressor: Pollination Reduction (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The recovery plan (Service 1999 p. 10) and critical habitat designation (Service 2006 p. 66387) listed a reduction in pollinators because of habitat fragmentation as a possible threat. A pollination study (Fotheringham and Keeley 1998 pp. 14–15) found that the species selfpollinates and produces seeds at a rate not significantly different than if it is open to visitation by generalist bees. The study did not investigate the genetic consequences of the lack of pollination by other A. brauntonii within or between occurrences. There could be local inbreeding effects if there was no effective pollen transfer between occurrences, but this remains to be investigated. The magnitude of the threat of reduction of pollinators is unclear (USFWS, 2023).

Recovery

Reclassification Criteria:
1. All 20 current populations are fully protected (including seed banks), and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 1999)

2. Seed is securely stored and plants are successfully germinated from collected seed and/or historic sites e.g. propagation techniques for reintroduction are developed. (USFWS, 1999)

Recovery Priority Number: 2

Delisting Criteria:
1. When monitoring shows that the habitat is secure; provisions for ecological requirements exist; and conditions for the species indicate stability over a minimum of 15 years. This 15 years of monitoring will be extended by an additional 5 years of monitoring which is required by the Endangered Species Act for newly listed species. (USFWS, 1999)

Recovery Actions:
- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).
- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)

- Recommendations for Future Actions from 2009 5-Year Review: 1) Work with private landowners and local agencies to protect and manage habitat for Astragalus brauntonii. This may be accomplished by conservation easements or other permanent devices. 2) Work with local agencies, fire departments, and utility companies to ensure that maintenance activities, such as grading of roads and/or mowing along dirt fire access roads and utility corridors, do not negatively impact Astragalus brauntonii. This includes conservation measures such as waiting until seeds mature to cut plants, and depositing plants and seeds on-site so that they replenish the seed bank. 3) Examine genetic diversity in the species and incorporate that data into the sampling and maintenance methodologies for seed banking called for in the recovery plan. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Conduct thorough population census surveys of all known occurrences and areas of suitable habitat, especially in the San Gabriel Mountains and Santa Ana Mountains areas. These surveys are needed to accumulate baseline information about distribution so that it can be compared with distribution after wildfire or other disturbance. 2. Develop and implement a monitoring plan for all occurrences. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. Monitoring data should be in place so that comparisons can be made if at future dates the monitoring areas burn. 3. Review protective measures in place for all occurrences on public lands. 4. Work with public and private entities to prevent damage to plants and raise public awareness to support appropriate conservation measures. 5. Develop a method to assess the number of seeds in the soil seed banks of occurrences, and test how that relates to numbers of plants that germinate after disturbance. 6. Increase the number of accessions in conservation seed banks so that a greater number of known occurrences are represented and add accessions for previously collected occurrences so that a greater number of years is represented (USFWS, 2023).

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SPECIES ACCOUNT: *Astragalus clarianus* (Clara Hunt's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/22/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A slender, sparsely leafy annual herb, mostly 7-12 cm in height. Flowers (March-April) are bicolored, with the wings whitish and the banner and keel bright purple-tipped (NatureServe, 2015).

Taxonomy

Name generally spelled "clarianus" (e.g., by Barneby (Astragalus), Kartesz 1994 and 1999, Hickman 1993, and USFWS); has also appeared as the strictly Latinized version "claranus" but that spelling does not appear to be in current usage (NatureServe, 2015). A member of the pea family (Fabaceae) (USFWS, 2009).

Historical Range

Historically, Clara Hunt's milkvetch was known from six occurrences in Sonoma and Napa counties (Service 1997, p. 55792). It is possible that this plant has always been rare, but more common in the hills surrounding the Napa Valley and possibly on the valley floor itself, before the planting of vineyards (Service 2019, p. 3). By the time of listing in 1997, two of the known occurrences had been extirpated due to urbanization and viticulture, leaving only one occurrence in eastern Sonoma County (Diversity Database #3 - Saint Helena Road) and three occurrences in northwestern Napa County (Diversity Database #7 - Bothe-Napa Valley State Park, Diversity Database #11 - Lake Hennessey, and Diversity Database #12 - Lewelling Lane) (Service 1997, p. 55792). As noted in the 2009 status review, one additional occurrence of Clara Hunt's milkvetch was discovered in 1998 within Spring Valley (Diversity Database #13) in Napa County, approximately 3.2 kilometers (2 miles) east of Lake Hennessey (Service 2009, p. 3). At the time of the 2019 status review, the species was still known from these five occurrences; however, the status of the Bothe-Napa Valley State Park occurrence was uncertain as no plants had been observed at the site since 2009 despite multiple survey attempts (USFWS, 2024).

Current Range

Highly limited today due to development of vineyards and urbanization (NatureServe, 2015). The species is currently known from five localities in Napa county and Sonoma county (USFWS, 2009). The species is restricted to six localities in northwestern Napa County and eastern Sonoma County. Habitat destruction and modification due to urbanization and competition from invasive plant species pose the most significant threats to this species (USFWS, 2024).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2009)

Breeding Season

Adult: March - April (USFWS, 2009)

Reproduction Narrative

Adult: Flowers from March through April (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Manzanita and oak woodlands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 75 - 225 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Openings in manzanita and oak woodlands, on thin, rocky clay soils derived from volcanic materials or on serpentine substrates. Occurs at 75 - 225 m elevation (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

6 (USFWS, 2024)

Population Size:

>2,000 (USFWS, 2024)

Population Narrative:

Only about 500 total plants in normal year. This species is declining due to habitat modification (USFWS 1997) (NatureServe, 2015). Currently, three occurrences support fewer than 100 individuals (CNDDB 2008) (USFWS, 2009). The species is restricted to six localities in northwestern Napa County and eastern Sonoma County. Habitat destruction and modification

due to urbanization and competition from invasive plant species pose the most significant threats to this species (USFWS, 2024). In 2021, two Clara Hunt's milkvetch plants were found at the Bothe-Napa Valley State Park occurrence (Bjerke 2021, p. 3). The reappearance of Clara Hunt's milkvetch at this occurrence after its absence for over a decade may be attributed to the 2020 Glass Fire (Bjerke 2021, p. 2). The 2021 survey of the occurrence found that patches of habitat had burned at low intensity and most of the woody debris and herbaceous layer had been burned away in the immediate vicinity of the two Clara Hunt's milkvetch plants (Bjerke 2021, p. 2). The Saint Helena Road and Saddle Mountain/Hayfork Ranch occurrences were also within the perimeter of the 2020 Glass Fire (Watershed Emergency Response Team 2020, p. 20). The distribution of the species at both of these occurrences expanded the year following the fire (Bjerke in litt. 2024). All Clara Hunt's milkvetch plants observed at the Saint Helena Road occurrence in 2021 were found in areas that burned during the Glass Fire or that were bulldozed to create a fire break (Bjerke 2021, p. 4). A total of approximately 2,300 plants were observed at the Saddle Mountain/Hayfork Ranch occurrence the year following the fire (Bjerke 2021, p. 4). This is one of the largest population sizes recorded for the species (Bjerke 2021, pp. 3–4; Diversity Database 2024, entire). Fifty-three plants were counted on the Saddle Mountain Open Space Preserve and approximately 1,000–2,500 plants were present within the adjacent portion of the occurrence on Hayfork Ranch (Bjerke 2021, p. 3). The smaller, occupied area to the west on Hayfork Ranch was estimated to contain approximately 500 plants (Bjerke 2021, p. 4). In 2022 and 2023, the species was present at the Saint Helena Road and Saddle Mountain/Hayfork Ranch occurrences in similar densities, which were more abundant than prior to the Glass Fire (Bjerke in litt. 2024; Delmartini in litt. 2024) (USFWS, 2024).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The loss and modification of habitat via development, recreational activities and uprooting by feral pigs continues to threaten this species, especially in areas where urbanization is expected to expand further. Three populations are located on private lands where potential development is not precluded; the general trend of habitat loss due to urbanization has continued and will likely continue at or adjacent to known populations (USFWS, 2009).

Stressor: Competition with introduced species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Centaurea solstitialis (yellow star-thistle) has infested the Lake Hennessey and Bale Grist Mill populations and threatens A. claranus via competition for resources. The threat posed by introduced species may become more sever with climate change. The Lewelling Lane population is threatened by competition from Genista monospessulana (French Broom) (CNDDB 1996). Based on its annual habit and size, it is thought that A. claranus has difficulty competing with introduced annual grasses (Howald, in litt. 2008) (USFWS, 2009).

Stressor: Community succession (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: Plant succession at Bale Grist State Historic Park is excluding or reducing the population of A. claranus (Ruygt 1994). Fire suppression has reduced fire frequency, allowing new manzanita seedlings to become established, which results in less space available for A. claranus (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Having few individuals leaves A. claranus susceptible to extirpation throughout a significant position of its range from random events and increases the threat of genetic drift and inbreeding. Therefore, this species is threatened with extinction or extirpation throughout a significant portion of its range due to random events such as flood, drought, disease, or other events (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: While the particular impacts of climate change on A. claranus have not been investigated, evidence suggests that the distribution of appropriate habitat elements (microclimate, community associations) may be altered in the coming decades resulting in a further decline of the species (USFWS, 2009).

Stressor: Pesticides (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. The overall importance of pollinating insects for Clara Hunt's milkvetch is poorly understood (Ruygt 1994, p. 45; Department 2019, p. 5). However, bee pollination is a common mode of pollination in the milkvetch genus (Astragalus) (Watrous and Cane 2011, Table 1, pp. 228–229) and bees have been observed visiting Clara Hunt's milkvetch plants (Liston 1992, p. 376). The Agency's final biological evaluations determined that all three pesticides are highly toxic to bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Clara Hunt's milkvetch, there is a potential for the three pesticides to indirectly adversely affect the species (USFWS, 2024)

Recovery

Reclassification Criteria:

Not available - this species does not have a recovery plan.

Recovery Priority Number: 5C

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Complete a recovery plan for Astragalus claranus (USFWS, 2009).
- Develop habitat suitability model for Astragalus claranus and then project anticipated shifts in range and occurrences under various climate change scenarios (USFWS, 2009).
- Secure landowner agreements with property owners at the Lake Hennessey, Spring Valley, Lewelling Lane and St. Helena Road populations to facilitate the management of Astragalus claranus habitat to reduce or eliminate competition with introduced plant species and uprooting by feral pigs (at Lewelling Lane) (USFWS, 2009).
- Conduct three consecutive years of surveys at each of the five localities to better understand population sizes and inter-annual population fluctuations. Surveys should also include an assessment of current threats facing the A. claranus populations (USFWS, 2009).
- Work with California Department of Parks and Recreation at Bale Crist Mill State Historic Park to manage habitat (e.g., conduct introduced species control) near the A. claranus population in the park (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Here we propose several habitat conservation and management recommendations which will aid in the recovery and conservation of the Clara Hunt's milkvetch. Some of these recommendations have already been discussed in previous Service recovery documents (Service 2009, p. 13; Service 2019, p. 2) or were identified during the Department's 5-Year Status Review of the species (Department 2019, p. 25) and remain valid. 1. Secure landowner agreements with property owners for the Lake Hennessey, Spring Valley, and Lewelling Lane occurrences to protect the occurrences from development and facilitate the management of Clara Hunt's milkvetch habitat to reduce or eliminate competition with introduced plant species and uprooting by feral pigs, if still an issue at Lewelling Lane. 2. Conduct annual demographic monitoring at all six localities. Monitoring surveys should also include an assessment of current threats facing the Clara Hunt's milkvetch at each locality. 3. Collect seeds from the Bothe-Napa Valley State Park and Saddle Mountain/Hayfork Ranch occurrences and request that the California Botanic Garden conduct seed viability tests on previously collected seeds. Seeds were collected from the other four occurrences of Clara Hunt's milkvetch in 2009 and are stored at the California Botanic Garden. 4. Work with California Department of Parks and Recreation at Bothe-Napa Valley State Park to manage habitat (e.g., vegetation removal, introduced species control, prescribed burns) occupied by Clara Hunt's milkvetch. If habitat management efforts do not result in growth and reproduction of the species, discuss the possibility of implementing population augmentation with the California Department of Parks and Recreation and the California Department of Fish and Wildlife. 5. Conduct coordinated research or adaptive management to identify effective habitat management techniques for maintaining Clara Hunt's milkvetch habitat (preventing community succession) and controlling invasive plant species. 6. In collaboration with the City of Napa, investigate ways to reduce impacts from recreational use, invasive species, and

remnant topsoil piles at the Lake Hennessey population (USFWS, 2024).

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SPECIES ACCOUNT: *Astragalus cremnophylax var. cremnophylax* (Sentry milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/04/1991; Southwest Region (R2)

Physical Description

Perennial herb with silvery-haired leaves and stems. Flowers have short, campanulate calyxes with pale, purplish-pink petals and white-tipped wings. It has compact, 3 to 12 millimeter (0.1 to 0.5 inch) long, pinnately compound leaves that bear 5 to 9 minute leaflets. Flowers are small white to pale-purple with banners 5 to 6 millimeters (0.2 inch) and keels not over 4.5 millimeters (0.2 inch) long . Pistils have 4 to 6 ovules; pods are 3.0 to 4.5 millimeters (0.1 to 0.2 inch) long, obliquely egg-shaped and densely hairy (USFWS, 2006).

Taxonomy

A. cremnophylax and three other species are in the subsection Humillimi of the genus Astragalus, family Fabaceae (pea family). Although Jones made the first collection of Astragalus cremnophylax in 1903, the species was not described until 45 years later (Barneby 1948). Barneby assigned a specific epithet that describes the dramatic site occupied by the species. The English translation of the Latin word cremnophylax means "watchman of the gorge." In 1979, Barneby described a new variety, A. cremnophylax var. myriorrhaphis (cliff milkvetch), from plants discovered by Ralph Gierisch, Bureau of Land Management (BLM), and associates in 1978, on Buckskin Mountain, Coconino County, Arizona (Barneby 1979). A third variety, A. cremnophylax var. hevronii (Marble Canyon milk-vetch), was also described by Barneby (1992). The Marble Canyon milk-vetch was discovered in 1991 by Bill Hevron of the Navajo Natural Heritage Program, on the east rim of Marble Canyon, Coconino County, Arizona. After the discovery of variety myriorrhaphis, the group of plants containing the type-specimen of the species was automatically assigned the name A. cremnophylax var. cremnophylax. (USFWS, 2006)

Historical Range

Coconino County, Arizona (USFWS, 2006).

Current Range

Several locations on the south and north rims of the Grand Canyon (USFWS 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: The South Rim plants are obligate outcrossers (need pollen from a different plant to produce viable seed), and the plants in the Cape Final population on the North Rim are

inbreeders, or self-compatible (USFWS 2006).

Dependency on Other Individuals or Species

Adult: Insects as pollinators; primarily the mason bees Osmia ribifloris and O. ribifloris ribifloris (USFWS 2018).

Breeding Season

Adult: Flowers from March through April and from September through November (USFWS, 2006), 2015)

Other Reproductive Information

Adult: Pollinator studies conducted within the South Rim populations confirmed the mason bees Osmia ribifloris and O. ribifloris ribifloris are the primary spring pollinators of sentry milk-vetch when the plant flowers, typically in late April to May. At Maricopa Point, O. ribifloris was far more prevalent than O. ribifloris ribifloris. GRCA also noted several other small bee species pollinating sentry milk-vetch, but these bees were not collected or identified. Pollinator visits coincided with less windy periods, and peak pollination time for O. ribifloris was between 1300 and 1500 hours. (USFWS, 2018)

Reproduction Narrative

Adult: Sentry milk-vetch exhibits two episodes of flowering from March through April and from September through November. Spring is the most common flowering time and usually results in successful fruit and seed set (Maschinski 1990a). Fall flowering plants set fruit, but seeds may not germinate until the next year (Maschinski 1991). This bi-seasonal flowering pattern has also been observed in plants cultivated at The Arboretum at Flagstaff (Maschinski 1990a). Plants in cultivation produced flowers after one year of vegetative growth. Age of first reproduction in the wild population is known to occur as early as one year from germination in individuals that have not been stressed by external factors (e.g., damage to foliage, lack of moisture) (Warren 1993). Plants bearing the greatest number of mature fruits and seeds in May and June are generally the largest plants in the population. These large plants produced an average of 200 fruits in spring 1992 (Warren 1993). Smaller sized individuals produced disproportionately fewer fruits than projected based on the size of the plant (Warren 1993). The average number of seeds per fruit is 3.02, but the number can vary from one to six seeds (Maschinski 1990a, 1991) (USFWS, 2006). More seeds germinated in the moderate light level than in either high or low light levels. Seedlings grown in the high light level had greatest survival. Seeds germinated in both cold and warm treatments. Seedlings at ambient greenhouse temperature germinated an average of three days before their refrigerated counterparts. Tap water appeared to be best for seed germination and early growth and resulted in higher germination rate and lower mortality than reclaimed water. (USFWS, 2018).

Habitat Type

Adult: Terrestrial (USFWS, 2006)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodland (USFWS, 2018)

Dependencies on Specific Environmental Elements

Adult: The species appears to occur on one specific, pure white layer of Kaibab limestone where the bedrock forms an unshaded platform (USFWS 2006).

Geographic or Habitat Restraints or Barriers

Adult: Elevations of 6102 - 7125 ft (USFWS, 2006)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Sentry milk-vetch forms mats or shallow mounds in scarcely visible cracks on Kaibab limestone bedrock, in sand-filled hollows of rock (Barneby 1964), or on shallow gravelly soils. The species appears to occur on one specific, pure white layer of Kaibab limestone where the bedrock forms an unshaded platform. It has not been found on small, shaded ledges or cliffs. The Grandview Point plants occur in a large crack in a small isolated ledge. The habitat is characterized by shallow soils or bedrock on the limestone platforms (55 FR 50184-50187). Prevost (1991) investigated soils at Maricopa Point and found them to be extremely shallow at less than 7 centimeters (2.8 inches) deep. Textures ranged from very gravelly, very fine sandy loam to extremely gravelly loamy fine sand. Clay content ranged from about 8 to 14 percent. Soils were mildly alkaline, with a pH value of 7.8, and were only slightly effervescent. The first 2 centimeters (0.8 inch) of the soil profile was characterized by subangular to subrounded fragments of mixed mineralogy, predominantly comprised of limestone, chert, and basalt less than 2 centimeters (0.8 inch) in diameter. The soil profile from 2 to 6 centimeters (0.8 to 2.4 inches) was very gravelly, very fine sandy loam with a weak thick platy structure, which was soft, very friable, slightly sticky, and nonplastic with fine irregular and tubular pores. Below 6 centimeters (2.4 inches) lies the Kaibab limestone bedrock (Prevost 1991). (USFWS, 2006)

Dispersal/Migration

Motility/Mobility

Adult: [see reproductive strategy]

Dispersal

Adult: Uncertain (USFWS, 2006)

Dispersal/Migration Narrative

Adult: Dispersal of seeds is very limited. Because the soft, pliable pods do not forcefully expel seeds as they split, seeds may remain within the pod attached to the parent plant for months (Maschinski et al. 1994). Seeds often fall into the foliage of the parent plant. Ants have been seen visiting the plants, but their influence on sentry milk-vetch is unknown. Ants may act as dispersal agents, but some species of ants eat seeds, flowers, or flower parts. Wind and water likely play an important role in seed dispersal (Maschinski 1990b). Because the fruits and tiny orange seeds are inconspicuous and do not seem to attract birds and mammals, the seeds are probably not dispersed or eaten by them. (USFWS, 2006)

Population Information and Trends

Population Trends:

Unknown

Species Trends:

Unknown

Resiliency:

no SSA

Representation:

no SSA

Redundancy:

no SSA

Number of Populations:

9 populations (USFWS, 2018). We have found additional patches/populations since the 2018 5TR. The definition of a population is not well established.

Population Size:

Approximately 6,000 individual plants (USFWS, 2018)

Additional Population-level Information:

When we finalized the recovery plan (USFWS 2006), genetic material from the Lollipop, Shoshone, and recently discovered North Rim populations was not included in the published examinations of the genetic relationships of the various sentry milk-vetch populations. In addition, researchers observed anomalous characteristics (e.g., seed color, plant habit) among the populations in the wild and in the greenhouse. Therefore, in 2013, GRCA and U.S. Geological Survey (USGS) initiated taxonomic studies, including phenetic and genetic analyses, to determine which populations we would assign to the listed entity of sentry milkvetch. The study focused on determining if any the newly discovered populations on the North Rim, as well as of the previously studied North Rim populations, are Astragalus cremnophylax var. cremnophylax (Wood 2014). The current work, which is in the data analysis phase, includes 77 individual plant samples of North Rim populations that taxonomists tentatively referred to an unpublished taxon, “Astragalus septentriorema” (commonly referred to as “North Rim Astragalus”). The researcher used a technique called amplified fragment length polymorphismpolymerase chain reaction (AFLP-PCR) genotyping to determine if “North Rim Astragalus” is the same species as the South Rim populations of sentry milkvetch. In total, 290 individuals from these groups have been sampled and genotyped at 694 loci. Preliminary results suggest that we would ascribe the populations on the South Rim (listed entity) and the North Rim Astragalus to sentry milk-vetch. We are currently waiting on a full report and publication of these results. However, once the authors publish this information, it is likely to result in an increase in the number of sentry milk-vetch populations and an increase in the geographic extent of the species that would include areas on both the South and North rims of Grand Canyon. At this time, the full results of that additional taxonomic work are not available. Thus, the relationship of the populations, and even the current number of populations of the species, remain unconfirmed. (USFWS, 2018)

Population Narrative:

During GRCA's annual May monitoring of the wild population at Maricopa Point, staff counted 989 sentry milk-vetch plants in 2014, compared with 556 plants in 2009, 528 plants in 2010, 608 plants in 2011, 539 plants in 2012, and 624 plants in 2013. While some of this increase may be the result of increased accuracy resulting from the tagging process, there were also at least 400 new sentry milk-vetch plants in 2014 compared with 188 in 2013 and only 46 new plants in 2012. This increase in the number of new plants found in the May 2014 monitoring is likely due to the large number of seedlings that came up with the above average summer 2013 monsoon rains and survived the winter. Anecdotal observations made during the summer of 2014 indicate that many of these very small seedlings perish during the hot summer months and do not make it to the next monitoring cycle. In 2011 and 2012, GRCA completed North and South Rim surveys for all areas identified as potential sentry milk-vetch habitat. GRCA located 200 individuals in a new population at Walhalla Sky Island (North Rim location), 560 individuals in a new population at Cape Final North (North Rim location), and 30 individuals in a new population at Walhalla Glades (North Rim location). In 2013, GRCA discovered a new population of 139 individual plants near Shoshone Point (South Rim location). GRCA established three reintroduction sites: Maricopa Reintroduction, Lollipop Reintroduction and Grandview Reintroduction. Plantings of sentry milk-vetch at these sites were supplemented with wild-collected seeds. GRCA put new plants in cages immediately after planting and watered the plants on a regular schedule. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2006)
Exposure:
Response:
Consequence:
Narrative: Because the largest known confirmed population has sustained severe declines, the species remains in danger of extinction. Human traffic indirectly affects the sentry milk-vetch population through habitat degradation. Over time, trampling has resulted in the loss of plant cover, which has resulted in erosion of the thin soil. Foot traffic can also displace what little soil builds on the limestone surface, thus reducing the number of microsites available for germination. Most seedlings establish near plants or other obstructions that stop the sheet flow. The loss of plant cover due to trampling can reduce the microsites available for seedling establishment. Maschinski et al. (1996) stated that the continued existence of the species would depend on continued protection, environmental conditions that promote recruitment, and recovery efforts such as habitat enhancement and augmentation (USFWS, 2006).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2006)
Exposure:
Response:
Consequence:
Narrative: The species is protected by National Park Service regulations, as are all plant species within the Park. Sentry milk-vetch is protected by the Arizona Native Plant Law. That law prohibits the collection of the species unless the Arizona Department of Agriculture grants a permit for educational or scientific purposes. However, the law does not provide habitat protection. Protection provided to the species under the Endangered Species Act is discussed below, in Conservation Measures (USFWS< 2006).

Stressor: Predation (USFWS, 2006)
Exposure:
Response:
Consequence:
Narrative: The threat of predation to sentry milk-vetch is not well understood. Damage to plants in 2006 may have been due to predation by rock squirrels, or the damage may have been collateral; that is, the plants were dug up when rock squirrels were digging for roots to eat (USFWS, 2006).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2006)
Exposure:
Response:
Consequence:
Narrative: Plant collecting by botanists and other rare plant enthusiasts is a potential, but currently minor, threat to sentry milk-vetch. Although the extent of this threat is unknown, publicity could make this species susceptible to increased visitation and collection. Because the number of populations and individuals is so small, even a small or moderate amount of collecting could seriously impact the species. The minor threat of unauthorized collection must be weighed against the potential benefits of education of the general public. The Park receives visitors from all over the globe, and the conservation status of this species could be enhanced by public education in the form of informational signs at Maricopa Point (USFWS, 2006).

Stressor: Trampling by ungulates (USFWS 2018).
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
1. There are at least four viable populations of 1,000 individuals each (4,000 total) protected in perpetuity (USFWS, 2006).

2. Naturally occurring populations are stable or increasing over a ten-year period (USFWS, 2006).

3. Reintroduced populations are stable or increasing over a thirty-year period (USFWS, 2006).

Delisting Criteria:
1. There are at least eight viable populations of 1,000 individuals each (8,000 total) protected in perpetuity (USFWS, 2006).

2. Naturally occurring populations are stable or increasing over a ten-year period (USFWS, 2006).

3. Reintroduced populations are stable or increasing over a thirty-year period (USFWS, 2006).

Recovery Actions:

- Protect the population at Maricopa Point from disturbance. Monitor threats and evaluate the need for additional protective measures. Conduct surveys to positively identify and determine taxonomic relationships of new populations as they are found. Increase the number of individuals and the amount of occupied habitat at all occupied sites to the carrying capacity of the habitat. Establish new populations as necessary to meet recovery criteria. Based on the results of the pilot project and availability of suitable introduction sites, establish additional new populations (USFWS, 2006).
- Coordinate research activities. Develop public awareness, appreciation, and support for preservation of sentry milk-vetch.(USFWS, 2006)
- Enforce laws and regulations. Ensure long-term protection (USFWS, 2006).
- Provide assistance to Grand Canyon National Park (and other land owners and managers) to recover and protect the species and its habitat. Adjust management as necessary. Conduct research on the existing populations. Establish an ex situ (botanical garden/greenhouse) conservation program. Exchange information between agencies, the public, and the scientific community (USFWS, 2006).
- Develop a post-listing monitoring plan. The plant and its habitat will be monitored for 5 years after recovery (delisting) has been achieved. (USFWS, 2006)
- Recommended Actions from 2018 5-Year Review: • USGS and GRCA need to complete the final report and publish the results of the taxonomic study that ascribe the populations on the South Rim (listed entity) and the North Rim Astragalus to sentry milk-vetch. 11 • Improve communication and coordination by all partners. We will plan to have regular meetings in order to share important findings, changes in the species status, and progress towards recovery. • The Fish and Wildlife Service, GRCA, and The Arboretum at Flagstaff will address and determine what constitutes populations of the species and their locations in the context of the recovery plan. This group also should analyze and summarize the long-term data set and define what constitutes stability in terms of the recovery criteria. (USFWS, 2018)
- As part of two section 7 consultations we conducted with GRCA, the following conservation measures are now part of the GRCA recovery program (USFWS 2011, 2012). GRCA updated their sentry milk-vetch reintroduction plan to follow the latest version of the Center for Plant Conservation Best Reintroduction Practices Guidelines.
- • Restoration activities will avoid sentry milk-vetch plants. • The number of researchers and number of entries within each population will be limited to what is essential to accomplish the project. Researchers will wear soft shoes and will not enter the population area when soils are saturated. • GRCA will use a dedicated research greenhouse to grow and hold sentry milk-vetch plants. GRCA will keep field collected seed and seed received from The Arboretum at Flagstaff in a cool dry place until use and will ensure the seed is secure from rodents and insects. • Upon the completion of the project, GRCA will deposit any excess seed into the National Center for Genetic Resources Preservation, or distribute the seed according to instructions from the Fish and Wildlife Service. • GRCA will use only pure Maricopa Point sentry milk-vetch material for augmentation or introduction at Maricopa Point and the surrounding vicinity, only Lollipop Point material at Lollipop Point, and only Grandview material at Grandview, until the taxonomic relationships among the Maricopa, Lollipop, and Grandview populations are better defined. Until the taxonomy of the North Rim populations is known, genetic material will not be mixed at these sites as well. (USFWS,

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SPECIES ACCOUNT: *Astragalus holmgreniorum* (Holmgren milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9-28-2001; Mountain-Prairie Region (Region 6)

Physical Description

A member of the pea family, this species grows close to the ground and is a herbaceous, non-woody perennial that produces small purple flowers in the spring, and dies back to the root crown after the flowering season. The plant's pinnately compound (arranged on opposite sides of the stem in a row) leaves arise directly from the root crown. The leaves are pressed close to the ground, and are 4 to 13 cm (1.5 to 5.1 in) long, and have 9 to 15 leaflets. The leaflets are 0.8 to 1.6 cm (0.3 to 0.6 in) long and are broadly obovate (oval with the narrow end towards the base of the leaf) in shape. The flowers are purple, 1.8 to 2.4 cm (0.7 to 0.9 in) long, and 0.6 to 0.9 cm (0.2 to 0.4 in) wide and have the distinctive pea-like flowers with 5 petals. Flowers occur along the stalk in groups of 6 to 16. The fruits are pods 3 to 5 cm (1 to 2 in) long and 0.6 to 0.9 cm (0.2 to 0.4 in) across. The pods retain seeds even after the pods fully open up along the margin. With age, each pod eventually drys out and opens up at both the top and bottom ends (Barneby 1989; Stubben 1997).

Taxonomy

A. holmgreniorum was first collected in 1941 by Melvin Ogden; the species was subsequently rediscovered by Rupert Barneby and Noel and Patricia Holmgren in 1979. Barneby recognized the species as a unique taxon occurring along the western Utah-Arizona border and named the species for his co-discoverers.

Historical Range

Historical distribution is not known for this species, that is, records are not available to ascertain whether the current distribution of A. holmgreniorum populations represents either a loss of individual populations or a range contraction for the species. Given historical configurations of available habitat, it is possible that additional populations once occurred on the landscape. It is unknown, but also is possible that this species is a relatively new endemic, which has speciated relatively recently in or near its present locations.

Current Range

Washington County, Utah (4 populations); and Mohave County, Arizona (1 population). These Astragalus populations are distributed across a limited range. Known populations of A. holmgreniorum occur within approximately 10 miles (mi) (16 kilometers (km)) of St. George in Washington County, Utah, and Mohave County, Arizona. The largest concentration of this species spans the Utah-Arizona border, extending from the Atkinville Wash area eastward across Interstate 15 (I-15) to the Arizona Strip Highway; this concentration comprises three populations--State Line, Gardner Well, and Central Valley. Two populations, South Hills and Stucki Spring, are found south of the City of Santa Clara. An isolated population called Purgatory Flat is associated with a limestone outcrop found east of St. George. About half of the areas occupied by A. holmgreniorum are on lands owned and managed by the State of Utah (Van Buren and Harper 2003a).

Critical Habitat Designated

Yes; 12/27/2006.

Legal Description

On December 27, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus holmgreniorum (Holmgren milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Arizona and Utah (71 FR 77972-78012).

Critical Habitat Designation

The critical habitat designation for Astragalus holmgreniorum includes three CHUs (Including 5 subunits) in Mohave County, Arizona, and Washington County, Utah. This species critical habitat encompasses approximately 6,289 acres (ac) (2,545 hectares (ha)) (71 FR 77972-78012).

Unit 1—Utah-Arizona Border This unit consists of approximately 5,546 ac (2,244 ha) divided into three subunits: State Line, Gardner Well, and Central Valley. This unit contains PCEs and is important to the conservation of Astragalus holmgreniorum because it is one of only three populations of the plant and is the largest population of the species. Subunit 1a—State Line This subunit, known to be occupied at the time of listing, consists of 3,836 ac (1,552 ha), with 9 percent managed by BLM AZ, 44 percent managed by BLM UT, 23 percent managed by ASLD, 19 percent managed by SITLA, and 5 percent private land or land ownership unknown. Subunit 1a is located east and west of I–15 as this highway crosses the State line of Arizona and Utah, and is bounded by the Atkinville Wash and Virgin River to the north. Documents pertaining to occupancy, soil type, and land formations were evaluated to determine unit boundaries. Administrative lines were used for boundaries on the west and east sides of the unit, and soil type, land features, and straight connecting lines were used for northern and southern boundaries of the unit. Recent surveys on lands managed by SITLA (Van Buren 2004, p. 3) and BLM UT (Van Buren 2005) west and east of I–15 confirmed occupancy of Astragalus holmgreniorum individuals, and BLM AZ (Hughes 2005) verified A. holmgreniorum in several locations on BLM and ASLD lands. Suitable habitat conditions supporting the identified PCEs occur throughout the area. Land between sections 31, 32, and 8 contains known PCEs for A. holmgreniorum; however, information is incomplete on intervening occupancy. Subunit 1a has features that are essential to the conservation of the species, and it supports the highest number of individuals documented to date (Service 2006) within a continuous geographic area, fragmented only by I– 15. Astragalus holmgreniorum also occupies land found between the northbound and southbound lanes of I– 15. This intervening area within the highway right-of-way may allow pollinator flow between sites situated west and east of the highway (Douglas 2005). As a large population, subunit 1a retains importance as representative of the species' potential range of genetic diversity. Species surveys documented a high number of seedlings (Van Buren 2004, p. 2; 2005, p. 16), which indicates that this subunit supports a large seed bank. This information indicates a viable seed bank, the protection of which enhances the genetic diversity and boosts the likely persistence of the species (Van Buren 2003, p. 6). Seed bank protection is necessary for longterm species persistence (McCue and Holtsford 1998, p. 35). Special management considerations may be required to control invasive plant species, to control habitat degradation due to activities that lead to erosion, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. The BLM AZ and BLM UT do not currently have a management plan specific to Astragalus holmgreniorum; however, the agency worked in partnership with the Service on a recovery plan for the species (71 FR 57557, September 29, 2006). The BLM UT states that the timing of cattle grazing has been

adjusted to avoid the flowering period for the species (Douglas 2004). Additionally SITLA is signatory to a Letter of Intent intended to place roughly 175 ac (71 ha) of land occupied by A. homgreniorum into long-term conservation (SITLA et al. 2005, pp. 3– 4). Subunit 1b—Gardner Well Subunit 1b consists of 564 ac (228 ha), entirely managed by ASLD. This subunit is found in Arizona, south of the Arizona-Utah State border, 2 mi (3.2 km) east of I–15. Reconnaissance maps dating to the early 1990s and herbarium information for Astragalus holmgreniorum indicate plant occupancy on ASLD lands. The acreage proposed within this subunit was further refined based on known plant locations, geologic maps, and occurrence of PCEs, including soil types. This subunit is determined to be critical habitat because it contains features essential to the conservation of Astragalus holmgreniorum, is occupied by the species, and represents the southeastern-most site in Arizona within the primary population, as discussed in the final listing rule (66 FR 49560, September 28, 2001). Yearly monitoring indicates a relatively high density of A. holmgreniorum (Van Buren and Harper 2004a, p. 6). In 2005, the Gardner Well monitoring site contained an estimated 150 plants, all seedlings (Van Buren 2005). The abundance of seedlings indicates a persistent seed bank that is considered important for genetic diversity and local survivorship (McCue and Holtsford 1998, pp. 34–35; Van Buren 2003, p. 6; Van Buren 2005). This subunit also is historically significant because it includes the type locality (the location of the specimen from which the original species' description was made) for the species. Special management may be required to minimize disturbance to the surface structure within this subunit, to control invasive species, to maintain the identified vegetation types, and to maintain pollinator habitat essential to the conservation of the species. Currently, no management plan has been developed for these lands. Subunit 1c—Central Valley Subunit 1c consists of 1,146 ac (464 ha), entirely managed by SITLA. This subunit is found north of the ArizonaUtah State border, west of a geological feature called White Dome, and east of I–15. This subunit is determined to be critical habitat because it contains features essential to conservation of Astragalus holmgreniorum, it is occupied by the species, and contains a large, densely occupied portion of the primary population described in the final listing rule (66 FR 49560; September 28, 2001). This subunit contains the second largest continuous land base for A. holmgreniorum and the second largest number of individuals counted to date (Van Buren 2003, p. 5). Approximately 99.8 percent of plants identified in the 2003 surveys were seedlings (Van Buren 2003, p. 6). The high number of seedlings and near lack of reproductive adults indicates a historic seed bank (Van Buren and Harper 2004a, pp. 3–4). Protection of known seed banks is essential for longterm survival of the species. The retention of these seeds can have a dramatic effect on demography and reduce the expected inbreeding coefficient (McCue and Holtsford 1998, p. 34). Seed banks also ensure population persistence during periods of changing environmental conditions (Facelli, Chesson, and Barnes 2005, pp. 3001–3003). Plants within this subunit are threatened by urban development. Special management may be required to minimize disturbance to the surface and subsurface structure within this subunit, and to maintain the identified soil and vegetation types. No management plan currently exists. A Letter of Intent signed by SITLA indicates a willingness to develop a management plan for this species on a limited portion of their property; however, SITLA plans to develop a master planned community in the area (SITLA et al. 2005, pp. 5–6).

Unit 2—Santa Clara Unit Unit 2 comprises 567 ac (229 ha) divided into two subunits: Stucki Spring and South Hills. Unit 2 contains the PCEs, and is also important to conserving genetic diversity of the taxon because plants in this area contain a unique genetic marker not present in the other two populations (Stubben 1997, p. 46). Therefore, the two subunits in the Santa Clara Unit are needed to conserve genetic variation held within the gene pool for this taxon (Van Buren 2005). Additionally, this unit represents one of only three known populations of the species.

Subunit 2a—Stucki Spring Subunit 2a consists of 438 ac (177 ha) managed by BLM UT. This unit is found west of Box Canyon, in an area before Box Canyon Wash narrows, and near Stucki Spring. Astragalus holmgreniorum was known to occupy this subunit at the time of listing (66 FR 49560; September 28, 2001). In 2005, individuals were confirmed in a roadside visit (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of Astragalus holmgreniorum, is occupied by the species, supports genetic diversity, and provides connectivity between Subunits 1a (State Line) and 1c (Central Valley) to the south, and Subunit 2b (South Hills) to the north. The land within this unit supports the PCEs for the species that are necessary for the growth, reproduction, and establishment of Astragalus holmgreniorum. Special management may be required in this subunit to minimize habitat fragmentation, to minimize disturbance to the surface and subsurface structure due to recreation or other activities, and to maintain the identified soil and vegetation types. Plants within this subunit are currently threatened by unmanaged ORV use. Additionally, BLM is considering selling adjacent areas for urban development; we anticipate that the proximity of the development would result in an indirect effect to Astragalus holmgreniorum. BLM UT does not currently have a management plan specific to A. holmgreniorum, but the agency worked with us to develop a recovery plan for this species (71 FR 57557, September 29, 2006). The objective of the Santa Clara River Reserve Recreation and Open Space Management Plan is development of user-specific trails and areas of activities to reduce the effects of unregulated and potentially damaging activities on habitat components, including plants (USDI 2005, p. 10). However, specific details regarding facility locations, impacts, and conservation measures have not been identified. Subunit 2b—South Hills Subunit 2b consists of approximately 129 ac (52 ha), with 97 percent managed by BLM UT and 3 percent private lands (or land ownership unknown). This subunit was known to be occupied at the time of listing (66 FR 49560; September 28, 2001). A 2005 survey of the area documented a healthy number of plants in this subunit (Van Buren 2005). This subunit is determined to be critical habitat because it contains features essential to conservation of Astragalus holmgreniorum, is occupied by the species, supports genetic diversity, and represents the northcentral-most occupied site of the species. The land within this subunit supports the PCEs necessary for the growth, reproduction, and establishment of A. holmgreniorum. Special management may be required to minimize urban encroachment, maintain land in Federal ownership, reduce disturbance to the surface and subsurface structure, control invasive species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species. Plants within this subunit are threatened by urban development, land trades, and recreation. Public land sales are authorized for eligible parcels under the Federal Land Transaction Facilitation Act of 2000 (Crisp 2004). BLM is working with the city of Santa Clara and the local community to sell approximately 1,400 ac (567 ha) in the Santa Clara area. This proposed sale is believed to contain all Astragalus holmgreniorum individuals in this subunit. The intent of the local community would be to develop the land for residential housing.

Unit 3—Purgatory Flat Unit 3 consists of approximately 176 ac (72 ha) of land; 68 percent is managed by BLM UT, and 32 percent is under private ownership or county ownership. Part of the critical habitat contains lands within a regional shooting range. The final listing rule (66 FR 49561, September 28, 2001) indicated that there were 30 to 300 plants at this location. More recent site visits confirm the presence of individual plants (Barnes 2005; Van Buren 2005); however, a census was not conducted. Purgatory Flat is determined to be critical habitat because it contains features essential to conservation of Astragalus holmgreniorum, is occupied by the species, and represents the northeastern-most occupied site and third known population. This unit is the farthest from all other critical habitat units. Distant populations are often the most active regions

of speciation and may be important for protecting genetic diversity (Lesica and Allendorf 1995, p. 756). The land within this unit supports the PCEs that are necessary for the growth, reproduction, and establishment of A. holmgreniorum. Special management may be required to minimize disturbance to the surface structure within this subunit, control invasive species, maintain the identified vegetation types, and maintain pollinator habitat essential to the conservation of the species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus holmgreniorum critical habitat consists of three components (71 FR 77972-78012):

(i) Soils that support individual Astragalus holmgreniorum plants. These include the Virgin Limestone member, middle red member, and upper red member of the Moenkopi Formation, and the Petrified Forest member of the Chinle Formation. Associated soils are Badland; Badland, very steep; Eroded land-Shalet complex, warm; Hobog-rock land association; Isom cobbly sandy loam; Ruesh very gravelly fine sandy loam; Gypill Hobog complex, 6 to 35 percent slopes; Gypill very cobbly sandy loam, 15 to 40 percent slopes; and Hobog-Grapevine complex, 2 to 35 percent slopes;

(ii) Topographic features/relief (mesas, ridge remnants, alluvial fans and fan terraces, their summits and backslopes, and gently rolling to steep swales) and the drainage areas along formation edges with little to moderate slope (0 to 20 percent); and

(iii) The presence of insect visitors or pollinators, such as Anthophora captognatha, A. damnersi, A. porterae, other Anthophora species, Eucera quadricincta, Omia titus, and two types of Dialictus species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one or more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

When designating the three critical habitat units, including Subunits 1a, 1b, 1c, 2a, and 2b, for Astragalus holmgreniorum, and the four critical habitat units, including Subunits 4a and 4b, for A. ampullarioides, we assessed whether the areas determined to be occupied at the time of listing and containing the primary constituent elements may require special management considerations or protections. As discussed in more detail in the proposed critical habitat designation (71 FR 15966, September 26, 2006) and in the unit and subunit descriptions below, we found that the features essential to the conservation of A. holmgreniorum and A. ampullarioides, in all areas we are designating, may require special management considerations and protections, including measures necessary to alleviate the effects of urban development, retaining plants and their habitat on Federal lands, fencing small populations, removing or limiting access routes, ensuring vehicles and pedestrians stay on designated routes, reducing land use practices that disturb the hydrologic regime, minimizing the effects of grazing and recreation use, managing invasive nonnative plant species, evaluating revegetation and restoration with native plant species, developing adequate fire management buffers for these plant species and their habitat, and educating fire management staff on the location of the

plants. Additionally these areas may require special management considerations and protections for ground-nesting and local pollinator communities.

Life History

Food/Nutrient Resources

Food Source

Adult: Soil nutrients

Competition

Adult: Nonnative annuals make up the highest percentage of living cover in A. holmgreniorum habitat, and they tend to emerge prior to A. holmgreniorum, thus potentially competing for soil moisture and nutrients.

Food/Nutrient Narrative

Adult: The primary geological layers or parent materials associated with A. holmgreniorum occurrences include the Virgin Limestone member and Upper Red member of the Moenkopi Formation (Harper and Van Buren 1997). It is typically found on the skirt edges of hill and plateau formations slightly above or at the edge of drainage areas; it occurs on soils characterized by small stone and gravel deposits and where living cover averages less than 20 percent of the landscape. Runoff received from nearby sloping areas, combined with slower evaporation due to shading produced by the stone and gravel, may increase water availability for the plants in excess of regional rainfall (Harper 1997; Harper and Van Buren 1997). Nonnative annuals make up the highest percentage of living cover in A. holmgreniorum habitat, and they tend to emerge prior to A. holmgreniorum, thus potentially competing for soil moisture and nutrients.

Reproductive Strategy

Adult: Iteroparous (capable of producing seed in more than 1 year); not capable of vegetative reproduction, so setting of seed is necessary.

Lifespan

Adult: Few plants live past two growing seasons (Stubben 1997; Van Buren and Harper 2003) and less than 2% of seedlings (nonreproductive plants with a rosette diameter of 0-2.4 in. (0-6 cm)) tracked in 1993 lived into their fourth growing season (Van Buren and Harper, 2001a).

Dependency on Other Individuals or Species

Adult: Solitary bees are the primary pollinators. Anthophora poterae is the most frequent; other pollinators include Anthophora coptognatha, Anthophora dammersi, Eucera quadricincta, Osmia titusi, two Dialictus species, an undetermined Anthophora species, and the introduced honeybee, Apis mellifera (Tepedina 2005).

Breeding Season

Adult: Flowering occurs between March and April; the majority of plants set fruit by the ned of April; seed pods persist until the end of May.

Key Resources Needed for Breeding

Adult: A variety of suitable ground nesting substrates is probably required for these pollinators.

Reproduction Narrative

Adult: A. holmgreniorum is an extremely short-lived perennial herb with low survivorship from germination to 1 year-old juvenile or reproductive adult. Few plants live past two growing seasons (Stubben 1997; Van Buren and Harper 2003) and less than 2% of seedlings (nonreproductive plants with a rosette diameter of 0-2.4 in. (0-6 cm)) tracked in 1993 lived into their fourth growing season (Van Buren and Harper, 2001a). Although very few plants live to exhibit this quality A. holmgreniorum is iteroparous, capable of producing seed in more than 1 year. Nonseedlings, i.e., plants entering their second year of growth or older plants, appear several weeks before seedlings, generally in late February or early March, although some emerge as early as mid-January. Seedlings are present several weeks following adult emergence. The best time to detect the species is while it is producing flowers and fruit. Flowering occurs between March and April, and the majority of plants set fruit by the end of April. Seed pods persist until the end of May. Plants then die back to roots between late May and mid-June (Van Buren and Harper 2003a).Depending on precipitation, A. holmgreniorum has variable seedling output followed by a low rate of survivorship, limiting the number of reproductive adults within a population. Solitary bees are the primary pollinators. Anthophora poterae is the most frequent; other pollinators include Anthophora coptognatha, Anthophora dammersi, Eucera quadricincta, Osmia titusi, two Dialictus species, an undetermined Anthophora species, and the introduced honeybee, Apis mellifera (Tepedina 2005). For bees to be present in a landscape, habitat must provide suitable nesting substrate and resources such as food, water, and nesting materials (Tepedino et al. 1997, Tepedino 2000). With the diversity of bees visiting A. holmgreniorum, a variety of suitable ground nesting substrates is probably required for these pollinators (V. Tepedino, pers. comm. 2006). Also, several of these species nest in wood rather than the ground (V. Tepedino, pers. comm. 2006).

Habitat Type

Adult: Terrestrial; warm desert shrub communities on gravelly clay hills.

Habitat Vegetation or Surface Water Classification

Adult: Desert, Shrubland/chaparral;

Environmental Specificity

Adult: Narrow (inferred from USFWS 2006b)

Tolerance Ranges/Thresholds

Adult: Elevations between 2,480-2,999 feet (ft) (756-914 meters (m)) in areas that drain to the Santa Clara and Virgin rivers; 20% slope or less (USFWS unpubl, data 2005).

Site Fidelity

Adult: High

Habitat Narrative

Adult: A. holmgreniorum occurs at elevations between 2,480-2,999 feet (ft) (756-914 meters (m)) in areas that drain to the Santa Clara and Virgin rivers. It is typically found on the skirt edges of hill and plateau formations slightly above or at the edge of drainage areas; it occurs on soils characterized by small stone and gravel deposits and where living cover averages less than 20

percent of the landscape. Runoff received from nearby sloping areas, combined with slower evaporation due to shading produced by the stone and gravel, may increase water availability for the plants in excess of regional rainfall (Harper 1997; Harper and Van Buren 1997). The species is associated with geological layers or parent materials found within the Moenkopi formation. The majority of plants (approximately 95%) are found on a 20 percent slope or less (USFWS unpubl, data 2005). A. holmgreniorum is thinly and discontinuously distributed within its habitat. At the landscape level, the dominant plant community or land cover within which A. holmgreniorum occurs is described as Sonora-Mojave Creosotebush-White Bursage Desert Scrub (NatureServe 2003) and, alternatively, as Mohave Mixed Shrub and Mohave Creosote/Bursage habitats (Bennett et al. 2004).

Dispersal/Migration

Motility/Mobility

Adult: Low

Dispersal

Adult: By water mammals, birds

Dependency on Other Individuals or Species for Dispersal

Adult: Rodents and smaller, ground-dwelling birds are likely disperal agents as well as water.

Dispersal/Migration Narrative

Adult: A. holmgreniorum habitat is dynamic, and within a given locality occupancy and distribution of plants may shift over time. Seeds are thought to be dispersed by water, as the plants are generally found on the skirt edges of washes or in run-off channels around mounds (Van Buren and Harper 2004a). Rodents and smaller, ground-dwelling birds are other likely dispersal agents (S.L. Welsh, Brigham Young University, pers. comm. 2005).

Population Information and Trends

Number of Populations:

7 (USFWS, 2021)

Population Size:

~7,100 adults (USFWS, 2021)

Population Narrative:

We now know of seven geographically discrete Holmgren milkvetch populations on Federal (Bureau of Land Management (BLM)), state, and private lands. The seventh population (Green Valley) is on private lands along a utility corridor outside of designated critical habitat (McCormick and Wheeler 2018). We estimate 7,100 adult plants occur range wide, with 56 percent occurring in the State Line population on BLM land, 42 percent occurring in the Central Valley population on state land, and two percent occurring in the five remaining populations. The current estimate of 7,100 individuals (adult plants) is lower than the 2001 and 2006 estimates due to declining population trends on BLM lands within four populations (State Line, Purgatory Flat, South Hills, and Stucki Springs) as well as some loss of plants to development on state and private lands (Van Buren et al. 2016; Lewinsohn 2021). In the smallest three Holmgren

milkvetch populations (South Hills, Stucki Springs, and Purgatory Flat), plant abundance has declined, and surveys detected few to no plants in recent years. The decline in the State Line population appears to be the result of threats (livestock grazing, nonnative weeds, and recreation) acting on the species, singly or in combination (Van Buren et al. 2016; Searle and Meyer 2020). The decline in the three smaller populations (Purgatory Flat, South Hills, and Stucki Springs) appears to be the result of threats (nonnative weeds) in combination with seed limitation. Container seed production and seed salvage efforts on state lands support the current population augmentation and introduction efforts on BLM and The Nature Conservancy (TNC) lands intended to improve population size and trends (Schultz and Meyer 2015; Meyer et al. 2017, 2018, 2020; Rominger et al. 2019b; Schultz et al. 2021). (USFWS, 2021)

Threats and Stressors

Stressor: Development activities
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Development activities result in an irredeemable loss of habitat, unlike invasive species, which may be amenable to control if effective management techniques can be developed. Land development not only causes direct habitat destruction, it also can result in disturbance of nearby habitat (e.g., through soil disturbance, changes in hydrology, and increased human access), which could in turn set the stage for additional problems with invasive species. Together, habitat loss and disturbance could cause the extirpation of local populations and, through synergistic effects, rangewide extinction. This is an acute problem for the Central Valley population, which coincides with the planning area for a large residential community that will destroy most of the plant's habitat. Some onsite areas are being set aside for the plant, but as planned, these will provide habitat for only a small, isolated portion of the extant population, and there are doubts about the long-term continued viability of this population unless additional and linked habitat preserves can be secured. The acquisition of land and its protection would directly offset population loss and would highly improve recovery scenarios. Unfortunately, habitat conservation through land acquisitions and easements is costly due to sharply increasing property values in the vicinity of St. George.

Stressor: Introduction of invasive plants
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Introduction of invasive plants is one of the fastest growing threats for many rare and endangered species, and bringing invasive species under control once they are established has proven to be a difficult issue; however, as long as the soil substrate and seedbank for A. holmgreniorum are protected, a remedy to invasive species may be achieved. Just as invasive species affect all known A. holmgreniorum populations, so could fires associated with the spread of nonnative invasive species. The spread of fire through vegetation communities occupied by A. holmgreniorum has not been a problem in the past and is not an active concern at the present time, but as exotic plant species become more prevalent within the Mojave Desert ecosystem, fire holds the potential to affect this species throughout its range.

Stressor: Drought

Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Although long-term changes in regional precipitation and temperature regimes may affect the distribution and viability of this and other endemic plant species in the future, much uncertainty remains about climatic trends and the ability of A. holmgreniorum to adapt to gradual changes. The primary concern at this point with regard to climate change is the potential for drought -- whether part of a broader climatic trend or not -- to outlast the period over which the species can withstand consecutive years of reduced reproductive output and seedbank depletion. Thus, while climate change is viewed as a potential rather than current threat, drought years warrant close observation for effects on each population. Measures to mitigate loss of reproductive adults and seed output may be necessary on an emergency and ongoing basis.

Stressor: Authorized and unauthorized outdoor activities
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Natural resource utilization for outdoor recreation, particularly ORV use, affects all populations; however, human use at one population (Purgatory Flat) has been effectively controlled with fencing. Other human uses in milk-vetch habitat have included the illegal dumping of household items. Subsequent use of these household items for target practice results in increased litter accumulation from ammunition cartridges. If left unabated, these activities, particularly ORV use in the direct localities of the plants, could cause long-term, irreparable harm. Although known populations of A. holmgreniorum could rebound and persist with effective management controls, the required enforcement efforts will be substantial. In addition, the demand for recreational and general access is likely to grow as the regional population increases and land development expands, exerting more pressure on A. holmgreniorum.

Stressor: Impacts on pollinators
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: The presence of pollinators depends on meeting their habitat and foraging requirements, which can be impaired by the same activities that affect the plants. Reduced availability of pollinators could severely reduce A. holmgreniorum population viability; thus, impacts on the plants and their pollinators must be considered together.

Stressor: Cattle activities
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Impacts associated with cattle include trampling of individual A. holmgreniorum plants (R. Van Buren, pers. comm. 2006), as well as the defoliation and removal of palatable plant species, which changes plant community structure, soil compaction, abrasion, and destabilization, and redistribution of soil nutrients and ecological succession (Fleischner 2006; Cole and Landres 1996). The normal grazing period for the River Pasture, containing the State Line population, within the Curly Hollow Allotment is November 1 to January 31; however, due to recent wildfires, adjustments have allowed Spring grazing in River Pasture to allow the

restoration of other pastures within this allotment (J. Crisp, BLM, St. George Field Office, pers. comm. 2006). Additionally, the Gardner Well population experiences grazing under a Arizona State grazing lease (Lizard allotment). Soil compaction due to cattle activities, can indirectly impact the soil seedbank. If seedlings cannot emerge from the soils, germination will not occur (R. Van Buren, pers. comm. 2006). Also, soil compaction reduces the ability for moisture to penetrate into soils and thus be available to seeds (R. Van Buren, pers. comm. 2006). Nonetheless, the effects of cattle at the State Line and Gardner Well populations are considered to be of low severity due to undemonstrated potential.

Stressor: Herbicide use
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Herbicide use may affect the State Line population due to vegetation control on Interstate highway I-15 (Northwest Economic Associates 2006). Herbicide use within or adjacent to other A. holmgreniorum populations has not been documented. The threat of herbicide use is thus localized and of lesser concern with regard to A. holmgreniorum survival and recovery. However, it should be noted that threat scenarios can change over time, and all activities thought to pose a current or future threat to the species should be monitored and addressed.

Recovery

Reclassification Criteria:
When population trends for four out of six extant A. holmgreniorum recovery populations are primarily stable or improving, as indicated by species presence, mean occupied habitat, density of occupied habitat, and demographic modeling, over a 20-year period.

When the habitat base for each recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for gene flow within and among populations.

Population and habitat management is implemented for all recovery populations in accordance with site-specific management plans.

Delisting Criteria:
Two additional populations of the species are either located or successfully introduced to habitat in proximity to extant populations. Thus, a minimum of eight recovery populations will be needed to delist the species.

The available habitat base for each newly discovered or introduced recovery population is large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and among populations.

Population trends for all A. holmgreniorum recovery populations are primarily stable or improving, as indicated as indicated by species presence, occupied habitat, density of occupied habitat, and demographic modeling.

Each of the eight A. holmgreniorum recovery populations has a post-delisting conservation plan with the species' conservation as a primary objective.

Permanent land conservation is achieved for all recovery populations whether extant or introduced (a minimum of 8 populations), such that Endangered Species Act (ESA) protection is no longer needed to compensate for regulatory inadequacies.

Adverse population-level effects from herbivory, disease, or predation, if any, are identified and abated within all A. holmgreniorum recovery populations.

A long-term offsite conservation program is ongoing for all milk-vetch recovery populations.

Recovery Actions:

- Achieve committed land protection to abate impacts and direct habitat loss, in collaboration with various landowners and land management agencies.
- Complete surveys to locate and document presence/absence and conserve identified populations and habitat type.
- Develop a range-wide monitoring plan and protocol.
- Seek funding to provide need-based research aimed at abating or reducing threats.
- Develop propagation techniques for potential population augmentation and/or introduction.
- Continue and increase communications with partners, stakeholders, and the public regarding the milk-vetch's recovery needs and progress.
- Habitat conservation through land acquisitions and easements
- Protect soil substrate and seedbank
- Enforcement efforts to control authorized and unauthorized recreational activities and waste disposal.
- Restoration of pasture-land.

Conservation Measures and Best Management Practices:

- Recommended future actions: Based on recent discussions with conservation partners, we recommend the following future actions: (1) work with partners to develop conservation and management agreements that provide long-term protections for the Central Valley population; (2) develop appropriate grazing management actions and adaptive management plans for the State Line population location to reduce livestock trampling effects to the species; (3) implement pilot fall herbicide treatments to control cheatgrass and red brome on BLM and TNC lands at the State Line and Purgatory Flat populations; (4) develop appropriate travel management plans and restrictions for the State Line population; (5) continue to augment declining BLM populations; (6) establish new populations to meet recovery goals; and (7) develop a local greenhouse propagation program to increase seed collections for population augmentation efforts. (USFWS, 2021)

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SPECIES ACCOUNT: *Astragalus humillimus* (Mancos milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/1985; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Mancos milkvetch is a diminutive, tufted perennial forming clumps up to 30 cm (12 in) across, that are crowned with a dense aggregation of persistent, spiny leaf stalks. The stems are up to 1 cm (0.4 inch) long, and are crowded with leaves along their entire length. The leaves are up to 4 cm (1.6 in) long, each with 7—11 oval leaflets, 0.7—2.0 mm (0.1 in) in length. Flowers are lavender to purplish with a conspicuous lighter-colored spot in the throat of the corolla tube. The banner is usually 7—10 mm (0.25—0.4 in) long, with the keel and banner petal between 6—8 mm (0.25 in) in length. Fruits are egg shaped, are about 4.5 mm (0.2 in) long and 2 mm (0.1 inch==) wide, and each produces 4—9 seeds. Flowers are lavender with white veins and have a sweet-pungent smell. (USFWS, 1989; NatureServe, 2015)

Taxonomy

Astragalus humillimus was first described by Gray in 1876 in the Bulletin of the U.S. Geological Survey. The name was changed to Tragacantha humillima by Kuntze (1891), changed again to Phaca humillima by Rydberg (1905), and was finally placed in the genus Astragalus, Section Humillimi, by Barneby (1964). The Mancos milkvetch is most closely related to A. siliceus and A. wittmanii, and is easily distinguished from these species by its persistent subspinescent petioles. (USFWS, 1989)

Historical Range

Mancos milkvetch is known only from remote semi—arid sandstone rimrock ledges and mesa tops of northwest New Mexico and southwest Colorado. (USFWS, 1989)

Current Range

The range of this species is restricted to San Juan County, New Mexico and Montezuma County, Colorado between 1,585 and 1,829 m (5,200 and 6,000 feet) in elevation (USFWS 1989, p. 7). The total range of the species is approximately 48 km (30 miles) x 24 km (15 miles) In New Mexico the majority of Mancos milkvetch are found at least partially on the Navajo Nation, BLM lands, State Trust lands, and in Colorado on the Ute Mountain Ute Tribal Reservation (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (selfing and outcrossing) (NatureServe, 2015)

Breeding Season

Adult: Late April to early May (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Flowers of rare plants, including A. humillimus, often require pollination by native bees to produce seeds (Tepedino 2002). Researchers found the most common visitors were two members of the bee family Megachilidae: Osmia titusi and O. sculleni. Honey bees and butterflies, including the painted lady butterfly (Vanessa cardui), were also noted as potential pollinators (Service 1989).

Reproduction Narrative

Adult: Astragalus humillimus flowers in late April and early May (Service 1989). Larger plants may produce over 100 flowers in a growing season and fruits mature by mid-June (Service 1989). The fruit is egg-shaped and laterally compressed measuring about 4.5 millimeters (mm) (0.2 in) long and 2 mm (0.1 in) in diameter (Barneby 1964), and each produces 4 to 9 seeds (Service 1989). Astragalus humillimus plants produce viable fruit by outcrossing and self-pollination (Tepedino 2002). Flowers of rare plants, including A. humillimus, often require pollination by native bees to produce seeds (Tepedino 2002). Researchers found the most common visitors were two members of the bee family Megachilidae: Osmia titusi and O. sculleni. Honey bees and butterflies, including the painted lady butterfly (Vanessa cardui), were also noted as potential pollinators (Service 1989). A. humillimus and the closely related A. cremnophylax var. cremnophylax (sentry milkvetch), appear to have low fecundity (fertility). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, desert, sand/dune (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at an average elevation of 1,854 meters (5,650 ft); vegetative cover is less than 5% (USFWS, 2011)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2011)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: This species occurs on sandstone substrate ledges and mesa tops in cracks or shallow bowl-like depressions (tinajas) that accumulate sandy soils and rainfall (Service 1989; New Mexico State Forestry Division 2008). Populations are found along the Colorado Plateau subdivision of the Great Basin Desert of northwestern New Mexico and southwestern Colorado within pinyon-juniper woodland and desert scrub communities (Dick-Peddie 1993). Potential habitat corresponds to rimrock outcrops of the Point Lookout and Cliffhouse members of the Mesa Verde sandstone series with flat or gently sloping surfaces at an average elevation of 1,854 meters (m) (5,650 feet [ft]) (Service 1989). This species is confined to large sheets of

exfoliating whitish-tan colored sandstone (New Mexico State Forestry Division 2008) alongside Fraxinus anomala (single leaf ash), Brickellia microphyla var. scabra (scabrous bricklebush), Cercocarpus intricatus (small leaf mohagany), and Ipomopsis roseata (rosy ipomopsis) (Service 1989). Overall cover is very low (less than five percent), and resource competition for all of these species is minimal (Service 1989). The majority of plants remaining were small to medium in size; dead plants were observed in almost all locations; plants were widely scattered and only a very small fraction of the habitat was occupied in a study in 2008 (Navajo Natural Heritage Program 2008a; Navajo Nation Department of Fish and Wildlife 2009). (USFWS, 2011)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Number of Populations:

14 (USFWS, 2023)

Population Size:

>2,500 individuals (USFWS, 2023)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Long-term population trends are unknown, whereas short-term trends indicate a decline of >10%. Research has shown that this species has low fecundity (USFWS 2011). In addition, there has been no long-term propagation success despite numerous attempts (USFWS 2011). In 2007/2008, less than 400 plants total were found in 12 populations on the Navajo Nation and only 2 of the 12 populations had more than 50 live plants (Navajo Natural Heritage Program 2008, Navajo Nation Department of Fish and Wildlife 2009 cited by USFWS 2011). (USFWS, 2011; NatureServe, 2015). Prior to 1989, we knew of a total of 13 populations, with three of these located on Ute Mountain Ute Tribal reservation in Colorado (USFWS 1989, p. 6). The Ute Mountain Ute Tribe has been monitoring two of the three populations since 2020, which are the Tribal Park, previously known as “Chimney Rock Mesa” and Tanner Mesa sites. New plots were installed for BLM and State of New Mexico lands starting in 1990. Monitoring has been ongoing within the BLM and State of New Mexico. Currently there have been efforts to locate any new populations within the Hogback Area of Critical Environmental Concern by the Southwest Conservation Corps Rare Plants Crew. We know of 14 populations on Navajo Nation lands, including previously known and recently discovered populations. Total live percent cover has been measured for Mancos milkvetch individuals occurring at the Navajo Nation demography sites using the formula for the area of an ellipse (area (cm2) = pi * radius A * radius B), allowing some comparisons to past population numbers (USFWS, 2023).

Threats and Stressors

Stressor: Energy exploration and development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The majority of known occupied and potential A. humillimus habitat is located on the Navajo Nation lands. Most of this habitat is located on Palmer Mesa and the Hogback areas covering approximately 16,187 ha (40,000 ac) on Navajo Nation lands. These areas contain active and plugged oil and gas wells, including numerous roads associated with these activities. Navajo Nation and BLM lands contain significant deposits of oil and natural gas, and the development of these energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). Nearly all known and potential A. humillimus habitat may be affected by natural gas or oil exploration and development. Most damage occurs after vehicles and heavy equipment drive over and crush individual plants as well as break apart sandstone areas that contain tinajas, which are required for A. humillimus seedling establishment (Navajo Nation Department of Fish and Wildlife 2009). Astragalus humillimus populations and their habitat have been negatively impacted by crushing from vehicles and equipment, direct removal and destruction from energy-related activities, and indirect effects of unauthorized traffic using roads constructed by oil and gas companies. Oil and gas well construction has resulted in a variety of unauthorized roads, multiple pipelines, and small but enduring piles of waste, all of which further degrade A. humillimus habitat over the larger landscape. Also, some habitat damage has been reported by Navajo Nation from vandalism associated with theft of copper cables running between oil wells (Navajo Natural Heritage Program 2008b). Thus, we believe oil and gas development remains a severe threat to the species and will likely increase in the foreseeable future. (USFWS, 2011)

Stressor: Transmission lines (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Transmission lines have likely impacted A. humillimus populations because potential habitat and recently surveyed plants have been found along several major transmission line corridors (Ecosphere Environmental Services 2007). A large population of approximately 1,000 plants was bisected by two major transmission lines, the Glen Canyon-Shiprock and the CurecantiShiprock transmission lines, which were constructed in 1962 and 1963 prior to the National Environmental Policy Act taking effect (50 FR 26570). Immediate impacts were complete scraping of topsoil and vegetation directly underneath the power line, thus it is unknown how many plants may have been destroyed. Since that time, any plants underneath and nearby the power line have been driven over by either maintenance vehicles or off-road recreation vehicles. At the time of listing in 1985, no repopulation had occurred, but the most recent survey done by Western Area Power Administration found 71 plants over approximately 45 km (28 mi) of Navajo Nation, State of New Mexico, and BLM lands; total area surveyed was 138 ha (342 ac) (Ecosphere Environmental Services 2007). Impacts are generally associated with maintaining transmission line roads and the associated vehicles that crush plants. Conservation measures recommended in the recovery plan (Service 1989) and the HMP for Navajo Nation lands (House and Engelking 1992), such as avoidance and transplanting, could minimize impacts within the construction footprint of these types of projects. We do not know if these

conservation measures were enacted on past projects, and whether they are being implemented currently. Thus, we believe that the ongoing impacts associated with transmission lines could be severe if they involve A. humillimus habitat, but could be easily mitigated by implementing recommended conservations measures along these proposed corridors. (USFWS, 2011)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Off-highway vehicles (OHVs) were not a threat until recently, but their impacts are now being considered. The recreational use of OHVs has increased dramatically since the plant was listed. This increase is most likely due to the recent expansion of oil and gas extraction and the resultant population growth within San Juan County. From 1980 to 2006, the human population of San Juan county increased by 55 percent (http://wrdc.usu.edu/htm/publications/). OHV-related damage to A. humillimus and its habitat has increased, especially around oil and gas well pads and transmission line corridor roads (Service 1989; House and Engelking 1992; Bureau of Land Management 2007; Navajo Nation Natural Heritage Program 2007, 2008, and 2008b; Navajo Nation Department of Fish and Wildlife 2009). Unauthorized roads, trails, and recreational OHV use on sandstone cliffs and outcrops have been observed on and near known populations of A. humillimus (Bureau of Land Management 2006). For example, surveys undertaken in 2006 on BLM plots found scattered glass and OHV tire marks where 24 plants were found alive and 11 dead; cause of mortality was unknown, but this site is a popular recreational parking area with unrestricted access (Bureau of Land Management 2006). Not only did several plants appear damaged from being crushed, but their micro-habitat (small depressions or tinajas) has been fractured leaving a dearth of required habitat for future seedling establishment. Although most OHV activity is restricted to the southern part of the ACEC (outside of known milkvetch habitat), the potential for impacts still exists (Kendall 2011). Lack of law enforcement continues to be problematic for both BLM and Navajo Nation. We believe that use of OHVs is presently a moderate threat to this species and will likely increase in the foreseeable future. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Some insect herbivory by seed weevils and Lepidoptera larvae has been reported (NatureServe 2010), but appears to occur at insignificant levels during favorable rainfall years (New Mexico State Forestry Division 2008). Spider mite infestations have been recorded and appear to kill plants particularly during drought periods when the plant is already stressed (Siviniski and Knight 2001). The mites pierce the epidermis to ingest the sap which results in leaf discoloration and death, weakening the plant even further and causing mortality (Sivinski and Knight 2001). Insect infestations appear to be relatively rare, but could increase if drought continues into the foreseeable future. Thus, insect predation is considered a minor threat at this time. (USFWS, 2011)

Stressor: Pesticide use (USFWS, 2011)
Exposure:
Response:

Consequence:
Narrative: Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of A. humillimus or their host plants (Service 1989). Herbicides are commonly used for noxious weed control, but no documentation has been provided on whether any A. humillimus populations have been directly or indirectly affected. In the Navajo Nation Habitat Management Plan for A. humillimus from 1992, agricultural use of pesticides is mentioned in regard to the Navajo Indian Irrigation Project and local Navajo farmers along the San Juan River (House and Engelking 1992). Pesticides, particularly insecticides, are linked to bee declines (Kearns et al. 1998, Kremen et al. 2002, National Academy of Sciences 2007), with the abundance and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008, Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (Apis mellifera) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the pollinator community than just a targeted area (Kevan 1975, Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007, Tuell and Isaacs 2010). Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests in Farmington, New Mexico. Most of the A. humillimus populations are miles away, but could be affected by drift if aerial spraying were to occur on Navajo Nation lands, particularly the Navajo Indian Irrigation Project or local Navajo farmers (House and Engelking 1992). There is no information on pesticide use and subsequent monitoring on Navajo lands and local farmers are not monitored. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of A. humillimus. Thus, we do not consider pesticides to be a threat to this species currently or in the foreseeable future. (USFWS, 2011)

Stressor: Natural processes (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Natural processes such as erosion could account for some mortality, yet they also are responsible for soil deposition in the bedrock depressions that are essential habitat for this species. Since this species is restricted to small and widely dispersed segments of sandstone, the resulting populations are disjunct and scattered. This fragmented distribution impedes gene flow among subpopulations. Without the maintenance of genetic diversity to buffer against stochastic events, the species becomes increasingly vulnerable to external threats. Genetic limitations (low fecundity) and ecological isolation (disjunct and small populations) increase the risk of extinction when considering additional pressure from human impacts as well as stochastic events such as severe drought. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 º C (1.3 º F) during the 20th century (IPCC 2007) and, since 1960, the annual average temperature across the United States has increased by more than 2º F (1.1º C) (Global Climate Change Impacts in the United States [GCCIUS] 2009). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. The IPCC projects there will be an increase in the frequency of extreme weather events that are temporally and spatially more variable as a result of climate change (IPCC 2007). Astragalus humillimus is likely to have experienced and rebounded from periods of drought in the past. If climate change materializes with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Narrow endemics, like A. humillimus, often have very specific habitat requirements. This species has affinity for depressions in the sandstone, suggesting that water is critical for its germination and development, thus climate change could affect its continued existence. We believe the 2008 low population numbers are likely caused by cumulative losses since the 1980s due to several notable drought periods for this region, thus we believe that climate change is a severe threat to this species in the foreseeable future. (USFWS, 2011)

Recovery

Reclassification Criteria:

1. Develop formal documentation of the long—term mineral, oil, gas and energy development potential of the Mancos milkvetch habitat. (USFWS, 1989)

2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of 75 percent of the known habitat according to steps outlined in this plan. (USFWS, 1989)

3. Census and monitor known populations and establish permanent study plots at these sites. (USFWS, 1989)

The main objective of this recovery plan is to protect Astraaalus humillimus and manage its essential habitat so that healthy populations can be sustained in their natural habitats. To meet these objectives and to downlist the Mancos milkvetch to threatened, the following actions are required: (USFWS, 1989).

1. Develop formal documentation of the long—term mineral, oil, gas and energy development potential of the Mancos milkvetch habitat (USFWS, 1989).

2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of 75 percent of the known habitat according to steps outlined in this plan (USFWS, 1989).

3. Census and monitor known populations and establish permanent study plots at these sites (USFWS, 1989).

Recovery Priority Number: 5C

Delisting Criteria:
Delisting criteria are not available.

Actions identified as necessary for meeting the main objective and for removing Astragalus humillimus from the list of threatened or endangered species include: (USFWS, 1989).

1. Demonstrating long—term stability of populations and habitat through at least 10 years of monitoring (USFWS, 1989).

2. Implementating actions that will provide permanent protection for all of the presently known plants and habitat, and 75 percent of any plants and habitat discovered in the future. These actions include: 1) contacting individual landowners or grazing leaseholders and reaching agreements on protecting plants; and 2) implementing management plans that provide guidelines for energy or minerals exploration and development, management of oil spills, chemical spills, or oil and gas well by-products, management of ORV use, and management of pipeline, powerline, and road rights-of -way (USFWS, 1989).

Recovery Actions:
- 1. Demonstrating long—term stability of populations and habitat through at least 10 years of monitoring. (USFWS, 1989)
- 2. Implementing actions that will provide permanent protection for all of the presently known plants and habitat, and 75 percent of any plants and habitat discovered in the future. These actions include: 1) contacting individual landowners or grazing leaseholders and reaching agreements on protecting plants; and 2) implementing management plans that provide guidelines for energy or minerals exploration and development, management of oil spills, chemical spills, or oil and gas well by—products, management of ORV use, and management of pipeline, powerline, and road rights— of -way. (USFWS, 1989)
- Protect existing populations of Astracjalus humillimus by removing threats to the species and by managing its habitat (USFWS, 1989).
- Study populations in their natural habitat (USFWS, 1989).
- Conduct laboratory studies on the Mancos milkvetch (USFWS, 2011).
- Develop public awareness, appreciation, and support for preservation of Mancos milkvetch (USFWS, 2011).
- Revise recovery plan to incorporate new information on biology, ecology, threats, and conservation recommendations (USFWS, 2011).
- Recommend Federal plant permittees report on number of seeds collected over time and status of attempts to germinate (success/failures). Because native seed bank viability and longevity in the field is unknown, knowing how many cumulative seeds are being taken from this rare species could be important to its future regenerative capacity in the field, particularly during drought periods (USFWS, 2011).
- Provide viable A. humillimus seeds to a seed bank operating under the Center for Plant Conservation guidelines (USFWS, 2011).
- Continue research on species biology, ecology, reclamation, and transplantation (USFWS, 2011).

- Develop standardized survey and monitoring protocols for this species to be conducted annually by experienced personnel (USFWS, 2011).
- Develop a mitigation banking requirement (a system whereby proponents of projects that may cause harm to A. humillimus or its habitat pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects) (USFWS, 2011).
- Develop an A. humillimus multi-agency working group to share and disseminate information regarding this listed species by promoting education, protection, and recovery actions (USFWS, 2011).
- Work with the BLM Farmington Field Office to develop and implement consistent conservation measures in the Resource Management Plan revision that will avoid and minimize impacts to A. humillimus and its habitat from livestock trampling, ORV activities, and energy development. Include protection for all occupied and suitable habitat in the conservation measures (USFWS, 2011).
- Work with the Ute Mountain Ute tribe to encourage and support surveys, monitoring and conservation measures for A. humillimus on their land, and development of their management plan to include this species (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Conservation Measures: The standard conservation measures for plants apply to the Mancos milkvetch. The following additional conservation measures are often included for projects with impacts to Mancos milkvetch. • Conduct surveys by a qualified botanist within suitable or occupied habitat of the action area at least once every ten (10) years. Mancos milkvetch locations will be collected via Global Positioning System (GPS) and mapped via Geographic Information System (GIS) to illustrate avoidance areas. • Within occupied or suitable habitat for Mancos milkvetch, restrict vehicles to existing roads and two-tracks, to the maximum extent possible. To conduct maintenance on rights-of-way, vehicles would park on existing roads and crews will walk to their site. • For routine vegetation maintenance, conduct work by hand crews walking into identified suitable or occupied habitat for Mancos milkvetch. • Report any new plants found by maintenance or other project personnel working within suitable or occupied habitat for Mancos milkvetch to the Service. • Require operators to wash all machinery (trailers, trucks, etc.) before entering the action area and working on the project to prevent transportation of non-native invasive species. To prevent needs for rewashing, keep machinery stationary until the project is completed. • Require a biological monitor, with appropriate training and all required permits, to be present to observe all ground disturbing activities (vehicular access into right-of-way, mowing, digging, outrigger activities) except in the case of emergency maintenance, within suitable or occupied habitat for Mancos milkvetch or the appropriate species-specific buffers surrounding occupied. • Immediate notify the Service when emergency vegetation maintenance may occur within suitable or occupied habitat for Mancos milkvetch. The Service will recommend best management practices to minimize impacts to suitable or occupied habitat such as minimizing vehicular traffic, and restricting access to existing roadways when possible, and minimizing disturbances (USFWS, 2023).
- RECOMMENDATIONS FOR FUTURE ACTIONS • Maintain visible and prominent signage at ACEC boundaries to make wood cutters aware of applicable prohibitions. • Actively control or prohibit OHV traffic in areas unauthorized for their travel. • Retire existing oil and gas leases, including inactive leases, when they expire within areas impacting Mancos milkvetch habitat. • Consider fencing the remaining populations of Mancos milkvetch in the vicinity of the transmission lines and other infrastructure, or otherwise block unauthorized access to habitat. • Improve coordination of

management between State Trust and BLM lands within the Hogback ACEC via land exchanges or developing a management agreement among land managers. • Sample soils to determine current soil chemistry and pH. • Maintain fences and lock access gates to prevent unauthorized travel in Mancos milkvetch habitat. • Determine whether certain populations of Mancos milkvetch, or the species itself, is a pollinator-limited, or if there are other factors limiting seed-set in this species. • Develop a propagation protocol from seed collections for potential population augmentation in the future. • Expand monitoring sites by increasing the number of monitoring plots at each site. • Monitor and control invasive species. • Increase monitoring frequency and document reproductive effort in the data gathering. • Conduct and utilize genetic analyses across the species range to best guide translocation and population augmentation efforts by pinpointing populations with high genetic diversity. • Strengthen regulatory mechanisms and associated enforcement capacity for oil and gas activities occurring on the Navajo Nation in Mancos milkvetch habitat to help ensure damage to this species is minimized to the greatest extent possible (USFWS, 2023).

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SPECIES ACCOUNT: *Astragalus jaegerianus* (Lane Mountain milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Perennial; somewhat woody at the base. Stems often grow in a zigzag pattern, usually up through low bushes. Leaves have 7-15 silvery pubescent linear leaflets. Flowers, 5-15 per stalk, are cream to purple, or lighter with veins of a deeper color. Fruits are pencil-shaped, linear, smooth, and pendant (NatureServe, 2015).

Taxonomy

Astragalus jaegerianus is a member of the pea family (Fabaceae) (USFWS, 2004).

Historical Range

Narrowly endemic to a small area in the Mojave desert, San Bernardino County, California (NatureServe, 2015).

Current Range

Known populations are arrayed more or less linearly along a 32 km long axis that trends in a northeasterly-to-southwesterly direction (USFWS 2004) (NatureServe, 2015). It is restricted in its range to a portion of the west Mojave Desert north of Barstow, in San Bernardino County, CA (USFWS, 2004).

Critical Habitat Designated

Yes; 5/19/2011.

Legal Description

On May 19, 2011, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus jaegerianus (Lane Mountain milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (76 FR 29108-29129).

Critical Habitat Designation

The critical habitat designation for Astragalus jaegerianus includestwo CHUs in San Bernardino County, California. This species critical habitat encompasses approximately 14,069 acres (ac) (5,693 hectares (ha)) (76 FR 29108-29129).

Paradise Unit The Paradise unit consists of approximately 7,032 ac (2,846 ha). We are designating critical habitat for Astragalus jaegerianus on 964 ac (390 ha). Of this, 318 ac (129 ha) is Armyowned land adjacent to the NTC (off Fort Irwin), 237 ac (96 ha) is privately owned land located adjacent to the NTC, and approximately 409 ac (166 ha) is on adjacent Federal lands managed by the Bureau. The remaining 6,068 acres (2,456 ha) within this unit are on Army lands at NTC subject to the INRMP and have been exempted under section 4(a)(3) of the Act (see Exemptions section below). As part of the plan amendments to the CDCA, the Bureau in 2005

designated an area of approximately 1,000 ac (405 ha) as part of the West Paradise Valley Conservation Area. It generally overlaps with the 964 ac (390 ha) in this designation of critical habitat. The boundary of the West Paradise Valley Conservation Area encompasses some Army lands not on NTC and some private inholdings. This unit contains the PBFs essential to the conservation of the species. The unit supports a portion of the Paradise population which is one of the four populations of Astragalus jaegerianus. In 2001, approximately 1,667 individuals were observed in this population. The land within this unit supports the granitic soils (PCE 1) and host shrubs (PCE 2) that are necessary for the growth, reproduction, and establishment of A. jaegerianus individuals. These granitic soils and host shrubs also provide habitat for (1) the pollinators that visit A. jaegerianus flowers that result in the production of seed; (2) seed dispersers (birds, small mammals, and large insects) that carry seed between the coppices of suitable host shrubs; and (3) sites for long-term storage for seedbank of A. jaegerianus. The Paradise unit may require special management considerations or protection due to the threats to the species and its habitat posed by: Invasions of nonnative plants such as Sahara mustard (Brassica tournefortii) and other plant species that may take over habitat for the species; habitat fragmentation that detrimentally affects plant-host plant and plant-pollinator interactions (i.e., composition and structure of the desert scrub community), leading to a decline in species reproduction and increasing susceptibility to nonnative plant invasion; and vehicles that cause direct and indirect impacts, such as excessive dust, to the plant. Habitat for Astragalus jaegerianus in the Paradise unit has been fragmented to a minor extent. We anticipate that, in the future, habitat fragmentation may increase, composition and structure of the plant community may be altered by the spread of nonnative plants, and direct and indirect effects of dust may increase. All of these threats would render the habitat less suitable for A. jaegerianus, and special management may be needed to address them.

Coolgardie Unit The Coolgardie unit consists of approximately 13,105 ac (5,303 ha), primarily on Federal lands managed by the Bureau. The designated Coolgardie critical habitat unit overlaps to a great extent with the Bureau's Coolgardie Mesa Conservation Area (CMCA). Of this acreage, approximately 9,479 ac (3,836 ha) are managed by the Bureau, and approximately 964 ac (390 ha) were formerly in private ownership, but have been acquired by the Army since 2005 for the purposes of conservation of Astragalus jaegerianus. These lands are not contiguous with the NTC and are not covered under the Army's INRMP. Parcels of private land are scattered throughout this unit and total approximately 2,662 ac (1,077 ha). Some of these parcels may be acquired by the Bureau and added to the CMCA. This unit supports one of only four populations of A. jaegerianus. In 2001, surveyors observed 2,014 plants in this population. The land within this unit contains the PBFs essential to the conservation of the species and supports the granitic soils (PCE 1) and host shrubs (PCE 2) that are necessary for the growth, reproduction, and establishment of Astragalus jaegerianus individuals. It should be noted that the proposed critical habitat does not include the ''donut hole'' in the center of the unit, where granitic soils are absent. Within the proposed unit, the granitic soils and host shrubs: (1) Provide habitat for the pollinators that visit A. jaegerianus flowers and result in the production of seed; (2) provide habitat for seed dispersers (birds, small mammals, and large insects) that carry seed between the coppices of suitable host shrubs; and (3) provide for longterm seedbank storage for A. jaegerianus. The Coolgardie unit may require special management considerations or protection due to the threats to the species and its habitat posed by: Invasions of nonnative plants such as Sahara mustard (Brassica tournefortii) and other plant species that may take over habitat for the species; habitat fragmentation that detrimentally affects plant-host plant and plant-pollinator interactions (composition and structure of the desert scrub community), leading to a decline in species

reproduction and increasing susceptibility to nonnative plant invasion; vehicles that cause direct and indirect impacts, such as excessive dust, to the plant; and limited mining activities that can lead to changes in habitat conditions (e.g., decreases in plant cover, and increases in nonnative species). Habitat for Astragalus jaegerianus in the Coolgardie unit has been fragmented to a moderate extent from current and historical mining and from off-road vehicle use, and non-native species have been introduced into the area. We anticipate that in the future, habitat fragmentation may increase, and composition and structure of the plant community may be altered by the continued spread of nonnative plants. Due to increased recreational pressure, off-road vehicle use has increased in the past 4 years. All of these threats would render the habitat less suitable for A. jaegerianus, and special management may be needed to address them.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus jaegerianus critical habitat consists of two components (76 FR 29108-29129):

(i) Shallow soils at elevations between 3,100 and 4,200 ft (945 to 1,280 m) derived primarily from Jurassic or Cretaceous granitic bedrock, and less frequently on soils derived from diorite or gabbroid bedrock, or on granitic soils overlain by scattered rhyolitic cobble, gravel, and sand.

(ii) Host shrubs at elevations between 3,100 and 4,200 ft (945 to 1,280 m). The primary host shrubs include, but are not limited to: Thamnosma montana (turpentine bush), Ambrosia dumosa (burro bush), Eriogonum fasciculatum ssp. Polifolium (California buckwheat), Ericameria cooperi var. cooperi (golden bush), Ephedra nevadensis (Mormon tea), and Salazaria mexicana (paperbag bush) that are usually found in mixed desert shrub communities.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and may require special management considerations or protection. A detailed discussion of threats affecting the PBFs essential to the conservation of Astragalus jaegerianus, and that may require special management considerations or protection, can be found in the previous proposed critical habitat designation of April 6, 2004 (69 FR 18018), and the 5- year review (Service 2008, pp. 1–21). In summary, these threats include surface mining, unauthorized OHV recreation, military training activities, competition with nonnative species, and habitat fragmentation. In addition, the Bureau has received interest from wind energy companies that are seeking sites for wind energy development, although no specific plans for the areas occupied by Astragalus jaegerianus are currently being considered for any energy development projects. The areas included in this revised critical habitat designation will require some level of management to address the current and future threats to Astragalus jaegerianus and to maintain the PBFs essential to the conservation of the species. In units that were occupied at the time of listing and are currently occupied, special management will be needed to ensure that designated habitat is able to provide areas for germination, pollination, reproduction, and sites for the host plants that provide structural support for A. jaegerianus; intervening areas that allow gene flow and provide connectivity or linkage within segments of the larger population; and areas that provide basic requirements for growth, such as water, light, and minerals. There will be impacts from military activities on Astragalus jaegerianus and its habitat at NTC. We will not discuss these impacts any further, because areas where A. jaegerianus occurs on NTC are

being exempted (see Exemptions section below). Army-owned lands in the Paradise and Coolgardie units that are not part of the NTC were purchased for A. jaegerianus conservation and will not be impacted by military activities. The designation of critical habitat does not imply that lands outside of critical habitat do not play an important role in the conservation of Astragalus jaegerianus. Activities with a Federal nexus that may affect those areas outside of critical habitat, such as surface mining, off-highway vehicle recreation, land transfer programs, and military training activities, are still subject to review under section 7 of the Act, if they may affect A. jaegerianus. The prohibitions of section 9 of the Act applicable to plants also continue to apply both inside and outside of designated critical habitat. With respect to plants, section 9 of the Act includes among its prohibitions the import or export of listed species, the removal to possession or malicious damage or destruction of species on areas under Federal jurisdiction, or the removal, damage, or destruction of species in violation of State law (16 U.S.C. 1538(a)(2)).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; self-pollination, cross-pollination (USFWS, 2008)

Lifespan

Adult: ~15 years (USFWS, 2008)

Key Resources Needed for Breeding

Adult: High to moderate precipitation (NatureServe, 2015); insect pollinators, soil seed bank (USFWS, 2008)

Reproduction Narrative

Adult: Does not reproduce vegetatively - relies on reproduction by seed. It seems that successful recruitment requires high precipitation in one year, followed by at least moderate precipitation the following year so that germinated seedlings are able to persist (R. Sharifi pers. comm. 2009) (NatureServe, 2015). Estimates from several studies indicate that the maximum lifespan of an individual may be on the order of 15 years, though many will not reach that age (Rutherford, in litt. 2005; Prigge et al. 2006). The most abundant insects observed that are likely effective pollinators included the leaf-cutter and metal leaf-cutter bees (Anthidium dammersi, A. emarginatum, and Osmia latisculata). Under greenhouse conditions, Rundel et al. (2005) found that the number of flowers producing seed resulting from both self-pollination and cross-pollination manipulations was higher (40 and 30 percent, respectively) than the number of flowers producing seed without being pollinated (8 percent); these results support the importance of pollinators in achieving seed production. Because substantial recruitment may be an episodic event that occurs on the order of once every 10 to 15 years, long-term persistence of populations may depend on maintaining sufficient numbers of reproductive individuals to build up a soil seed bank available for the next recruitment event (USFWS, 2008). In favorable years, seed production may be substantial. In unfavorable years, the plants may desiccate prior to flowering or setting seed, or the taproots may remain dormant and not resprout (USFWS, 2004).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mojave mixed woody scrub, creosote bush scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 950 - 1300 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Linear (USFWS, 2008)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Depends on a host plant.

Habitat Narrative

Adult: Found within Larrea tridentata-Ambrosia dumosa (Mojave mixed woody scrub or creosote bush scrub) communities. The plants are almost exclusively found growing up through shrubs or, occasionally, through clumps of dead bunchgrass. Prefers coarse shallow soil underlain by decomposing granite. Associated shrub species include turpentine bush (Thamnosma montana), white bursage (Ambrosia dumosa), Mormon tea (Ephedra nevadensis), Cooper goldenbush (Ericameria cooperi var. cooperi), California buckwheat (Eriogonum fasciculatum var. polifolium), brittlebush (Encelia farinosa or E. actoni), desert aster (Xylorrhiza tortifolia), goldenheads (Acamptopappus spherocephalus), spiny hop-sage (Grayia spinosa), cheesebush (Hymenoclea salsola), winter fat (Kraschenninikovia lanata), and paper bag bush (Salazaria mexicana). Occurs at 950 - 1300 m elevation. Usually found growing within the canopy of a host shrub which provides a climbing support, protection from rabbit herbivory (R. Sharifi pers. comm. 2009), and perhaps a suitable microhabitat for germination (USFWS 2004). A variety of species are used as host shrubs (USFWS 2004) (NatureServe, 2015). The populations are arrayed more or less linearly along a 20-mile-long (32- kilometer) axis. Most individuals occur on shallow, well-drained soils derived from either Jurassic or Cretaceous granitic bedrock (90 percent) or diorite or gabbroid bedrock (9 percent) (Prigge et al. 2000; Charis Corporation 2003b) (USFWS, 2008).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Ants likely play a role in seed dispersal (USFWS 2004) (NatureServe, 2015). Seeds are likely used by small mammals and birds in the area (USFWS, 2008).

Population Information and Trends

Population Trends:

Decline of <30% to increase of 25% (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:
3 (USFWS, 2008)

Population Size:
13 (USFWS, 2023)

Population Narrative:
Declines appear to be related to recruitment difficulties. No evidence as yet supports the idea that this species was once more widespread (USFWS 2004). This species has experienced a long-term decline of <30% to increase of 25% In 1985 a total of 87 plants were counted; in 1989 two additional populations totaling 42 individuals were located; surveys conducted in 1991 resulted in locating a total of six individuals - these surveys combined resulted in a small population estimate, < 160 individuals (USFWS 1992). However, throughout the 1990s, hundreds more plants were found. The cumulative total number of individuals found from all surveys through 2002 was approximately 5,800; more individuals may exist in suitable habitat in the vicinity of counted plants (USFWS 2004). However, the total number of individuals is likely much lower in climatically unfavorable years (NatureServe, 2015). The four general areas in which Astragalus jaegerianus occurs comprise approximately 21,400 acres (8,660 hectares), totaling 5,723 individuals. Walker and Metcalf (2005a, 2005b) did not detect genetic variation within or between populations using DNA sequencing within chloroplast and nuclear genomes. The species currently appears to be in a downward trend since 2001 (USFWS, 2008). Fort Irwin provides annual monitoring of all Lane Mountain milk-vetch populations (Figure 1). We reviewed Fort Irwin's Annual Monitoring Report (Skandalis 2021, entire) for changes in Lane Mountain milk-vetch abundance. Information on abundance, survivorship, reproduction, and habitat (host plant condition) is available from 2005 through 2021 (Skandalis 2021, pp. 12–33). In 2013, Lane Mountain milk-vetch relative abundance in monitoring plots was stable, but low (114 plants) Counts during 2021 found 13 plants, which was one of the lowest years in terms of abundance and reproduction (Skandalis 2021, p. 31). Similarly, live host plant cover was lower compared to the previous year (Skandalis 2021, p. 31). This is significant because host plants are required for Lane Mountain milk-vetch survival.

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Most of the current mining claims are held by members of "mining clubs" that engage in small-scale recreational gold mining. The effects of such surface disturbance are cumulative, even though the size of these mining operations falls below the threshold that would require the claimholder to file a plan of operations, including restoration, with the Bureau. The extent of the overlap between mining claims and patches of Astragalus jaegerianus has not been determined. Since the time of listing, unauthorized off-road vehicle use has increased within the Coolgardie and Paradise areas. Although most of the increased use has been dispersed in nature, one area on the west side of Coolgardie sustained a large increase in concentrated use. Training activities are scheduled to commence in the year 2009. These activities will affect approximately 4,600

acres (1,862 hectares) and 20 percent of the known distribution of the species. Due to the nature of the training activities (force-on-force tank maneuvers), habitat for Astragalus jaegerianus will likely be adversely affected over a period of years. Pockets of habitat that support A. jaegerianus within the Montana-Brinkman and Paradise populations may persist for several decades even after training commences, particularly in portions of the training area that are rocky and where tanks are less likely to go. However, over time, the remaining habitat will become more fragmented and these individuals will become reproductively isolated from the rest of the population and cease to contribute to the long-term persistence of the species. The Bureau has recently received recent expressions of interest from wind energy companies that are seeking sites for wind energy development; one such inquiry was made concerning the Coolgardie area. The development of wind farms within habitat for Astragalus jaegerianus would most likely alter the habitat such that the long-term persistence of the species would be compromised (USFWS, 2008).

Stressor: Fire (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the threat of fire due to an increase in fuel load contributed by non-native species was considered a threat, particularly for the Coolgardie population of Astragalus jaegerianus due to its closer proximity to human activities, which can be the source of both the increase in non-native species and the ignition source. Nonnative grasses such as schismus (Schismus spp.) and bromes (Bromus spp.) have been shown to carry fire in the western Mojave Desert (Brooks 1999). Ongoing research supports the theory that desert ecosystems were not adapted to burn frequently, and are unable to regenerate as easily as fire-adapted plant communities (Brooks 1999; U.S. Geologic Survey 2005). An increase in fires would likely alter the composition of the vegetation community and reduce the number of host shrubs available to support A. jaegerianus (USFWS, 2008).

Stressor: Low recruitment (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Although the total number of Astragalus jaegerianus individuals is much larger than that known at the time of listing, ongoing research indicates that substantial recruitment may occur in only the most favorable years (Rundel et al. 2005). Patches of plants may die out prior to being replaced if the interval between substantial recruitment events is too long. Within the Coolgardie population, patches of plants that were visible in the early 1990s have not been seen in the last 5 years (C. Rutherford, pers. obs. 2006). In addition, in a series of unfavorable years, not only would recruitment be low, but extant plants that are persisting as dormant underground rootstalks would be spending more resources on maintaining vegetative biomass rather than using it for reproduction in the future. In long-term plots, the number of living plants has declined between 1999 and 2005 (Rundel et al. 2005; Sharifi et al. 2006) (USFWS, 2008).

Stressor: Nonnative species (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: Non-native plant species have increased in abundance across the Mojave Desert with the increase and spread of human activities. Species including schismus and bromes can occur beneath the canopy of shrubs, or in interspaces between shrubs, and can increase the probability that fires will carry across the desert landscape (Brooks 1999). If fire frequency increases, the shrubs that serve as hosts to Astragalus jaegerianus could become less common over time and provide fewer sites for individuals to persist. A second threat to Astragalus jaegerianus posed by non-native grasses is competition for space, light, and nutrients during the seedling stage. Researchers have observed that bromes beneath the shrub canopy were so dense that they had overtaken A. jaegerianus seedlings (R. Sharifi, pers. obs. 2006; B. Prigge, pers. obs. 2006; C. Rutherford, pers. obs. 2006), making it unlikely the seedlings would be able to survive to adulthood (USFWS, 2008).

Stressor: Military Training (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: In 2021, we issued a biological opinion to Fort Irwin for the use of additional training lands which also included the implementation of the Recovery and Sustainment Partnership (RASP) Initiative (Service 2021b, entire). While the Biological Opinion for this action stated that there would be no change in effects to Lane Mountain milk-vetch from increased training flexibility and the intention of the RASP agreement was for desert tortoise conservation, the Army provided funding for conservation actions off-installation that included the Coolgardie Mesa Lane Mountain milk-vetch population area; therefore these actions are expected to benefit both the Lane Mountain milk-vetch population as well as desert tortoise (Service 2021b, pp. 2, 75). Fort Irwin's plan to expand training could disturb Lane Mountain milk-vetch on 4,598 of the 21,349 acres (ac) [1,861 of the 8,640 hectares (ha)] rangewide habitat (Service 2021b, p. 73); however, the previously approved expansion has not yet occurred. Areas proposed for future training will be used at varying intensities, and the levels of loss of individuals and habitat will differ accordingly (Service 2021b, pp. 69–70). The Army continues to maintain conservation areas for Lane Mountain milk-vetch, including the fenced 2,471 ac (1,000 ha) National Training Center-Gemini Conservation Area at Goldstone, the 4,300 ac (1,740 ha) East Paradise Conservation Area, and 1,872 ac (758 ha) of habitat in the Brinkman Wash Restricted area. Through implementation of the Department of Defense's Readiness and Environmental Protection Integration program, the Army has voluntarily secured 3,476 ac (1,407 ha, calculated using overlap between Department of Defense lands and Lane Mountain milk-vetch Conservation Areas-West Mojave Plan GIS datasets). This habitat is permanently protected outside the base within the BLM Coolgardie Mesa ACEC boundary (Service 2021b, p. 74). These areas are primarily small parcels purchased adjacent to larger tracts of BLM land, which benefit Lane Mountain milk-vetch by precluding development on these lands and reducing the potential for increased fragmentation of Lane Mountain milk-vetch habitat (USFWS, 2023).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 5

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Continue to work cooperatively with the Army and the Bureau to ensure that we are supporting them in carrying out monitoring and management actions that have been called for in the Integrated Natural Resources Management Plan and the West Mojave Plan (USFWS, 2008).
- Assess recruitment rates across all four populations. Most of these efforts are currently focused within the Montana-Brinkman population. Comparison of recruitment rates across all populations is important to determine whether low recruitment is a concern at all sites (USFWS, 2008).
- Carry out research on soil seed bank ecology to assist in understanding patch dynamics within each population, including assessment of the presence and abundance of seed banks at all four populations and determination of the longevity and viability of seed (USFWS, 2008).
- Carry out research on short- and long-distance seed dispersal. Determine if small mammals are utilizing and dispersing seed, and if so, the proportion that is consumed (and lost) and the proportion that is cached (USFWS, 2008).
- Store seed from all four populations (including the two genetically different populations at Coolgardie) in a long-term seed-storage facility sponsored by the Center for Plant Conservation, to hedge against local extirpations (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that the following actions be completed over the next 5 years to enhance habitat and manage threats to Lane Mountain milk-vetch. Conservation of this species will require cooperation and coordination with partners. 1. Develop and conduct Lane Mountain milk-vetch restoration projects to enhance depleted or disturbed sites and expand the species' distribution. Assess future site suitability based on climate projections. Collect seed and evaluate restoration techniques such as bulk seed growing, direct seeding, and pelletized seeding. 2. Collect seed from areas of Fort Irwin which may be impacted by training expansion. 3. Evaluate the effects of recent drought on the distribution of Lane Mountain milk-vetch. Re-inventory EOs at the lowest elevations and driest aspects to determine whether the distribution may have changed. 4. Support Bureau of Land Management route restoration efforts to ameliorate the effects of unauthorized OHV use on Lane Mountain milk-vetch. 5. Protect Lane Mountain milk-vetch populations from new mining activities by completing the previously proposed minerals withdrawal (USFWS, 2023).

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SPECIES ACCOUNT: *Astragalus lentiginosus var. coachellae* (Coachella Valley milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/1998; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

An erect winter annual or short-lived perennial covered with white-silky hairs. Flowers are deep pink-purple, in a loose or dense 13-25 flowered raceme. Fruits are two-chambered and strongly inflated (NatureServe, 2015).

Taxonomy

A member of the Fabaceae (pea family). Astragalus lentiginosus var. coachellae (Coachella Valley milk-vetch) was described by Rupert C. Barneby (1964, p. 695) based on a specimen collected in 1913 by Alice Eastwood in Palm Springs, California. Astragalus lentiginosus var. coachellae is one of 19 varieties of A. lentiginosus found in California (Spellenberg 1993, pp. 597 – 598), none of which occur in the same region or habitat types (USFWS, 2009).

Historical Range

Endemic to the Coachella Valley, Riverside County in the southern California portion of the western Sonoran Desert (USFWS, 2009).

Current Range

The spatial distribution of Astragalus lentiginosus var. coachellae has remained the same since the taxon was listed as endangered in 1998, and at that time the distribution was effectively the same as the known historical distribution of the taxon (USFWS, 2009). Occurs in the Coachella Valley from Cabazon to Salton Sea, Riverside County, California. Also known from one disjunct occurrence 50 miles east in the Chuckwalla Valley (USFWS 2005) (NatureServe, 2015).

Critical Habitat Designated

Yes; 2/13/2013.

Legal Description

On February 13, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus lentiginosus var. coachellae (Coachella Valley milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (78 FR 10450-10497).

Critical Habitat Designation

The critical habitat designation for Astragalus lentiginosus var. coachellae includes four CHUs in Riverside County, California. This species critical habitat encompasses approximately 9,603 acres (3,886 ha) (78 FR 10450-10497).

Unit 1: San Gorgonio River/Snow Creek System Unit 1 consists of 1,172 ac (474 ha) of Federal land, 61 ac (25 ha) of private land, and 102 ac (41 ha) of local government-owned land in the Coachella Valley, Riverside County. Unit 1 contains approximately 238 ac (96 ha) of unoccupied

fluvial sand transport area associated with the San Gorgonio River and Snow Creek drainages. These areas are being designated under section 3(5)(A)(ii) of the Act, because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the species. The remainder of Unit 1 consists of approximately 1,097 ac (444 ha) of occupied suitable habitat extending approximately from the eastern edge of the community of Cabazon to just west of Whitewater River, and is approximately bound by State Route 111 to the north and the foot of the San Jacinto Mountains to the south. These areas are being designated under section 3(5)(A)(i) of the Act, because they are within the geographical area occupied by the species at the time of listing and contain those physical or biological features essential to the conservation of the species. In total, Unit 1 consists of 1,335 ac (540 ha) of land. Unoccupied fluvial sand transport areas in this unit contain active washes associated with San Gorgonio River and Snow Creek, which carry substrates created by fluvial erosion of the surrounding hills to occupied fluvial deposition areas in Unit 1 on the valley floor (Griffiths et al. 2002, pp. 10–11). The unoccupied areas in Unit 1 are essential for the conservation of Astragalus lentiginosus var. coachellae because they support the fluvial sand transport process crucial to the maintenance of the sand formations that form the foundation of A. l. var. coachellae habitat in the occupied areas of Unit 1. Occupied habitat areas of Unit 1 constitute one of the four main habitat areas supporting Astragalus lentiginosus var. coachellae (Coachella Valley MSHCP/NCCP, p. 9–21) and contain the physical or biological features essential to the conservation of A. l. var. coachellae, including active sand dunes, sand fields, and stabilized and partially stabilized sand fields that provide substrate components and conditions suitable for the growth of A. l. var. coachellae (Coachella Valley MSHCP/ NCCP 2008, Table 10–1a) and areas over which unobstructed aeolian sand transport can occur. The essential features in Unit 1 may require special management considerations or protection to address threats from nonnative invasive plants and unauthorized OHV activity in the occupied areas and threats from alteration of stream flow in the unoccupied areas that impact habitat in the occupied areas. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. l. var. coachellae habitat and potential management considerations. The physical or biological features in the occupied areas in Unit 1 are also essential to the conservation of Astragalus lentiginosus var. coachellae because they support the westernmost occurrences of the taxon. Because of their geographic location, these plants and their habitat receive more rainfall than occurrences and suitable habitat farther east, which allows many individuals to survive more than one year, grow larger, and produce more seed, all of which promote the stability and reduce the chance of extirpation of the occurrences in this unit (Meinke et al. 2007, p. 33). Also, due to strong winds moving through this area from the west to east, the occupied habitat in Unit 1 likely acts as a source of seed (and hence, a source of genetic diversity) for areas of suitable habitat to the southeast (Meinke et al. 2007, p. 40). Unit 1 likely also contributes to the maintenance of genetic diversity in other occupied areas through the movement of pollinators (Meinke et al. 2007, p. 37).

Unit 2: Whitewater River System Unit 2 consists of 1,955 ac (791 ha) of Federal land; 19 ac (8 ha) of private land; and 176 ac (71 ha) of local government-owned land in the Coachella Valley, Riverside County. Unit 2 contains approximately 554 ac (224 ha) of unoccupied fluvial sand transport areas associated with the Whitewater River watershed. These areas are being designated under section 3(5)(A)(ii) of the Act because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the taxon. The remainder of Unit 2 consists of approximately 1,596 ac (646 ha) of occupied suitable habitat and is approximately bound by State Route 111 to the west, the

Southern Pacific Railroad to the north and east, and dense urban development in the cities of Palm Springs and Cathedral City to the south. These areas are being designated under section 3(5)(A)(i) of the Act because they are within the geographical area occupied by the species at the time of listing and contain those physical or biological features essential to the conservation of the species. In total, Unit 2 consists of 2,150 ac (870 ha) of land. Unoccupied fluvial sand transport areas in this unit contain active washes associated with Whitewater River, which carry substrates created by fluvial erosion of the surrounding hills to occupied fluvial deposition areas in Unit 2 on the valley floor (Griffiths et al. 2002, pp. 10–11). The unoccupied areas in Unit 2 are essential for the conservation of Astragalus lentiginosus var. coachellae because they contain portions of the Whitewater River that support the fluvial sand transport process crucial to the maintenance of the sand formations that form the foundation of A. l. var. coachellae habitat in the occupied areas of Unit 2. Occupied habitat areas of Unit 2 constitute one of the four main habitat areas supporting Astragalus lentiginosus var. coachellae (Coachella Valley MSHCP/NCCP, p. 9–21) and contain the physical or biological features essential to the conservation of A. l. var. coachellae, including active and ephemeral sand fields and stabilized and partially stabilized sand fields that provide substrate components and conditions suitable for the growth of A. l. var. coachellae (Coachella Valley MSHCP/NCCP 2008, Table 10–1a) and areas over which unobstructed aeolian sand transport can occur. The essential features in Unit 2 may require special management considerations or protection to address threats from nonnative plants, urban development, alteration of stream flow, unauthorized OHV activity in the occupied depositional areas, and threats from alteration of stream flow that impact habitat in occupied areas. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. l. var. coachellae habitat and potential management considerations. The physical or biological features in the occupied areas in Unit 2 are also essential to the conservation of Astragalus lentiginosus var. coachellae because they serve as a corridor between the habitat and occurrences to the west in Unit 1 and the habitat and occurrences to the east in Unit 3. Although Unit 2 does not serve as a substantial source of aeolian sand to Unit 3 relative to the onsite fluvial sand transport areas in Unit 3 (Mission Creek and Morongo Wash), it may serve as a corridor for gene flow by means of pollen and seed dispersal between Units 1, 2, and 3 due to dispersal of seeds from Unit 1 into Unit 2 and from Unit 2 into Unit 3, combined with movement of pollinators among the three units (Meinke et al. 2007, p. 37).

Unit 3: Mission Creek/Morongo Wash System Unit 3 consists of 502 ac (203 ha) of Federal land, 1,497 ac (606 ha) of private land, and 268 ac (108 ha) of local government-owned land in the Coachella Valley, Riverside County. Unit 3 contains approximately 1,055 ac (427 ha) of unoccupied fluvial sand transport area associated with the Mission Creek watershed and a portion of the Morongo Wash watershed (north of Pierson Boulevard). These areas are being designated under section 3(5)(A)(ii) of the Act because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the taxon. The remainder of Unit 3 consists of approximately 1,211 ac (490 ha) of occupied habitat and includes sand deposits on the floodplain terraces of Morongo Wash south of Pierson Boulevard, and fluvial depositional areas and aeolian transport and depositional areas approximately bound (clockwise from the western boundary) by Little Morongo Road, 18th Avenue, Palm Drive, 20th Avenue, Artesia Road, and Mihalyo Road, in or near the City of Desert Hot Springs. These areas are being designated under section 3(5)(A)(i) of the Act, because they are within the geographical area occupied by the species at the time of listing. In total, Unit 3 consists of 2,313 ac (936 ha) of land. Unoccupied fluvial sand transport areas in this unit contain

active washes associated with Mission Creek and Morongo Wash (north of Pierson Boulevard), which carry substrates created by fluvial erosion of the surrounding hills to occupied fluvial deposition areas in Unit 3 on the valley floor (Griffiths et al. 2002, pp. 10–11). The unoccupied areas in Unit 3 are essential for the conservation of Astragalus lentiginosus var. coachellae because they contain portions of Mission Creek and Morongo Wash that support the fluvial sand transport process crucial to the maintenance of the sand formations that form the foundation of A. l. var. coachellae habitat in the occupied areas of Unit 3. Occupied habitat areas of Unit 3 constitute one of the four main habitat areas supporting Astragalus lentiginosus var. coachellae (Coachella Valley MSHCP/NCCP, pp. 9–21–9–22) and contain the physical or biological features essential to the conservation of A. l. var. coachellae including stabilized and partially stabilized sand dunes, active and ephemeral sand fields, stabilized and partially stabilized sand fields, fluvial sand deposits on floodplain terraces of active washes (certain areas of Morongo Wash), and mesquite hummocks that provide substrate components and conditions suitable for the growth of A. l. var. coachellae (Coachella Valley MSHCP/ NCCP 2008, Table 10–1a). Unit 3 also contains areas over which unobstructed aeolian sand transport can occur. The essential features in Unit 3 may require special management considerations or protection to address threats from nonnative plants, urban development, OHV use in the occupied floodplain terrace areas, and threats from alteration of stream flow that impact habitat in occupied areas. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. l. var. coachellae habitat and potential management considerations. The physical or biological features in occupied areas in Unit 3 are also essential to the conservation of Astragalus lentiginosus var. coachellae because they support the northernmost extent of the taxon's range and large occurrences containing high densities of the taxon. Each of these factors contributes to the overall genetic diversity of A. l. var. coachellae (Meinke et al. 2007, p. 35) and the maintenance of genetic diversity via the movement of seeds and pollinators (Meinke et al. 2007, p. 37). The large numbers of individuals also likely contribute numerous seeds to the soil seed bank. Unit 3 also contains the only area where A. l. var. coachellae is known to occur in large numbers on floodplain terraces of an active wash (Morongo Wash).

Unit 4: Thousand Palms System Unit 4 consists of 3,670 ac (1,485 ha) of Federal land, and 182 ac (74 ha) of private land in the Coachella Valley, Riverside County. Unit 4 contains approximately 206 ac (83 ha) of unoccupied lands supporting fluvial sand transport and fluvial deposition (this unit contains alluvial sand deposition areas that are not occupied) associated with drainages originating in the Indio Hills. These areas are being designated under section 3(5)(A)(ii) of the Act because they are specific areas outside the geographical area occupied by the species at the time of listing and are essential for the conservation of the species. The remainder of Unit 4 consists of approximately 3,646 ac (1,475 ha) of occupied habitat area in the Thousand Palms Preserve along Ramon Road. These areas are being designated under section 3(5)(A)(i) of the Act because they are within the geographical area occupied by the species at the time of listing and contain those physical or biological features essential to the conservation of the species. In total, Unit 4 consists of 3,851 ac (1,559 ha) of land. Unoccupied areas in this unit contain active ephemeral washes that carry substrates from alluvial deposits to alluvial fan areas where they can be transported to occupied habitat areas via wind (Lancaster et al. 1993, p. 28). The unoccupied areas in Unit 4 are essential for the conservation of Astragalus lentiginosus var. coachellae because they contain alluvial sand deposits that support the fluvial and aeolian sand transport processes crucial to the maintenance of the sand formations that form the foundation of A. l. var. coachellae habitat in the occupied areas of Unit 4. Occupied habitat areas of Unit 4 constitute one of the four main habitat areas supporting Astragalus lentiginosus var. coachellae (Coachella Valley MSHCP/NCCP,

p. 9–22) and contain the physical or biological features essential to the conservation of A. l. var. coachellae, including active dunes, active sand fields, and mesquite hummocks that provide substrate components and conditions suitable for the growth of A. l. var. coachellae (Coachella Valley MSHCP/NCCP 2008, Table 10–1a), and areas over which unobstructed aeolian sand transport can occur. The essential features in the occupied portion of Unit 4 may require special management considerations or protection to address threats from nonnative plants. According to Meinke et al. (2007, p. 18), this area supports infestations of Brassica tournefortii (Saharan mustard); researchers observed thousands of acres of A. l. var. coachellae habitat inundated with dense populations of this nonnative plant species. Existing suburban development may require active management measures (for example, collection of sand from developed areas for redistribution within the wind movement corridor). The expansion of new urban development in areas supporting fluvial sand transport and deposition is also a threat to the essential features in this unit that may require special management considerations or protection, as are unauthorized OHV activity and a proposed flood control project that could disrupt or permanently destroy the sand transport system in the Thousand Palms area by diverting drainages that provide sand to occupied areas during large flooding events. Please see the Special Management Considerations or Protection section of this rule for a discussion of the threats to A. l. var. coachellae habitat and potential management considerations. The physical or biological features in the occupied areas of Unit 4 are also essential to the conservation of the species because they support occurrences containing large numbers of the taxon that contribute to the overall genetic diversity of Astragalus lentiginosus var. coachellae (Meinke et al. 2007, p. 35) and because they are located in the southeasternmost portion of the taxon’s range that is hydrologically independent and physically isolated from the other units. As such, this unit is important to help buffer excessive losses in other parts of the range.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus lentiginosus var. coachellae critical habitat consists of three components (78 FR 10450-10497):

(i) They are active sand dunes, stabilized or partially stabilized sand dunes, active or stabilized sand fields (including hummocks forming on leeward sides of shrubs), ephemeral sand fields or dunes, and fluvial sand deposits on floodplain terraces of active washes.

(ii) They are found within the fluvial sand depositional areas, and the aeolian sand source, transport, and depositional areas of the sand transport system.

(iii) They comprise sand originating in the hills surrounding Coachella Valley and alluvial deposits at the base of the Indio Hills, which is moved into the valley by water (fluvial transport) and through the valley by wind (aeolian transport).

Special Management Considerations or Protections

Special management considerations or protection of the essential physical or biological features within critical habitat areas are needed to address the threats posed to Astragalus lentiginosus var. coachellae habitat by urban and recreational development. Management actions that could ameliorate these threats include, but are not limited to: Protection of lands that support suitable habitat and associated sand transport systems and siting future development such that disruption of fluvial and aeolian sand transport processes is minimized and deposition areas are

preserved. These management actions will protect the essential physical or biological features for the taxon by decreasing the direct loss of habitat to development and by helping to maintain the sand transport system and sand deposition areas that together provide the sand formations that are necessary components of A. l. var. coachellae habitat

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination (USFWS, 2009); cross-pollination (inferred from USFWS, 2009)

Lifespan

Adult: 1 - 2+ years (USFWS, 2009)

Breeding Season

Adult: December - April (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Soil seed bank, insect (especially bee) pollinators (USFWS, 2009), winter rains (USFWS, 2004)

Reproduction Narrative

Adult: Astragalus lentiginosus var. coachellae seeds germinate in fall to early winter (Meinke et al. 2007, p. 46). Seasonally dormant root crowns (i.e., the point at which the root and stem of a plant meet) sprout new shoots in December - January. The date of first flowering may be as early as December in perennial plants, but usually not until January or February for plants in their first year, and continues into April (Meinke et al. 2007, p. 6). Plants in the northwestern portion of the range where rainfall is higher may survive into their second year or longer, while plants that occur in the southeastern extent of the range which receives less rain are primarily annuals (Meinke et al. 2007, p. 31). Astragalus lentiginosus var. coachellae populations can survive prolonged drought periods as dormant seeds (seed bank) (Sanders and Thomas Olsen Associates 1996, p. 3) in the soil, so the numbers of above ground plants at any given time is only a limited and partial indication of population size. Astragalus lentiginosus var. coachellae is genetically self-compatible (i.e., capable of producing viable seeds from the union of pollen and ovules from the same plant), although it is only minimally autogamous (self pollinating) (Meinke et al. 2007, pp. 36 – 37). Experiments demonstrate that seed production in Astragalus lentiginosus var. coachellae is highly dependent on pollinators. Bees in the family Megachilidae are known to visit flowers of Astragalus lentiginosus taxa. The primary pollinator of Astragalus lentiginosus var. coachellae in some instances may be nonnative honeybees (Apis mellifera) (Meinke et al. 2007, p. 36) (USFWS, 2009). Astragalus lentiginosus var. coachellae seeds germinate in response to winter rains (White 2004). Also in response to these winter rains, seasonally dormant root crowns (the point at which the root and stem of a plant meet) sprout new shoots (USFWS, 2004).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Creosote bush scrub, sand dune (NatureServe, 2015); alluvial washes (USFWS, 2004)

Dependencies on Specific Environmental Elements

Adult: Aeolian sand transport system (USFWS, 2009); suitable flooding regime (USFWS, 2004)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2004)

Habitat Narrative

Adult: Sandy areas in washes and sometimes on dunes in creosote bush scrub or in blow sand areas around valley margins (NatureServe, 2015). Astragalus lentiginosus var. coachellae is strongly affiliated with active, stabilized, and shielded sandy substrates (Sanders and Thomas Olsen Associates 1996). Most of the sandy habitat suitable for A. lentiginosus var. coachellae is generated from aeolian sand derived from alluvial fans and floodplains. The distribution, maintenance, and morphology of sand dunes in the Coachella Valley that support A. lentiginosus var. coachellae depend upon adequate sand sources and an intact aeolian sand transport system that is not blocked by structures or windbreaks. Active sand dunes are an important habitat type for Astragalus lentiginosus var. coachellae and are generally characterized as almost barren expanses of moving sand where few perennial shrub species survive. Astragalus lentiginosus var. coachellae also occur in localized patches of aeolian sand or along active washes that are, in some cases, fairly distant from large dunes or sand field areas (USFWS GIS data) (USFWS, 2009). Astragalus lentiginosus var. coachellae is found on loose windblown sands in dunes and flats, and in sandy alluvial washes. This species requires suitable flooding regimes to transport unconsolidated sands from rivers and tributaries to the alluvial fans (USFWS, 2004).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Fruits of A. lentiginosus var. coachellae are inflated, an apparent adaptation for being dispersed by wind (USFWS, 2009). At maturity, the pods dry and fall to the ground, where they are then dispersed by wind (USFWS, 2004).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2009)

Number of Populations:

~34 (NatureServe, 2015)

Population Size:

Unknown (USFWS, 2009)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Population sizes vary widely from year to year, depending on environmental conditions. Surveys for the plant in 1987, a drought year, resulted in the location of less than 300 individuals. Annual monitoring of 1 population showed a drop from 209 individuals in 1979 to 2 individuals in 1982. At sites monitored in 1995, densities varied from 1.25 plants per hectare to 60 plants per ha (Fish and Wildlife Service 1998). Approximately 34 occurrences observed since 1989 (CNDDB 2008). Small population sizes, particularly in drought years, leave the Coachella Valley milk-vetch vulnerable to extinction from stochastic events (NatureServe, 2015). Detecting changes in numbers of individuals of A. lentiginosus var. coachellae and demographic trends over time is difficult because the number seeds in a given area that germinate and produce standing plants can vary widely from year to year depending on environmental conditions (Sanders and Thomas Olsen Associates 1996, p. 3). Additionally, the number of standing plants at any given time is only a partial indication of population size because the other portion of the population is the seed bank in the substrate that can persist dormant for a number of years (Sanders and Thomas Olsen Associates 1996, p. 3). A great deal of genetic variation has been observed between A. lentiginosus var. coachellae individuals, possibly due to the apparently long-lived seed bank of the taxon, which may result in grossly overlapping generations (i.e., young seeds and much older seeds germinating contemporaneously) (Knaus pers. comm. 2008). Astragalus lentiginosus var. coachellae continues to exist in the Coachella Valley, although population estimates are unknown (USFWS, 2009). Its distribution in the Coachella Valley area roughly spans from just east of Cabezon to the dunes off Washington Avenue, north and west of Indio. The occurrences in the Chuckwalla Valley are all along a 5-mile stretch of Highway 177 just north of Desert Center (USFWS, 2004).

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Coachella Valley has experienced significant growth since the 1970s. The projection of a population of 500,000 people by 2010 in the listing rule (USFWS 1998, p. 53605) is close to current projections of approximately 418,300 people by the year 2010 and 518,500 by 2010 forecasted by the Southern California Association of Governments and provided in the Coachella Valley MSHCP (Coachella Valley MSHCP 2007, Table 2-1, p. 2-2). This predicted growth suggests urban and commercial/industrial development pressures will continue to rise within the extant range of A. lentiginosus var. coachellae. Development continues to result in direct or indirect impacts to Astragalus lentiginosus var. coachellae habitat. Direct impact includes loss of habitat by conversion of the sandy substrates to development. Development activities indirectly impact habitat through alteration of the wind sand transport systems of wind, and modifications of flood scour and sediment deposition patterns. These impacts, in turn, ultimately diminish the amount and distribution of sand available to maintain habitat for the species, and diminish the amount and ecological functions of sandy habitats themselves (causes of habitat degradation). Direct loss of Astragalus lentiginosus var. coachellae habitat results when essential habitat features are displaced by structures, roads, or landscaping. These losses include complete loss of specific habitat types necessary for germination and survival of future cohorts of A. lentiginosus var. coachellae as well as the mortality of any plants and seeds in the seed bank occupying the developed former habitat. Development of A. lentiginosus var. coachellae habitat has continued since the taxon was listed in 1998, although many of these development projects have been

subject to consultation under section 7 of the Act (Service files). Structures, percolation ponds, utility substations, spoil piles and levees, road fill, and windrows associated with development have been constructed or planted within most of the sand source and sand transport corridors remaining in the Coachella Valley. This development has artificially stabilized, confined, re-directed, or blocked the majority of fluvial or aeolian sand that previously would have moved freely southeasterly down the valley. Therefore, the continued replenishment of blow sand in Astragalus lentiginosus var. coachellae habitat has been greatly reduced or prevented in many areas. Mesquite hummocks contribute to the creation and stabilization of sand dunes and sand fields by anchoring dunes and making them less vulnerable to wind erosion. The honey mesquite shrubs associated with the Banning Fault are senescent, degraded, and appear to be dying along its western extent (between Mission Creek and Morongo Wash), likely due to ongoing artificial lowering of groundwater levels in the subbasin to provide water for human use (Mission Springs Water District 2008); they are predicted to be effectively dead by 2016. Loss of the mesquite hummocks may lead to the erosion of blow sand deposits, therefore affecting Astragalus lentiginosus var. coachellae habitat created/maintained by the trapping of blow sand (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Invasive, nonnative plant species can potentially affect A. lentiginosus var. coachellae habitat by stabilizing loose sediments in otherwise unsuitable locations and obstructing transport of sediment to occupied habitat downwind. Nonnative plants, in particular the annual Brassica tournefortii, potentially pose a significant threat to Astragalus lentiginosus var. coachellae. Brassica tournefortii has invaded most suitable habitat occupied by A. lentiginosus var. coachellae in the Coachella Valley, and in years when precipitation has been high, dense populations of B. tournefortii have been found in reserve areas vital to the persistence of A. lentiginosus var. coachellae (Meinke et al 2007, p. 51). Brassica tournefortii populations reproduce prolifically and create large, long-lived seed banks which sustain populations through dry years, and make eradication of the species effectively impossible (Meinke et al 2007, p. 64). In addition to competition for space, nonnative plants that germinate and grow more readily even in dryer years may also directly compete with A. lentiginosus var. coachellae for water (USFWS, 2009).

Stressor: Off-highway vehicles (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Off-highway vehicle use continues to threaten the taxon and its habitat, although control of unauthorized OHV use in habitat occupied by Astragalus lentiginosus var. coachellae has recently improved through stepped-up local enforcement. Habitat effects of OHV use include disruption of soil hydrology and changes in plant community composition (USFWS 2008a, p. 8766). Off-highway vehicle use also impacts A. lentiginosus var. coachellae by directly damaging plants and seed (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: Predation of Astragalus lentiginosus var. coachellae seeds was documented in a 2005/2006 study (Meinke et al. 2007, p. 40). The most commonly observed larval seed predators were a chalcid wasp (Bruchophagus mexicanus) and seed beetles (Brucidae; genus Acanthoscelides). Additionally, weevil larvae (Curculionidae; possibly genus Tychius) and stinkbug nymphs (Pentatomidae; genus Chlorochora) were believed to feed on ovules and seeds in pods (Meinke et al. 2007, pp. 40 – 43). Larval predation of ovules and seeds may result in the destruction of a sizable proportion of the annual seed output for A. lentiginosus var. coachellae. For example, in 2005 and 2006, 78.4 percent and 64.2 percent, respectively, of mature pods sampled by Meinke et al. (2007, p. 43) had been impacted by at least one larval seed predator, all of which were native species. Mammal herbivory on Astragalus lentiginosus var. coachellae leaves and green seed pods was also observed (Meinke et al. 2007, pp. 43 – 44). Herbivory by mammals (possibly rabbits and ground squirrels) was more prevalent in 2006 than 2005, possibly because 2006 was a drier year and forage was at a premium. Destruction and presumed predation of green seed pods (most likely by ground squirrels and/or kangaroo rats) though uncommon overall, was also observed more often in 2006. Herbivory likely decreases the survival and reproductive potential of the plants and therefore input to the seed bank (USFWS, 2009).

Stressor: Disease (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: An unidentified fungal or viral disease was observed to infect Astragalus lentiginosus var. coachellae during 2005, possibly due to the wetter, cooler weather conditions (the disease was not observed in 2006; Meinke et al. 2007, p. 45). The disease caused all flowers on infected racemes to wilt, which prevented pollination and production of fruit, and at times killed the entire plant (Meinke et al. 2007, p. 45) (USFWS, 2009).

Stressor: Habitat fragmentation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: As habitat for the taxon becomes increasingly fragmented by urban development, remaining populations become more vulnerable to edge effects at the habitat/development interface. Impacts often thought to increase edge effects include: disturbance caused by OHV use, roadside maintenance or subsequent paving/landscaping, and nonnative plant invasions that may accompany such activities (USFWS 2008c, p. 30). Fragmentation increases the potential for stochastic events to detrimentally affect long-term survival of smaller or more isolated occurrences. Similarly, fragmentation decreases the taxons' resilience to rebound from periodic or local extinctions (USFWS 2008c, p. 17). Seed dispersal and pollinator movement can be inhibited by habitat fragmentation or degradation. Astragalus lentiginosus var. coachellae depends on insect pollinators and wind dispersal of fruits and habitat fragmentation poses a significant threat to the populations of A. lentiginosus var. coachellae by diminishing the opportunities for these actions (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume Astragalus lentiginosus var. coachellae may be affected, the Service lacks sufficient certainty regarding how and when climate change will affect the species and the extent of average temperature increases in California (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 12C

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Work with partners and identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat management, restoration, and enhancement opportunities for Astragalus lentiginosus var. coachellae (USFWS, 2009).
- Determine the magnitude of the threat posed to Astragalus lentiginosus var. coachellae and its habitat from nonnative plants, especially Brassica tournefortii (Sahara mustard), and effective management options (USFWS, 2009).
- Determine the identity of native Astragalus lentiginosus var. coachellae pollinators, their ecology, and management needs. a. Incorporate management of native pollinators and their habitat into management strategies for A. lentiginosus var. coachellae. b. Determine threshold habitat conditions for Astragalus lentiginosus var. coachellae and its pollinators to include occupancy patterns (USFWS, 2009).
- Implement a system for tracking Astragalus lentiginosus var. coachellae habitat losses (or habitat degradation), and gains due to permanent conservation (USFWS, 2009).
- Develop a Recovery Plan for Astragalus lentiginosus var. coachellae that would coordinate and direct survey and research actions beneficial to species recovery and that will reduce or eliminate threats to the species. Include occurrence map with risk assessment (USFWS, 2009).

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SPECIES ACCOUNT: *Astragalus lentiginosus var. piscinensis* (Fish Slough milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2016) The Fish Slough milkvetch (Astragalus lentiginosus var. piscinensis) was originally listed on October 6, 1998 as threatened (63 FR 53596) and critical habitat was designated on June 9, 2005 (70 FR 33774). The Service completed a recovery plan that addresses the species (Service 1998), and a 5-year review in 2009 (Service 2009). In the 5-year review, the Service determined that no change was needed to the classification as threatened.

Physical Description

A perennial herb with a few hairy, branched, prostrate stems radiating from a central rootstock. Stems can be as long as 1 m and individual plants can occupy a 2.7 square m area. Leaflets are reduced to only two lateral pairs with an elongate terminal leaflet longer than the leaf stalk. The flowers, arranged in loose racemes, are pale lavender and number from 5 to 12 per inflorescence. Loose clusters of pale lavender flowers bloom in late spring. Fruits are brightly mottled, strongly inflated, leathery pods, with a complete septum and an incurved beak (USFWS 1998NatureServe, 2015). Fish Slough milk-vetch is distinguished from other varieties of Astragalus lentiginosus by its three to five linear-oblanceolate leaflets, and its densely strigose, strongly inflated pods (Barneby 1977).

Taxonomy

Astragalus lentiginosus var. piscinensis was described by Barneby (1977) based on a collection made by Mary DeDecker in 1974, from BLM Spring, Fish Slough, northwest of Bishop, California. Spellenberg (1993) retained this variety in his treatment of Astragalus for the Jepson Manual, and no other changes in taxonomic classification or nomenclature have been made since then. (USFWS, 2009) Dicot.

Historical Range

At the present, Astragalus lentiginosus var. piscinensis is restricted to the same range as it was at the time of listing, a 10 kilometer (6 mile) stretch of alkaline flats paralleling Fish Slough. The slough supports the species on less than 540 acres (219 hectares; USFWS 2009).

Current Range

Restricted to a 10-kilometer mile stretch of alkaline flats paralleling Fish Slough, Mono County, California. (NatureServe, 2015)

Critical Habitat Designated

Yes; 6/9/2005.

Legal Description

On June 9, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus lentiginosus var. piscinensis (Fish Slough milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (70 FR 33774-33795).

Critical Habitat Designation

The critical habitat designation for Astragalus lentiginosus var. piscinensis includes one CHU Mono and Inyo Counties, California. In total, approximately 8,007 acres (ac) (3,240 hectares (ha)) fall within the boundary of the critical habitat designation (70 FR 33774-33795).

Mono Counties, California. From USGS 1:24,000 quadrangle maps Chidago Canyon and Fish Slough, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus lentiginosus var. piscinensis critical habitat consists of four components (70 FR 33774-33795):

(i) Alkaline soils that occur in areas with little or no slope, and which overlay a groundwater table that is 19 to 60 in (48 to 152 cm) below the land surface;

(ii) Plant associations dominated by Spartina-Sporobolis, or where a sparse amount of Chrysothamnus albidus occurs in the transition zone between Spartina-Sporobolis and Chrysothamnus albidus-Distichlis plant associations;

(iii) The presence of pollinator populations for Astragalus lentiginosus var. piscinensis; and

(iv) Hydrologic conditions that provide suitable periods of soil moisture and chemistry for Astragalus lentiginosus var. piscinensis germination, growth, reproduction, and dispersal.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

When designating critical habitat, we assess whether the physical and biological features determined to be essential for conservation may require special management considerations or protection. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In 1982, BLM established the Fish Slough ACEC in an

effort to provide protection for the federally endangered Owens pupfish, several rare plant taxa including Astragalus lentiginosus var. piscinensis, and the wetland and riparian habitats upon which these species depend. The Fish Slough ACEC has three zones (BLM 1984). The designated critical habitat unit is predominantly located within Zone 1 of the ACEC, includes a very small portion of Zone 2, and also extends slightly beyond the southern boundary of the ACEC. The land in Zone 1 is owned by BLM, CDFG, LADWP, and one private landowner. The portion of the designated critical habitat unit in Zone 2, or in the area immediately south of the ACEC, is owned by BLM or LADWP. A management plan for the ACEC was finalized in 1984, but the plan has not been revised since it was completed. Previously identified threats to Astragalus lentiginosus var. piscinensis include the presence of roads, effects related to the use of OHV, effects related to cattle grazing, and effects from herbivory by native vertebrates and insects (Service 1998). A potential threat to A. l. var. piscinensis not previously identified in other documents includes competition with, or displacement by, nonnative plant species (P. Hubbard, LADWP, pers. comm. 2003). The modification of wetland habitats that results from groundwater pumping or water diversion activities altering the surface and underground hydrology of Fish Slough is also a threat to the species (Service 1998). The suite of threats affecting Astragalus lentiginosus var. piscinensis is complex. The establishment of the Fish Slough ACEC has helped provide some benefit for A. l. var. piscinensis by coordinating the activities of staff from BLM, LADWP, and CDFG on various land management challenges that exist in the local area. Because the long, narrow configuration of the slough is bounded by upland habitat, the amount of alkaline habitat that can be occupied by A. l. var. piscinensis is limited. Ferren (1991b) summarizes threats to botanical resources at Fish Slough, noting that those threats related to the enhancement of fisheries (construction of ponds, impoundments, roads, and ditches) may have had the greatest effect on the Fish Slough ecosystem because they modified the hydrological conditions that historically occurred in Fish Slough. In the central portion of the slough, Fish Slough Lake appears to have expanded in size between 1944 and 1981. This increase may be due to natural geologic subsidence, the construction of Red Willow Dam, or the construction of water impoundments by beavers. The increase in aquatic habitat has likely resulted in the loss of alkaline habitat for Astragalus lentiginosus var. piscinensis as soils near the lake are now saturated for greater portions of the year (Ferren 1991c). Some earthquake events in Chalfant Valley appear to have resulted in decreases in spring discharge or changes in local water table levels (Brian Tillemans, LADWP, pers. comm. 2000), thereby making it more difficult to clearly understand the nature of the local aquifer. Modifications to the slough environment from changes in the local hydrology are not well understood or easily reversed. These factors, in combination with essential data gaps that include, but are not limited to, a more thorough understanding of the ecology and habitat requirements of the species, have made it difficult for local land managers to understand and reverse the decline in the number of A. l. var. piscinensis within the ACEC over he past decade. A downward trend in the species' abundance during the past decade suggests that, despite the ongoing efforts by the relevant land management agencies, additional factors need to be addressed to reverse the decline in the status of A. l. var. piscinensis. We believe that the designated critical habitat unit may require special management considerations to maintain the identified primary constituent elements. These include the potential need to respond to the following: (1) Activities that have the potential to change the hydrology of Fish Slough and adversely affect the survivorship, seed germination, growth, or photosynthesis of Astragalus lentiginosus var. piscinensis, unless such activities are designed and have the effect of recreating the historic environmental conditions that existed in Fish Slough; (2) Activities that have the potential to adversely affect the suitability of alkaline areas that could provide habitat for Astragalus lentiginosus var. piscinensis including, but not limited to, OHV use, levels of cattle

grazing that could result in increased soil compaction, road construction and maintenance activities, and water diversion activities; (3) Activities that have the potential to modify the species composition, character, or persistence of the native plant associations that are associated with Astragalus lentiginosus var. piscinensis; (4) Activities that could adversely affect the insect pollinators that inhabit the native upland desert scrub community that is adjacent to alkaline habitats in Fish Slough, including, but not limited to, livestock grazing at levels that would increase soil compaction, use of heavy-wheeled vehicles or OHVs (including motorcycles and all terrain vehicles), pesticide use, and incompatible recreational activities; and (5) Management activities, particularly those that involve cattle grazing and road maintenance, which have the potential to introduce new nonnative plant species that may compete with or displace Astragalus lentiginosus var. piscinensis.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1998). Astragalus lentiginosus var. piscinensis cannot self-pollinate; therefore, seed production is dependent on cross-pollination (Mazer and Travers 1992).

Lifespan

Adult: 15 to 35 years; median of 10 years (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: the most likely pollinators (based on records of pollinators on other Astragalus) include bumble bees, leafcutting and mason bees (Megachilidae: Anthidium spp., Hoplitis spp., Osmia spp., Megachile spp.), non-corbiculate (no pollen basket on hind tibia) Apidae (Anthophorinae, Eucerini: Melissodes spp., Synhalonia spp., and Anthophorini: (Anthophora spp., Habropoda spp.), and Andrenidae (Thorp in litt. 2004). (USFWS, 2009)

Breeding Season

Adult: Late spring (USFWS, 2009)

Reproduction Narrative

Adult: Astragalus lentiginosus var. piscinensis cannot self-pollinate; therefore, seed production is dependent on cross-pollination (Mazer and Travers 1992). Although specific pollinators of A. lentiginosus var piscinensis have not been studied, the most likely pollinators (based on records of pollinators on other Astragalus) include bumble bees, leafcutting and mason bees (Megachilidae: Anthidium spp., Hoplitis spp., Osmia spp., Megachile spp.), non-corbiculate (no pollen basket on hind tibia) Apidae (Anthophorinae, Eucerini: Melissodes spp., Synhalonia spp., and Anthophorini: (Anthophora spp., Habropoda spp.), and Andrenidae (Thorp in litt. 2004). Astragalus lentiginosus var. piscinensis is an herbaceous perennial that produces relatively few seeds with narrow germination requirements and low probability of dispersal. Seed scarification is essential for seed germination. The potential life span is estimated at 15 to 35 years, but median life span appears to be about 10 years. (USFWS, 2009) Fish Slough milk-vetch may grow as much as 30 cm (12 in.) per month during its growing season, which lasts from May to September. Flowering usually begins in late spring and bumblebees (Bombus sp.) are the only flower visitors that have been identified. Fruit is typically set in June and July. Pollinator

exclusion experiments demonstrated that Fish Slough milk-vetch is not self-fertilizing. Reproductive output is correlated with plant size and differs between colonies in the north and middle areas o fFish Slough. Grazing of flowering and fruiting branches by jackrabbit (Lepus californicus) and rodents reduced reproductive output during the study period (Mazer and Travers 1992).

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alkali flats (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: The establishment, survival, and growth of juvenile Fish Slough milkvetch plants are strongly influenced by hydrologic conditions at specific sites (Service 2009). Water table level is of ecological importance to Fish Slough milkvetch. Under experimental conditions, this taxon's physiological performance, growth, and fecundity (seed mass, seed production per plant) are limited by hydric soils in excess of approximately 40 percent water content per volume. The taxon's net photosynthetic rates, growth rates, and seed mass were highest in areas of slough habitat where early season (May-June) water table depths exceeded approximately 11.8 in (30 cm) (Murray and Sala 2003). Studies have also indicated that the growth and survival of Fish Slough milkvetch in relatively nitrogen-limited alkali flat habitats are related to the acquisition of biologically fixed nitrogen (root symbiotic bacteria).

Geographic or Habitat Restraints or Barriers

Adult: Found along borders of a slough but not in lower wetter habitats (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009; NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 2009)

Habitat Narrative

Adult: Ferren (1991) and Odion et al. (1991) characterized Fish Slough soils and plant communities and provided information about the habitat of Fish Slough milk-vetch. This taxon occurs in the alkali flats in Spartina-Sporobolus plant associations and in the transition zone between Spartina-Sporobolus and Distichlis-Chrysothamnus plant associations described by Odion et al. (1991). It is frequently found with alkali ivesia (Ivesia kingui var. kingui) but rarely in wetter alkali habitats (USFWS 1998).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The seeds have narrow germination requirements and low probability of dispersal. (USFWS, 2009)

Population Information and Trends

Population Trends:

results suggest an increase in populations, however it is unclear how survey effort may be affecting census numbers (USFWS 2018).

Resiliency:

Low (inferred from USFWS, 2009)

Representation:

Low (inferred from USFWS, 2009)

Redundancy:

Low (inferred from USFWS, 2009)

Number of Populations:

7 (USFWS 2009)

Population Size:

9,131 individuals (USFWS 2018)

Additional Population-level Information:

Harrison et al 2019 found that the three regions are genetically distinct.

Population Narrative:

The first comprehensive assessment of the abundance and distribution of Astragalus lentiginosus var. piscinensis was conducted in 1992. At that time, zones (also called colonies) were identified to delineate occupied and/or suitable habitat There are seven zones within three regions located across the range of Astragalus lentiginosus var. piscinensis. These regions and their zones are as follows: Northern Region (Zones 6 and 7), Middle Region (Zones 1 (a and b) and 5), and Southern Region (Zones 2, 3, and 4). Plants in the northern region of Fish Slough are entirely on LADWP lands while those in the middle and southern regions are on lands managed by both LADWP and BLM. The Northern Region contains the largest percentage of the Astragalus lentiginosus var. piscinensis population whereas the Southern Region has the lowest. Similar surveys were conducted in 2000, 2008, and 2016, which identified seven colonies grouped in three regions. Results of these surveys are provided in Table X. Table X. Number of adult and juvenile Astragalus lentiginosus var. piscinensis counted during each census (modified from Service 2018). Year Region Total Number of Plants (Adults and juveniles) Northern Middle Southern 1992 1,993 1,076 94 3,163 2000 717 747 79 1,543 2008 3,299 1,063 131 4,493 2016* 6,274 2,783 74 9,131 *The survey conducted in 2016 was not a true census since the survey did not cover the entire range of the species. The fewest plants were observed in 2000 and the most were observed in 2016. There is little to no information from the previous censuses to compare how survey effort may have varied over time (Service 2018). Survey effort affects ability to accurately compare population counts across years.

Threats and Stressors

Stressor: Grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In the listing rule we noted that grazing that began in the 1860s was ongoing on all LADWP lands except in the northern 80 ac (32 ha) exclosure (63 FR 53608). Over time, trampling by livestock has the potential to alters the composition of the plant community by reducing or eliminating those that cannot tolerate trampling and increasing those species that tolerate disturbance. This may also introduce taxa that were not previously part of the native plant community. (USFWS, 2009)

Stressor: Alteration of habitat- hydrology and non-native plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Past modifications to Fish Slough hydrology include creation of dams and weirs in the main channel of Fish Slough, construction of a dirt road through milkvetch habitat, and soil compaction and trail creation by cattle. These activities have altered hydrology by causing an increase in permanently flooded habitats, artificial ponding, alteration in drainage patterns, and changes in seasonal flooding of milkvetch habitat (Service 1998a). Recovery actions for Owens pupfish that elevate groundwater levels also reduce habitat suitability for Fish Slough milkvetch. Ferren and Davis (1991b) summarized impacts to botanical resources at Fish Slough, noting that those related to the enhancement of fisheries (construction of ponds, impoundments, roads, and ditches) have resulted in the greatest losses to the milkvetch's specific alkali habitats. IN addition, impacts to groundwater that affect spring flow feeding spring springs around Fish Slough and thus the Slough itself (such as those discussed in Zdon et al. 2020) may result in changes to hydrologic conditions needed by the species. Undesirable plant species may be introduced and flourish under disturbance caused by grazing or other sources. Their presence may reduce or eliminate Fish Slough milkvetch through competition for resources (Service 1998a, 2009). Undesirable plant species such as perennial pepperweed are a threat to Fish Slough milkvetch (USFWS, 2009).

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Herbivory remains a threat to Astragalus lentiginosus var. piscinensis. Seedling herbivory remains a threat to recruitment of new individuals. Field observations suggest that several factors (herbivory, seed germination requirements, seedling establishment, and interspecific competition) interact, placing constraints on Astragalus lentiginosus var. piscinensis survival (Murray and Sala 2003). Infestations of vegetative parts and root systems by phloem-sucking insects and red ants, respectively, and high rabbit herbivory were all reported for individuals of Astragalus lentiginosus var. piscinensis in the middle region of Fish Slough by Mazer and Travers (1992). (USFWS, 2009)

Stressor: Lack of recruitment (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: At the time of listing, the Service noted that lack of recruitment was a potential threat to Astragalus lentiginosus var. piscinensis. Potential causes cited in the rule were high rabbit/rodent herbivory of seedlings (discussed in Factor C) and changes in soil hydrology or chemistry that make the area less hospitable for seedlings (63 FR 53608). We also discussed the threat of livestock grazing under Factor E of the rule. However, Factor A (which would include alteration in habitat due to cattle grazing) and Factor C (which would include grazing of individual Astragalus plants) are more appropriate. Data on numbers of individuals of A. lentiginosus var. piscinensis, collected from plots in cattle-grazed or trampled and ungrazed areas of Fish Slough from 1991 to 1996, suggest that some recruitment was occurring in both the grazed and ungrazed sample areas. Because the alkali meadow habitat that A. lentiginosus var. piscinensis occupies is likewise moist, cattle may facilitate the establishment of new individuals. (USFWS, 2009)

Stressor: Seismic activity (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Fish Sough was created recently by geologic events. Although not mentioned in the listing rule, seismic activity leading to changes in hydrology have and will likely continue to have significant effects on the distribution and extent of water availability in Fish Slough and will influence the distribution and viability of Astragalus lentiginosus var. piscinensis habitat (Halford in litt. 2007). (USFWS, 2009) Seismic instability at the Northeast Spring area of Fish Slough was demonstrated in 1986 when an earthquake occurred and changed spring seep patterns.(USFWS, 2009)

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Astragalus lentiginosus var. piscinensis may be vulnerable to extirpation by stochastic factors including demographic stochasticity, environmental stochasticity, and genetic stochasticity (Shaffer 1981). Demographic stochasticity refers to random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of A. lentiginosus var. piscinensis. Environmental stochasticity is the variation in birth and death rates from one season to the next in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981), and this could also play a role in extirpations of small populations. Genetic stochasticity results from the changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The naturally disjunct distribution of A. lentiginosus var. piscinensis decreases genetic variation within the population, which could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). Small population size makes it difficult for A. lentiginosus var. piscinensis to persist while sustaining the impacts of high seedling herbivory rates and changes in soil hydrology or chemistry that make the area less hospitable for seedlings; while impacts from cattle grazing have been reduced, they still remain a concern, exacerbating concerns about the risks associated with small

population size. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Climate change was not discussed at the time of listing. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Astragalus lentiginosus var. piscinensis; small ranged species, such as Astragalus lentiginosus var. piscinensis, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Stressor: Roads and off highway vehicles
Exposure:
Response:
Consequence:
Narrative: The use of motorized off-road vehicles and the presence of roads have affected habitat occupied by Astragalus lentiginosus var. piscinensis. Approximately 19 mi (30.6 km) of roads exist within 3,280 ft (1,000 m) of the alkaline habitats within Fish Slough. South of BLM Spring, on the east side of the slough, a road bisects one cluster of the listed plants, and off-road vehicle use in the central portion of the slough has been documented (Novak 1992). Soil compaction and topographic changes resulting from road presence and off-road vehicle activity can affect soil moisture regimes in Fish Slough, and potentially result in changes in seasonal inundation patterns that may adversely affect A. l. var. piscinensis. Roads through upland areas in Fish Slough also create increased levels of human visitation that would otherwise be unlikely if roads were absent. Roads have been associated with negative impacts that alter the biotic integrity of both terrestrial and aquatic habitats (Trombulak and Frissell 2000). A growing body of published literature indicates that vehicular traffic along road networks in terrestrial habitats increases the likelihood that non-native plant seeds will be introduced into areas where they were previously absent (Wace 1977; Schmidt 1989; Lonsdale and Lane 1994). Some of the non-native plant species in Fish Slough (e.g., five hook bassia (Bassia hyssopifolia)) are identified as pest plants of ecological concern (CalEPPC 1999) and have the potential to invade and degrade the quality of alkaline habitats and compete with Astragalus lentiginosus var. piscinensis.

Stressor: Pesticides
Exposure:
Response:
Consequence:

Narrative: Pesticides have the ability to directly affect the species and its pollinators.

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. The Fish Slough vegetation communities [specifically for Astragalus lentiginosus var. piscinensis] are restored and are being managed to maintain conditions such as those described in the Natural Resources Conservation Service (NRCS) Ecological Site Descriptions, the Bureau of Land Management's (BLM) Desired Plant Community Definitions for springs and wet meadows, and the guidelines for riparian zone proper functioning condition. (USFWS, 2009)

2. Colonies in the north, middle and south regions of the slough are secured from the negative effects of invasive nonnative species, livestock grazing and other human induced threats. (USFWS, 2009)

3. Recruitment of new individuals into the populations and other demographic factors appear sufficient to ensure viability over time as determined by monitoring over a 10 to 15-year period. (USFWS, 2009)

4. Unless research and monitoring show otherwise, population targets for juvenile and adult plants should be a minimum of 2,100 plants in the northern region of Fish Slough, 1,200 in the middle region of Fish Slough and 105 plants in the southern region of Fish Slough; these targets assume that habitat restoration will increase carrying capacity beyond the 1992 levels. (USFWS, 2009)

Recovery Actions:
- Needed recovery actions include protection of spring discharges, modification of livestock grazing to ensure that its habitat is not being degraded, restoration of previously suitable habitat that no longer supports the milk-vetch, removal and control of nonnative species and other threats that may arise, protection of lands on which the milk-vetch occurs through a conservation easement or other permanent mechanism, and research to determine its critical life history and habitat components and how these are affected by management actions. Continued monitoring will also be needed. (USFWS, 1998)
- CDFG, BLM and LADWP should work to lower water levels by regulating flow in Fish Slough Lake and monitor Astragalus lentiginosus var. piscinensis recruitment results. (USFWS, 2009)
- BLM should study the benefits of soil disturbances on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- BLM should continue with propagation and out-planting projects to enhance recruitment. (USFWS, 2009)
- BLM should study the extent and population impacts of herbivory and ant colony infestations on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- The Service should work with LADWP to develop and implement a grazing plan for LADWP cattle allotment lands within the Fish Slough ACEC. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- • Conduct annual monitoring of A. lentiginosus var. piscinensis. If negative effects from activities are detected, take corrective action. • Ensure grazing leasees operating in areas with A. lentiginosus var. piscinensis are aware of this federally-listed species and measures that can help to minimize impacts from grazing such as adjusting season of use, stocking rates, and careful placement of supplements • Implement appropriate rest/rotation grazing to allow for seed maturity and seed set and to reduce trampling of plants. • Conduct a robust analysis of the impacts of grazing on A. lentiginosus var. piscinensis ; report outcome of analysis to partners. • If using herbicides in A. lentiginosus var. piscinensis occupied habitat, implement measures to avoid chemical contact with this species. These measures include using licensed applicators; follow all label directions, warnings, and precautions to avoid surface runoff and drift; using backpack sprayers or wicking applicators (rather than broadcast spraying); avoiding spraying in/near known locations of milkvetch plants to avoid direct spray and drift; and conducting spot treatments of weeds to confine the area sprayed to the smallest possible area to avoid A. lentiginosus plants and their pollinators.
- Fish Slough Area of Critical Environmental Concern has been established that includes much of the species habitat.
- CDFG, BLM and LADWP should work to lower water levels by regulating flow in Fish Slough Lake and monitor Astragalus lentiginosus var. piscinensis recruitment results. (USFWS, 2009)
- BLM should study the benefits of soil disturbances on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- BLM should continue with propagation and out-planting projects to enhance recruitment. (USFWS, 2009)
- BLM should study the extent and population impacts of herbivory and ant colony infestations on Astragalus lentiginosus var. piscinensis recruitment. (USFWS, 2009)
- The Service should work with LADWP to develop and implement a grazing plan for LADWP cattle allotment lands within the Fish Slough ACEC. (USFWS, 2009)

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SPECIES ACCOUNT: *Astragalus magdalenae var. peirsonii* (Peirson's milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/05/1998; Pacific Southwest Region (R8)

Physical Description

An erect to spreading, herbaceous, short-lived perennial in the Fabaceae (Pea family) (Barneby 1959, 1964). This taxon is a psammophyte, meaning that it grows in shifting sands. Plants may reach 8 to 35 inches (in) (20 to 90 centimeters (cm)) in height (Barneby 1964, pp. 862–863, Wojciechowski and Spellenberg 2012). The root system is 2 composed of a deep taproot and shallow lateral roots; taproots of older plants may be as long as 13 feet (ft) (4 meters (m)) deep (Porter et al. 2005, p. 28). The stems and leaves are covered with fine, silky appressed hairs. The leaflets, which may fall off in response to drought, are small and widely spaced, giving the plants a brushy appearance. The terminal leaflet (leaflet at the tip) is continuous with the rachis (the central axis of a compound leaf along which leaflets are attached) rather than articulated with it (Barneby 1959, p. 879; Wojciechowski and Spellenberg 2012). Each raceme (flower stalk) supports 10 to 17 purple flowers (Barneby 1959, p. 879). The inflated, single-chambered fruits (pods) of A. m. var. peirsonii are 0.8 to 1.4 in (20 to 35 mm) long and 0.4 to 0.8 in (10 to 20 cm) wide (Barneby 1964, Wojciechowski and Spellenberg 2012). Barneby (1964) reported 11 to 16 ovules per fruit, but only a portion of a pod's ovules develop into mature seeds (McKinney et al. 2006, p. 85). (USFWS, 2019c)

Taxonomy

Although originally described at the species rank by Munz and McBurney (Munz 1932, p. 7) Peirson's milk-vetch is currently recognized at the varietal level as A. magdalenae var. peirsonii (Wojciechowski and Spellenberg 2012). However, 2007 genetic analysis suggested that Barneby's (1964, pp. 862–863) reduction of Peirson's milk-vetch to varietal status may have been inappropriate, and that A. magdalenae var. peirsonii should be recognized at the rank of species (Porter and Prince 2007, p. 10). Since 2008, no taxonomic changes have been formalized, and so we continue to recognize the taxon as Astragalus magdalenae var. peirsonii across its range. (USFWS, 2019c)

Historical Range

Found in Sonoran Desert dune environments in southeastern California, United States, and in Sonora, Mexico. (USFWS, 2019c)

Current Range

In the United States, A. m. var. peirsonii is restricted to the western portion of the Algodones Dunes (also referred to as the Imperial Sand Dunes) of eastern Imperial County, California. This taxon occurs within about 53,000 acres (ac) (21,500 hectares (ha)) in a narrow band running 40 miles (mi) (64 kilometers (km)) northwest to southeast along the western portion of the dunes. (USFWS, 2019c)

Critical Habitat Designated

Yes; 3/17/2008.

Legal Description

On February 14, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective March 17, 2008) for Astragalus magdalenae var. peirsonii (Peirson's milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (73 FR 8748-8785).

Critical Habitat Designation

The critical habitat designation for Astragalus magdalenae var. peirsonii includes three CHUs (with seven sub-units) in Imperial County, California. This species' critical habitat encompasses approximately 9.758 acres (ac) (3,949 hectares (ha)) (73 FR 8748-8785). Brief descriptions are provided below; detailed coordinates and maps are available in the Final Rule (USFWS, 2008).

Unit 1: Mammoth Wash/North Algodones Dunes Wilderness: Unit 1 consists of 4,675 ac (1,892 ha) of land, further divided into 4 subunits (1A, 1B, 1C, 1D), the majority of which is primarily Federal land under BLM management This unit includes land in the BLM's Mammoth Wash and North Algodones Dunes Wilderness Management Areas. Areas are as follows: Subunits 1A (421 ac (170 ha)) and 1B (1,411 ac (571 ha)); Subunits 1C (741 ac (300 ha)) and 1D (2,103 ac (851 ha)) (USFWS, 2008)

Unit 3: Adaptive Management Area (AMA)/Ogilby: Unit 3 consists of 7,212 ac (2,919 ha) of land further divided into 3 subunits (3A, 3B, 3C), which are Federal lands under BLM management. This unit includes lands in the BLM’s AMA and Ogilby Management Areas. Areas are as follows: Subunits 3A (4,487 ac (1,816 ha)), 3B (1,176 ac (476 ha)), and 3C (1,549 ac (627 ha)) . (USFWS, 2008)

Unit 4: Buttercup Unit 4 consists of 218 ac (88 ha) of Federal land entirely under BLM management. This unit includes lands in the BLM’s Buttercup Management Area. (USFWS, 2008)

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus magdalenae var. peirsonii critical habitat consists of the following components (73 FR 8748-8785):

(i) West and/or northwest-facing sides of bowls, swales, and slopes consisting of Rositas fine sands within intact, active sand dune systems (defined as sand areas that are subject to sandmoving winds) in the existing range of the species that provide space needed for individual and population growth, including sites for germination, reproduction, seed dispersal, seed bank, and pollination (USFWS, 2008)

(ii) The associated co-adapted psammophytic scrub plant community characterized by Croton wigginsii, Eriogonum deserticola, Helianthus niveus ssp. tephrodes, Palafoxia arida var. gigantea, Pholisma sonorae, Tiquilia plicata, Petalonyx thurberi, and Panicum urvilleanum that provides habitat for insect pollinators, particularly the white-faced digger bee (Habropoda pallida), required for reproduction (USFWS, 2008)

(iii) Areas within intact, active sand dune systems between occupied bowls, swales, and slopes that allow for pollinator movement and wind dispersal of fruit and seeds. (USFWS, 2008)

Special Management Considerations or Protections

Special management considerations or protection may be required to minimize impacts to Astragalus magdalenae var. peirsonii habitat resulting from OHV recreation. The BLM (2003, Appendix 1, p. 13) listed the following possible management options to protect A. m. var. peirsonii and its habitat: (1) Use restrictions based on a permit system that would allow a specified level of use (high, medium, low, no use); (2) temporally based closures or limitations (open during some months or years, closed in others); (3) recognition and management of certain areas within a management area; and/or (4) increased education and outreach to OHV users to avoid certain areas. Special management considerations or protection needed may also include additional enforcement to ensure visitor compliance with these management options. (USFWS, 2008)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrossing (NatureServe, 2015)

Breeding Season

Adult: mid-November through May (USFWS, 2019c)

Key Resources Needed for Breeding

Adult: Sufficient rain (USFWS, 2019c)

Other Reproductive Information

Adult: Plants, regardless of age, may flower from as early as mid-November through May. Mature fruits are found on plants from the beginning of February to late June, with peak production occurring in March and April . In the spring of 2002, Porter et al. (2005) documented fruit set in Astragalus magdalenae var. peirsonii. They found a range of 0 to 4,311 fruits per plant, with a mean of 629 . There was a significant correlation between the number of seed pods and plant size, and plant size explained approximately 39 percent of the observed variation in fruit set. (USFWS, 2019c)

Reproduction Narrative

Adult: The seeds of Astragalus magdalenae var. peirsonii exhibit a long-term dormancy mechanism in which the hardened layers of the outer seed coat are impermeable to water. Seeds must be scarified (abraded, cut, or disrupted in some way) for water to penetrate the seed and induce germination. Astragalus magdalenae var. peirsonii displays different reproductive strategies depending on the level and time of precipitation. If winter rains begin in early November, seeds germinating in early December may grow rapidly, flower by February, and set seed in March. In wetter years, a second germination event may occur in late winter, but these plants often fail to reproduce and die in large numbers at the onset of summer drought. If winter rains do not occur until late January, sufficient soil moisture or time may not exist for young plants to develop the root structure needed to flower and set seeds before the onset of desiccating summer heat. Both seedling and adult plants display very high annual mortality. Young plants often die during summer in significant numbers, likely because such

plants lack a sufficiently developed root system to tap water from deeper soils. Older plants also die during the summer. However, some plants develop an adequate root system and perennate to live 2 to 3 years. Some perennial individuals will flower and produce seeds in years with no precipitation. Years with optimal or prolonged precipitation may experience two or more germinations and increased seed production. (USFWS, 2019c)

Habitat Type

Adult: Terrestrial (USFWS, 2019c)

Habitat Vegetation or Surface Water Classification

Adult: Sonoran desert scrub, sand dune (USFWS, 2019c)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2003)

Habitat Narrative

Adult: Astragalus magdalenae var. peirsonii occurs on the bowls, swales, and slopes of active, windblown sand dunes. The majority of A. m. var. peirsonii habitat within the Algodones Dunes is located along the western edge of the dune system. In this area, a series of barchan dunes is oriented northwest to southeast, and aligned with seasonal wind patterns. Each dune is a sequence composed of a back dune, a dune slip face, and a bowl. Winds move sand along the back dune and over-deposit sand grains on the slip face, which is highly unstable. The dune bowl is a blow-out area from the bottom of the slip face that transitions up-slope to the back dune of the next dune sequence. Astragalus magdalenae var. peirsonii is generally associated with the upwind back dune area of most dune sequences, where sand is wind-packed and more stable. (USFWS, 2019c)

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2003)

Dispersal/Migration Narrative

Adult: Astragalus magdalenae var. peirsonii seeds are the largest of any Astragalus in North America (Barneby 1964, pp. 862–863). Bowers (1996, p. 69) found that A. m. var. peirsonii seeds averaged 0.2 inches (4.7 (millimeters (mm)) in length and 15 milligrams (mg) in weight, and McKinney et al. (2006, p. 85) reported similar average seed lengths of approximately 0.2 in 6 (4.98 mm) (n=73). Seed pods may contain 11 to 16 ovules (Barneby 1964, p. 862). McKinney et al. (2006) reported an average of 11.41 mature seeds and ovules per pod (n=78) (p. 85). An average of 5.2 mature seeds were present per pod (McKinney et al. 2006, p. 85), indicating that only a portion of ovules develop into mature seeds. The inflated fruits may be blown by winds (ASA 2002, p. 23; Porter 2003, p. 5), and may become buried in the dune surface (ASA 2002, p. 23). While some seeds may remain within the fruits, both Porter (2003, p. 3) and Phillips and Kennedy (ASA 2002, pp. 23–24) noted that a large number of solitary seeds were found on the dune surface. It is possible that the large, inflated fruits may have some role in seed germination (Porter 2003, p. 3), but this observation has not been studied further. Porter (2003, p. 5) observed rodent seed caches of A. m. var. peirsonii within the Algodones Dunes Wilderness, but it is not known whether caches occur in other parts of the dunes, or whether rodent caching is

an important seed dispersal mechanism for this taxon. (USFWS, 2019c)

Population Information and Trends

Population Trends:
Unknown (NatureServe, 2015)

Number of Populations:
1 - 20 (NatureServe, 2015)

Population Size:
< 100,000 to > 1.5 million, depending on climatic conditions (NatureServe, 2015)

Population Narrative:
Porter et al. (2005, p. 21) considered Astragalus magdalenae var. peirsonii at the Algodones Dunes to be a single, extensive population. However, Astragalus magdalenae var. peirsonii is not evenly distributed throughout the dunes. The population extends northwest to southeast across the dunes, and plants generally occur in the western, interior portions of the dunes. Plant density is generally lower in the northern areas of the dunes, and higher in southern areas of the dunes. The Service's analysis of BLM's 2005 surveys indicate that A. m. var. peirsonii occurred in 21 percent of the cells surveyed across the dune system. Eleven percent of the cells surveyed contained fewer than six plants per cell, and half of the total number of plants recorded in 2005 occurred in just 0.7 percent of the cells. (USFWS, 2019c)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: The primary threat to Astragalus magdalenae var. peirsonii was considered to be the destruction of individuals and dune habitat from OHV use and the associated recreational development. The Service's 2008 12-month finding and 5-year review continued to consider OHV activity to be the primary threat to A. m. var. peirsonii habitat. The implementation of BLM's 2013 Imperial Sand Dunes Recreation Area Management Plan (ISD-RAMP) have largely ameliorated Factor A threats to A. m. var. peirsonii in areas designated as critical habitat. Astragalus magdalenae var. peirsonii habitat continues to be impacted by OHV use within the Open Management Area, and by vehicle trespass into critical habitat closures. Continued educational efforts by BLM and dune associations may reduce the incidence of trespass over time). (USFWS, 2019a)

Stressor: Predation and herbivory (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Herbivory and seed predation by native insects and rodents may impact Astragalus magdalenae var. peirsonii at the Algodones Dunes by reducing plant reproductive output or consuming seeds post-dispersal. However, information about these impacts is observational, and

impacts have not been well studied across the dunes or through time. The degree to which native insects and rodents may benefit A. m. var. peirsonii—for example, by scarifying or dispersing seeds—is also unknown. We do not believe that herbivory and seed predation by native taxa are likely to pose a direct threat to the conservation of A. m. var. peirsonii. Rather, these taxa are part of the ecology of A. m. var. peirsonii, and other threats to this variety should be considered in the context of baseline levels of herbivory and predation by native taxa. Nonnative aphids have been observed on A. m. var. peirsonii, but we do not have enough information to fully analyze the geographic scope, magnitude, or immediacy of this potential threat. We will update our threats assessment if new information about the impacts of nonnative aphids becomes available. (USFWS, 2019a)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: BLM's closure and ongoing management of Astragalus magdalenae var. peirsonii critical habitat has largely ameliorated direct OHV impacts to several stages of the taxon's life cycle within critical habitat. Plants within the Open Management area are still vulnerable to impacts from OHV use, and trespass into critical habitat closures also occurs. Other Factor E threats—low reproduction, loss of genetic diversity, and changing climate (changes in temperature and precipitation)—need additional study. Since A. m. var. peirsonii plants are self-incompatible, limited gene flow, loss of S-alleles within the population, or impacts to the primary pollinator could affect population viability. (USFWS, 2019a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Though there have been ongoing recreational impacts to Astragalus magdalenae var. peirsonii and its habitat since listing, Federal regulatory mechanisms have reduced the overall loss and degradation of habitat because of the taxon's occurrence on BLM lands. BLM completed the ISD- RAMP in 2013, which provides management and protections for A. m. var. peirsonii. In order to comply with the Service's Biological Opinion, BLM is implementing (1) a monitoring plan for A. m. var. peirsonii which monitors the status of the taxon within and outside of critical habitat (CM 1) (BLM 2018a, pp. 5–7), and (2) four management actions to minimize recreational impacts to Peirson's milk-vetch and its habitat (CM 2) (BLM 2018a, pp. 7–14). We believe that the Act continues to remain the primary regulatory mechanism providing for the conservation of A. m. var. peirsonii. BLM's management and implementation of provisions in the ISD-RAMP have also contributed considerably to the protection of this taxon. (USFWS, 2019a)

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
A.1 Occupancy is maintained within the seven Astragalus magdalenae var. peirsonii occurrences at the Algodones Dunes. Population connectivity among the seven occurrences is maintained at

a level that allows seed bank regeneration and gene flow. (USFWS, 2019b)

A.2 The level, timing, and duration of permitted OHV use in the Open Management Area occupied by Astragalus magdalenae var. peirsonii is compatible with the recovery and longterm conservation of the taxon. (USFWS, 2019b)

E.1 The life history, genetics, and seed bank dynamics of Astragalus magdalenae var. peirsonii are sufficiently understood to allow confident scientific conclusions that impacts from OHV use in occupied areas are consistent with the long-term resilience of this taxon. (USFWS, 2019b)

E.2 Mean population size of Astragalus magdalenae var. peirsonii at the Algodones Dunes is stable or increasing for 20 years. (Twenty years represents the time frame over which three full-scale monitoring events are likely to occur. Stable or increasing population size would be demonstrated by analysis of data from at least three additional full-scale monitoring efforts, analyzed in conjunction with previously collected monitoring data and controlled for growing season precipitation.) (USFWS, 2019b)

E.3 Long-term adaptive management plans have been developed throughout the U.S. range of Astragalus magdalenae var. peirsonii and are being implemented to ensure the long-term viability of the taxon. Adaptive management plans should be designed in consideration of ongoing management efforts and with post-delisting monitoring requirements in mind. (USFWS, 2019b)

E.4 Adequate levels of genetic diversity at S-loci are maintained and preserved in the U.S. population of A. m. var. peirsonii to maintain long-term viability of the taxon, and an ex situ seed bank representative of the genetic diversity in the population is established at an institution certified by the Center for Plant Conservation. (USFWS, 2019b)

Recovery Actions:

- 1. Continue monitoring of Astragalus magdalenae var. peirsonii, and ensure that the current monitoring protocol informs management of the taxon and allows us to accurately assess population trends. (USFWS, 2019d)
- 2. Conduct research projects to inform management actions that further Astragalus magdalenae var. peirsonii recovery. There are numerous gaps in our understanding of A. m. var. peirsonii biology and ecology. Additional information will also inform the development of an adaptive management plan and future status reviews. 2.1. Further study seed predation by native taxa and seed scarification mechanisms. (USFWS, 2019d)
- 3. Ameliorate Factor A threats associated with present or threatened destruction, modification, or curtailment of the habitat or range of Astragalus magdalenae var. peirsonii at the Algodones Dunes. (USFWS, 2019d)
- 4. Ameliorate Factor E threats associated with other natural or manmade factors affecting the continued existence of Astragalus magdalenae var. peirsonii at the Algodones Dunes. (USFWS, 2019d)

References

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Carlsbad Fish and Wildlife Office. 62 pp. July 10, 2019.

USFWS. 2019b. Recovery Plan for Astragalus magdalenae var. peirsonii (Peirson's milk-vetch). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. iv + 23 pp.

USFWS. 2019d. Recovery Implementation Strategy for Astragalus magdalenae var. peirsonii. U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. ii + 15.

SPECIES ACCOUNT: *Astragalus montii* (Heliotrope milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/06/1987; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

Astragalus montii is a small, tufted perennial herb, 1-5 cm tall, producing pink-purple flowers, the wings white-tipped, and purple-mottled, globe-shaped fruits. (NatureServe, 2015)

Taxonomy

It has also been recognized as a variety of Astragalus limnocharis (Isely, 1983), but the Service considers it to be a distinct species. (USFWS, 1987)

Historical Range

The species has not been found in areas other than those currently known. (USFWS, 1995)

Current Range

Occurs on the southern Wasatch Plateau on Ferron, Heliotrope and White mountains in Sanpete and Sevier counties (Franklin, 2005). (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/6/1987.

Legal Description

On November 6, 1987, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus montii (Heliotrope milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Utah (52 FR 42652-42657).

Critical Habitat Designation

The critical habitat designation for Astragalus montii includes one CHU in Sanpete County, Utah. This species critical habitat encompasses approximately 65 acres (52 FR 42652-42657).

Utah, Sanpete County, western Heliotrope Mountain.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus montii critical habitat are the following (52 FR 42652-42657):

The primary constituent element is the white limestone barrens of the Flagstaff Formation.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Mixed selfing and outcrossing (USFWS, 1995)

Dependency on Other Individuals or Species

Adult: Wild bees for pollination (USFWS, 1995)

Breeding Season

Adult: Flowers as soon as snow melts - usually mid-June (USFWS, 1995)

Reproduction Narrative

Adult: Astragalus montii reproduction is sexual. Asexual reproduction is unknown. The plants begin flowering immediately after winter snows melt in their subalpine habitat, usually about mid-June. The stigmas are receptive during the first three days of anthesis. The species is capable of self-fertilization but has significantly higher seed production and presumed higher vigor from cross-fertilization (Geer and Tepideno 1993). The species is pollinated by wild bees of the family Megachilidae, especially those of the genus Osmia (Tepideno and Griswold 1990). The seeds are shed beginning in July and continuing into August. (USFWS, 1995)

Habitat Type

Adult: High elevation limestone barrens (USFWS, 1995)

Habitat Vegetation or Surface Water Classification

Adult: Subalpine mixed grass-forb communities. (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Rocky, limestone soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Presumably clumped (inferred from USFWS, 1995)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1995)

Habitat Narrative

Adult: The habitat of A. montii is high elevation, 3,200 to 3,352 meters (10,500 to 11,000 ft), limestone barrens derived from the Flagstaff Geological Formation. The species habitat type is an inclusion within a subalpine mixed grass-forb plant community with scattered stands of subalpine fir (Abies lasiocarpa) and Engelmann spruce (Picea engelmannii) krummholz. (USFWS, 1995)

Dispersal/Migration

Population Information and Trends

Population Trends:

Not well known (USFWS, 1995)

Species Trends:

Not well known (USFWS, 1995)

Number of Populations:

3 (NatureServe, 2015)

Population Size:

~2,000,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 1995)

Population Narrative:

The heliotrope milk-vetch is slow growing and intolerant of habitat disturbance. The three populations numbered about 2500, 4000, and 4000 each as of 1985 (Lowe, 1990, WWF Guide to Endangered Sp.). Franklin (2005) estimated that 2 million individuals were present across three populations, with 65% of those individuals occurring at one site. Three known populations: Ferron Mountain, White Mountain and Heliotrope Mountain (Franklin 2005). (NatureServe, 2015) The size of the populations in the limited area it occupies, along with the apparent fluctuation in numbers, implies a healthy population growth rate. (inferred from USFWS, 1995; NatureServe, 2015)

Threats and Stressors

Stressor: Oil and gas activities (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Oil and gas exploration, drilling, and production, are past, existing and potential threats to the habitat of A. montii. The population of A. montii is underlain by petroleum deposits associated with the "Overthrust Belt" of the western United States. Habitat disturbance associated with unrestricted oil and gas exploration and production could have a serious impact on its survival. (USFWS, 1995)

Stressor: Sheep grazing (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Limited sheep grazing under grazing management plans occur in the habitat of A. montii. Actual detrimental impacts to this species resulting from direct grazing or trampling have not been observed. The Wasatch Plateau was more intensely grazed historically, but Forest Service grazing management plans have reduced grazing to levels believed to be compatible with the conservation of A. montii and its immediate plant community. The harshness of the alpine environment contributes to the fragility of the A. montii ecosystem. Disturbances may have catastrophic and as yet unknown long-term consequences to such a narrow endemic occupying these subalpine habitats. (USFWS, 1995)

Recovery

Delisting Criteria:
A total population of 200,000 A. montii individuals is documented for 5 consecutive years. (USFWS, 1995)

All three populations have been maintained at minimum viable population levels for 5 consecutive years. (USFWS, 1995)

Establish and implement formal land management designations and resource management plans for each of the three populations to assure their continued long-term protection. (USFWS, 1995)

Recovery Actions:

- Control activities which affect the habitat of A. montii through Sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 1995)
- Inventory suitable habitat for A. montii and determine with a high degree of accuracy the population and distribution of the species. (USFWS, 1995)
- Determine the biological and ecological factors critical to the species conservation and conduct minimum viable population studies in each of the species known populations. (USFWS, 1995)
- Establish and implement formal Forest Service land management designations and habitat management plans which will provide for long term, undisturbed protection for A. montii and its habitat. (USFWS, 1995)
- Develop public awareness, appreciation, and support for the conservation of A. montii. (USFWS, 1995)
- None specified

References

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SPECIES ACCOUNT: *Astragalus osterhoutii* (Osterhout milkvetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/13/1989; Mountain-Prairie Region (R6) (USFWS, 2015)

Physical Description

A tall rush-like plant with linear leaflets and several bright green stems up to 100 centimeters (40 inches) tall. There are 12-25 large white flowers, 2.4 centimeters (1.0 inch) long, per inflorescence (flowering stalk), and stipitate pendulous pods, 4.5 centimeters (1.8 inches) long. (USFWS, 1992)

Taxonomy

Astracialus osterhoutii Jones was described in 1923 by Marcus Jones (in Barneby 1964) from material first collected by George Osterhout in 1905 and 1906 at "Sulphur Springs" in Grand County. A member of the pea family (Fabaceae). (USFWS, 1992)

Historical Range

Endemic to Middle Park near Kremmling in Grand County, Colorado (USFWS, 1992).

Current Range

Near Kremmling in Grand County, Colorado .(USFWS, 1992)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 1992)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: June - August (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1992)

Reproduction Narrative

Adult: A perennial plant. Flowers bloom June - August, followed by fruit (NatureServe, 2015). Karron (1987a) found that Astracialus osterhoutii shared generalist pollinators (polylectic bees) with the common Astracialus Dattersonii, rather than its own specialist species of pollinator, but it apparently had less pollinator visits (Karron 1987b). As expected for rare plant species, Astragalus osterhoutii, although an outcrosser, is still more self-compatible than widespread

congenes, evidenced by higher fruit set (Karron 1989) (USFWS, 1992).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Badlands, open shrubland (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: 2250 - 2400 m elevation (NatureServe, 2015); mountains surrounding Middle Park, closed shrubland vegetation (USFWS, 1992)

Spatial Arrangements of the Population

Adult: Scattered colonies (USFWS, 1992; see current range/distribution)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits highly seleniferous soils (grayish-brown clays) derived from Niobrara Shale. On moderate slopes, sometimes found growing up through sagebrush (Spackman et al. 1997). Occurs at 2250 - 2400 m elevation. Associated species: Artemesia tridentata, Chrysothamnus viscidiflorus, Gutierrezia sarothrae, Eurotia lanata, Phlox hoodii, Eriogonum brevicaule, Agropogon smithii (NatureServe, 2015). Expansion and migration to possibly suitable habitats elsewhere is blocked by the high mountains surrounding Middle Park. Where shrubs, particularly big sagebrush, have increased in density, resulting in a more closed shrubland vegetation type, the Osterhout milkvetch is reduced in density. Osterhout milkvetch shows evidence of light grazing and can be found on old road cuts and fills, indicating some tolerance for disturbance (Bio/West 1987). The badlands where this species grows are characterized by an open grassy vegetation with scattered shrubs (USFWS, 1992).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

5 (NatureServe, 2015)

Population Size:

2,500 - 50,000 (NatureServe, 2015)

Adaptability:

Low (inferred from USFWS, 1992)

Population Narrative:

The long term population trend is unknown. Restricted to a specialized soil type which is vulnerable to alteration by human activities. The Federal Register (1998) states that there are 25,000 to 50,000 individuals. There are 6 principal occurrences documented in the Colorado Natural Heritage Program database. One of the 6 occurrences has not been observed in over 20 years (NatureServe, 2015). Life history studies indicate that Astracialus osterhoutii has the rare plant attributes of low pollinator visitation and low genetic polymorphism. (USFWS, 1992).

Threats and Stressors

Stressor: Off-highway vehicles (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Presently, the major threat is from habitat destruction from all-terrain vehicles going off road. OHVs target the barren hillsides that are Astragalus osterhoutii's habitat. The Colorado Natural Areas Program has worked with the State Land Board and the local OHV community on the Idiot's Hill population to mitigate OHV impacts, by keeping folks on trails and away from A. osterhoutii, and in 2011 put up an interpretative sign at the site (NatureServe, 2015).

Stressor: Reservoir construction (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: The major population of Astracialus osterhoutii along Muddy Creek, on 132 acres and representing about 90 percent of the total for the species, is threatened by the proposed Muddy Creek Reservoir. With construction of the high dam proposal at 7,485 feet elevation, 18 acres or about 3 percent of the Muddy Creek population would be inundated. In addition, 80 acres, or 60 percent of the habitat of Astracialus osterhoutii, could be threatened by secondary impacts from recreational activities associated with the Muddy Creek Reservoir proposal. Additional direct losses from reservoir construction could result from the raised water table through perennial soil saturation and from surface disturbance due to construction activities such as road building, creation of borrow pits, and heavy equipment movement (Bio/West 1988, Grah and Neese 1987). The presence of the reservoir would likely stimulate private development within the plant’s range near the reservoir (USFWS, 1992).

Stressor: Mining and energy development (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Mining claims exist along Muddy Creek where the Osterhout milkvetch occurs. This habitat is open to oil and gas leasing (USFWS, 1992).

Recovery

Reclassification Criteria:

The following criteria should ensure the continued existence of the species and the maintenance of its habitat:

1. Land management designations are established and habitat management programs are developed and implemented for all known populations of Astracialus osterhoutii (USFWS, 1992).

2. The species is protected from detrimental environmental impacts through fulfillment of informal and formal consultation responsibilities under Section 7 and protection regulations under Section 9 of the Endangered Species Act (USFWS, 1992).

Factors required to establish and maintain minimum viable populations of the species are identified and minimum viable populations are documented as being maintained (USFWS, 1992).

Delisting Criteria:
N/A: removal from the list of endangered and threatened species (recovery) is not considered feasible because of small natural populations, limited habitat, and persistent nature of potential threats (USFWS, 1992).

Recovery Actions:

- Inventory any remaining potential habitat: Identifying and surveying potential habitat is important for both species, but especially so for Penstemon penlandii due to its very limited known distribution. The best way to ensure this species long-term viability would be to discover more populations and ensure their protection and management. Most populations of Penstemon oenlandii occur on private lands. The discovery of additional populations of this species on public lands would decrease the species vulnerability and help ensure its long-term viability. Surveys for this species on public lands are a high priority need. (USFWS, 1992)
- Protect existing habitat: Because of the limited amount of habitat, it is important that known habitats be impacted as little as possible. Various strategies are needed for the different threats and landownerships. (USFWS, 1992)
- Protect pollinators Successful reproduction and maintenance of genetic diversity requires sufficient numbers and types of pollinators. (USFWS, 1992)
- Conduct life history/ecology studies In order to understand how to establish and maintain minimum viable populations of each species, additional population biology and ecology studies are necessary. (USFWS, 1992)
- Future actions: The necessity of these actions will be determined by the results of the studies described above. These may include: Management of surface disturbance; Management of plant communities; and Restoration of disturbed habitats. (USFWS, 1992)
- CLARIFIED RECOVERY CRITERIA Population Based Recovery Criteria P-1. Overall population trends for Osterhout milkvetch and Penland beardtongue must be stable or increasing across the current range of each species (as described above) according to the following measures and not reduced from the baseline (see description of baseline above): a) Range-wide populations trends (measured using density (plants/m2JJ must be stable or increasing over a 10-year period as determined by the Bureau of Land Management's monitoring methodology (BLM 2017); and b) Range-wide population trends (measured using density (plants/m2JJ must maintain at least 90 percent confidence that Osterhout milkvetch and

Penland beardtongue density estimates are within 10 percent of their estimated true value (BLM 2017). Data collected in years preceding this clarification can be used to measure this criterion. (USFWS, 2020)

References

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USFWS. 2020. 5-YEAR REVIEW California clapper rail (Rallus longirostris obsoletus). 33 pp.

SPECIES ACCOUNT: *Astragalus phoenix* (Ash meadows milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/20/1985; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

A low, mat-forming perennial herb; mats up to 5 dm in diameter. Purple flowers are borne on tiny erect stems from April to early May (NatureServe, 2015).

Taxonomy

A member of the Fabaceae (pea family) (USFWS, 2009).

Historical Range

This species is endemic to the Ash Meadows area of Nye County, Nevada (USFWS, 2009).

Current Range

Occurs in a 7 x 3 mile area in Ash Meadows, Nye Co., Nevada (NatureServe, 2015). The range of the species encompasses the Ash Meadows National Wildlife Refuge and adjacent Bureau of Land Management and private lands (USFWS, 2009).

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus phoenix (Ash meadows milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Astragalus phoenix includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus phoenix critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include dry, hard, white, barren, saline, clay flats, knolls, and slopes.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilization (USFWS, 2009)

Lifespan

Adult: Unknown, presumed > 10 years (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: Probably Anthophora porterae (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Winter and early spring rains (USFWS, 2009)

Reproduction Narrative

Adult: Flowers are present from April to early May (Reveal 1979, pp. 2 - 4 and 14 - 15). The biology and life history of the Ash Meadows milkvetch are consistent with a stress-tolerant life history as described by Grime (1977, pp. 1175 - 1181; 1984, pp. 29 - 33). Stress-tolerant plants are typically relatively long-lived with low annual seed production, except during favorable conditions (Grime 1977, pp. 1174 and 1180). Reveal notes winter and early spring rains are required to produce large numbers of flowers, but some flowering probably occurs each year regardless of conditions. During a year with above average precipitation, seed production was estimated to be between 45 and 246 fully formed seeds per average size plant. An examination of the seed to ovule ratio in mature fruits suggested that the ash Meadows milkvetch is an inbreeding species with no pollinator limitations (Pavlik et al. 2006, p. 29). More recent studies indicate that it is visited by a bee (Anthophora porterae) that is likely a vital pollinator for the species (Bio-West 2009, pg 3). Germination events and seedlings are rare (Reveal 1978, p. 12). The lifespan of individual pants is not known, but is believed to exceed 10 years (USFWS, 2009).

Habitat Type

Adult: Terrestrial, wetland, spring (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert wetland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 2,200 - 2,300 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from USFWS, 2009; see reproduction narrative)

Habitat Narrative

Adult: Occurs on dry, hard, white, barren flats, washes, and knolls of calcarious alkaline soils at Ash Meadows - a desert wetland ecosystem maintained by several dozen springs and seeps (NatureServe, 2015). Given the presence of salt crusts and occurrence of halophytes, it is likely that Ash Meadows milkvetch has adaptations that allow it to tolerate saline soils. It grows between 2,200 and 2,300 feet above sea level. Surface and/or subsurface groundwater that

reaches the surface through capillary action may be an important habitat determinant for at least some populations (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Wind and water appear to be the primary vectors for dispersal (Reveal 1978, p. 12). Reveal (1978, p. 14) observed much of the seed produced probably does not disperse long distances and remains within the leaves and branches of the parent plant (USFWS, 2009).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Improving (USFWS, 2009)

Number of Populations:

12 (USFWS, 2020)

Population Size:

~15,606 (USFWS, 2020)

Population Narrative:

At the time of listing, it was estimated that there were 1,000 Ash Meadows milk-vetch individuals (Reveal 1978). In 2001, the Ash Meadows milk-vetch population was estimated to be approximately 1,943 individuals (Morefield 2001). Results from the 2008–2010 Refuge-wide rare plant survey estimate that 15,606 individuals are present on the Refuge (Table 1; BIOWEST 2011). Distribution of Ash Meadows milk-vetch is provided in Figure 1. (USFWS, 2020)

Threats and Stressors

Stressor: Groundwater pumping (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: This species depends, in part, on near-surface water for its survival. Although the Service has established water rights to 96% of the spring discharge within the Refuge, the Service will have to demonstrate through analyses that the net impact of any change applications will have a negative effect on Ash Meadows. To the extent that the Service is unsuccessful in demonstrating net negative impacts in at least some of these cases, additional incremental declines in spring discharge may occur at Ash Meadows. Such incremental declines could be difficult to attribute to any particular cause after the fact and, therefore, would be difficult to remedy (USFWS, 2009).

Stressor: Surface mining (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The playa sediments covering much of the ash Meadows area contain clays and other minerals, which may be considered "uncommon varieties", and therefore could potentially be classified as "locatable minerals" under existing mining laws. New mineral claims and subsequent mining could cause direct loss of Ash Meadows milkvetch habitat, as well as indirect impacts by diverting or draining water away from occupied habitat. About 80% of the known occurrences of Ash Meadows milkvetch within the Refuge are open to mineral entry (USFWS, 2009).

Stressor: Nonnative species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Over 100 nonnative species occur on the Refuge. Of these, salt cedar, Russian knapweed, five hook bassia, Malta star thistle, yellow star thistle, and hoary cress are noxious weeds that could potentially threaten the Ash Meadows milkvetch (Service 2006, p. 8). Cheatgrass, red brome, Mediterranean grass, and annual fescue are annual grasses that could potentially threaten the Ash Meadows milkvetch (USFWS, 2009).

Stressor: Rabbit herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: During a demographic study initiated in the spring of 2005, Pavlik et al. (2006, p. 9) found that a very high proportion of developing fruits had been clipped off at the pedicel and eaten by rabbits. They found an 80% loss of potential reproductive output across all subpopulations. Herbivory poses no short-term threat to Ash Meadows milkvetch because individual plants are long-lived, but the significance of any threat posed by rabbits to its persistence over the foreseeable future is poorly understood (USFWS, 2009).

Recovery

Reclassification Criteria:
1. All non-native animals and plant species must be eradicated for essential habitat. These non-native species currently include sailfin mollies, mosquito fish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive (USFWS, 2009).

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 2009).

3. Reestablish water to historic springbrook channels, which are free of barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic range (USFWS, 2009).

4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 2009).

Delisting Criteria:
1. Criteria shown above for downlisting from endangered to threatened (USFWS, 2009).

2. Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 2009).

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats (USFWS, 2009).

4. All of the listed plant species and the candidate plant species are present in all the sites that they have historically occupied as identified in Appendix A Table XV of the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater that the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population (USFWS, 2009).

Recovery Actions:
- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new & existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).
- Over the next five years, the Service should focus on clarifying or resolving the uncertainties regarding the significance of the remaining threats to Ash Meadows milkvetch, i.e., groundwater pumping, surface mining, and herbivory (USFWS, 2009).
- The Service anticipates that major issues with respect to the significance of the threat posed by groundwater pumping will become clear over the next five years. Specifically, we expect that the Nevada State Engineer will clarify how Order 1197 will be implemented. In addition, environmental analyses will likely be completed on the anticipated effects of at least some of the proposed solar energy projects, and these should include detailed assessments of the potential effects of any groundwater development requirements on the regional and local aquifers, including potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these analyses to ensure that they adequately disclose all potential impacts that could affect Ash Meadows milkvetch. The Service will also continue its participation in interagency monitoring, modeling, and assessment of the Death Valley Groundwater Flow System (USFWS, 2009).
- The Service and BLM should continue to work toward the completion of the land and mineral withdrawals for public lands within the Refuge and the ACEC. This will likely require that once the withdrawal packages have been forwarded by BLM's Nevada State Director to BLM's Washington Office, that briefings be scheduled with the Service's Washington Office to ensure that the importance of this withdrawal to all of the listed spies at Ash Meadows, as well as the ash Meadows ecosystem, is recognized (USFWS, 2009).
- Research on the potential significance of the rabbit herbivory on the long-term viability of Ash Meadows milkvetch should be prioritized, especially research focused on whether a sufficient seed bank is present to support recruitment when the proper environmental

conditions occur. This research should also address potential management options to mitigate the impacts of herbivory on Ash Meadows milkvetch. Additional research is also needed on the sensitivity of the species to hydrological alterations and, in particular, its dependency on soil moisture drawn by capillary action from the near surface groundwater table. Finally, research is needed on the role of hydrologic process in seed dispersal and the extent to which past surface modifications have disrupted this process and the degree to which that affects the viability of current populations (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Over the next five years, the Service should focus on: • Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). • Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); • Support Ash Meadows milk-vetch research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); • Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. • Continue to research and implement a jackrabbit exclusion study to determine the impacts jackrabbits are having on reproduction of Ash Meadows milk-vetch. (USFWS, 2020)

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U.S. Fish and Wildlife Service. 1990. Recovery plan for the endangered and threatened species of Ash Meadows, Nevada. U.S. Fish and Wildlife Service, Portland, Oregon. 123 pp.

USFWS. 2020. 5 5-YEAR REVIEW Ash Meadows milk-vetch (Astragalus phoenix). 9 pp.

SPECIES ACCOUNT: *Astragalus pycnostachyus var. lanosissimus* (Ventura Marsh Milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/21/2001; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Astragalus pycnostachyus var. lanosissimus is a short-lived herbaceous perennial. It has a thick taproot and multiple erect, reddish stems, 40 to 90 centimeters (cm) (16 to 36 inches (in)) tall that emerge from the root crown. The pinnately compound leaves are densely covered with silvery-white hairs with 27 to 39 leaflets that are 5 to 20 millimeters (mm) (0.2 to 0.8 in) long. The numerous yellowish-white to cream colored flowers are in dense clusters and are 7 to 10 mm (0.3 to 0.4 in) long with 2 to 4 cm (0.8 to 1.6 in) peduncles (Spellenberg 1993). The calyx tube is 3 to 4 mm (0.12 to 0.16 in) long with 1.2- to 1.5-mm (0.04-in) long calyx teeth (Spellenberg 1993). The nearly sessile, single-celled pod is 8 to 11 mm (0.31 to 0.43 in) long (Barneby 1964) (USFWS, 2010).

Taxonomy

Member of the Fabaceae (pea family) (USFWS, 2010).

Historical Range

Historically, Ventura to Orange County, California; along the coast in salt marshes (NatureServe, 2015).

Current Range

Currently known from one naturally-occurring site in Ventura County (U.S. Fish and Wildlife Service 2001). There are also four introduction sites, two in Ventura County and two in Santa Barbara County (which is outside the historic range of this taxon) (M. Meyer pers. comm. 2010) (NatureServe, 2015).

Critical Habitat Designated

Yes; 5/20/2004.

Legal Description

On May 20, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus pycnostachyus var. lanosissimus (Ventura Marsh Milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (69 FR 29081-29100).

Critical Habitat Designation

The critical habitat designation for Astragalus pycnostachyus var. lanosissimus includes three CHUs in Santa Barbara and Ventura Counties, California. This species critical habitat encompasses approximately 420 acres (ac) (170 hectares (ha)) (69 FR 29081-29100).

Mandalay Unit: The Mandalay Unit is approximately 153 ac (62 ha) in size and is essential to the conservation of Astragalus pycnostachyus var. lanosissimus because it contains the only known

location where Astragalus pycnostachyus var. lanosissimus naturally exists and the remainder of the unit also supports the primary constituent elements. The State-owned Mandalay State Beach is managed by the Ventura County Parks and Recreation Department and comprises about 49 ac (20 ha) of this unit. The remaining area of the unit is privately owned and is currently undeveloped, but has been chosen as the site for a 300-housing-unit subdivision (Economic and Planning Systems, Inc. 2003). The pending development is called North Shore at Mandalay and would occur in the eastern portion of this critical habitat unit. The project includes a 1.65-ac (0.67-ha) ''milk-vetch preservation area'' encompassing the entire natural population (California Coastal Commission 2002), which in turn, would be inside a 23.8-ac (9.6-ha) resource protection area (RPA). The RPA would be buffered from adjacent residential development by a 50-ft (15 m) wide landscaped area. The population will be mostly isolated from surrounding vegetation, and the ecological processes sustaining the population may be interrupted. Also, the project may allow increased human intrusion, provide habitat for nonnative plants and snails, alter the hydrologic regime, and introduce pesticides and fertilizers that adversely affect the plants. Therefore, the risk of extinction of the subspecies is high without the development of additional populations. The portion of this unit on Mandalay State Beach is identified by Wilken and Wardlaw (2001) as a possible site for establishing a new population of Astragalus pycnostachyus var. lanosissimus. In 2003, the first efforts at researching how new populations could be established in this unit were begun. The proximity of Mandalay State Beach to the extant population indicates that some natural exchange of seeds or pollen could take place if a second population were established at Mandalay State Beach. The site contains one or more of the primary constituent elements defined for Astragalus pycnostachyus var. lanosissimus critical habitat, although Wilken and Wardlaw (2001) note some dense cover of nonnative annuals. Also, using their five parameters, Wilken and Wardlaw (2001) ranked the Mandalay State Beach portion of this unit as one of the most similar to the natural occurrences of Astragalus pycnostachyus var. lanosissimus and the closely related Astragalus pycnostachyus var. pycnostachyus, and hence one of the top candidates for establishing a new population. California Department of Parks and Recreation (CDPR) has approved experimental introductions of Astragalus pycnostachyus var. lanosissimus conducted by the CDFG. Because the area is public land owned by the CDPR and the species is Statelisted, we will work with the State to develop conservation strategies to reintroduce the subspecies and develop and manage reserves. As discussed above, this unit is essential for the conservation of Astragalus pycnostachyus var. lanosissimus because it contains the primary constituent elements for Astragalus pycnostachyus var. lanosissimus. The population of Astragalus pycnostachyus var. lanosissimus at the North Shore at Mandalay site is the only naturallyoccurring, self-perpetuating population of the species in existence. It has provided all of the initial propagules for establishing research populations of the species at other sites, and continues to be the source of genetic variability for future propagation. The research populations at McGrath State Beach and Carpinteria Marsh are not intended to become new populations for the recovery of the species, but were established to generate data on the species' needs when such introductions for recovery begin. Their persistence is uncertain, and we have observed some failures (see Background section). Consequently, the population of Astragalus pycnostachyus var. lanosissimus on the North Shore at Mandalay site is currently the only one of which we can be relatively certain that the plants will persist. If this population is extirpated, and the research populations ultimately fail, all of the remaining individuals of Astragalus pycnostachyus var. lanosissimus will exist as seeds in collections or propagated in greenhouses. The designation of the North Shore at Mandalay site as critical habitat recognizes that this population is essential to the species' conservation. This southernmost unit is geographically separated from other critical habitat within its historical

range. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

McGrath Unit: The site within McGrath Beach State Park is adjacent to McGrath Lake on the leeward side of the southern end of the lake, between the lake and Harbor Boulevard. The unit covers 62 ac (25 ha). It includes 35 ac (14 ha) of private land and 27 ac (11 ha) of State-owned land managed by CDPR. Of the sites they examined, Wilken and Wardlaw (2001) identify the McGrath Lake area as having the best combination of habitat characteristics similar to that of the extant population of Astragalus pycnostachyus var. lanosissimus and its closest relative, Astragalus pycnostachyus var. pycnostachyus based upon five parameters (i.e., dominant vegetation composed of a shrub canopy less than 75 percent; absence of competitive annual or perennial exotic plants; water table in close proximity; soil types consistent with that at the site of the extant population; and native habitat supporting pollinators). CDPR agreed to allow CDFG and RSABG establish a research population on this site. This effort is still in its early stages, and no conclusive data have yet been retrieved. Because the area is currently operated by CDPR and is public land, there is opportunity to work with the State to develop reintroduction strategies for Astragalus pycnostachyus var. lanosissimus and to form manageable reserves. This unit is also one of the last known places where the subspecies was observed growing naturally, and it is close to the extant population and shares many of the broader climatic and habitat features of that site. As discussed above, this unit is essential for the conservation of Astragalus pycnostachyus var. lanosissimus because it once supported a population Astragalus pycnostachyus var. lanosissimus until it was extirpated in 1967. It contains the primary constituent elements for Astragalus pycnostachyus var. lanosissimus. It includes habitat that is necessary for the expansion of the only known population, which may become nonviable in the future. It contains habitat features that are essential for this species including, but not limited to, high diversity of native plants, open canopy, sandy dune hollows, seep margin areas, subterranean water table. This central unit is geographically separated from other critical habitat within Astragalus pycnostachyus var. lanosissimus historical range. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

Carpinteria Salt Marsh Unit: The Carpinteria Salt Marsh Unit extends from the Southern Pacific Railroad tracks south and west to Sand Point Drive and Santa Monica Creek and is approximately 205 ac (83 ha) in size. The entire unit is managed by the UC, Santa Barbara. This unit includes saltmarsh habitat, which is essential to support the pollinators and other ecological processes that Astragalus pycnostachyus var. lanosissimus requires for its survival. The research population of Astragalus pycnostachyus var. lanosissimus was introduced in April 2002 into a portion of the unit. As of February 2003, 44 percent (68) of the 155 original plants survived. By June 2003, only 20 seedlings had been produced by plants at one of the planting sites. We have determined that this area contains the primary constituent elements necessary for the introduction of Astragalus pycnostachyus var. lanosissimus based on Wilken and Wardlaw's (2001) description of five parameters of habitat suitability. These parameters closely parallel the primary constituent elements, so one or more of the elements are represented at this site. The diverse native vegetation provides for a robust pollinator community. The unit is bordered by a residential community where nonnative snails were observed; protection is required for herbivory by snails on Astragalus pycnostachyus var. lanosissimus plants. This site in Santa Barbara County is near the range of the subspecies as predicted by the historical collections and described by Skinner and Pavlik (1994), who list the known counties as Ventura, Los Angeles, and Orange. We have included this unit because, although it is outside the historical range for Astragalus

pycnostachyus var. lanosissimus: (1) Insufficient suitable habitat for the subspecies remains within its historical range; and (2) the area has habitat features essential to the conservation of the subspecies, which suggests a high potential for successful establishment of a new population (Wilken and Wardlaw 2001). This unit is essential for the conservation of Astragalus pycnostachyus var. lanosissimus because it supports the pollinators and other ecological processes for Astragalus pycnostachyus var. lanosissimus. It contains habitat features that are essential for this species including, but not limited to, dominant vegetation composed of a shrub canopy less than 75 percent; absence of competitive annual or perennial exotic plants; water table in close proximity; soil type; and native habitat supporting pollinators. Seedling recruitment has been observed at this site in the research population. This northernmost unit is geographically separated from other critical habitat. This will reduce the likelihood of all populations being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus pycnostachyus var. lanosissimus critical habitat consists of five components (69 FR 29081-29100):

(i) Vegetation cover of at least 50 percent but not exceeding 75 percent, consisting primarily of known associated native species, including but not limited to, Baccharis salicifolia, Baccharis pilularis, Salix lasiolepis, Lotus scoparius, and Ericameria ericoides;

(ii) Low densities of nonnative annual plants and shrubs;

(iii) The presence of a high water table, either fresh or brackish, as evidenced by the presence of channels, sloughs, or depressions that may support stands of Salix lasiolepis, Typha spp., and Scirpus spp.;

(iv) Soils that are fine-grained, composed primarily of sand with some clay and silt, yet are well-drained; and

(v) Soils that do not exhibit a white crystalline crust that would indicate saline or alkaline conditions.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be essential for the conservation of the species may require special management or protections. The Mandalay Unit may require special management considerations or protections due to the threats to the species and its habitat posed by development (e.g., loss of native vegetation, disruption of pollinator community, herbivory by snails, increase in non-native plants, soil remediation), herbivory by rabbits, and trampling as a result of human activity. Currently, competition by non-native plants, herbivory by snails and rabbits, and human activity are ongoing in the Mandalay Unit. The McGrath Unit may require special management considerations or protections due to the threats to the species and its habitat posed by invasive, non-native plants and trampling as a result of human activity. Currently, competition from non-native plants and human activity are ongoing in the McGrath Unit. The Carpinteria Salt Marsh Unit may require special management considerations or protections due to the threats to the species and its habitat posed by nonnative plants and high salinity. Currently, competition from non-native plants and

fluctuations in salinity levels are ongoing in the Carpinteria Salt Marsh Unit.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2010)

Lifespan

Adult: 3 - 4 years (USFWS, 2010)

Breeding Season

Adult: July - October, one observation in June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2010); soil seed bank (USFWS, 2004)

Reproduction Narrative

Adult: It is believed to have a 3 to 4-year life span (Wilken and Wardlaw 2001). The blooming time has been recorded as July to October (Barneby 1964); however, the population at the site where the plants were rediscovered, referred to as the site of natural occurrence, was observed in flower in June 1997. Wilken and Wardlaw (2001) observed peak flowering of the plants at this site in mid-July with most flowers maturing into fruits by early September. The variety appears to be self-compatible and partly self-pollinating (Wilken and Wardlaw 2001); however, the flower structure of this variety, and other Astragalus species, suggests that pollination requires manipulation of flower parts by insects (Wilken and Wardlaw 2001). Wilken and Wardlaw (2001) observed a limited number of skippers (family Hesperidae) and bumblebees (Bombus spp.) visiting the plants. Other researchers have observed various bee and butterfly species frequently visiting A. pycnostachyus var. lanosissimus (Meyer 2007a, Jensen 2007), indicating that insects may be the natural pollinators of this plant. The life cycle of A. pycnostachyus var. lanosissimus likely requires a pollinator community to be present (Greer et al. 1995; Karron 1987). Wilken and Wardlaw (2001) observed an average of 26 inflorescences per plant, with an average of 36 flowers per inflorescence, and between 7 and 9 ovules per ovary (a potential maximum of 7 to 9 seeds per flower). However, the number of seeds per fruit was only approximately 2 on average. This level of productivity is low relative to many other species of Astragalus that are known to be self compatible and therefore would be expected to produce more seed (Karron 1987). Seed production is suspected to be limited by a lack of pollination. This delayed seed germination, combined with the observation that plants may not become reproductive until 18 to 30 months following germination, and a low seedling survival rate (Wilken and Wardlaw 2001), indicates a low recruitment rate for the variety (USFWS, 2010). The population is able to persist due to having established a seedbank (not all seeds produced in one year will germinate the following year) (USFWS, 2004).

Habitat Type

Adult: Terrestrial, wetland, aquatic (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dune, grassland, shrubland, spring, herbaceous wetland (NatureServe, 2015); coastal dune-swales (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 30 m elevation (NatureServe, 2015); high competition from other plant species (USFWS, 2010)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Historically probably occurred on open sites near the coast on soils with a high water table, such as on bluffs or flats near seeps or bodies of brackish or fresh water, or in or near coastal marshes. Currently, a population occurs on an abandoned oil-field waste site in remnant backdunes. This area has an artificially compact substrate of clay, sand, and small gravel, above a capped oil layer, generally about 45 cm below the soil surface. Occurs from 0 - 30 m elevation. The environmental specificity is very narrow to narrow, although habitat requirements are poorly understood (NatureServe, 2015). Based on existing information from historical collections, Wilken and Wardlaw (2001) concluded that the variety occurs in low elevation coastal dune-swale areas where freshwater levels (in the form of saturated soils or groundwater) are high enough to reach the roots of the plants. The soils associated with Astragalus pycnostachyus var. lanosissimus are well-drained, yet contain a mix of sand and clay. Meyer (2007a) indicated that low competition from native and nonnative species contributes to the success of Astragalus pycnostachyus var. lanosissimus establishment in these areas (USFWS, 2010). Primary constituent elements include vegetation cover of at least 50 percent but not exceeding 75 percent; low densities of nonnative annual plants and shrubs; the presence of a high water table, either fresh or brackish; soils that are fine-grained, composed primarily of sand with some clay and silt, yet are well-drained; and soils that do not exhibit a white crystalline crust that would indicate saline or alkaline conditions (USFWS, 2004).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decline of 50-90% (NatureServe, 2015); believed extinct until 1997 (USFWS, 2010)

Species Trends:

Declining (USFWS, 2010)

Population Growth Rate:

Slow (inferred from USFWS, 2004)

Number of Populations:

4 (USFWS, 2023)

Population Size:

>700 individuals in 4 populations (USFWS, 2023)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

For the only known naturally-occurring population, low population size increases vulnerability to decline/extirpation from stochastic events. This species has experienced a long-term decline of 50-90%. Recent population sizes at the naturally-occurring site include 104 plants (60 flowering) in 2006 and 27 plants (19 flowering) in 2009 (M. Meyer unpublished data 2010). This represents an overall decline corresponding to two low rainfall years and completion (in 2007) of remediation on the surrounding area outside the 1.6 acre exclosure in which plants occur. Collectively, the four introduced sites had 801 plants (283 flowering) in 2009; most of these individuals were at one of the Santa Barbara County sites (M. Meyer unpublished data 2010). Most historical or extirpated; one naturally-occurring site discovered in Ventura County in 1997 (U.S. Fish and Wildlife Service 2001). The presumption is that the original source of seed at this site came from some either onsite or nearby top soil brought in to cap the oil waste facility when it closed in 1982 (M. Meyer pers. comm. 2010). There are also four introduction sites, two in Ventura County and two in Santa Barbara County (which is outside the historic range of this taxon). As yet, it is unclear whether these introductions will persist and become self-sustaining populations (M. Meyer pers. comm. 2010) (NatureServe, 2015). It was believed to be extinct until its rediscovery in 1997. Currently the North Shore site supports only 31 individuals and the habitat at the site has possibly been permanently negatively altered by remediation activities in areas surrounding the plants. Research was conducted to identify potential suitable habitat characteristics and introductions were attempted at several sites within and outside the historic range of the species, including Ormond Beach, Mandalay State Beach, McGrath Beach, Carpinteria Salt Marsh, and Coal Oil Point. Astragalus pycnostachyus var. lanosissimus did not survive at Ormond Beach. Plants currently remain at the other outplanting sites, but have shown a relatively steady decline in abundance since the heavy rains of 2004-2005, and may benefit from another substantially wet season (USFWS, 2010). The single natural population of Astragalus pycnostachyus var. lanosissimus near the city of Oxnard is in a degraded backdune community. Due to the combination of poor seedling and young plant survivorship and low seed production, the single naturally occurring population of Astragalus pycnostachyus var. lanosissimus has continued to decline since its rediscovery in 1997 and through the 2001 season (Impacts Sciences 1997, 1998; Wilken and Wardlaw 2001; Dieter Wilken, Santa Barbara Botanic Garden, pers. comm. 2002) (USFWS, 2004). Ventura marsh milk-vetch (Astragalus pycnostachyus var. lanosissimus) was historically found in Los Angeles and Ventura County coastal wetlands. There is one known naturally occurring population (North Shore), and eight deliberately planted populations, which were all planted from North Shore seed stock. Four of the planted populations are north of the historically known range, justified by available planting locations and anticipated climate change. There are 4 populations of reproductive adults (the rediscovered population and three introduced populations), 2 populations of seed banks in suitable habitat, and 3 populations of seed banks in unsuitable habitat. (USFWS, 2020) The four currently occupied sites are North Shore, McGrath Parcel, North Campus Open Space, and Carpinteria Salt Marsh (Table 1), and occupy four unique ecological, ownership, and management situations. For a new site to be established with the goal of establishing a new

population, it would need to be spatially and ecologically distinct from any existing sites (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: much of the habitat that supported historical populations of Astragalus pycnostachyus var. lanosissimus has been altered or destroyed such that it is no longer suitable for the species. Habitat conditions at the North Shore site have been altered by remediation activities, but will be protected by a preserve created as part of the MOU between CDFG and the project proponent (USFWS, 2010).

Stressor: Disease and predation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The seeds of Astragalus pycnostachyus var. lanosissimus at the site of natural occurrence were heavily infested with seed beetles (Bruchidae: Coleptera) in 1997. In a seed collection made for conservation purposes in 1997, most fruits partially developed at least 4 seeds but seed predation reduced the average number of undamaged seeds to only 1.8 per fruit (Steeck and Meyer, in litt. 1997). The nonnative milk snail (Otala lacteal) was observed causing damage to the foliage of Astragalus pycnostachyus var. lanosissimus in 1998 and 1999 concurrent with a dramatic decline in seedling plants (Meyer 2007a). European brown garden snails (Helix aspera) are frequently observed at the outplanting sites and can potentially defoliate individual plants, damage new growth, and compromise vigor (Jensen 2007; Meyer 2007a). Meyer (2007a) reports that gophers (Thomomys bottae), rabbits (presumably Lepus spp. or Sylvilagus spp.), and meadow voles (Microtus spp.) are common at the milk-vetch outplanting sites and impact plants by removing seedlings and damaging established plants. Sooty fungus continues to be occasionally observed on A. pycnostachyus var. lanosissimus individuals, but does not appear to substantially adversely affect the health or productivity of the plants (USFWS, 2010).

Stressor: Stochastic events (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At the time of listing Astragalus pycnostachyus var. lanosissimus in 2001, the Service discussed that the taxon is threatened with extinction from unanticipated human activities and natural events by virtue of the very limited number of individuals in, and the small area occupied by, the only known extant population. A wildlife predation event in the summer before seeds have matured, a plane crash (the taxon is under the extended center flight line of the Oxnard airport and a crash occurred on the site in 1995), and other natural or unanticipated human-caused events could eliminate the existing population and result in the extirpation of this taxon from the only known remaining site of natural occurrence in the wild.

Stressor: Inadequate preserve design (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The small size of the preserve and its proximity to future urban and suburban uses makes it subject to the effects of nonnative, invasive plant and animal species, increased nutrient-rich water supply due to suburban irrigation runoff and increased impervious surfaces, and chemicals such as herbicides, pesticides, and fertilizers (see Conservation Biology Institute 2000, CDFG 2000 and references therein). Independently or in combinations, these factors present difficult management challenges which, if not adequately addressed, could lead to the elimination of A. pycnostachyus var. lanosissimus from the North Shore site. Nonnative plant and animal species are competitors and predators, respectively, that can directly reduce survival of native plants and they can also upset the invertebrate (pollinator) and vascular plant associations upon which native plants depend (Conservation Biology Institute 2000). While the life history requirements of A. pycnostachyus var. lanosissimus are not well understood, any factor that substantially alters the hydrology of the site, such as increases or decreases in urban/suburban runoff, may make the site unsuitable for this wetland species (Conservation Biology Institute 2000). Likewise, increased levels of chemicals arriving via runoff or drift can be expected in small preserves and can harm native species (Conservation Biology Institute 2000). These increases could harm A. pycnostachyus var. lanosissimus directly, or alter the pollinator or plant associations upon which it depends (USFWS, 2010).

Stressor: Competition (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Nonnative weeds such as iceplant, as well as some native species such as Anemopsis californica (yerba mansa), Potentilla anserina (silverweed) and Distichlis spicata (salt grass) can form dense continuous patches that exclude Astragalus pycnostachyus var. lanosissimus (Meyer 2007a) (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, and that species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. While the Service lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Astragalus pycnostachyus var. lanosissimus, small-ranged species, such as A. pycnostachyus var. lanosissimus, are generally more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2010).

Stressor: Sea level rise (USFWS, 2010)
Exposure:
Response:

Consequence:
Narrative: An increase in the rate of sea level rise has been predicted for the coast of California (California Climate Change Center 2006). The occurrences of Astragalus pycnostachyus var. lanosissimus at Mandalay State Beach, McGrath Lake, and Carpinteria Salt Marsh Reserve are bounded by residential, industrial, or agricultural areas that would preclude the taxon's migration inland as sea level rises (USFWS, 2010).

Recovery

Reclassification Criteria:
Ventura marsh milk-vetch may be considered for downlisting when all the following criteria are met: 1. Abundance within each of four sites is an average of 100 or more reproductive individuals per site with a stable or increasing trend based on a minimum of 10 years of data. Funding and resources are available so that if a population drops below 25 reproductive individuals in any single year, supplemental seed or seedlings may be planted, or artificial disturbance applied. 2. The four sites are managed such that the functions of disturbance, colonization, and succession allow for successful Ventura marsh milk-vetch population persistence, including site plant species composition comprised of at least 50% appropriate native species, with native species vegetative cover being greater than non-native species vegetative cover. Details of suitable habitat conditions are described in the SSA (Service 2020, pp. 12-20). 3. Management at the four sites is assured in perpetuity and is shown to be effective by stable or increasing populations based on a minimum of 10 years of data. 4. Ex situ recovery seed banks are established and maintained over time with sufficient seed so that stored seed may be used for recovery efforts while not exhausting the seed supply and decreasing seed bank genetic diversity. At a minimum, seed should be stored within a longterm storage facility such as the National Laboratory for Genetic Resources Preservation in Fort Collins, Colorado, as well as in at least two institutions approved by the Center for Plant Conservation with the capability to test viability and germination as needed. New accessions are added to each institution as new sites are established, and seed is added so that the most recent accession is no more than 15 years old (USFWS, 2023).

Recovery Priority Number: 6C

Delisting Criteria:
Once the downlisting criteria have been met, Ventura marsh milk-vetch may be considered for delisting when all the following criteria are met: 1. Two additional sites are established (for a total of six) that have an average abundance of 100 or more reproductive individuals per site with a stable or increasing trend over 10 years of data. Funding and resources are available so that if a population drops below 25 reproductive individuals in any single year, supplemental seed or seedlings may be planted, or artificial disturbance applied. 2. The two additional sites are managed such that the functions of disturbance, colonization, and succession allow for successful Ventura marsh milk-vetch population persistence, including site plant species composition comprised of at least 50% appropriate native species, with native species vegetative cover being greater than non-native species vegetative cover. Details of suitable habitat conditions are described in the SSA (Service 2020, pp. 12-20). 3. Management at the two additional sites is assured in perpetuity and is shown to be effective by stable or increasing populations based on a minimum of 10 years of data (USFWS, 2023).

Recovery Actions:

- 1. Manage habitat that supports the species to reduce or eliminate threats, including supplemental seeding, irrigation, vegetation composition and density, and herbivore control. (Priority 1) 2. Conduct annual monitoring to identify population trajectories and environmental conditions that might be adversely affecting the species. (Priority 1) 3. Protect currently unprotected habitat where the taxon occurs or could occur. (Priority 2) 4. Collect seed and deposit accessions into a permanent conservation seed bank. (Priority 2) 5. Conduct experimental research projects, including those that examine the roles of biotic and abiotic environmental effects, natural soil seed banks, and disturbance. (Priority 2) (USFWS, 2023)
- Convene a recovery team and develop a recovery plan for Astragalus pycnostachyus var. lanosissimus (USFWS, 2010).
- Work with CDPR staff to continue iceplant removal and habitat restoration around McGrath Lake to improve and expand available habitat for Astragalus pycnostachyus var. lanosissimus (USFWS, 2010).
- Determine if changes in the upper aquifer at the North Shore site have resulted from remediation activities surrounding the plants, and determine whether a supplemental watering system can compensate for altered water availability, or if additional measures are needed to compensate for negative impacts (USFWS, 2010).
- Build on the work of Meyer, Jensen, Wilken, and others to identify freshwater-dominated coastal wetlands with sufficient surrounding area and proper vegetation (i.e., sufficiently sparse areas, free of dense mats of vegetation) for Astragalus pycnostachyus var. lanosissimus introduction (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Develop a recovery plan for Astragalus pycnostachyus var. lanosissimus. 2. Continue habitat restoration at McGrath Parcel to improve and expand available habitat for Astragalus pycnostachyus var. lanosissimus. 3. Monitor the success of the North Campus Open Space planting site. 4. Enhance the sites with extant seed banks and potential habitat. 5. Build on previous work to identify appropriate fresh-water dominated coastal wetlands of sufficient area and proper conditions (sparsely vegetated, free of mats of perennial vegetation, proper hydrology) for Astragalus pycnostachyus var. lanosissimus introduction. (USFWS, 2020)
- FUTURE SCENARIO 2 (INCREASING MANAGEMENT) Under Future Scenario 2, management activities that benefit Astragalus pycnostachyus var. lanosissimus increase at past and current reintroduction sites. Key management activities that increase the suitability of habitat include non-native and native species management to reduce competition for juvenile and adult individuals of the species, controlling herbivory through exclusion fencing, removing snails, and decreasing shrub and tree vegetation in order to reduce cover for and thus discourage herbivorous mammals. Currently, supplemental planting is used infrequently at introduced sites, only when reproducing adults have not been present for several years and when conditions are believed to be suitable. This is done to both check site suitability at that time and to increase the local seed bank if the supplemental plants successfully produce seed. Supplemental watering is used to establish populations at initial introduction or when supplemental planting occurs. Additional supplemental water is used sparingly to reduce the effects of drought and desiccation from changes in seasonal precipitation. These activities already occur at the North Shore site and the McGrath Parcel and will continue under this scenario. Additional sites for reintroduction are identified and managed under Future Scenario 2.

This includes the North Campus Open Space (NCOS) Restoration Project and the Ormond Beach Restoration and Public Access Project. Restoration activities at the NCOS restoration site are likely to have positive influences on associated species and vegetation cover facilitating the survival of individuals planted in 2019. Those adults will contribute to a growing seedbank as they reach reproductive maturity. The success of this restoration project will provide future opportunity for introducing Astragalus pycnostachyus var. lanosissimus into newly suitable habitat in other areas within the NCOS restoration site. The expansion of natural environments within the broader Devereux Slough ecosystem may also provide some ability for the migration of suitable habitat reducing the negative effects of climate change at this specific location. In this scenario we also expect a new population to be introduced to a unique location at the newly restored Ormond Beach Restoration and Public Access Project (not at the location of the extirpated Ormond Beach site). The Coal Oil Point Reserve pond site, Carpinteria Salt Marsh Reserve, and McGrath State Beach will have increased management resulting in the reestablishment of reproductive adults in these populations. Weed management and supplemental planting are likely to have the greatest effect at these sites. Development surrounding the North Shore site has negative impacts on the North Shore population, but these will be mitigated through continued and/or additional measures as necessary because of the requirement to manage in perpetuity. The North Shore population continues to be conservation reliant in this scenario. The effects of climate change are still significant in this scenario, with decreases in winter precipitation frequency, increases in winter precipitation intensity, and increases in average, maximum, and minimum temperatures. The results increase stress and mortality on existing and potential future Astragalus pycnostachyus var. lanosissimus populations while decreasing the amount of available suitable habitat. The effects are offset only slightly through management activities since they cannot directly address declining water tables and broad shifts in precipitation patterns and temperature. The management under this scenario does improve habitat locally at all sites, as well as potential sites, resulting in a greater ability for migration of vegetation and suitable habitat. (USFWS, 2020a)

References

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SPECIES ACCOUNT: *Astragalus robbinsii var. jesupi* (Jesup's milk-vetch)

Species Taxonomic and Listing Information

Commonly-used Acronym: JMV

Listing Status: Endangered; 7/6/1987; Northeast Region (R5)

Physical Description

A short-lived perennial, herbaceous legume that is 10 to 50 centimeters (cm) (4 to 20 inches [in]) tall with a tap root. Jesup's milk-vetch stems originate from a single root crown and may branch several times. Older plants tend to be more profusely branched than younger plants. Its leaves are pinnately compound, divided into 9 to 15 oblong to elliptical, glabrous leaflets 8 to 20 millimeters (mm) (0.3 to 0.8 in) long. The first true leaves of seedlings are produced in triads and arrayed in a clover-leaf fashion; as plants mature, the number of leaflets per leaf increases. The raceme2 of 8 to 21 small (9 to 12 mm [0.3 to 0.5 in long]), pale bluish-violet, pea-like flowers is borne at the top of the stem. Flowering plants may have from 1 to 120 racemes. The inflorescence is compact initially, but as flowering proceeds, the axis of the raceme continues to elongate somewhat throughout fruit development, especially in more shaded conditions (Farnsworth and Harvey 2004). The fruit is a legume about 1.5 to 2 cm (0.6 to 0.8 in) long, borne on a short stem, narrowed at both ends and terminated with a distinctive beak 1.5 to 3 mm (0.8 to 0.1 in) long. The body of the legume has scattered black, appressed hairs. Inflorescences produce, on average, approximately 56 seeds per inflorescence (8 legumes per inflorescence, 7 seeds per legume), although larger plants produce more legumes and seeds per legumes. (USFWS, 2019)

Taxonomy

A member of the legume family (Fabaceae). Jesup's milk-vetch was first collected in 1877 at Sumner Falls in Plainfield, NH by Professor Henry Griswold Jesup of Dartmouth College. The variety (as "jesupi") was subsequently described by Eggleston and Sheldon in 1894 in Minnesota Botanical Studies 1: 155, following collection of the specimens (deposited at MINN) by Eggleston on June 7, 1891, on "old ledges above high water of the Connecticut River near Hartland, Vt.... and on ledges near Sumner Falls, near Plainfield, N.H." (Barneby 1964: 131; Revised Jesup's Milk-Vetch Recovery Plan 4 w 3Tropicos Database 2019). Recent synonyms for this taxon include Astragalus jesupii (Egglest. & Sheldon) Britt. (published in Britton 1901: 1048) and Atelophragma jesupii (Egglest. & Sheldon) Rydberg published in Bulletin of the Torrey Botanical Club 55: 125 (1928). Although the taxon was federally listed endangered under the variant spelling Astragalus robbinsii var. jesupi, and the first recovery plan recognized the taxon as Astragalus robbinsii var. jesupi, the current nomenclature for the species is Astragalus robbinsii var. jesupii, following the standards outlined in the International Code of Botanical Nomenclature (accessed February 4, 2019). (USFWS, 2019)

Historical Range

In Sullivan County, New Hampshire, and Windsor County, Vermont. Known from five distinct sites along a 16-mi sector of the Connecticut River between central New Hampshire and central Vermont. (USFWS, 2019)

Current Range

In Sullivan County, New Hampshire, and Windsor County, Vermont. Extant at three distinct sites along a 16-mi sector of the Connecticut River between central New Hampshire and central Vermont. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect and Self-fertilization (USFWS, 2019)

Lifespan

Adult: Generally 3 years (USFWS, 2019)

Breeding Season

Adult: Flowers in late May or early June; sets seed through August (USFWS, 2019)

Other Reproductive Information

Adult: The Jesup's milk-vetch life cycle consists of seed germination and growth to seedling in year one; emerging as a small, generally nonflowering plant in year two, flowering and dying after flowering in year three. Some plants may produce small Revised Jesup's Milk-Vetch Recovery Plan 14 numbers of flowers in the second year, in which case the plants will typically flower again the following year. Alternatively, depauperate plants may live for 4 years with minimal flowering. Some vegetative plants survive to a fourth year. Self-fertilization is commonly documented in the genus Astragalus, facilitated by simultaneous maturation of anthers and stigmas (Barneby 1964). Experiments that excluded pollinators from flowers have shown Jesup's milk-vetch to be capable of selffertilization. The most common insect visitors of Jesup's milk-vetch flowers are bumblebees identified as Bombus vagans vagans Smith (USFWS, 2019)

Reproduction Narrative

Adult: Jesup's milk-vetch plants emerge in April (or as soon as ice cover and temperature permits), and bloom in early- to mid-May. Flowering times are variable year to year (Dunlop 1994). Dunlop (1994) observed that the plants closest to the water's edge at all three sites are the last to flower, possibly reflecting longer periods of spring inundation or a cooling effect on the lower slope. Flowering generally lasts to early July, and seed set occurs from late June to mid-July (Brumback 2009). Most fruits have dehisced by early July. Some fruiting stems have typically withered by mid-August, but vegetative stems usually remain green until September or October (Brumback and Piantedosi 2018a). Seed germination is delayed until the following year (or later) (Brumback 2009). This latter group typically includes depauperate individuals that have not previously flowered or produced very sparse blooms. (USFWS, 2019)

Habitat Type

Adult: Terrestrial (USFWS, 2019)

Habitat Vegetation or Surface Water Classification

Adult: Calcareous bedrock outcrops which are ice-scoured annually (USFWS, 2019)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2019)

Habitat Narrative

Adult: Jesup's milk-vetch inhabits bedrock outcrops of chlorite or phyllite schist that are periodically scoured by flooding and ice-rafting along the Connecticut River. As such, these riparian ledges are sparsely vegetated; however, they support a globally rare natural community type and several rare plant species in addition to Jesup's milk-vetch. Plants at each site occupy a narrow band between a lower bound determined by typical water levels during the growing season and an upper bound defined by the deep shade of long-lived woody vegetation that is at a high enough elevation to survive the occasional severe scouring by ice. (USFWS, 2019)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are unknown for this species, although there is evidence that long distance dispersal is extremely unusual. Given the proximity of the populations to water, it is reasonable to expect that flooding, especially spring freshets, would play a role in transporting overwintering seeds among sites. However, seed dispersal may be naturally limited since mature seeds readily sink in water (Kane 2011a, It is probable that the vast majority of seeds produced by a population likely remain in close proximity to parent plants and that long-distance dispersal is rare. (USFWS, 2019)

Population Information and Trends

Population Trends:

Tenuous (USFWS, 2019)

Species Trends:

Stable (inferrred from USFWS, 2019)

Number of Populations:

3 (USFWS, 2019)

Population Size:

Approx 736 natural plants (USFWS, 2019)

Population Narrative:

This species is known from only three extant populations along the Connecticut River in New Hampshire and Vermont: Sumner Falls and Jarvis Hill (NH) and Hartland Ledges (VT). These populations comprised 736 plants in 2018 (not including introduced plants at one site). Population sizes are highly variable among years; in the years between 1997 and 2018, the global population has ranged from 260 plants to over 2,000 plants. As thie 2018 population

value is based on careful searches of all available habitat at all known populations, it is unlikely to underestimate actual population size by a considerable amount. The Jarvis Hill population has been consistently and significantly larger than the other two populations throughout this time period. Despite intensive surveys, no additional extant Jesup's milk-vetch populations were discovered, although potential suitable habitat was documented. (USFWS, 2019)

Threats and Stressors

Stressor: Herbivory (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Herbivory has been noted on the stems, leaves, fruits, and seeds of Jesup's milk-vetch since 1990. The major herbivores remain unidentified, but deer and woodchucks were suspected in 1990 and 1992, respectively. The proportion of stems affected is generally small (less than 10 percent). Nothnagle noted the loss of an "estimated 95 percent of flowers to herbivory in 1998" without identifying the herbivore (NHNHI 2002). No similar incidents of large-scale herbivory have been documented in the last decade. (USFWS, 2019)

Stressor: Trampling (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Trampling of plants has been noted at Sumner Falls on several occasions: 1990, 1992, and 2001. Sumner Falls receives many visits from kayakers who shoot the nearby rapids, fishermen, and other recreational users. Picnicking, boat landing, and campfire building can threaten plants. Vandalism was noted in the past; several plants were "pulled up" in 1990. Likewise, activities nearby can also have inadvertent impacts: a crew erecting signage at Sumner Falls in 2003, for example, dumped brush very near to the plants (but fortunately did not damage any). With so few plants present at the site, the population is vulnerable to even small-scale disturbances. Other sites are not as attractive for boat landings, they are too steep to access from the water and overland access points are in private ownership. (USFWS, 2019)

Stressor: Land use change (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Because Jesup's milk-vetch habitats typically occur far apart from each other, colonization of new habitat and establishment of new populations depends on rare long-distance dispersal events. Land use changes that reduce the availability of appropriate Jesup's milk-vetch habitat can reduce the prospects for successful establishment of new populations. Residential and recreational development is increasing along the Connecticut River. While local regulations may prevent siting of new development in the riparian buffers that provide potential habitat for Jesup's milk-vetch, logging and construction activities in the upland areas can cause erosion of shoreline habitats, lead to dumping of materials (e.g., coarse woody debris) in shoreline habitats, and result in increased human visitation to shoreline habitats. These effects can result in degradation of Jesup's milk-vetch habitat and trampling of Jesup's milk-vetch plants. (USFWS, 2019)

Stressor: Invasive Species (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Jesup's milk-vetch relies on the availability of open habitat, which is maintained in an early-successional state by periodic flooding and ice scour. Populations of black swallowwort, shrubby honeysuckle, cypress spurge, and purple loosestrife have been noted by surveyors at one or more sites since 1997. As of 2002, all of these species were present at all three sites (with the exception of purple loosestrife, which occurred only at Hartland Ledges and Jarvis Hill) and (with the exception of cypress spurge) are the focus of intensive removal efforts. Recently, Cardamine impatiens (bushy rock-cress) is being treated manually at Sumner Falls and Hartland Ledges (Brumback and Piantedosi 2018b) (appendix 3 and 4). The Hartland Ledges site has the highest percent cover of invasive species. Black swallowwort appears to be spreading more rapidly than other species, particularly at Hartland Ledges, where a nearby railroad bed is infested in places with up to 100 percent cover and plants are rapidly spreading into the surrounding forest and down onto the riverbank and the rock outcrops where Jesup's milk-vetch grows. Despite repeated herbicide application to control swallowwort at Hartland Ledges, the upslope population by the railroad continues to shed seed, providing the source for recruitment of this highly invasive species. Shrubby honeysuckle has been increasing more slowly. Several other native, aggressive species are also increasing in cover at the sites, including Toxicodendron radicans (poison ivy) and Apios americana (ground-nut) at Hartland Ledges. (USFWS, 2019)

Stressor: Problems intrinsic to small populations (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Jesup's milk-vetch populations are subject to dramatic "boom and bust" cycles. In 2003, 2009, and 2012 through 2014, all three populations were at some of their lowest numbers since consistent monitoring began in 1997 (appendix 6). While apparent rebounds have occurred after some of the precipitous declines (e.g., 2004 and 2010), monitoring data indicate that these are likely to be followed by future dips under normal conditions. However, extreme storm events in 2008, 2009, and 2011 may have been responsible for the prolonged decline in total plant numbers from 2012 through 2014. Demographic stochasticity can lead to random extinction, and small populations are particularly vulnerable (Morris and Doak 2002; Farnsworth 2008). These populations are also clearly subject to environmental stochasticity, which further compounds year-to-year variation in population size and is a major driver of extinction probabilities in rare plants.The distinctiveness of the three populations is critical to maintaining the genetic diversity represented by each population. The loss of any population would result in a substantial loss of the species-wide genetic diversity and potentially impact the species' ability to respond to stochastic changes in the environment, including climate change. Maintaining genetic representation of all three populations will be critical in the recovery of the species. (USFWS, 2019)

Stressor: Hydrological alteration (USFWS, 2019)
Exposure:
Response:
Consequence:

Narrative: The extant Jesup's milk-vetch populations are located in the 90-mi (145-km)8 stretch of river with flows directly affected by two hydropower dams, Wilder Dam (Wilder, VT/Hanover, NH) and Bellows Falls Dam (Rockingham, VT/Walpole, NH) (NHNHB 2014). Specifically, the three Jesup's milk-vetch populations occur in the 25 mi (40 km) of free-flowing river between the two dams. The Sumner Falls population is approximately 9.5 river-mi (15 river-km) downriver of Wilder Dam, the Hartland Ledges population is approximately 12.5 river-mi mid-way between the Wilder Dam and BellowsFalls Dam (20 river-km), while the Jarvis Hills population is above the head of the impoundment for the Bellows Falls Dam. Both dams influence the hydrology of the Connecticut River in the vicinity of the Jesup's milk-vetch populations. (USFWS, 2019)

Stressor: Climate change (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change models predict that precipitation will increase by 14 percent with the greatest increase in the fall and winter and in the form of rain rather than snow (Runkle et al. 2017a; Runkle et al. 2017b). In Jesup's milk-vetch habitat, riverbank ledges are kept clear by ice scour and spring flooding. These disturbances remove other vegetation that might colonize Jesup's milk-vetch habitat and shade out Jesup's milk-vetch seedlings (USFWS 1989), and/or deposit alluvial sediment to renourish Jesup's milk-vetch plants. The most significant annual floods currently occur during spring runoff, with decreasing flows during the summer. With increasing winter temperatures and winter precipitation in the form of rain, the decrease in snowpack may result in reduced spring flooding and ice scour, critical components to reduce competing vegetation in the rock outcrops. (USFWS, 2019)

Recovery

Reclassification Criteria:
Demographic criteria: 1a: A minimum of four persisting populations occurring within the historically known and/or expanded that conserve the genetic diversity of the species. (USFWS, 2019)

Demographic criteria: 1b: A persisting population is defined as having a site-specific median number of total plants (excluding transplants)11 over 5 consecutive years (based on a minimum of one generation) as described below. (i) Sumner Falls: A median of 113 natural plants; (ii) Hartland Ledges: A median of 132 natural plants; (iii) Jarvis Hill: A median of 477 natural plants; (iv) expanded range populations: (1) sites similar in area to the Sumner Falls population: a median of 100 plants; and (2) sites similar in area to the Jarvis Hill population: a median of 400 plants. (USFWS, 2019)

Threats-abatement criteria: 2a: A long-term landowner agreement or other mechanism is in place for each of the four persisting populations that provides: (i) protection against habitat loss. For example, forested buffers are established/maintained between a population and developed land (agricultural land, development, etc.); and (ii) access for long-term monitoring and management. (USFWS, 2019)

Threats-abatement criteria: 2b: A rapid response plan is in place for each of the four persisting populations that addresses new threats (e.g., invasive species) and the need for population

augmentation (adaptive management). (USFWS, 2019)

Delisting Criteria:
Demographic criteria 1a: A minimum of six resilient populations occurring within the historically known and/or expanded ranges that conserves the genetic diversity of the species. (USFWS, 2019)

Demographic criteria 1b: A resilient population is defined as having a site-specific median number of plants and a median number of total inflorescences (excluding transplants) over 8 consecutive years (based on a minimum of three generations) as described below. (i) extant populations: (1) Sumner Falls: A median of 113 natural plants and a median of 193 inflorescences; (2) Hartland Ledges: A median of 132 natural plants and a median of 507 inflorescences; (3) Jarvis Hill: A median of 477 natural plants and a median of 4337 inflorescences; (ii) expanded range populations: (1) sites similar in area to the Sumner Falls population: A median of 100 plants and a median of 193 inflorescences; and (2) sites similar in area to the Jarvis Hill population: a median of 400 plants and a median of 4,337 inflorescences. (USFWS, 2019)

Threats-abatement criteria 2a: A long-term landowner agreement or other mechanism is in place for each of the six resilient populations that provides: (i) protection against habitat loss. For example, forested buffers are established/maintained between a population and developed land (agricultural land, development, etc.); and (ii) access for long-term monitoring and management. (USFWS, 2019)

Threats-abatement criteria 2b. A rapid response plan is in place for each of the six resilient populations that addresses new threats (e.g., invasive species) and the need for population augmentation (adaptive management). (USFWS, 2019)

Recovery Actions:
- Protect extant and introduced populations: Securing Jesup's milk-vetch populations requires protecting them from land and water use impacts that cause habitat loss or degradation or result in direct mortality of plants. Protect occupied habitat with conservation easements, management agreements, or acquisition. Conserve vegetative buffers at Jesup's milk-vetch populations. Develop protective hydrological management regimes for dams potentially impacting historically known and expanded range populations. (USFWS, 2019)
- Establish additional populations: Increasing population redundancy for Jesup's milk-vetch requires establishment of additional populations. Introduced populations should represent the range of genetic diversity of the three populations. Because no suitable introduction sites have been identified within the historically known range to date, populations must be established at suitable introduction sites outside the historically known range. (USFWS, 2019)
- Evaluate status of existing populations: Annual quantitative monitoring of historically known and expanded range populations is necessary to assess population trends and status. Annual monitoring of Jesup's milk-vetch populations will determine whether augmentation is warranted and whether there are a sufficient number of plants to allow for seed collection. Annual monitoring for the presence and density of invasive plant species will determine recovery management actions needed to maintain viable Jesup's milkvetch populations, or document new threats from future invasive species. (USFWS, 2019)

- Manage Habitat: Securing Jesup's milk-vetch populations requires managing their habitats to reduce threats from invasive plant species, recreational activities, and herbivory. Habitat management protocols must be thoroughly documented and data collected in a statistically meaningful way so that successes can be replicated elsewhere and future failures averted. (USFWS, 2019)
- Bank seeds and perfect propagation and transplantation techniques: Seed banking provides insurance against catastrophic declines in natural populations by enabling the propagation of seedlings for population augmentation or introduction efforts. Genetic representation of all populations is maintained by collecting and preserving seed from the three extant populations. Jesup's milk-vetch seeds are collected and banked at NPT. (USFWS, 2019)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Protect extant and introduced populations. Secure conservation easements or management agreements to ensure that population monitoring, invasive plant species management, and population augmentation will continue. 2. Establish additional populations by conducting conservation introductions and translocations in suitable habitat. 3. Establish rapid response plans that incorporate decision making matrices for invasive plant species management and population augmentation. 4. Bank seeds and perfect propagation and transplantation techniques. Experiment with direct seeding. 5. Investigate the potential for early spring high water release from upriver hydropower projects. Identify the flows needed to scour occupied habitat. (USFWS, 2021)

References

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SPECIES ACCOUNT: *Astragalus tener var. titi* (Coastal dunes milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/12/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small annual herb with slender stems, usually 1-1.2 dm tall. Flowers (March-May) are 5-6 mm long, lavender to purple in color. Seed pods are straight to half-moon shaped, 1-2.5 cm long (NatureServe, 2015).

Taxonomy

A member of the pea family (Fabaceae) (USFWS, 2009).

Historical Range

It was once a regional endemic with a range including San Diego, Los Angeles, and Monterey counties; it was never very common in its range though, being restricted to a very specific habitat (NatureServe, 2015).

Current Range

Today it is only verified at one area in Monterey County. The total known range in the 3 areas adds up to about 270 sq mi (NatureServe, 2015). It is currently known from one highly fragmented population located on a coastal terrace grassland along 17-Mile Drive in Pebble Beach on the Monterey Peninsula, Monterey County, California. The population is bordered along one side by the Pacific Ocean and the other side by a golf course; 17-Mile Drive bisects the population. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, self-fertilization (USFWS, 2009)

Breeding Season

Adult: March - May (USFWS, 2004)

Reproduction Narrative

Adult: Crossing studies conducted by Liston (1992) indicate that the plants are self-compatible and capable of self-fertilization. Doak et al. (2000) investigated reproductive biology. They found that seed set could be high; mean seed set in plants not damaged by gophers or other herbivores was 44 seeds per individual, and of 207 pods checked for seed production, approximately 70 percent had a seed set of between 4 and 7 seeds per pod. At the same time,

they observed only one pollinator in the field over the course of 3 years, and also that greenhouse-grown plants without access to pollinators set high numbers of seed. Based on these combined observations, they concluded that this species is a successful self-pollinator and that pollinators are not a strong concern in the establishment and maintenance of populations (Doak et al. 2000) (USFWS, 2009). Astragalus tener var. titi flowers between March and May. Small bees have been presumed to be its main pollinators based on floral structure (USFWS, 2004).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal terrace, dune (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs within 100 ft. of ocean surf zone, 25 ft. elevation; shade-intolerant (USFWS, 2004)

Spatial Arrangements of the Population

Adult: Scattered clumps (USFWS, 2009)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2004)

Habitat Narrative

Adult: The extant population grows in shallow swales on the flat surface of a coastal terrace. These depressions hold standing water during wet winter and spring seasons. The substrate is a loamy fine sand. The plants are associated with the non-native hottentot fig (Carpobrotus edulis) and cut-leaf plantain (Plantago coronopus). The environmental specificity is very narrow; it is only known from 3 small areas along the immediate coarse in sandy soil (NatureServe, 2015). The entire distribution of the population occurs on patches of remaining habitat that is interspersed with roads, trails, golf greens, and other recreational facilities (USFWS, 2009). Astragalus tener var. titi occurs on sandy soil within 30 meters (100 feet) of the ocean surf zone and 25 ft. above sea level. plants occur primarily on Antioch soils, with a few colonies found on compacted Sheridan soils (Jones and Stokes Associates 1996). Astragalus tener var. titi plants will germinate and grow to healthy maturity in areas of low-level disturbance, such as that caused by gophers or light pedestrian traffic (Doak et al. 2000, M. Stromberg in litt. 2002). Research conducted on plants under cultivation confirms that any competition or shading will result in unhealthy plants (V. Yadon, in litt. 2002, M. Stromberg in litt. 2002) (USFWS, 2004).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2004)

Dispersal/Migration Narrative

Adult: Under cultivation, seed capsules may burst and throw their seeds up to 2 meters (6.5 feet) (V. Yadon in litt. 2002). Many capsules are not dehiscent and simply drop to the soil where they may float to other areas to colonize if those areas become flooded during winter rains (V. Yadon, in litt. 2002) (USFWS, 2004).

Population Information and Trends

Population Trends:

Decline of 70 - 90% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2022)

Population Size:

Variable; 100 - 7,000 depending on climatic conditions (USFWS, 2009). Approximately 2,000 individuals were observed in 2011, the last year that the population was surveyed. (USFWS, 2019).

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Very vulnerable due to habitat type and small size. Long term trend is one of steep decline due to habitat destruction in 3/4 of its range. This species has experienced a long-term decline of 70-90%. The short term trend is one of decline (10 - 30%) due to presence on private land. The Pebble Beach Corporation site on the Monterey Peninsula had 4000 plants in 1995. 6 known EO's, but 5 are extirpated or historical. Only 1 extant occurrence is known (NatureServe, 2015). Annual population numbers have fluctuated between less than 100 and approximately 7,000, depending on winter and spring climatic conditions (USFWS, 2009).

Threats and Stressors

Stressor: Habitat loss and degradation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Although vehicles have been prevented from entering the habitat of the plant in one roadside area, the individuals remain vulnerable to vehicles as well as trampling from other recreational activities along other portions of the roadside. Inundation by salt water and beach cobble during storm events may be new threats that may affect the portion of the population closest to the ocean. Little opportunity for population expansion is available adjacent to the existing population because habitat has already been converted to other uses, including roads, trails, and golf courses (USFWS, 2009).

Stressor: Predation (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: California voles (Microtus californicus), which are known to harvest seeds of many species in general (Martin et al. 1951, Peronne 2002), are known to occur in the area occupied by the plant (Yadon in litt. 2002; Stromberg in litt. 2002). No data have been gathered to determine the extent of this threat. Since the time of listing, herbivory by snails (various species), slugs (various species), and aphids (Aphis spp.) has also been observed on both vegetative and reproductive structures (Doak et al. 2000, Stromberg in litt. 2002) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The existence of only one population and small number of individuals in the population place Astragalus tener var. titi at extreme risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, although the plants are apparently self-compatible and capable of self-fertilization, the small size of the population makes it difficult for this species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The extent to which such events are caused by climate change and the extent to which it could affect Astragalus tener var. titi are unknown at this time (USFWS, 2009).

Recovery

Reclassification Criteria:
1. At least five viable populations (i.e., populations that are stable or increasing based on multiple years of monitoring, including at least two populations in San Diego or Los Angeles Counties) occur on suitable habitat with few to no nonnative competitors, and no threats from trampling. The area surrounding each population should allow for movement and expansion (USFWS, 2009).

2. A minimum of five populations are on land that is permanently protected from development (e.g., residential, commercial, recreational, etc.) including the population that currently exists on Pebble Beach Company and Monterey Peninsula Country Club property. Funds must be

available for appropriate long-term management. Protected habitat must be of adequate size and configuration to ensure that ecosystem and community processes (e.g., hydrologic regime, food webs, pollinator fauna, coastal dune community associates, and associated species) are maintained, and an adequate diversity of sites exist for colonization of new areas as microhabitat conditions change (USFWS, 2009).

3. Site selection, restoration, and plant reintroduction has been initiated in at least two historical localities in Los Angeles or San Diego Counties. These two reintroduced populations will be considered as part of the five populations of plants described in 1 (a) and 1(b) above (USFWS, 2009).

4. The populations of plants are being adequately maintained, such that encroachment by nonnative plants, excessive herbivory, fire prevention activities, or other threats are not negatively affecting Astragalus tener var. titi directly or indirectly (USFWS, 2009).

5. The 17-Mile Drive population and additional populations have been appropriately managed such that monitoring has determined that these populations are stable or increasing for a minimum of 3 consecutive years (USFWS, 2009).

6. A seed bank has been established at a recognized institution that is certified by the Center for Plant Conservation (CPC) (USFWS, 2009).

Recovery Priority Number: 6C

Delisting Criteria:
Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: protection from recreational activities such as hiking, picnicking, equestrian use, and golfing; research is needed on soil seed bank dynamics. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts directly adjacent to occupied patches to allow for expansion, especially to offset losses of patches along the immediate coast due to storm surge and saltwater intrusion; and three additional, new populations are established and protected where appropriate, with a goal of increasing redundancy and representation with the establishment of new populations on the Central Coast, in Los Angeles County, and San Diego County. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. We expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

Recovery Actions:

- Secure and protect existing populations and habitat on private or unprotected lands through willing landowners (USFWS, 2004).
- Manage lands to control or eliminate threats to the plants and their habitat (USFWS, 2004).
- Conduct research to document life history characteristics and plants' responses to vegetation management (USFWS, 2004).
- Survey for additional populations and suitable habitat for reintroduction or reestablishment and establish new populations (USFWS, 2004).
- Develop management strategies and monitor populations to determine effectiveness of management (USFWS, 2004).
- Coordinate recovery actions with other listed species or species of concern (USFWS, 2004).
- Develop and implement a public outreach program (USFWS, 2004).
- Reevaluate recovery criteria and revise recovery plan based on knowledge obtained from research, monitoring, and management (USFWS, 2004).
- Work with Pebble Beach Company and Monterey Peninsula Country Club to clarify current management practices within Astragalus tener var. titi habitat and determine if any modifications could be made to improve the status of the taxon (USFWS, 2009).
- Develop and implement a population monitoring design that focuses on aerial extent of populations rather than exact population counts, and includes the full range of the population (USFWS, 2009).
- Experiment with establishment of new populations in other coastal terrace habitat on the Monterey Peninsula or at Point Lobos State Reserve. If these efforts are successful, attempts to establish other populations could be undertaken in Los Angeles and San Diego Counties (USFWS, 2009).
- Survey historical occurrence areas and potential habitat in San Luis Obispo, Los Angeles, and San Diego counties to detect populations and assess habitat for potential restoration and reintroduction. This effort should include a broader habitat definition to accommodate previously overlooked potential habitat (USFWS, 2009).
- Continue with research on seed characteristics, particularly to determine whether there is a difference in seed viability between those produced from self-fertilization and those produced by cross-pollination (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Establish a minimum 10-year monitoring program for coastal dunes milk-vetch on the Monterey Peninsula that includes the entirety of the population. The monitoring program should include annual systematic surveys of abundance and more frequent assessments of invasive species, trampling, or other emergent threats. 2. Evaluate the existence of a seed bank at sites in Monterey that have been recently occupied (within the past 3 years) and sites that have not been occupied for at least 5 years. 3. Conduct restoration and outplanting trials at suitable sites in Monterey County. 4. Conduct surveys, site evaluation, restoration and outplanting trials at sites in Los Angeles and San Diego County after successful trials in Monterey County (USFWS, 2022)

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SPECIES ACCOUNT: *Astragalus tricarinatus* (Triple-ribbed milk-vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Short-lived erect perennial. Leaves with 17-20 leaflets that are silvery strigose on the upper surface. Flowers are white or pale cream-colored, arranged in loose 6-17 flowered racemes. Fruit is narrow, glabrous and distinctly 3-ribbed (NatureServe, 2015).

Taxonomy

A member of the Fabacae (pea) family (USFWS, 2009).

Historical Range

Endemic to a small area of the state extending from Morongo Wash to the hills northeast of Mecca in Riverside and San Bernardino counties, California (NatureServe, 2015).

Current Range

Since listing, 8 of the original occurrences are considered extant (lower section of Whitewater Canyon, Mission Creek, Dry Morongo Creek and Wash, Big Morongo Canyon, Coyote Hole Spring, Key's Ranch, Orocopia Mountains, and Agua Alta (discounting Cushenberry Canyon); and 4 additional occurrences (Wathier Landing, Catclaw Flat, Long Canyon, and East Deception Canyon; have been detected at the northern end of the historical distribution and in Joshua Tree NP (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 3 - 5 years (USFWS, 2009)

Reproduction Narrative

Adult: This species is a short lived (3 to 5 years) perennial (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert: Dry wash, canyon slope, scree slope (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 1,300 - 4,000 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2009)

Habitat Narrative

Adult: Occurs on sandy and gravelly soils of dry washes, or on decomposed granite or gravelly soils at the base of canyon slopes (NatureServe, 2015). Astragalus tricarinatus habitat includes dry washes, bases of canyon slopes, and scree slopes (Barrows 1987, p. 2; Sanders and Thomas Olsen Associates 1996, p. 3). Astragalus tricarinatus is found in transition areas of the Sonoran and Mojave Deserts from 1,300 feet to 4,000 feet (400 to 1,220 meters) (Sanders 1999, p. 4) (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low to moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Specific seed dispersal mechanisms for A. tricarinatus are unknown. Seeds likely disperse from standing plants only over short distances. Based on patterns of occurrence known at the time of listing, there is potential for downstream dispersal over several miles based, in part, on patterns of occurrences known at time of listing (USFWS, 2009).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2009)

Number of Populations:

12 (USFWS, 2009)

Population Size:

< 500 (USFWS, 2009)

Population Narrative:

The only known extant occurrence consisted of twenty plants in 1992 (Fish and Wildlife Service 1998). Was known from four sites in the Coachella Valley. No plants had been seen since 1985 (Rutherford 1992). Now known from only one extant occurrence (Fish and Wildlife Service 1998) (NatureServe, 2015). Since listing, the number of occurrences has increased to 12. Although the number of occurrences has increased, the total number of individuals known remains low (i.e., less than 500 individuals range-wide). It ranges within transition areas of the Sonoran and Mojave Deserts in San Bernardino and Riverside Counties in California (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: The only potential habitat threat to Astragalus tricarinatus since listing is residential development. Pipeline maintenance and unanticipated pipeline ruptures continue to be a potential threat to A. tricarinatus habitat at Big Morongo Canyon. Potential threats associated with pipelines affect Big Morongo Canyon (EO 1, 2, 6, 7, and 13) where a natural gas pipeline extends the length of the canyon. Since the pipeline carries natural gas, leaks and/or ruptures present the increased threat of fire. The pipeline is still in use though specific impacts have not been recorded since listing. Additionally, maintenance activities may crush existing plants. Impacts from illegal OHV use have been identified as a threat to occurrences in Joshua Tree NP (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: With the exceptions of two source populations, all present and historical occurrences are comprised of waif individuals or demes. These small population sizes of A. tricarinatus make them particularly vulnerable to extinction from random natural events (e.g., large flood events and climate change) or other potentially calamitous anthropogenic events (e.g., wildfire suppression activities and pipeline leaks or repairs). Five categories of small population vulnerability are outlined: (1) species with a very narrow geographic range; (2) species with only one or a few populations; (3) species in which population size is small (identified as one of the best predictors of species extinction rate); (4) species in which population size is declining; and (5) species that are hunted or harvested by people (Primack 2006, p.159). Three of these categories apply to Astragalus tricarinatus (#2–4). Additionally, demographic fluctuations, environmental variation, and loss of genetic variability and related problems of inbreeding depression and genetic drift; and/or to natural catastrophes are cause for greater vulnerability to extinction of small populations (Barrett and Kohn 1991, p. 3). By these measures, the species is at increased risk of extinction (USFWS, 2009).

Stressor: Fire (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Wildland fires have impacted occurrences of Astragalus tricarinatus in recent years. The Wathier Landing occurrence burned in the Verbenia Fire in 1995 and again in the Millard fire in 2006. Also, sections of Big Morongo Canyon Preserve and Dry Morongo Wash were burned in the 2005 Paradise Fire. In 2006, the Sawtooth Complex burned the upper half of Dry Morongo Wash. Fire can burn existing plants and possibly affect seeds in the soil. Additionally, response to wildland fires can affect the species. Direct physiological impacts to a source population or a floral bloom of competing nonnative invasive plants from a phosphate-rich fire retardant drop are very realistic scenarios. Wildland fires are possible throughout the range of Astragalus tricarinatus. Suppression activities including fire retardant drops and bulldozer use threaten populations in small areas (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Impacts to the species under predicted future climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume Astragalus tricarinatus may be affected, the Service lacks sufficient certainty regarding how and when climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by fire and increased fire frequency (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Perform annual surveys at known extant occurrences to acquire demographic and survival information related to abundance. Also perform predictive GIS modeling involving source soil type in search of new source populations. The Wildlands Conservancy is a potential partner for occurrences under its preservation (USFWS, 2009).
- Develop a site-specific plan to coordinate fire-fighting that is available to dispatch authority of interagency fire response. The Forest Service, BLM, and NPS-Joshua Tree National Park may be partners for occurrences in their respective jurisdictions. This plan might contain suggestions regarding areas to avoid when accessing the areas, cutting bulldozer lines, or making aerial retardant drops. These same areas would become areas of post-fire surveys in coordination with a BAER plan (USFWS, 2009).
- Surveying all known occurrences (including extralimital sites such as Agua Alta Canyon, Key's Ranch, and the Orocopia Mountains) within the next 5 years. Make use of descriptive parameters of more recently detected upland occurrences to assemble predictive maps of likely habitat (USFWS, 2009).
- Coordination with Four Corners Pipeline on protocol to ensure low-impact pipeline maintenance procedures. Vehicles driven along the pipeline and trenching equipment used to maintain the pipeline can minimize their impacts (USFWS, 2009).
- Produce a Recovery Plan which would coordinate and direct survey and research actions beneficial to species recovery and that will reduce or eliminate threats to the species. Include occurrence map with risk assessment (USFWS, 2009).

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SPECIES ACCOUNT: *Astrophytum asterias* (Star cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/1993; Southwest Region (R2) (USFWS, 2016)

Physical Description

A small, spineless, disk or dome-shaped member of the Family Cactaceae (Cactus Family). It is 2 to 15 centimeters (1S6 inches) across, and up to 7 centimeters (3 inches) tall. Star cactus is dull green-to-brown in color, often speckled with a covering of tiny white scales. The body is divided into eight, vaguely triangular sections. Each triangular section has a central line of circular indentations (areoles) filled with whitish, wooly hairs. During periods of adequate moisture, star cactus is usually a dull green color; however, during droughts, the cactus becomes brownish and loses fullness so that it becomes flush with the ground and almost perfectly camouflaged (Figure 2). Flowers are yellow with orange centers, and up to 15 centimeters (6 inches) in diameter. The fruits of star cactus are green to grayish-red, somewhat obscured by white wooly hairs, about 1.25 centimeters (0.5 inches) long, oval, and fleshy when mature. The seeds are glossy, dark brown with an enlargement of a chamber of the seed coat forming a flaring collar that encircles the hilum (Damude and Poole 1990, Benson 1982) (USFWS, 2003).

Taxonomy

This plant is a member of the cactus family (Cactaceae) (USFWS, 2016). Astrophytum asterias was originally collected by Baron von Karwinsky in 1843 and described as Echinocactus asterias by Joseph Zuccarini in 1845 (Damude and Poole 1990, USFWS 2003). Charles Lemaire described the new genus Astrophytum in 1868, into which he placed A. asterias. Common names for A. asterias include: Biznaga-algononcillo de estrella, sand dollar, sea urchin star cactus, and false peyote (Integrated Taxonomic Information System 2011) (USFWS, 2013).

Historical Range

The historical range of star cactus included Hidalgo, Starr, Zapata, and possibly Cameron Counties in South Texas and the States of Nuevo Leon and Tamaulipas in Mexico. The Nuevo Leon site near Linares was probably extirpated by collectors (USFWS, 2003). When listed in 1993, only two extant populations of A. asterias were known, one population in the United States, in Starr County, Texas; and one population in Tamaulipas, Mexico (USFWS, 2013).

Current Range

Currently only known from Starr County in extreme south Texas and the adjacent state of Tamaulipas, Mexico (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Two growth rates were determined using different calculation methods. Based on the assumption that the mean annual growth rate is constant among all size classes, the growth rate was determined to be 2.71 millimeters (mm)/year (0.10 in/year). The second method took into account the premise that growth rates differ by size class (growth rates range from -0.85 – 3.65 mm/year (-0.03 – 0.14 in/year). This resulted in the mean diameter growth rate of 2.1 mm/year (0.08 in/year) (USFWS, 2013).

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Diadasia rinconi (USFWS, 2013)

Breeding Season

Adult: March - May (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Flowers usually bloom from March - May, opening in the morning and closing in the evening. Astrophytum asterias is an obligate outcrosser (USFWS 2003, 2013). Using the estimated growth rates, it would take 15 - 25 years to reach the 4-cm (1.57 in) benchmark for reproductive maturity. The cactus specialist bee Diadasia rinconis was found to be the most effective of all the observed pollinators (Janssen et al. 2010). Other insects visited the flowers more frequently but because of low effectiveness, they are not considered the most important (Janssen et al. 2010) (USFWS, 2013). Fruiting occurs April through June (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Historical: subtropical grassland or grassland/savannah; current: shrubland, non-native grassland (NatureServe, 2015); Tamaulipan thornscrub (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Partial shade (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Currently, this species is found in sparse, fairly open brushland. It is most often found growing in gravelly, sometimes saline, clays or loams in the partial shade of other plants or rocks. The vegetation in these areas was originally a subtropical grassland or grassland/savannah, but fire suppression, overgrazing, and pasture improvement have converted it to thorny shrublands and stands of non-native pasture grass. It is uncertain what habitat this species occupied in the original grassland ecosystem (NatureServe, 2015).

Astrophytum asterias occurs on flats in shrublands and grasslands in Tamaulipan thornscrub. Soil analysis indicates that the highest density of A. asterias was found on saline-sodic, followed by saline soils (Janssen et al. 2010) (USFWS, 2013).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms in the wild are virtually unknown. Mature fruits appear to disintegrate while still attached to the plant and leave a small cluster of seed on top of the plant. Wind and rain may carry the seeds away to establishment sites. Small rodents may also store the seeds at cache sites. Additionally, ants may play a role in seed dispersal (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

U.S.: 24; Mexico: 9 (USFWS, 2013)

Population Size:

U.S.: 5,125; Mexico: 1,275 (USFWS, 2013)

Population Narrative:

This species has experienced a short term decline of > 30%; the Nuevo Leon site is believed to have been extirpated by collectors, and the Tamaulipas site has been reduced to very few individuals (NatureServe, 2015). In Starr County, Texas, 2011 surveys brought the known total of extant A. asterias populations to 24, containing a total of 5,125 individual plants. There are nine populations in Mexico, totaling 1,275 plants (Janssen et al. 2010, Martinez-Avalos 2002) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The leading threat to A. asterias throughout its range currently, and at the time of listing, is habitat loss. All A. asterias populations in Starr County, Texas, are located on private property; the majority of which do not have signed conservation agreements. An extensive land area in Starr County has been root-plowed and converted to buffelgrass (Pennisetum ciliare) pasture; this has presumably destroyed an unknown amount of star cactus habitat. Mechanical disturbance makes habitat unsuitable for A. asterias. An additional but unknown amount of habitat has probably been lost to urban and residential development and highway construction. Highly competitive introduced grasses (specifically buffelgrass) are clearly incompatible with A.

asterias conservation. Buffelgrass reduces native vegetation coverage, density, species richness, and diversity (Sands et al. 2009). Seismic surveys, oil and gas well development, and other construction related to oil and gas exploration can cause surface damage and irrevocably damage or completely destroy the habitat (Conner 2011) (USFWS, 2013).

Stressor: Overutilization due to collection (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Collectors for many years have removed cacti for private collections. Astrophytum asterias are collected by individuals for personal use or trade, sometimes being mistaken for peyote (Lophophora williamsii). The demand for rare cacti by collectors has escalated in the United States and in other countries, including Asia and Europe (Westlund 1991). In 1991 the TPWD published a report on the cactus trade, monitoring impacts by investigating 72 individual collectors, family nurseries, and commercial nurseries (Westlund 1991). Although many of these collectors/growers had less than 50 individual cactus plants, representing only three to four species, one “digger” had more than 1,000 freshly dug cacti of 13 subspecies. Four hundred field-collected A. asterias were observed in nurseries, and eight mail order catalogs had A. asterias listed for sale (USFWS, 2013).

Stressor: Disease and predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: In the U.S. and Mexican populations, the leading cause of mortality was found to be herbivory by Mexican-ground squirrels. It does appear that during periods of drought, the level of herbivory is increased. Other causes of mortality were found to be insect herbivory and fungal infections. Combination of pathogens and herbivory was shown to greatly reduce the population by over 50 percent (Martinez-Avalos 2007). Several animal and insect species appear to utilize and destroy A. asterias. The threat to A. asterias continues to remain high, especially during periods of drought (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Rising temperatures might enable the species to survive further north than at present, but might also reduce the southern limit of the range. Similarly, changes in the frequency and amount of precipitation could favor a shift in geographic range or habitat type. However, the limited seed dispersal range, and the existence of new barriers to migration could impede alteration of the range of A. asterias (Malanson and Cairns 1997). Changes in temperature and rainfall amounts and patterns could alter the species’ competitive advantage in the unique micro-habitats it now inhabits. Regardless of how these changes may affect the autecology of A. asterias, the altered synecology may be far more significant. For example, higher winter temperatures could increase competition from invasive grasses (Patterson 1993) (USFWS, 2013).

Stressor: Reduction of genetic variability (USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: At the time of listing, the one site known to have the star cactus present contained fewer than 2,100 plants. Genetic variability and viability decrease with reduced numbers of plants across the range (Ledig 1986). This, along with the pressures of other natural and anthropogenically-induced threats, increases the possibility of extinction of the species in the wild (USFWS, 2013).

Recovery

Reclassification Criteria:
1. Maintain or establish ten geographically distinct, fully protected, self-sustaining populations of star cactus in the United States or Mexico, each with a minimum of 2,000 individuals and an age class structure reflecting that plants are reproducing and becoming naturally established within the population (USFWS, 2013).

2. Develop and implement a formal conservation agreement between the U.S. and Mexico (USFWS, 2013).

Delisting Criteria:
1. Over a 60-year period, maintain the 5 fully protected sites in each designated recovery unit at the MVP of 2,500 individuals per site with at least 50% being of reproductive age. All sites will be fully protected, self-sustaining sites occurring across the species known range within each recovery unit. (USFWS, 2019)

Recovery Actions:
- Protect and manage existing star cactus populations and habitat in the United States and Mexico (USFWS, 2003).
- Gather information for management and monitoring programs for star cactus (USFWS, 2003).
- Search for new populations of star cactus in the United States and Mexico (USFWS, 2003).
- Establish and maintain a botanical garden population of star cactus (USFWS, 2003).
- Establish new populations in natural habitat as necessary to meet reclassification criteria (USFWS, 2003).
- Develop and implement a formal conservation agreement for star cactus between the United States and Mexico through the Trilateral Agreement (USFWS, 2003).
- Develop a public education and awareness program for the species (USFWS, 2003).
- Evaluate progress toward recovery, management direction, and status of information needed for development of delisting criteria within five years (2008-2009) (USFWS, 2003).
- Continue periodic monitoring of the known populations in Texas and Mexico to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2013).
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. Work with private landowners to establish a private landowner support group and pursue conservation agreements with landowners (USFWS, 2013).
- Conduct surveys of high-potential habitat within the known range of the species in South Texas and Mexico, focusing on sites that have not previously been surveyed (USFWS, 2013).

- Develop an official reintroduction plan for A. asterias. Collect seeds from the known populations, propagate in a greenhouse to produce seedlings, and reintroduce at protected sites, in accordance with Service policy on controlled propagation of endangered species (65 FR 56916) (USFWS, 2013).
- Although the recovery plan (USFWS 2003, p. 13) stated that at least two distinct tracts of National Wildlife Refuge (NWR) land in Texas have the type of soil and habitat necessary for A. asterias reintroduction, and Recovery Action 5 further stated that reintroduction could be implemented on Lower Rio Grande Valley NWR, subsequent habitat assessments, conducted by two separate teams of star cactus experts (in 2005 and in 2010), did not find any suitable star cactus habitat on any existing tracts of Lower Rio Grande valley NWR. However, this refuge could target some future land acquisitions to include suitable habitat for A. asterias (USFWS, 2013).
- Amended recovery criteria 1. Maintain or establish at least 5 sites (>1 km of separation between sites) within each of a total of 3 designated recovery units in Texas and Mexico. Recovery units will be based on geology and/or soils. Each site will contain at least 2,500 individuals, 50% of which will be of reproductive age as determined by a size of ≥ 4 cm diameter. The sites must occur across the species known range within each recovery unit; however, coalescence of sites due to recovery or discovery of new sites will not reduce the number of recognized sites. 2. All sites described above in downlisting criterion 1 must be fully protected in perpetuity and managed appropriately for the species, its habitat, and pollinators. 3. Develop and implement a formal conservation agreement for star cactus between the U.S. and Mexico. (USFWS, 2019)

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SPECIES ACCOUNT: *Atriplex coronata var. notatior* (San Jacinto Valley crownscale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, 1-3 dm tall, with gray-scaly herbage. Flowers are inconspicuous, with rounded, often bumpy bracts developing in the fruiting stage. Usually flowers in April and May and sets fruit by May or June (NatureServe, 2015).

Taxonomy

Atriplex coronata var. notatior (San Jacinto Valley crownscale) was first described by Willis Jepson in 1914, eased on specimen material he collected ii 1901 from the dried bed of San Jacinto Lake. Riverside County, California This taxon was considered a minor variant in a monographic treatment of the genus Atriplex (Hall and Clements 1923) and was generally not recognized as distinct from A. coronata until Munz (1974) concurred in Jepsons findings in his treatment of southern California plants (USFWS, 1994). It is a member of the Chenopodiaceae (goosefoot family) (Zacharias 2012, p. 629) (USFWS, 2012).

Historical Range

See Current

Current Range

Restricted to the San Jacinto, Perris, Menifee, and Elsinore Valleys of western Riverside County, California. Occurrences are associated primarily with the San Jacinto River and Old Salt Creek tributary drainages, with an additional occurrence near Lake Elsinore (USFWS 2008) (NatureServe, 2015).

Critical Habitat Designated

Yes; 4/16/2013.

Legal Description

On April 17, 2012, the U.S. Fish and Wildlife Service (Service) proposed to designate critical habitat for San Jacinto Valley crownscale (Atriplex coronata var. notatior) under the Endangered Species Act of 1973, as amended (77 FR 23008 - 23057). On April 26, 2013, the Service issued a Final Rule in which no critical habitat was designated for San Jacinto Valley crownscale (78 FR 22626 - 22658). The Final Rule states "The Secretary is exercising his discretion to exclude approximately 8,020 ac (3,246 ha) of previously proposed critical habitat for Atriplex coronata var. notatior. The Service determined that the benefits of exclusion outweigh the benefits of inclusion for lands previously proposed as critical habitat within areas covered under the Western Riverside County Multiple Species Habitat Conservation Plan, the Rancho Bella Vista Habitat Conservation Plan, and the Southwestern Riverside Multi-species Reserve Cooperative Management Agreement." On October 13, 2005, the Service issued a Final Rule that did not designate critical habitat for this species (70 FR 59952 - 59974).

Life History

Food/Nutrient Resources

Breeding Season

Adult: April - August (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Wind (USFWS, 2012)

Reproduction Narrative

Adult: Seeds may remain viable for more than five years, such that a soil seed bank may be present at occupied and formerly-occupied sites (USFWS 2008) (NatureServe, 2015). Atriplex coronata var. notatior is monoecious (plants bear separate male and female flowers on the same plant) and is believed to be wind-pollinated. Atriplex coronata var. notatior is reported to be a prolific seed producer (Ogden Environmental and Energy Services Corporation [OEESC] 1993, p. 27). Seeds generally germinate in the spring as flows recede, flower in April and May, and set fruit by May or June (Bramlet 1992, pers. comm.). The flowering period may extend to August in years when the water recedes late in the spring season (Munz 1974, p. 355; California Native Plant Society [CNPS] 2001, p. 93) (USFWS, 2012).

Habitat Type

Adult: Wetland, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alkali vernal plain, alkali playa, alkali scrub, alkali grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Dynamic hydrological regime (NatureServe, 2015); seasonal large-scale flooding (USFWS, 2012)

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in seasonal wetlands, such as floodplains and vernal pools, on slow-draining alkali soils; communities include alkali vernal plain, alkali playa, alkali scrub, and alkali grassland. Sites are typically flooded by winter rains, after which the water drains or evaporates over a variable period of time. Prefers areas with a dynamic hydrological regime that includes both local and large-scale flooding events (USFWS 2008). The environmental specificity is very narrow to narrow (NatureServe, 2015). It is associated with alkaline-saline soils. A hydrologic regime that includes seasonal and large-scale flooding in combination with slow drainage in alkaline soils with low nutrient loads is a key habitat element for this taxon. Atriplex coronata var. notatior is adapted to grow in slow-draining alkaline-saline clay soils, primarily the Willows soil series and, to a lesser extent, the Domino, Traver, Waukena, and Chino soils series (Knecht 1971, p. 23; Bramlet 1993, p. 4) (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Fruits appear capable of floating, which would allow them to be dispersed by annual flood waters (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decline of 50 - 90% (NatureServe, 2015)

Species Trends:

50 - 70% decline (NatureServe, 2015)

Number of Populations:

15 (USFWS, 2021)

Population Size:

106,000; variable depending on year (USFWS, 2012)

Adaptability:

Low (inferred from USFWS, 2012)

Population Narrative:

The U.S. Fish and Wildlife Service (1998) estimates that approximately 75% of this taxon's historically suitable habitat has been destroyed or heavily impacted. This species has experienced a long-term decline of 50-90%. Between 1992 and 1998, the number of individuals and area occupied appeared to decline about 70% (U.S. Fish and Wildlife Service 1998). Between 1998 and 2008, the overall extent of the range did not change appreciably, but fragmentation of the spatial distribution within the range (in both space and time) continued due to ongoing threats (USFWS 2008). In 2000, the rangewide population was estimated to be 106,000 individuals (Glen Lukos Associates cited in USFWS 2008); as of 2008, this was still considered the best available estimate. However, the 2000 survey was conducted under the unusually favorable conditions of a two-year suspension of discing and manure dumping by the majority of landowners; these activities have since resumed and are expected to have decreased the number of plants (USFWS 2008). In addition, this annual plant undergoes significant year-to-year fluctuations in the number of standing individuals in response to annual rainfall, extent of winter flooding, temperature, and habitat conditions; therefore, estimates of plant numbers based on short-term data should be used very cautiously (USFWS 2008). Approximately 8 occurrences are believed to have excellent or good viability (CNDDB 2008) (NatureServe, 2015). The Service has defined three geographic locations representing four occurrences of A. c. var. notatior in western Riverside County. A rangewide population estimate of 106,000 individuals of Atriplex coronata var. notatior is based on estimates from surveys conducted in the spring of 2000 (Glenn Lukos Associates, Inc. 2000, p. 15). This taxon exhibits several attributes that might limit its distribution and population growth; particularly habitat specificity and dependence on hydrologic processes represent significant vulnerabilities for Atriplex coronata var. notatior (USFWS, 2012).

Threats and Stressors

Stressor: Urban and agricultural development (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The Alberhill Creek occurrence of Atriplex coronata var. notatior in the floodplain north of Lake Elsinore is located in an increasingly urbanized area that contains both local and private lands. An example of a recent development threat at this occurrence is a proposed subtransmission line (in association with a recently completed electrical power substation), as part of the Southern California Edison Valley-Ivyglen Subtransmission Line and Fogarty Substation Project (W. Worthey, Consultant, 2011, pers. comm.). Efforts are in place to reduce threats to Atriplex coronata var. notatior from urban development and related infrastructure; however, comprehensive surveys have not been conducted for the Lower San Jacinto and Alberhill Creek occurrences. An increase in the addition of manure and biosolids along the Lower San Jacinto River occurrence related to agricultural activities has been observed (USFWS 2008, p. 10). These soils amendments can permanently impact alkaline soil habitat where Atriplex coronata var. notatior is found as a result of: (1) disruption of essential physical or biological features due to continued ground disturbance and (2) alteration of soil chemistry, which causes permanent habitat conversion to a different plant community and expansion of nonnative plants that invade and may outcompete native taxa (Roberts 1999, pers. comm.). The Service believes that these agricultural developments continue as important direct threats to Atriplex coronata var. notatior within the Lower San Jacinto River occurrence. However, based on the best available information, the magnitude of this threat is high for this occurrence because many of the point localities of A. c. var. notatior in portions of the Upper and Lower San Jacinto River occurrences are found on private land that continue to be tilled for dryland farming or negatively impacted by soil amendments. Within the Upper San Jacinto River occurrence, overland flows that cross over agricultural lands into Mystic Lake during major flood events (i.e., winter storms) can transport sediments containing nutrients into the lake, which has increased in recent years as smaller flow events have caused failure of the Diversion Channel levees and flooding of agricultural lands in the San Jacinto Gap region (Tetra Tech and WRIME 2007, Appendix A, p. 1) (USFWS, 2012).

Stressor: Alteration of hydrology (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Habitats that support Atriplex coronata var. notatior are vulnerable to alteration of the supporting watershed, including prolonged inundation from increases in urban run-off as well as drainage of wetlands from removal of water supply (USFWS 1998, pp. 54984–54985). These alterations of hydrological processes are often the result of agriculture or urban development activities adjacent to alkaline wetlands. The San Jacinto River floodplain is often dry due to groundwater infiltration enhanced by low groundwater levels from excessive pumping and limited recharge (Tetra Tech and WRIME 2007, p. 28), which alter the seasonal flooding cycle. The Upper Salt Creek occurrence is bisected north to south by the San Diego Aqueduct Canal and currently includes open fields and cow pastures within the remaining alkaline vernal pool, alkaline grassland, and alkali scrub habitats (RECON 1995, pp. 15, 17; CNDDB 2012, EO 9). Additionally, historical drainage patterns in the Upper Salt Creek occurrence are disrupted by local roads, road ditches, and agricultural drainage ditches, which have reduced the degree and duration of ponding during the wet season (RECON 1995, p. 18) (USFWS, 2012).

Stressor: Disking (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: More than 500 ac (200 ha) of occupied or potential habitat for Atriplex coronata var. notatior has been disked for the purposes of fire suppression or weed abatement (USFWS 1998, p. 54984, citing Roberts 1993, p. 2). Disking (or tilling) is also used to prepare areas for farming activities. This activity changes the microtopography of the natural floodplains and the alkaline soils themselves, both of which are important features for establishment of this taxa and other native plants found in these seasonally flooded habitats (Bramlet 2009, pers. comm.). Disking for dryland farming has been an ongoing activity in the San Jacinto River floodplain for perhaps 100 years; however, this activity was, in the past, intermittent, allowing for recovery periods for Atriplex coronata var. notatior during fallow periods (Roberts 1999, pers. comm.) (USFWS, 2012).

Stressor: Invasive nonnative plants (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Displacement of Atriplex coronata var. notatior by nonnative plants was identified as a threat at the time of listing. In particular, the expansion of a nonnative grass, Crypsis schoenoides (swamp prickle grass), was described as an important threat as a result of its seeding as a food source for migratory waterfowl along the San Jacinto River (USFWS 1998, p. 54988). establishment of nonnative plants such as Brassica nigra (black mustard) and Salsola traga (Russian thistle) as a result of manure and sludge dumping along the Lower San Jacinto River floodplain has been documented (USFWS 2008, pp. 15–16). The continued planting of cover crops such as Festuca perennis (rye grass) (as Lolium multiflorum (Italian rye grass)) or Festuca (as Lolium) rigidum (Wimmera ryegrass; rigid Italian rye grass) for waterfowl, competes with existing alkali plant communities (Bramlet 2009, pers. comm.), displacing Atriplex coronata var. notatior and other native plants. The prevalence of nonnative plants remains a threat to Atriplex coronata var. notatior due to continued disturbance of these areas and the proximity of A. c. var. notatior occurrences to consistent sources of nonnative species of grasses and forbs from nearby residential development and highways (USFWS, 2012).

Stressor: Sheep grazing (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, intensive sheep grazing was described for the San Jacinto River and Hemet floodplain areas occupied by Atriplex coronata var. notatior (USFWS 1998, p. 54985). Sheep grazing in habitat occupied by A. c. var. notatior in the Upper Salt Creek occurrence was reported in 2005 (Roberts 2005, pers. comm.). Grazing is a recurring threat to the taxon at the Upper Salt Creek and the Lower San Jacinto River occurrences (USFWS, 2012).

Stressor: Trampling (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Sheep grazing has been previously described as the primary impact related to trampling to individual stands of plants. Trampling resulting from off-road vehicle use is likely to be a localized, individual threat to some populations of Atriplex coronata var. notatior within the most southern portion of the Lower San Jacinto River occurrence based on visible off-road trails and land disturbance observed with aerial imagery (ESRI 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Projected effects of climate change in the southwestern California ecoregion occupied by Atriplex coronata var. notatior from regional climate models indicate a mean annual temperature increase of 1.7 to 2.2º Celsius (C) (3.06 to 3.96º Fahrenheit (F)) by 2070, and a general consensus of a 2º C (3.6º F) increase in most months over the next 100 years (Point Reyes Bird Observatory [PRBO] Conservation Science 2011, p. 40). Vegetation changes are also expected. Drier climatic conditions can increase the threat to taxon such as Atriplex coronata var. notatior that rely on seasonal rainfall (USFWS 1998, p. 54989). Although there is currently uncertainty with current model projections of precipitation in southern California, the Service believes that predictions of warmer temperatures and increased variability in extreme rain or flood events are a threat to A. c. var. notatior through resultant changes in precipitation patterns that create conditions essential for maintaining habitat that supports plant populations (USFWS, 2012).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Survey all historical and extant occurrences to determine the location, status, and acreage of occupied and suitable habitat of each population to establish a comprehensive baseline against which to measure future changes. Surveys should be concentrated on the remaining Willows soil series within the basin and valley floors that form the U-shaped region surrounding the Lakeview Mountains, encompassing the San Jacinto River and Upper Salt Creek 100-year floodplains. Additionally, a more focused survey for Atriplex coronata var. notatior should be conducted within the Alberhill Creek floodplain during a year with above average rainfall (USFWS, 2012).
- Conserve or preserve Atriplex coronata var. notatior occurrences on private lands. Continue to identify key property easements or parcels in the San Jacinto and Upper Salt Creek floodplains for Partners for Fish and Wildlife programs or purchase through the Act's section 6 funding program (USFWS, 2012).
- Manage Atriplex coronata var. notatior occurrences to prevent potential impacts from recreational activities, dumping, or other human-related activities. This may include fencing or posting to prevent access to managed areas and evaluation of appropriate use of disking

practices for fire suppression and weed abatement (USFWS, 2012).

- Engage in the State of California's TMDL program to ensure that water quality (as discussed in FACTOR A and FACTOR D) within habitat occupied by sensitive taxon, such as Atriplex coronata var. notatior, is evaluated in determining "beneficial uses" within the Temescal Creek (and its tributaries) and Lake Elsinore TMDL process (USFWS, 2012).
- Develop a Population Viability Analysis model such as a metapopulation occupancy model for Atriplex coronata var. notatior to determine the key features for survival. Conduct a sensitivity analysis to identify those elements that represent the most important threats to maintaining minimum population size (USFWS, 2012).
- Conduct research to evaluate reproductive life history characteristics such as seed germination requirements, mechanism of seed dispersal, and seed viability. This will assist in identifying reasons for the persistence of certain occurrences and actions needed to help conserve others (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Atriplex coronata var. notatior and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Survey all historical and extant occurrences during the late spring-early summer subsequent to rainy seasons featuring average to above-average annual precipitation. This will help to determine the location, status, and acreage of occupied and suitable habitat of each population to establish a comprehensive baseline against which to measure future changes. Surveys should be concentrated on the remaining Willows, Traver, Domino, Chino, Waukena, Grangeville saline-alkaline, and Buchenau soil series within the basin and valley floors that form the U-shaped region surrounding the Lakeview Mountains, encompassing the San Jacinto River and Upper Salt Creek 100-year floodplains. Additionally, a more focused survey for A. c. var. notatior should be conducted within the Alberhill Creek floodplain during a year with above average rainfall. 2. Preserve A. c. var. notatior occurrences on private lands. Continue to identify key property easements or parcels in the San Jacinto and Upper Salt Creek floodplains for Partners for Fish and Wildlife programs or purchase through the Act's Section 6 funding program. 3. Conduct research to understand important life history characteristics such as confirming the breeding system, seed germination requirements, mechanism of seed dispersal, and seed viability that will assist in identifying the underlying reasons for the persistence of certain occurrences and actions needed to help conserve others. 4. Develop an approach for restoring degraded alkali vernal pool and alkali meadow habitat suitable for reintroducing the species including: conducting a genetic study throughout the species range to inform seed collection efforts; collect and bank seed, develop a GIS-based habitat suitability model to determine appropriate areas for restoration, and model the species hydrological needs. 5. Manage A. c. var. notatior occurrences to prevent potential impacts from recreational activities, dairy waste deposition, or other human-related activities. This may include fencing or posting to prevent access to managed areas and evaluation of appropriate use and timing of discing practices for fire suppression and weed abatement. 6. Conduct research to understand the magnitude of the impacts associated with nonnative plant competition and develop appropriate techniques for managing nonnative plant species, where appropriate. In particular, determine the effects of Oncosiphon pilulifer, Hordeum murinum, and Hordeum marinum on A. c. var. notatior recruitment and persistence. Research appropriate timing and techniques to control the two nonnative barley species and O. pilulifer while minimizing impacts to A. c. var. notatior and

the two, co-occuring native dwarf barley species (Hordeum intercedens and H. depressum). 7. Develop a Population Viability Analysis model such as a metapopulation occupancy model for A. c. var. notatior to determine the key features for survival. Conduct a sensitivity analysis to identify those elements that represent the most important threats to maintaining minimum population size. (USFWS, 2021)

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USFWS 1994. Endangered and Threatened Wildlife and Plants

Proposed Rule To List Four Southwestern California Plants as Endangered or Threatened. 59 Federal Register 240. December 15, 1994. Pages 64812 - 64823.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Revised Designation of Critical Habitat for Allium munzii (Munz's Onion) and Atriplex coronata var. notatior (San Jacinto Valley Crownscale)r. Final rule. 78 FR 22626-22658 (April 16, 2013)

U.S. Fish and Wildlife Servce. 2012. Endangered and Threatened Wildlife and Plants

Designation of Revised Critical Habitat for Allium munzii (Munz's onion) and Atriplex coronata var. notatior (San Jacinto Valley crownscale)

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SPECIES ACCOUNT: *Auerodendron pauciflorum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/20/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree which may reach up to 5 meters in height. The leaves are opposite or subopposite, ovate to ovate-elliptic, 6 to 15 centimeters long and 3.5 to 6 centimeters wide, glabrous, and with minute black glandular dots. Paired ovate-triangular, ciliate stipules, 1.5 millimeters long, are present at the base of the petiole. The peduncles vary from millimeters in length. Two to three flowers are borne in the leaf axils. The calyx tube is broadly campanulate, 2 millimeters long and 3 millimeters wide. The fruit is unknown at the present time (Proctor 1991). (USFWS, 1996)

Taxonomy

Auerodendron pauciflorum belongs to the family Rhamnaceae, a family consisting of approximately 55 to 58 genera and 900 species of cosmopolitan distribution but most common in the tropics and subtropics. The genus Auerodendron Urban includes eight or nine species: one in the Bahamas and Cuba, five or six endemic to Cuba, one endemic to Jamaica, and one endemic to Puerto Rico (Breckon and Kolterman 1994) (USFWS, 1996).

Historical Range

Historically, A. pauciflorum has been known from one population with 20 individuals in privately owned land at Coto Ward in the municipality of Isabela (Service 2011, Service 2017; Figure 1). Auerodendron pauciflorum is known from two natural populations, one at the Ramey Solar Observatory in the municipality of Aguadilla and another Coto Ward in the municipality of Isabela, and two introduced populations, one at Hacienda La Esperanza Nature Reserve in the municipality of Manatí, and another at Río Encantado Natural Protected Area in the municipality of Florida (USFWS, 2022).

Current Range

Municipality of Aguadilla. In 2014, Acevedo-Rodríguez (2014) reported a single mid-sized individual without evidence of sexual reproduction (flower or fruit) on federal land at the Ramey Solar Observatory municipality of Aguadilla (Service 2017; Figure 1). Currently, this population remains limited to a single individual tree. Municipality of Isabela. Recently, Alcides L. Morales-Pérez, from the non-governmental organization Para La Naturaleza (PLN), informed the Service of a rapid assessment he conducted for A. pauciflorum at the Coto Ward population in the municipality of Isabela (Morales-Pérez, 2022, pers. comm.). During this rapid assessment he observed a total of 20 individuals with different age classes (seedlings, juveniles, and adults) (Morales-Pérez, 2022, pers. comm.). However, he found a low presence of seedlings, all with whitish or yellowish leaves, probably due to the shaded conditions under parental trees (Morales-Pérez, 2022, pers. comm.). Additionally, Morales-Pérez (2022, pers. comm.) reported that the vegetation composition at this locality included trees species like: Calyptharnthes pallens (Tapón blanco), Sideroxylon salicifolium (Almendrón), Manilkara pleeana (Ausubo), Leucothrinax morrisii (Palma de escoba), Bourreria suculenta (Palo de Vaca), Oplonia spinosa (Espinosa), Tabebuia heterophylla (Roble nativo), Coccoloba diversifolia (Uvilla) and Gymnanthes lucida (Yaití). Municipalities of Manatí and Florida. In 2019, Para La Naturaleza

(PLN) propagated more than 100 seeds of A. pauciflorum from the population of Coto Ward. Then, in 2020, the Service signed a cooperative agreement with PLN for planting that propagated material as well as to implement habitat enhancement practices in at planting sites. The goal of this effort is to establish new populations of A. pauciflorum that eventually are capable of self-perpetuation within protected areas to help the species' recovery. A total of 50 A. pauciflorum individuals were planted at Hacienda La Esperanza Nature Reserve (HLENR) and other 50 individuals were planted at the Río Encantado Natural Protected Area (RENPA) (PLN 2022; Figure 1). These two reserves are managed for conservation by PLN. Furthermore, PLN had planted three A. pauciflorum individuals at an arboretum at HLENR in June 17, 2020, which flowered for the first time on November 6, 2021, only 17 months after planting (PLN 2022). Unfortunately, these three individuals did not produce any fruit (PLN 2022). In 2022, PLN staff evaluated the planted individuals at HLENR and RENPA, and documented 42 (84%) and 48 (92%) live trees, respectively. Additionally, field observations over a one-year period found that 56 percent of the trees planted at HLENR had the presence of damage from an unknown wood-boring insect, which could be the cause of death of the 8 individuals (PLN 2022) (Figure 2). Although the presence of this insect could affect the survival of A. pauciflorum, the insect was not observed in the individuals planted at RENPA. Therefore, further studies are needed to determine its effect on the species. The cause of death of two A. pauciflorum individuals at RENPA was believed to be an excess of shade in the planting area. Thus, PLN staff was conducting selective pruning of surrounding trees to avoid losing other A. pauciflorum individuals (USFWS, 2022).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016)

Reproduction Narrative

Adult: One herbarium specimen was in flower in November (USFWS, 1996).

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (USFWS, 1996)

Habitat Narrative

Adult: Both Myrcia paganii and Auerodendron pauciflorum are known from the seasonal evergreen or semi-evergreen forest types of the subtropical moist forest life zone in the limestone region of north and northwestern Puerto Rico (Ewel and Whitmore 1973). This area receives from 175 to 200 centimeters of rainfall per year, with the dry season extending from January to March and the wet season from May through November (Vivaldi and Woodbury 1981). The limestone or karst region of northwestern Puerto Rico is underlain by limestone rocks of Oligocene or Miocene age. Topography varies throughout the karst region, from extremely rugged to gentle rolling hills. Canyons, sinkholes, and subterranean rivers are the most common features ofthe region. Elevations vary from 150 to 300 meters. Soils are shallow,

well-drained, alkaline and interspersed between outcrops of hard limestone. The limestone outcrops may cover up to 75 percent of the surface (Vivaldi and Woodhury 1981). In the seasonal evergreen forest type, two strata are present. The upper strata is composed of a continuous layer which extends up to 20 meters in height with a few emergent trees reaching 25 meters. From one-third to two-thirds of the species are deciduous. The second strata reaches 10 meters in height and the number of deciduous species is low. Most species are evergreen, with simple, microphyllous leaves. Palm species may be common in this strata. Common species in the upper layer are Bucida buceras, Bursera simaruba, Clusia rosea and Tabebuja heterophylla. The understory includes species such as Eugenia biflora, E. foetida, F. axiZiaris, Gualacum officinalis, G. sanctum, Coccoloba diversifolia, and C. microstachya. Coccothrynax aita, a palm species, is an indicator species forthis seasonal evergreen forest (Vivaldi and Woodhury 1981) (USFWS, 1996).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Species Trends:

Unknown (USFWS, 2011)

Number of Populations:

2 natural pops, 2 planted. Total of 4 (USFWS, 2022)

Population Size:

~100 (USFWS, 2022)

Additional Population-level Information:

The most recent report from 2014 (Acevedo-Rodríguez, 2014) documented a new locality of Auerodendron pauciflorum within a federal land in the municipality of Aguadilla. Acevedo-Rodríguez (2014) reported a single mid-sized, healthy individual without evidence of sexual reproduction (flower or fruit) at the Ramey Solar Observatory property. (USFWS, 2017).

Population Narrative:

The species status is unknown; additional surveys are needed to update information on species' abundance and distribution. Only one fragmented population of approximately 21 individuals occurs (USFWS, 2011). At the time of listing, the species' abundance was estimated at about 19 natural individuals. Currently, the species abundance is estimated to be approximately 100 individuals distributed in two natural populations in the municipalities of Isabela (20 individuals) and Aguadilla (1 individual), and two populations planted in protected land: Hacienda La Esperanza Natural Reserve (42 individuals), and Río Encantado Natural Protected Area (38 individuals) in the municipalities of Manatí and Florida, respectively. (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and fragmentation (USFWS, 2011)

Exposure:
Response:
Consequence:
Narrative: The fact that only one fragmented population of Auerodendron pauciflorum occurs on privately-owned land is a concern for the Service. This site is located in the Coto Ward of Isabela, an area threatened with commercial, residential and tourist development projects. During the last decade, the Service has reviewed numerous projects in the northern karst region of Puerto Rico, where the only known population of Auerodendron pauciflorum is known to exist. We have provided technical assistance to the Puerto Rico Highway Authority for the expansion of the Highway PR-22 from Hatillo to Aguadilla to minimize possible adverse effects to Auerodendron pauciflorum and several other species. The currently proposed route (the preferred alternative) is located south of the existing population of Auerodendron pauciflorum, where adverse effects are not anticipated for the species. However, if the preferred route is not selected, the proposed highway may affect the species restricting more of its habitat or eliminating the entire population. In addition, indirect effects related to commercial, residential and tourist development associated with the road may affect the species and its habitat. Currently, road PR-113 already divides the principal population of Auerodendron pauciflorum. The numerous residential and tourist development projects proposed in the area may result in a higher demand for bigger roads to support the increased traffic in the area. Auerodendron pauciflorum remains threatened by habitat modification or destruction because of the development pressure for tourist and residential projects as well as roads and/or highways in the area (USFWS, 2011).

Stressor: Small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: In rare species like Auerodendron pauciflorum, genetic variation is very important because the loss of genetic variation can reduce the ability of the species to adapt to environmental changes. In addition, it may increase the susceptibility to diseases and pests. In addition, the limited number of individuals and its limited distribution is a threat for the species because any disturbance by human interaction or a natural disaster like a hurricane can eliminate the only known population (USFWS, 2011).

Recovery

Reclassification Criteria:
Not available

Recovery Priority Number: 5

Delisting Criteria:
1. Populations on privately owned land area placed under protective status (USFWS, 2011).

2. New populations (the number of which should be determined following the appropriate studies) of each species, capable of self-perpetuation, have been established within protected areas, such as the Guajataca Commonwealth Forest, the Cambalache Commonwealth Forest, or the Río Abajo Commonwealth Forest (USFWS, 2011).

Recovery Actions:

- Protect the existing populations known from privately owned land (USFWS, 1996).
- Develop management plans for known populations (USFWS, 1996).
- Monitor known populations (USFWS, 1996).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1996).
- Educate the public on conservation values and regulations (USFWS, 1996).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1996).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1996).
- Surveys should be conducted to establish the actual status of the species. New information will lead us to better knowledge of the species and it requirements and thus provide beneficial information towards the recovery of the species (USFWS, 2011).
- The Service, in cooperation with DNER and academia, needs to determine how many individuals constitute a self-sustainable population (USFWS, 2011).
- Efforts to protect privately-owned populations should be started to reduce habitat deterioration and maintain habitat or promote sustainable land use practices. Private lands initiatives (such as Partners for Fish and Wildlife and Coastal Program) are needed to further protect the area where Auerodendron pauciflorum is known to occur naturally (USFWS, 2011).
- Foster a working partnership with regulatory agencies to address and minimize potential adverse effects of development projects on the species and its habitat (USFWS, 2011).
- Monitor Auerodendron pauciflorum to see if we encounter the species in reproduction and try to propagate the species (USFWS, 2011).
- Develop and learn other propagation techniques to ensure the continued survival of the species and complement the existing population (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. Develop a plan for the long-term monitoring of known A. pauciflorum populations to establish population trends and to determine any evidence of natural recruitment. 2. Conduct further studies to address possible adverse effects of tree predation by insects. 3. The populations that are actively producing fruits should be monitored to collect seed material for recovery purposes. Due to the absence of natural recruitment in the wild, enhancement of natural populations with propagated material should be considered a priority for the species. 4. Evaluate the feasibility for the long-term conservation of seed material (seed banking). Due to the lack of natural recruitment in the wild, ex situ conservation efforts should be considered a priority for A. pauciflorum. 5. Further studies should be conducted on the species reproductive biology to address other limiting factors (e.g., seed dispersers) (USFWS, 2022).

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SPECIES ACCOUNT: *Ayenia limitaris* (Texas ayenia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/23/1994; Southwest Region (R2)

Physical Description

A spineless shrub with a canopy reaching up to 2.0 meters (m) (6.6 feet [ft]) in height and 2.8 m (9.2 ft) in breadth. However, mature, reproductive plants may be as little as 0.3 m (1.0 ft) tall and broad. The alternate, soft, heart-shaped leaves have minute hairs and toothed margins; microscopically, the hairs on the lower surfaces of the leaves are stellate. The older, woody stems are reddish-brown, up to 2 centimeters (cm) (0.8 inches [in]) thick, and dotted with cream-colored lenticels. Inflorescences arise from the leaf axils, from 1 to 4 per node; the peduncles are about 1 cm (0.4 in) long, usually bearing 3 flowers on pedicels up to 1 cm (0.4 in) long. The flowers are about 6 millimeters (mm) (0.24 in) wide, with five greenish, 3 mm- (0.12 in-) long sepals and 5 yellow- to cream-colored, kidney-shaped petals (having two prominent, ovate lobes) bearing filamentous claws. The fruit, a five-chambered capsule up to 1 cm (0.4 in) in diameter before drying, is covered with curved, velcro-like appendages that may adhere to the hair of animals. Capsules produce up to 5 dark brown to black, tuberculate seeds 4 to 5 mm (0.16 to 0.20 in) in length. The maturing capsules turn from green to straw-colored; eventually the 5 chambers split apart, ejecting the seeds up to about 3 m (10 ft) from the parent plant. (USFWS, 2016)

Taxonomy

Tamaulipan kidneypetal was first collected by C.G. Pringle (Pringle no. 2272) in 1888 in the vicinity of Hidalgo, Texas. This collection was initially identified as Ayenia berlandieri S. Watson; the genus Ayenia was classified at that time in the Sterculiaceae (cacao family). Robinson and Greenman (1896) based their description of a new species, Nephropetalum pringlei B.L. Rob. & Greenm., on Pringle's specimen. Tamaulipan kidneypetal was collected several times in Cameron County, Texas, between 1924 and 1955 (see Table 3), and identified as A. berlandieri. Cristóbal (1960) first described the species limitaris, based on Shiller's 1955 specimen from Brownsville, in her monograph on the genus Ayenia, which she also placed in the Sterculiaceae; this continues to be the authoritative treatment of the genus (Tropicos 2009). Both A. limitaris and N. pringlei were recognized as valid species until Dorr and Barnett (1986) established their synonymy. The name A. limitaris was retained, since Cristóbal had already described another species as A. pringlei Cristóbal. (USFWS, 2016)

Historical Range

In Texas, in Cameron, Hidalgo, and Willacy counties; also northeast Mexico. (USFWS, 2016)

Current Range

In Texas, in Cameron, Hidalgo, and Willacy counties, and northeast Mexico. (USFWS, 2016)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, based on closely related species (USFWS, 2016)

Lifespan

Adult: Unknown; propagated plants: 10+ years (USFWS, 2016)

Breeding Season

Adult: May - June, September - November: bimodal (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2010); direct sunlight, rainfall (USFWS, 2016)

Reproduction Narrative

Adult: A. limitaris is effectively pollinated by a locally abundant insect of the Rio Grande delta (USFWS, 2010). It appears to require at least some direct sunlight for successful reproduction. Herbarium specimens and observations of Tamaulipan kidneypetal in Texas indicate that wild plants flower most often in June, July, September, October, and November. The more consistent and prolific flowering and fruiting lasts from September through November; flowers and capsules may also be observed from May to June following significant rainfall. This pattern coincides with the prevailing bimodal rainfall pattern in the Rio Grande delta. During seasons when there has been little or no precipitation, Tamaulipan kidneypetal plants do not flower. Therefore, reproduction appears to be stimulated primarily by rainfall. Most members of the genus Ayenia, including A. limitaris, are obligately allogamous; their floral morphology renders self-fertilization mechanically impossible (Cristóbal 1960). The longevity of individual Tamaulipan kidneypetal plants is unknown. However, propagated plants in experimental plots and reintroduction sites have lived at least 10 years without any apparent decline in vigor. These plants began flowering and producing viable seed at about 1 to 2 years of age (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Partial shade (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Inland aridity, freezing temperatures, high elevations (USFWS, 2014)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2014)

Habitat Narrative

Adult: Dense subtropical woodland communities at low elevations. The current Texas site is within the Texas Ebony-Anacua (Pithecellobium ebano-Ehretia anacua) plant community - a

closed-canopy community of riparian terraces that once covered much of the Rio Grande delta, but is now reduced to remnant fragments surrounded by agricultural fields, pastures, and urban areas. The site was once an active floodplain, and the effects of hydrologic changes on Ayenia limitaris are unknown (NatureServe, 2015). Wild populations have now been documented in a wide range of alluvial soil types, from fine sandy loam to heavy clay. The species establishes well and reproduces rapidly in disturbed soils. Wild populations frequently occur in partial shade, or at the edge of shrub canopies, rather than under dense shrub or forest canopies (USFWS, 2010). The species' range appears to be restricted by increasing aridity further inland and by the prevalence of freezing weather further north and at higher elevations in the mountain ranges of northeast Mexico (USFWS, 2016).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2010)

Dispersal/Migration Narrative

Adult: The capsules dehisce upon drying, scattering the seeds up to a few meters away from the parent plant. The recurved appendages of the fruit capsule may also serve to disperse entire capsules by adhering to animal hair or feathers. Additional seed dispersal may be caused by insects, water flow, or other factors (USFWS, 2010).

Population Information and Trends

Population Trends:

Declining (inferred from USFWS, 2016)

Number of Populations:

U.S.: 5; Mexico: 10 (USFWS, 2016)

Population Size:

U.S.: 1,400 - 1,800; Mexico: 4,000+ (USFWS, 2010)

Minimum Viable Population Size:

250 mature plants (USFWS, 2016)

Population Narrative:

Five extant populations, ranging from about 100 to 1,000 individuals, have been documented in the three southernmost counties of Texas. Ten extant populations, totaling at least 4,000 individuals, occur in two municipios of the Mexican State of Tamaulipas. At least seven populations in Texas have been extirpated. One population reported from Coahuila, Mexico has not been seen since 1936. A specimen was collected in 1985 in Topia, Durango, Mexico, but the species has not subsequently been reported from that area. (USFWS, 2016)

Threats and Stressors

Stressor: Habitat fragmentation and isolation (USFWS, 2016)
Exposure:

Response:
Consequence:
Narrative: Fragmentation and isolation may prevent gene flow among populations and lead to a depletion of genetic diversity. Cristóbal (1960) stated that Ayenia species are allogamous and insectpollinated. Therefore, viable populations of Tamaulipan kidneypetal must be large enough to contain sufficient genetic diversity for out-crossing to occur, and habitats must be sufficiently large and diverse to sustain populations of the insect pollinators. The remaining habitats throughout the species' known range are greatly fragmented, and remaining populations are isolated from each other. Since the genetic diversity within and among populations has not been investigated, we do not know to what extent genetic depletion may have occurred or how soon it could occur. Currently, the known populations continue to reproduce successfully. In synthesis, we consider that habitat fragmentation and isolation and the resulting depletion of genetic diversity are real threats of unknown magnitude and immediacy. However, if not addressed, these are likely to become high magnitude, imminent threats. Furthermore, once genetic diversity has been lost it cannot be recovered. Therefore, the recovery actions that mitigate these threats should not be delayed. (USFWS, 2016)

Stressor: Ungulate browsing (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Ungulate browsing. Contreras-Arquieta (2005) observed several Tamaulipan kidneypetal sites in the municipio of Soto la Marina, Tamaulipas, that were used as goat pasture. He included goat browsing as a potential threat to the species. Although we have no information on the palatability of Tamaulipan kidneypetal to livestock, or the impacts of grazing on its populations and habitat, it is important to note that the largest U.S. population, and most if not all Mexican populations, occur on land that has been grazed by cattle. We conclude that cattle grazing is not a threat to the species and that goat browsing is an imminent but low-magnitude threat. Browsing by white-tailed deer (Odocoileus virginiana) may also constitute a threat where deer populations are high. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: We do not know how past climate changes have affected Tamaulipan kidneypetal populations and distribution, nor can we predict how future climate changes, forecast by the range of models and emissions scenarios, will affect the synecology of the species and its habitat. For example, a reduced amount or frequency of rainfall could reduce the species' range, while a decreased incidence of freezing could expand its range northward or into higher elevations in Mexican mountains. Furthermore, if the optimal geographic range of Tamaulipan kidneypetal shifts, the species may not be able to migrate fast enough to keep up with the rapid pace of climate changes. Conditions favorable to Tamaulipan kidneypetal might also increase competition from invasive plants, such as guineagrass, or allow new parasites and pathogens to spread into its range, affecting both Tamaulipan kidneypetal and guineagrass in an infinitely complex aggregation of interacting effects. Consequently, we currently have no evidence that the combined effects of climate changes threaten Tamaulipan kidneypetal. However, it is possible that threats induced by climate changes, based on predicted slight increases in temperature and

evaporative deficit, may arise in the future. (USFWS, 2016)

Stressor: Competition from introduced invasive grasses (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Several introduced grass species of African and Asian origin are invasive throughout the Tamaulipan region of Texas and northeast Mexico, and have replaced much of the herbaceous plant diversity. In particular, guineagrass has been recorded at most Tamaulipan kidneypetal sites in Texas, and is probably present at all sites in Texas and Tamaulipas. Guineagrass competes directly with Tamaulipan kidneypetal for the same partially-shaded niches. Buffelgrass, King Ranch bluestem (Bothriochloa ischaemum), and Angleton bluestem (Dichanthium aristatum) were also listed as threats in the listing (USFWS 1994). Buffelgrass is extremely abundant throughout the region, and is a major threat to many rare plant species. Although buffelgrass is not shade-tolerant, it might exclude Tamaulipan kidneypetal from the more open portions of the habitat. Tamaulipan kidneypetal is probably threatened more by Kleberg bluestem and Angleton bluestem than by King Ranch bluestem. The former two grass species are abundant in alluvial, fine-textured soils in the deltas and flood plains of south Texas and northeast Mexico. The latter species prevails in well-drained, rocky uplands, such as the Edwards Plateau of central Texas. These three closely-related taxa pertain to a species complex often generically referred to as Old World bluestems; they are difficult to distinguish in the field and are often confused. Other invasive plants, such as introduced Kalanchöe species, may also threaten Tamaulipan kidneypetal in some sites. In summary, competition from introduced invasive grasses is a high-magnitude, imminent threat to all known populations of Tamaulipan kidneypetal. (USFWS, 2016)

Stressor: Loss of pollinators (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Currently, flowers of Tamaulipan kidneypetal plants are effectively fertilized by unknown insect pollinators even when isolated from wild populations. This indicates that suitable pollinators are widespread and abundant in the region. Nevertheless, insect pollinators could be depleted, and pollinator access could be disrupted, by the loss and fragmentation of habitats, pesticide drift, or depletion of the native plant diversity. Pollinator loss is currently not a known, imminent threat, but could become a threat in the future. Several recovery actions included in this plan will help prevent the loss of Tamaulipan kidneypetal pollinators. (USFWS, 2016)

Stressor: Catastrophic events (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Since there are few populations, most populations have few individuals, and populations are confined to limited geographic areas, individual populations are vulnerable to chance catastrophic events, such as hurricanes or the introduction of an invasive pathogen or parasite. However, due to the geographic range of known populations, it is unlikely that a single event could impact all populations. We conclude that catastrophic events represent a low-magnitude, non-imminent threat. (USFWS, 2016)

Stressor: Pesticide drift and runoff (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: This potential threat has not been observed. However, due to the fragmentation and small size of occupied habitats and their proximity to agricultural fields and highway rights-of-way, herbicide and insecticide drift and chemical spills could harm some populations or the pollinators they depend on. Nevertheless, it is unlikely that accidental herbicide contamination will impact significant numbers of Tamaulipan kidneypetal plants. This low-magnitude, non-imminent threat can be further reduced through outreach to owners and managers of Tamaulipan kidneypetal habitats. (USFWS, 2016)

Stressor: Trampling (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Foot traffic can damage individual plants that occur along trails in parks and natural areas, or where people illicitly traverse habitats off-trail. Ordinarily, people avoid walking through dense thickets of spiny shrubs. However, undocumented aliens entering the U.S. from Mexico often pass through stands of native vegetation to avoid detection, and have damaged vegetation in natural areas along the border. Nevertheless, little if any actual damage to Tamaulipan kidneypetal plants has been observed from trampling. Consequently, we do not consider trampling to be a threat to the species. (USFWS, 2016)

Stressor: Oil and gas development (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: In Texas, mineral rights owners take precedence over surface owners and may clear land for drilling operations without landowner consent. Many surface landowners in south Texas, including most federal and state conservation agencies and non-governmental conservation organizations, do not own mineral rights. Similarly, mineral rights in Mexico are owned by the Mexican federal government rather than the surface owner. Oil and gas exploration and extraction continues at a rapid pace throughout much of south Texas and northeast Mexico, and an ever-increasing proportion of the land has or will be cleared for drilling platforms, pipelines, access roads, and related infrastructure. In addition to the direct loss of populations and habitat through land clearing, these operations will increase the fragmentation of habitat and will create new colonization pathways for invasive grasses. Tamaulipan kidneypetal populations on private lands are particularly vulnerable, since the U.S. ESA does not protect endangered plants on private lands unless there is another form of prevailing federal nexus, such as a federally-funded program or regulated action. Therefore, oil and gas development is an imminent threat; the magnitude is medium to high, depending on the duration and intensity of hydrocarbon exploration that in turn is dependent on economic factors and the intricacies of energy markets. (USFWS, 2016)

Stressor: Altered vegetation structure and composition (USFWS, 2016)
Exposure:

Response:
Consequence:
Narrative: Many ecologists believe that grasslands and savannas were more abundant in south Texas and northeast Mexico prior to European settlement, and that these vegetation types were converted to dense shrubland and forest as a consequence of poor rangeland management and changes in the natural fire cycle (see discussion in section I.d.-Ecology). This dramatic shift in vegetation composition and structure and fire dynamics may also have contributed to the decline of Tamaulipan kidneypetal. (USFWS, 2016)

Stressor: Unintended impacts of propagation and reintroduction (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The recovery actions proposed under the 2016 Recovery Plan include propagation and reintroduction of Tamaulipan kidneypetal into suitable habitats. These actions could cause unintended harm to the species, such as depletion of the seed banks of wild populations, genetic swamping due to excessive propagation from a genetically limited source population, inbreeding depression, outbreeding depression, and the spread of pathogens or parasites into healthy populations. Pilot reintroduction efforts conducted at LRGV NWR in the 1990s preceded the adoption, in 2000, of the USFWS policy on controlled propagation of endangered species (USFWS and NMFS 2000). This policy now requires that the potential risks of propagation be assessed and addressed prior to initiating propagation by USFWS or through USFWS support. Section E.13 of the policy requires preparation of a controlled propagation and reintroduction plan prior to the reintroduction of federally-listed threatened or endangered species. The plan should be based on strategies identified in an approved recovery plan, and should include protocols for health management, disease screening and disease-free certification, monitoring and evaluation of genetic, demographic, life-history, phenotypic, and behavioral characteristics, data collection, recordkeeping, and reporting, as appropriate. We conclude that, through compliance with USFWS policy on propagation and reintroduction, these actions will not threaten the species. (USFWS, 2016)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Tamaulipan kidneypetal is not protected by other U.S. federal or state laws. Federally-listed plants occurring on private lands have limited protection under the ESA, unless also protected by state laws; the State of Texas provides very little protection to listed plant species on private lands. Approximately 95 percent of Texas land area is privately owned. It is reasonable to assume that the vast majority of existing Tamaulipan kidneypetal habitat, including sites that have not been documented, occurs on private land. Therefore, most of the species' populations and habitats are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project. (USFWS, 2016)

Recovery

Reclassification Criteria:

1. The successful accomplishment of threats reduction and mitigation is demonstrated by a stable or improving status of Tamaulipan kidneypetal, compared to the baseline conditions, throughout its known range over a period of at least 10 years. (Threat-based objective) (USFWS, 2016)

2: At least 10 populations of Tamaulipan kidneypetal, and at least 1 per recovery unit, are documented in optimal habitats for a period of at least 10 years. Habitat is considered optimal when: It is protected for conservation purposes; it is managed in a manner that promotes the long-term survival of Tamaulipan kidneypetal; it has less than 10% cover of introduced invasive plant species; it consists of at least 400 ha (988 ac) of contiguous habitat; and where Tamaulipan kidneypetal populations are observed to be stable or increasing. (Habitat-based objective) (USFWS, 2016)

3. Conserve, protect, and restore populations of Tamaulipan kidneypetal needed for its recovery. Populations must be self-sustaining, of sufficient size to endure climatic variation and stochastic events, of sufficient number to endure catastrophic losses, and must represent the full range of the species' geographic and genetic variability. (Population-based objective) (USFWS, 2016)

Recovery Priority Number: 8C

Delisting Criteria:
Criteria 1 through 3: Same as Downlisting Criteria (USFWS, 2016)

4: Twenty (20) or more protected populations, including no less than 5 per recovery unit, have maintained stable or increasing populations of at least 500 mature individuals, 47 and at least 1 population per recovery unit maintains 1,000 or more individuals, for a total of at least 20 years. (USFWS, 2016)

Recovery Actions:

- 1. Protect and conserve the known populations and their habitats in the U.S. and Mexico. Promote cooperative efforts to conserve occupied habitats and protect known populations from invasive grass competition, excessive browsing, trampling, and other potential threats. Seek sources of financial and technical assistance to support these efforts. This action faces the following challenges: 1) Several known populations in the U.S. occur on private land; 2) a majority of the known populations, and almost all of the species' global range, occur in Mexico; 3) the known Mexican populations all occur on private or ejido land. Consequently, the U.S. ESA confers no authority to enforce the degree of population and habitat protection that is necessary to prevent a significant decline (jeopardy) of the species. Therefore, this action must rely heavily on voluntary conservation efforts and on close collaboration with Mexican agencies and conservation organizations. Furthermore, since it is probable that some populations on private and ejido lands will be destroyed or deteriorated through urban and agricultural development or other causes, this action addresses an objective of no net loss of populations and habitats; losses and deterioration of some populations and habitats may be offset through successful habitat restoration, improved management and protection of existing occupied habitat, or the discovery of new occupied habitats. (Priority 1) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)

- 2. Develop a monitoring plan, and monitor known populations and habitats. The objectives and requirements of the monitoring plan are discussed in II.1 of the 2016 Recovery Plan. Visit known populations at least once per year, if possible, to make qualitative observations of habitat conditions and the growth and reproduction of Tamaulipan kidneypetal. Determine if there are any new or existing threats to the population and recommend actions to alleviate threats. Collect quantitative data on population size and reproduction at least 5 times every 10 years to track long-term population dynamics. (Priority 1)[More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 3. Develop partnerships with Mexican government agencies, academic institutions, and NGOs to promote investigation, conservation, and recovery of the species in Mexico. Potential Mexican agency partners include the Secretaría de Desarrollo Urbano y Medio Ambiente (Secretary of Urban Development and Environment, State Government of Tamaulipas; SEDUMA) and SEMARNAT, CONANP, and CONABIO (federal). Academic institutions may include Universidad Autónoma de Tamaulipas, Universidad Autónoma de Nuevo León (particularly the Facultad de Ciencias Forestales [Forestry Sciences Department]), and the Instituto Tecnológico y de Estudios Superiores de Monterrey (Monterrey Institute for Technology and Advanced Studies; ITESM). Pronatura Noreste a.c., based in Monterrey, Nuevo León, is a potential NGO partner. (Priority 1) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 4. Improve management of known populations and habitats, based on monitoring data and the conclusions of scientific investigations (adaptive management). (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 5. Conduct public outreach in the U.S. and Mexico to promote the species' conservation and recovery. Disseminate outreach materials, attend public meetings, communicate with interested members of the public, and meet interested landowners to discuss conservation and recovery of Tamaulipan kidneypetal. (Priority 2) [More details are available in the 2016 Recovery Plan.] (USFWS, 2016)
- 6. Conduct scientific investigations necessary for conservation and recovery. (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 7. Search for new and historic populations in U.S. and Mexico. Seek permissions from public, private, and ejido landowners to conduct surveys in areas of intact habitat where the climate, soils, and vegetation are similar to known and historic populations. (Priority 2) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 8. Restore and subsequently manage native vegetation within the Rio Grande delta recovery units to increase the amount of suitable available habitat and to establish functioning ecological corridors that reconnect isolated habitat fragments. Restoration methods must use local ecotypes of native species, and must restore a diverse sub-shrub, native grass, and forb understory and a partially open tree and shrub canopy to be considered suitable for Tamaulipan kidneypetal. Effective habitat restoration will offset unpreventable losses of habitat on private lands, and will make the criterion of no net habitat loss more achievable and practical. (Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- 9. Augment and reintroduce populations in appropriate habitats within the known range in U.S. and Mexico. Augmentation is the supplementation of an existing population with progeny of the same population or another population that is genetically suitable. Reintroduction is the establishment of new populations within the species' known range and habitat types, but where a population currently does not exist. The objective in either

case is to attain the criteria of an MVP of 250 or more mature individuals per population, 5 or more populations per recovery unit, at least 1 population per recovery unit with 1,000 or more mature individuals, and a minimum of 20 populations overall. All propagation and reintroduction will conform to the guidelines stipulated in an established controlled propagation and reintroduction plan.(Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)

- 10. Prepare post-delisting monitoring plan. In accordance with ESA section 4(g)(1), upon recovery and removal from the endangered species list, the status of delisted species must be monitored for not less than five years. In consideration of the potential responses of 59 Tamaulipan kidneypetal populations, based on its lifespan, reproductive rate, and demography, to the removal of federal protection, monitoring should be continued for at least 10 years to ensure that the populations and criteria upon which delisting are based continue to be secure. Post-delisting monitoring must quantitatively document the extant populations upon which delisting is based, including population sizes, age structures, reproduction, recruitment and mortality, habitat conditions, invasive species impacts, degree and effectiveness of protection, and impacts of threats. (Priority 3) [More details are available in the 2016 Recovery Plan] (USFWS, 2016)
- Complete an approved recovery plan for the species (USFWS, 2010).
- Continue periodic monitoring and surveys of the known populations in Texas and Tamaulipas to track demographic trends, and to detect and attempt to alleviate threats to these populations (USFWS, 2010).
- Conduct surveys of high-potential habitat within the known range of the species in south Texas and Tamaulipas, focusing on sites that have not previously been surveyed (USFWS, 2010).
- Survey existing habitats in the municipios of Múzquiz, Coahuila and Topia, Durango to attempt to confirm extant populations at those sites (USFWS, 2010).
- Collect seeds from the known populations and implement a reintroduction program at LRGV NWR, in accordance with USFWS policy on controlled propagation of endangered species (65 FR 56916) (USFWS, 2010).
- Conduct scientific investigations of the species' reproductive biology, the genetic structure of known populations, and the genetic relationship between Ayenia limitaris and closely related species (USFWS, 2010).
- Conduct scientific investigation of the species' ecology, with emphasis on vegetation structure and fire ecology (USFWS, 2010).
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Follow recommended actions outlined by the 2016 Texas Ayenia Recovery Plan. • Continue periodic monitoring and survey of the known populations in Texas and Tamaulipas Mexico to track demographic trends, and to detect and attempt to alleviate threats to these populations • Conduct surveys of high-potential habitat within the known range of the species in south Texas and Tamaulipas Mexico, focusing on sites that have not previously been surveyed. • Survey existing habitats in the identified areas in Tamaulipas Mexico to attempt to confirm extant populations at those sites. • Collect seeds from the known populations and implement a reintroduction program at Lower Rio Grande Valley National Wildlife Refuge, in accordance with Service policy on controlled propagation of endangered species (65 FR 56916). •

Conduct scientific investigations of the species' reproductive biology, the genetic structure of known populations, and the genetic relationship between Ayenia limitaris and closely related species. • Conduct scientific investigation of the species' ecology, with emphasis on vegetation structure and fire ecology. • Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group (USFWS, 2022).

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SPECIES ACCOUNT: *Baccharis vanessae* (Encinitas baccharis)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/7/1996; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A shrub, < 2 m tall, broom-like in appearance with dense, erect branches, often leafless when the plants are in flower. Leaves are linear. Herbage is generally sticky-resinous. Whitish flower heads, lacking rays, bloom in the fall (August-November), Male and female flowers are borne on separate plants (NatureServe, 2015).

Taxonomy

A member of the Asteraceae (sunflower family) (USFWS, 2011).

Historical Range

Endemic to a narrow band of central-coastal San Diego County, California, from Encinitas eastward to Woodson Mountain, near Poway and southward to Mira Mesa; an area of ca 30 km E-W by 17 km N-S. Reported from 45 historical occurrences distributed within the same general range as that known at the time of listing, except for a southward extension of the range based on an occurrence detected in the Otay Mountain area. (NatureServe, 2015).

Current Range

This species is restricted to a patchy distribution along the coast and occasionally interior areas of San Diego County, California (USFWS, 2011).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2012)

Lifespan

Adult: Presumed long-lived (NatureServe, 2015)

Breeding Season

Adult: August - November (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Wind, insect pollinators (USFWS, 2011)

Reproduction Narrative

Adult: The blooming period is between August and November (CNPS 2010; San Diego Plant Atlas 2010). Baccharis vanessae is dioecious, meaning separate plants of both sexes must be in close

proximity for pollination and subsequent seed production to occur. Pollinated Baccharis flowers develop one-seeded dry fruits (achenes). Baccharis vanessae is probably pollinated by both wind and insects. Steffan (1997, pp. 52–54) collected native wasps, flies, beetles, and true bugs (from the order Hemiptera) from Baccharis pilularis (coyote bush), a related species that has flowers similar to B. vanessae and which also occurs in the same chaparral habitat. It exhibits an apparently low incidence of successful seedling establishment (USFWS, 2011). This species is presumed to be long-lived (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Maritime chaparral, mixed chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance/fire (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: 60 - 335 m elevation (NatureServe, 2015), tall leafy shrubs (USFWS, 2011)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2011)

Habitat Narrative

Adult: Occupies steep slopes on sandstone and volcanic (1 site) substrates in fairly open southern maritime chaparral and dense mixed chaparral communities. Occurs at 60 - 335 m elevation (NatureServe, 2015). Observations suggest that Baccharis vanessae is not able to compete with taller, leafier shrubs such as Arctostaphylos spp. (manazanita) and Ceanothus spp., (ceanothus) or that it is a short-lived plant (KEA 1999, p. 15). Baccharis vanessae appears to be a pioneer species that increases in numbers after disturbance, such as fire, that opens up the chaparral canopy (Messina 2001, pp. 2–3; CNDDB 2011, EOs 17 and 18). Overall, B. vanessae appears to increase in numbers in burned areas following fire events. Baccharis vanessae has been observed to occur on the following soil types: Cieneba series, Corralitos loamy sand alluvial Huerhuero, San Miguel Exchequer, granitic, andesite rock outcrops, and soils derived from acid igneous rock (CNDDB 2011) (USFWS, 2011).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Achenes are each attached to a cluster of bristly hairs (a pappus), which facilitates wind dispersal (Steinberg 2002, p. 5). (USFWS, 2011).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2011).

Number of Populations:
14 presumed extant (USFWS, 2021)

Population Size:
Unknown (USFWS, 2011)

Adaptability:
Low (inferred from USFWS, 2011)

Population Narrative:
The species is now presumed extant at 30 occurrences. accurate plant counts for B. vanessae do not exist because no rangewide surveys have been conducted using a single monitoring protocol. Life history traits and habitat specificity seem to comprise the most significant vulnerabilities of Baccharis vanessae. The number of occurrences currently considered extant increased from 16 to 30 since listing (USFWS, 2011). Our 2011 5-year review identified 45 occurrences of Baccharis vanessae. 30 were extant or presumed extant and 15 were extirpated or possibly extirpated. Our review of new information from the CNDDB and the SDMMP found that there are 45 occurrences of B. vanessae. Fifteen are extant, 14 are presumed extant, 10 are possibly extirpated, and 5 are extirpated, although the organization of the occurrences is different than the 2011 5-year review (Table 1, Figure 1, and Figure 2). (USFWS, 2021)

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Following listing, occurrences continued to be impacted by development. A portion of one occurrence in Rancho Cielo (CNDDB 2011 EO 7 that currently includes EOs 11, 13, and 14) was eliminated by urban development. development remains a threat to B. vanessae occurrences or portions of those occurrences as well as occurrences identified as REGSS points not encompassed by a CNDDB polygons or the quarter-mile buffer zone around them. Of the 30 extant occurrences, 11 continue to be threatened by development associated impacts (EOs 1, 3, 5, 7, 8, 9, 24, 25, 27, 31, and SD 115244) (USFWS, 2011).

Stressor: Altered fire regime (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: In southern California, populated areas in proximity to natural vegetation often are under some form of fuel modification requirements. Fuel modification generally includes the clearing or thinning of fire prone natural vegetation, which would include that occupied by B. vanessae. Historically, natural fire regimes in southern California were likely characterized by many small lightning ignited fires in the summer and a few large fires in the fall of varying fire intensity (Keeley and Fotheringham (2003, pp. 242–243). The current fire regime in southern California results in numerous small fires that periodically escalate into megafires that are

generally driven by extreme “Santa Ana” weather conditions of high temperatures, low humidity, and strong erratic winds (Keeley and Zedler 2009, p. 90). The primary difference between the current fire regime and historical fire regimes in southern California is that human-induced or anthropogenic ignitions have increased primarily due to an increase in human population density since 1960, resulting in human-triggered fire ignitions and in particular, megafires in many more localities (Keeley and Fotheringham 2003, p. 240), than were known historically. The primary concern with frequent megafires is the plant mortality associated with these extensive and intense events which may kill individual plants and thereby potentially precludes recolonization of burned areas by B. vanessae. The lack of habitat clearing brushfires, of adequate frequency and intensity, may pose a threat to B. vanessae reproduction. The absence of an appropriate disturbance regime may also limit opportunities for recruitment of B. vanessae (USFWS, 2011).

Stressor: Nonnative plants (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Prevalence of nonnative plants is expected to increase with proximity to persistent sources such as residential development and highways. Nonnative plants may crowd out suitable establishment sites for B. vanessae, as may unchecked native plants, and they may alter the fire regime of the site. Carpobrotus edulis (iceplant, Hottentot fig) has the ability to invade maritime chaparral after brushfires (Zedler and Scheid 1988, pp. 196–201). The thick mat of this nonnative plant can prevent seedlings of native plants from becoming established (D’Antonio and Mahall 1991, pp. 886–888). Centaurea seeds are known to germinate much faster than those of some Baccharis species, grow rapidly during the winter and spring, and reduce the performance (biomass gain) of Baccharis seedlings (Gomez-Gonzalez et al. (2009, p. 81) (USFWS, 2011).

Stressor: Restricted distribution and small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Baccharis vanessae is at risk of extinction from naturally occurring events because of its restricted distribution and small population size (USFWS 1996, p. 52381). The distribution of the species is relatively narrow and likely habitat limited. This situation may exacerbate any other threats that are rangewide in scope, such as wildfires or broad jurisdictional fire suppression efforts. The small size of many Baccharis vanessae populations increases the probability that those populations will disappear or be otherwise compromised through random fluctuations in the environment (such as severe droughts or fires), failure to be cross-pollinated, or random human caused events (such as the clearing of a parcel of southern maritime chaparral in northern Lux Canyon in 2009) (S. Vurbeff, City of Encinitas, pers. comm., 2010). Small populations are also more susceptible to the expression of deleterious genes (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The impacts of predicted climate changes on individuals and habitat of Baccharis vanessae and similar species are unknown at this time. Baccharis vanessae may already be suffering adverse effects from past climate changes resulting in a drier Holocene climate in

present-day southern California. The observed lack of B. vanessae seedlings could possibly indicate that this species is unable to survive the length, severity, or the current timing of the annual dry season in San Diego County. Williams and Hobbs (1989, pp. 62, 64–66) discovered that B. pilularis seedlings tend to survive only during rainy springs (March to May) brought on by rare mega-El Niños like the one in 1982 to 1983 because the seedlings' root growth is negligible prior to March (USFWS, 2011).

Stressor: Trampling (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Currently, unauthorized camping occurs at Oak Crest Park in Encinitas (CNDDB 2011, EO 1) even though the area is conserved (Thiede, pers. obs., 2010). Visitor foot traffic, as well as potential trail maintenance activities, also pose a threat to the B. vanessae populations at EOs 17 and 18, and rock climbers at Woodson Mountain likely impact plants at EO 15 (CNDDB 2011) (USFWS, 2011).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Survey all historical and extant occurrences to determine the location, status, age-class representation, and sex composition of each population to establish a comprehensive baseline against which to measure future changes. Survey all areas that support "maritime-like" southern mixed chaparral for additional occurrences (USFWS, 2011).
- Manage Baccharis vanessae occurrences to maintain plants of both sexes. Outplantings could be considered at occurrences such as EO 28 where only one plant has been observed (USFWS, 2011).
- Investigate the possible causes of seed mortality and low reproductive success, and identify likely remedies (USFWS, 2011).
- Conserve or preserve Baccharis vanessae occurrences on private lands. Property easements or purchases of parcels could also be made through the Act's section 6 funding and other programs (USFWS, 2011).
- Determine the appropriate use or substitute for a natural fire regime to perpetuate suitable habitat for Baccharis vanessae (USFWS, 2011).
- Determine which areas are most susceptible, to reduce impacts to Baccharis vanessae from fuel modification and fire suppression activities (i.e. using GIS analysis) (USFWS, 2011).
- Determine the distribution of genetic diversity in the species occurrences and identify the most appropriate means to preserve the diversity (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Baccharis vanessae. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future recovery efforts. 1. Conduct surveys for B. vanessae, including 1) surveys of Regionally Sensitive Species (REGSS) points and CNDDB polygons on conserved land that are not monitored by the SDMMP or other partners, and 2) surveys of suitable habitat where the species has not been detected. 2. Support partners to enhance habitat and manage highest-magnitude threats at B. vanessae occurrences (for example, from nonnative invasive plants). 3. Coordinate with the SDMMP on the development of a Rare Plant Management Plan for B. vanessae, which includes species-specific best management practices and identifies research needs. Work with the SDMMP to prioritize research and management needs for B. vanessae. 4. Collect seed from B. vanessae occurrences and conserve in an ex situ (off-site) conservation seed bank. Coordinate with the SDMMP on the development of a Seed Banking and Bulking Plan for B. vanessae. (USFWS< 2021)

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SPECIES ACCOUNT: *Banara vanderbiltii* (Palo de ramon)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/14/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

A small evergreen tree endemic to the island of Puerto Rico. The species is known only from two widely disjunct locations: the northwest karst limestone hills and the central mountains, volcanic in origin. (USFWS, 1991)

Taxonomy

The family Flacourtiaceae, to which it was formerly assigned, has been dismantled and the genus Banara has been transferred to the Salicaceae family (D. Kolterman and J. Chinea, UPRM, unpubl. data, 2013) (USFWS, 2014).

Historical Range

Palo de ramón is endemic to northern and south central Puerto Rico (D. Kolterman and J. Chinea, UPRM, unpubl. data, 2013) (USFWS, 2014).

Current Range

Known to exist in two populations, five at the central mountain “Tetas de Cayey” site and six in the Rio Lajas limestone hills near Bayamon in northwestern Puerto Rico. Both of these known populations occur on private land. (USFWS, 1991)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: April - June (USFWS, 1991))

Reproduction Narrative

Adult: Produces flowers April through June. Ripe fruit observed late August to early September. The flowers of Banara vanderbiltii are bisexual (USFWS, 1991).

Habitat Narrative

Adult: Banara vanderbiltii is found in the semi—evergreen forest of the subtropical moist forest life zone (Ewel and Whitmore 1973) on the limestone hills of the northwest coast at elevations of 100 to 150 meters and on the mountains of volcanic origin in central Puerto Rico at elevations of more than 800 meters. The subtropical moist forest and the various associated forest types is the most extensive life zone on the island. However, because of the low elevation and productive soils, much of the land has been deforested, and where forest exists it is second-growth (USFWS, 1991).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Bananaquit and stripe-headed tanager (USFWS, 1991)

Dispersal/Migration Narrative

Adult: Birds (bananaquit and stripe-headed tanager) have been observed taking fruit (USFWS, 1991).

Population Information and Trends

Population Trends:

Increasing (USFWS, 2014)

Species Trends:

Unknown (USFWS, 2020)

Number of Populations:

10; 2 Natural and 8 introduced (USFWS, 2020).

Population Size:

201 (USFWS, 2014). As of 2017: The (3) natural populations consist of approximately 39 individuals on Las Piedras del Collado in Salinas (also known as Las Tetas de Cayey), 2 individuals on Finca Tres Vidas in Aibonito; and 14 individuals on Rio Lajas, a private property within the municipality of Dorado (known as La Virgencita site) (PRDNER 2016). (USFWS, 2019).

Population Narrative:

Palo de ramón is listed as an endangered species and is currently known from 10 locations; two natural populations and eight introduced. In St. Thomas, the species has not been found since 1980, despite search efforts. (USFWS, 2020) Species Status: 2013. Unknown. The status and distribution of the Palo de ramón has not been re-evaluated since 1991 (Service 1991). When the species recovery plan was signed in 1991, only 11 plants were known from two localities: one at the Rio Lajas ward in the municipality of Dorado, and another at Las Piedras del Collado area (also known as Las Tetas de Cayey) in the municipality of Salinas. These natural populations have been poorly monitored, and currently, the status of these populations is unknown. No additional location information is available. Since the early 1990s, PRDNER has propagated approximately 201 individuals of Palo de ramón, introducing them in eight localities throughout Puerto Rico (Eduardo Cintrón, PRDNER, pers comm. 2013) on privately-owned lands and Commonwealth lands managed for conservation. However, due to the lack of updated information on its status, the current status of these introduced populations is uncertain. Because the natural and introduced populations of Palo de ramón have been poorly monitored and no status surveys on the species have been conducted recently, the status of Palo de ramón is unknown. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014)
Exposure:

Response:
Consequence:
Narrative: The Rio Lajas population occurs on private land located near to the metropolitan area of San Juan. This area is under intense development pressure for industrial and residential expansion. Currently, some agricultural practices and deforestation for residential, industrial, and commercial projects (i.e., landfills, construction of dwellings and roads, power lines, and limestone quarrying) remain threats to this species, and we believe some of these sources have been responsible for elimination of some mature individuals. Deforestation for urban development and agriculture practices have resulted in habitat degradation through fragmentation, soil erosion, and changes in forest structure at the Rio Lajas ward (C. Pacheco, Service, pers. obs. 2013). The Palo de ramón population in Rio Lajas is located a short distance from the right-of-way of a power line that provides energy to an adjacent community (Service 1991). Occasionally, the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and removal of vegetation growing under power lines and along their rights-of-way (USFWS, 2014).

Stressor: Stochastic events (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: One of the most important factors affecting the continued existence of the Palo de ramón is its limited distribution. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, human induced fire, landslides, and genetic variation. Palo de ramón is more susceptible to natural disturbances such as hurricanes, wildfire or landslides, because it is confined to geographically small areas (Service 1991). Due to the extremely limited range of the species, low number of individuals, and lack of information about its natural recruitment and habitat requirements, the Service believes that stochastic events such as severe tropical storms or hurricanes may have adverse impacts on the species, particularly in their natural populations in Rio Lajas and Las Piedras del Collado. Human induced fire is a current threat for the species at Salinas. Areas potentially used by the species in the municipalities of Salinas and Cayey have been negatively affected by human induced fires (C. Pacheco, Service, pers. obs. 2013). Fire is not a natural event in the subtropical moist forest of Puerto Rico. Thus, most species found in this type of forest are not fire-adapted. Human-induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., guinea grass [Megathyrsus maximus]), which serve as fuel for fires. The populations of Palo de ramón that occur in both northern and south central Puerto Rico may be subject to human induced fires, particularly on private lands where fire could be accidentally or deliberately ignited (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Given the extremely small numbers of individuals in natural populations and the limited geographic distribution of the Palo de ramón, it is highly likely that its genetic variability is very low. This would result in the loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn 2007)

(USFWS, 2014).

Stressor: Invasive species (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: As mentioned under Factor A, habitat modification for vegetation removal along the power lines right-of-way may increase the magnitude of the threat to Palo de ramón due to an increase in invasive species in these areas. Any disturbance of vegetation within the Palo de ramón habitat may create conditions favorable for the establishment of invasive species that may outcompete native plant species, changing the vegetation structure of the species' habitat. Invasive species (e.g., Leucaena leucocephala and Megathyrsus maximus) may spread and colonize the Palo de ramón habitat, altering fire regimes, microclimate, and nutrient cycling of the habitat the species depends on (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: An expected effect of climate change is the increase in intensity of hurricanes and tropical storms, followed by extended period of drought (IPPCC 2012). These events may alter the surrounding vegetation around the populations of the Palo de ramón. Hurricanes followed by extended periods of drought may result in changes in soil conditions and microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. Leucaena leucocephala and Megathyrsus maximus) may spread and colonize the Palo de ramón habitat, and it could alter fire regime, microclimate, and nutrient cycling of the habitat that the species depends on (USFWS, 2014).

Recovery

Reclassification Criteria:
1. The known populations at Rio Lajas and Las Piedras del Collado are placed under protective status (USFWS, 2014).

2. At least two new populations capable of self-perpetuation (basically self-sustaining) have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache Commonwealth Forests), and in the central mountain region (e.g., Carite or Toro Negro Commonwealth Forests) (USFWS, 2014).

Delisting Criteria:
1. Threats reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A). (USFWS, 2019).

2. Existing three (3) populations on Rio Lajas, Las Piedras del Collado, and Finca Tres Vidas show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

3. Within the historic range, establish four (4) additional populations with a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Recovery Actions:

- Monitor existing populations (USFWS, 1991).
- Provide protection for existing populations and their habitat (USFWS, 1991).
- Conduct research on the life history of the species, evaluate methods of propagation, and to look for introduction sites (USFWS, 1991).
- Propagate and produce seedlings for enhancement of existing populations and for the establishment of new populations on identified sites (USFWS, 1991).
- Added in 2019: Genetic material from all populations is preserved through long-term seed storage and/or propagation efforts at a credited botanical garden. (USFWS, 2019).
- The recovery of the species should focus both on the protection of the known populations and their habitat in private lands and also on increasing the number and size of the populations of Palo de ramón (USFWS, 2014).
- Field surveys on Palo de ramón should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence and distribution of the species (USFWS, 2014).
- Studies should be conducted to determine the species' phenology and reproductive biology (USFWS, 2014).
- Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2014).
- Studies should be conducted to determine the effects of the lobate lac scale bugs (Paratachardina pseudolobata) on the Palo de ramón (USFWS, 2014).
- Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service, taking into consideration the effects of seeds and/or seedlings removal effects on the species, existing threats, genetic variations, and considering ways to propagate by cuttings (USFWS, 2014).
- The populations, both natural and introduced, should be monitored on a regular basis, and additional surveys should be conducted after hurricanes, landslides, fires, or other major disturbances. The natural populations should be monitored on a long term basis to determine the species' trends (USFWS, 2014).
- The Service should work with partners (e.g., PRDNER, UPRM and USDA) to update the recovery plan as new information becomes available on the species. Such collaboration should lead to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTION 1. The recovery of the species should focus both on the protection of the known populations and their habitat in private lands and also on increasing the number and size of the populations of Palo de ramón. 2. Field surveys on Palo de ramón should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence and distribution of the species. 3. Studies should be conducted to determine the species' phenology and reproductive biology. 4. Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm. 5. Studies should

be conducted to determine the effects of the lobate lac scale bugs (Paratachardina pseudolobata) on the Palo de ramón. 6. Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service, taking into consideration the effects of seeds and/or seedlings removal effects on the species, existing threats, genetic variations, and considering ways to propagate by cuttings. 7. The populations, natural and introduced, should be monitored on a regular basis, and additional surveys should be conducted after hurricanes, landslides, fires, or other major disturbances. The natural populations should be monitored on a long term basis to determine the species' trends. 8. The Service should work with partners (e.g., PRDNER, UPRM and USDA) to update the recovery plan as new information becomes available on the species. Such collaboration should lead to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species. (USFWS, 2020)

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SPECIES ACCOUNT: *Baptisia arachnifera* (Hairy rattleweed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1978; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb, 5-8 dm tall, that is covered with grayish-white cobwebby hairs. Leaves are heart-shaped. Flowers (late June-early August) are bright yellow, borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Dr. Wilbur H. Duncan first collected the hairy rattleweed in the summer of 1942, and suspected that it was distinct from other Baptisia species which occur in the coastal plain of GA and FL. Subsequent collections in 1943 confirmed his suspicion (USFWS, 1984).

Historical Range

It is endemic to portions of Brantley and Wayne counties in southeastern GA (USFWS, 1984).

Current Range

Baptisia arachnifera only occurs in a 50-square mile area in Brantley and Wayne counties in Southeast Georgia, on the Lower Coastal Plain (Georgia Department of Natural Resources 1995). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (NatureServe, 2015); sexual (inferred from EPA, 2016)

Dependency on Other Individuals or Species

Adult: Insect pollinators, especially Say's weevil (EPA, 2016)

Reproduction Narrative

Adult: Capable of asexual reproduction if roots are cut (NatureServe, 2015). Flowering occurs June to August and fruiting occurs August to September. Pollinators are presumably insects. The weevil Apion rostrum Say (Say's weevil) is possibly a major pollinator (EPA, 2016). Humphrey (1987) estimated that 25% of plants reproduce and found the number of fruit per individual plant is highly variable, with a mean of 52 seeds per fruiting plant per year; therefore, the seed production per 100 plants has been estimated as 1300 (USFWS, 2011).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine-saw palmetto flatwoods (NatureServe, 2015); early successional forest (EPA, 2016)

Dependencies on Specific Environmental Elements

Adult: Periodic fires (EPA, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 55 - 85 ft. elevation (EPA, 2016)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow to moderate (inferred from EPA, 2016)

Habitat Narrative

Adult: This species naturally occurred in open sandy areas within longleaf pine-saw palmetto flatwoods. It is now persisting in intensively managed slash and loblolly pine plantations, powerline right-of-ways, roadsides and a few small natural areas. B. arachnifera can occur as widely scattered individual plants or in dense clusters. Research done by the Rayonier Corporation suggest that populations tend to be clumping (B. Krueger, written comm.) (NatureServe, 2015). Longleaf slash-pine flatwoods with sparse canopy, fewer larger shrubs, greater light penetration and greater cover of herbs (mainly wiregrass) and low shrubs of the Lower Coastal Plain of Georgia. Habitat has early successional characteristics of open canopy and low abundance of larger shrubs. Habitat includes mesic pine lowland forest or pine flatwoods. Also occurs in floristically similar but more open pine-wire grass (Aristida stricta) shrub woodlands with occasional oaks (Quercus laevis, Q. virginiana, Q. nigra). Fire adapted communities that would naturally burn every 2-4 years. Most abundant in communities with the early successional characteristics of open canopy and low abundance of larger shrubs. Often adjacent to/grades into pocosin or bay swamp habitats scrub-shrub wetlands toward the wetter end of spectrum to habitats typical of longleaf pine-turkey oak communities towards the drier end. Identified soils series include: Mascotte Sand, Rigdon Sand, Sapelo Fine Sand, Pottsburg Sand, and Olustee Sand. These are sandy to a depth of 3 ft or more and have spodic horizons within 20 inches of the surface. Acidic, low fertility. These soils are poorly drained to somewhat poorly drained and moderately permeable with Rigdon sand being the best drained. Runoff is slow and internal drainage is impeded by the shallow water table. Occurs at elevations between 55 to 85 ft. (known population sites) (EPA, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal occurs September to March; plants break off in wind and may disperse tumbleweed fashion with seeds still on the plant (EPA, 2016).

Population Information and Trends

Population Trends:

Declining (inferred from NatureServe, 2015)

Species Trends:
Declining (USFWS, 2011)

Number of Populations:
28 extant hairy rattleweed populations (USFWS, 2019)

Population Narrative:
Occurrences are scattered over a 125 square mile area. An estimated 95-99% of its original habitat has been converted to pine plantations (NatureServe, 2015). 22 extant populations occur entirely in Lower Coastal Plain of Georgia (EPA, 2016). The species status is declining; overstocking of trees, lack of fire management and seed predation by insects are the factors driving the species' decline. Ceska et al. (1997) found a substantial genetic diversity and relative uniformity in ten sampled plots (USFWS, 2011). Overall, there are 28 extant hairy rattleweed populations, 1 historical population, and 6 populations of unknown status (Figure 1). Only two populations, the Lewis Tract and Needmore Road, are apparently stable or increasing. The remaining 18 populations are likely declining due to incompatible silvicultural practices (e.g. bedding and timber harvesting). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Silvicultural practices in the timber industry have altered approximately 2741 acres of hairy rattleweed habitat and directly destroyed individual plants. Hairy rattleweed populations are able to survive clear-cutting, but site preparation and replanting severely impact populations (U.S. Fish and Wildlife Service 1984, Humphrey 1987, Kral 1980). The effects of bedding, unnaturally high stocking densities of seedlings and fire exclusion in pine plantations are dramatically impacting this species (U.S. Fish and Wildlife Service 1984, Tassin and McGee 1999, Humphrey 1988, Leege and Squire 2006). High stocking densities are used to maximize the Net Present Value on industrial timber land. As a result, canopy closure is achieved and growing space is fully occupied, resulting in shading and elimination of the herbaceous ground cover, including hairy rattleweed. Following timber harvest, populations do not respond to the release from shading and competition with increased recruitment, as might be expected. The loss of ground cover contributes to a change in the fire community and reduces the opportunity for natural fires to play a role in the ecology to the site. In the past, wildfires and use of fire by man maintained habitat suitable for hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Suppression of fire has resulted in increased competition from shrubs, which is considered to be a major factor responsible for reduction in abundance of hairy rattleweed (U.S. Fish and Wildlife Service 1984). Fire is still used for forest management, but the frequency and time of year of burning may not be beneficial to hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987). The use of herbicides in powerlines and road rights-of-way could adversely affect populations of hairy rattleweed, although, the effects of herbicides are solely based on field observations. Two extant populations occur on 274 acres of hairy rattleweed habitat in areas where rural housing development has occurred. The houses and surrounding landscaping

directly destroy hairy rattleweed (USFWS, 2011).

Stressor: Drought (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: It is expected that severe drought could be a threat to small populations and would likely reduce recruitment into the population (USFWS, 2011).

Recovery

Reclassification Criteria:
Four self sustaining populations are secured (USFWS, 2011).

Delisting Criteria:
1. There are at least eight self-sustaining populations secured and maintained within its historic or current range (eight would provide a reasonable degree of security against catastrophic loss and/or site alteration) (USFWS, 2011).

2. The number of individuals in the various populations has reached an optimum level or cover percentage and frequency occurrence, as established by management studies (USFWS, 2011).

3. Its biology is sufficiently understood to allow perpetuation of the species should circumstances require immediate or drastic alteration of populations and/or sites (USFWS, 2011).

4. Continuing protection and management after delisting are assured (U.S. Fish and Wildlife Service 1984) (USFWS, 2011).

Recovery Actions:
- Protect habitat and existing populations of the hairy rattleweed (USFWS, 1984).
- Monitor populations and their habitats (USFWS, 1984).
- Conduct searches for new stands of the hairy rattleweed (USFWS, 1984).
- Preserve existing germ plasm through cultivation and storage (USFWS, 1984).
- Conduct autoecological research (USFWS, 1984).
- Develop public awareness and support (USFWS, 1984).
- Investigate potential for longleaf pine planting on private land. Projects could be partially funded by the US Fish and Wildlife Service (USFWS, 2011).
- Secure funding for land acquisition to facilitate permanent protection for recovery of populations (USFWS, 2011).
- Implement conservation easements where possible (USFWS, 2011).
- Develop and distribute an information factsheet on hairy rattleweed (USFWS, 2011).
- Share with the local Natural Resource Conservation office information about the distribution and best management practices of hairy rattleweed (USFWS, 2011).
- Contact and cooperatively work with Okefenokee Electric Membership Cooperation/Georgia Department of Transportation regarding rights-of-way management (broadcast spraying along right-of-ways) (e.g., Georgia Power – mowing) (USFWS, 2011).

- Document change in industrial timber management over time and relate the change in management to the change in habitat (USFWS, 2011).
- Work with partners to help secure funding for protection and management efforts (USFWS, 2011).
- Reintroduce fire on select industrial timberland sites to study effects (USFWS, 2011).
- Create demonstration sites to establish effective hairy rattleweed habitat management (reflective of management guidelines that will be established and further researched) (USFWS, 2011).
- Investigate and provide incentives for hairy rattleweed management on private lands (e.g., appropriate mowing regimes or other management options) (USFWS, 2011).
- Prioritize tracts/sites for different purposes – acquisition/conservation, research plots, seedling recruitment, vulnerability to development, etc. (USFWS, 2011).
- Identify safeguarding sites (Sansavilla, others) for reintroduction efforts and potential expansion of the currently recognized distribution within historical area (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS I. Conservation/Management Strategies 1. Secure funding for land acquisition to facilitate permanent protection for the recovery of hairy rattleweed populations. 2. Partner with Georgia Department of Transportation, Georgia Power, and the respective landowners to secure hairy rattleweed populations along rights-of way. 3. Work with timber companies on alternative management strategies that will promote hairy rattleweed populations, such as creating buffers along roadsides where populations occur. 4. Survey unknown populations. 5. Implement conservation easements on private land. 6. Work with public and private schools in Wayne and Brantley Counties to educate the youth about the endangerment of hairy rattleweed and to foster future recovery. 7. Reintroduce fire on select industrial timberland sites. 8. Create demonstration sites to establish effective hairy rattleweed habitat management (reflective of management guidelines that will be established and further researched). 9. Investigate and provide incentives for hairy rattleweed management on private lands (e.g., appropriate mowing regimes or other management options). 10. Collaborate with the Georgia Plant Conservation Alliance to propagate this species at botanical gardens or arboreta along the Coastal Plain of Georgia to help with future reintroduction efforts. II. Research Priorities 1. Re-survey long-term monitoring plots and GPS each site to document status across the range of hairy rattleweed. 2. Determine canopy cover relationships to vigor of plants and reproduction. 3. Characterize the vegetation and habitat requirements of hairy rattleweed. 4. Conduct additional inventory/surveys to more accurately predict the size of occupied polygons and the distribution of the species. 5. Characterize hydrology of hairy rattleweed sites. (USFWS, 2019)

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SPECIES ACCOUNT: *Berberis nevinii* (Nevin's barberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An evergreen shrub, 1-4 m tall. Leaves have 3-5 leaflets with serrated, spine-tipped edges. Produces yellow flowers (March-April), followed by red or yellow-red berries (NatureServe, 2015).

Taxonomy

A member of the Berberidaceae (barberry family). Berberis nevinii is distinguished from other members of the genus by its nearly flat, narrow, serrate, pinnately veined leaflets, few flowered racemes, and reddish fruits (Munz 1974, p. 245; Niehaus 1977, p. 1; Williams 1993, pp. 362-363) (USFWS, 2009).

Historical Range

Its historical distribution likely consisted of fewer than 30 scattered occurrences in Los Angeles, San Bernardino, and Riverside Counties (Service 1998, p. 54958), and possibly San Diego County (Neihaus 1977, p. 1; Reiser 2001, p. 3; CNDDB 2008, Element Occurrence (EO) 45) (USFWS, 2009).

Current Range

Ranges from the foothills of the San Gabriel Mountains of Los Angeles County to near the foothills of the Peninsular Ranges of southwestern Riverside County, California (Fish and Wildlife Service 1998) (NatureServe, 2015).

Critical Habitat Designated

Yes; 2/13/2008.

Legal Description

On February 13, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Berberis nevinii (Nevin's barberry) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat units (CHU), in California (73 FR 8412-8440).

Critical Habitat Designation

The critical habitat designation for Berberis nevinii includes one CHU (six sub-units) in Rverside County, California. This species critical habitat encompasses approximately six acres (ac) (three hectares (ha)) (73 FR 8412-8440).

Unit 1: Agua Tibia/Vail Lake: Unit 1 comprises approximately 6 ac (3 ha) and is divided into two subunits: Big Oak Mountain Summit (1A) and Agua Tibia Mountain Foothills (1B). The lands in Unit 1 were occupied at the time of listing, contain the physical and biological features essential to the conservation of Berberis nevinii, and may be important for maintaining genetic diversity for the species as they include occurrences in ecologically unique areas. Subunit 1A: Big Oak Mountain Summit: Subunit 1A consists of approximately 5 ac (2 ha) of Federal land managed by

the BLM on Big Oak Mountain to the north of Vail Lake in southern Riverside County. Two Berberis nevinii individuals of different sizes (ages) occur in this subunit on the summit of Big Oak Mountain at approximately 2,700 ft (823 m) elevation (i.e., the lower edge of the marine layer) (PCE 1 and 3). One individual is an old plant that is covered in lichens, and the other individual is considerably smaller and at some distance to the northeast of the older plant. This location is considered unusual (i.e., ecologically unique) for the species in that it is at higher elevation and on relatively flat clay lenses consisting of heavy adobe/gabbro type soils with high water-holding capacity, derived from Mesozoic basic intrusive rock (PCE 2) (Soza 2003, unpaginated). Soils in this area are classified primarily as Auld clay, 8 to 15 percent slopes, and Las Posas loam, 8 to 15 percent slopes, eroded (PCE 2) (Service GIS data 2006). This occurrence is located in an open grassland area with chaparral nearby. Associated plant species include Chenopodium californicum, Avena fatua, Harpagonella palmeri, Plantago erecta, Convolvulus simulans, Galium porrigens, and Delphinium sp. We are designating this subunit as critical habitat even though it is occupied by only two Berberis nevinii plants because it represents an ecologically unique site for the species and contains the physical and biological features essential to the conservation of B. nevinii. Additionally, this site contains naturally occurring B. nevinii of different sizes (ages). Because this occurrence is on an ecologically unique site, this subunit may be important in terms of preserving genetic diversity throughout the range of the species. Berberis nevinii occupied this subunit at the time of listing (63 FR 54956; October 13, 1998). Bureau of Land Management land on Big Oak Mountain consists of three small parcels totaling 888 ac (360 ha) surrounded by private land. The primary threats to Berberis nevinii habitat in this area are the indirect effects associated with urban and residential development on private lands adjacent to BLM lands, such as increased human recreation; incursion or spread of invasive, nonnative plants; and changes to the natural fire regime (i.e., increased ignitions and fire frequency, and shortened fire return intervals that can lead to type conversion of shrublands to annual grasslands). The BLM Resource Management Plan indicates that these parcels are closed to motorized vehicles and livestock grazing (BLM 1994, p. 28). However, special management considerations or protection for the physical and biological features may be needed to minimize disturbance to the vegetation and soils within this subunit; control invasive, nonnative plants; and maintain the natural hydrologic and fire regime of the area resulting from urban and residential development. Subunit 1B: Agua Tibia Mountain Foothills: Subunit 1B consists of approximately 1 ac (<1 ha) of federally-owned land managed by the USFS on the CNF near the Agua Tibia Wilderness Area in southern Riverside County, California. Five Berberis nevinii individuals are known from this area and are located at the edge of a stream channel (PCE 1) growing in association with coast live oak and riparian woodland species (PCE 3). Nearby chaparral includes such species as Quercus berberidifolia, Adenostoma fasciculatum, and Haplopappus squarrosus, and nearby desert species include Yucca schidigera (CNDDB 2007). These B. nevinii plants are growing under a canopy of Quercus agrifolia and Platanus racemosa with the following species: Heteromeles arbutifolia, Q. berberidifolia, Elymus condensatus, Mimulus aurantiacus, Lonicera subspicata, Pterostegia drymarioides, and Epilobium canum. Soils in this area are classified as rough broken land and Visalia gravelly sandy loam, with 5 to 9 percent slopes (PCE 2) (Service GIS data 2007). We are designating this subunit as critical habitat because it contains the physical and biological features essential to conservation of Berberis nevinii and it contains a relatively large natural occurrence of the species. Additionally, Service personnel visited this site in June 2006 while B. nevinii was in fruit and found that several of the fruits had three to four seeds, which may be significant for a species that appears to rarely set seed. Berberis nevinii occupied this subunit at the time of listing, as identified in the final listing rule (63 FR 54956, October 13, 1998). The Berberis nevinii occurrence on the CNF is not as well protected as the occurrence on the ANF (USFS 2005, p. 238).

The primary threats to B. nevinii habitat in this area are human recreation (off-highway vehicle use, shooting); wildland fire, including an increased risk of fire ignition due to the proximity of State Highway 79 (USFS 2005, pp. 232, 237); fuels and fire management activities (USFS 2005, p. 237); and invasive, nonnative plants, including potential short-term adverse effects associated with control efforts (USFS 2005, p. 234). This occurrence on the CNF burned in 1996 and vigorously resprouted following the fire (USFS 2005, p. 237). According to the USFS, this location has shown signs of disturbance from road activities, with unauthorized use of off-highway vehicles occurring close to, but not within, the area occupied by the species (USFS 2005, p. 235). Nonetheless, the magnitude of impacts associated with roads and recreational activity in this area appears to be low (USFS 2005, p. 238). Also, the USFS does not anticipate substantial camping and hiking-related impacts to B. nevinii habitat, and intends to avoid or mitigate these impacts through implementation of Forest Plan standards (USFS 2005, p. 234). The February 6, 2007, proposed rule (72 FR 5552) identified the proximity of Highway 79 as a potential threat to the Berberis nevinii occurrence and habitat on the CNF, in part due to proposed highway widening and realignment activities (72 FR 5565). However, we no longer anticipate that these activities will affect Subunit 1B as there currently are no plans for widening or realigning Highway 79 in the section of roadway closest to this subunit. The revised subunit is now more than 525 ft (160 m) south of the highway. As discussed in the Special Management Considerations or Protection section above, the presence of invasive, nonnative plants may impact the B. nevinii occurrence and habitat at this site. However, the CNF anticipates an eradication effort of the nonnative Arundo donax and other invasive grasses (USFS 2005) present in this subunit, which should minimize the impacts of this threat to the species and its habitat. One of the greatest threats to occupied habitat on the CNF and the physical and biological features contained therein is from wildland fire and the management of fire and fuels (i.e., fire suppression and prevention activities). This subunit is within the Wildland-Urban Interface (WUI) Defense Zone (USFS 2005, p. 237; Service 2005, p. 127). Some plants or habitat within the WUI Defense Zone could be removed or degraded under the Revised Land and Resource Management Plan due to fuel removal for fire protection or overly frequent fuel treatments (Service 2005, p. 127). Special management considerations or protection of the physical and biological features may be required to minimize disturbance to the vegetation and soils within this subunit; control invasive, nonnative plants; and maintain the natural fire regime of the area. Subunit 1C: South Flank Big Oak Mountain: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion. Subunit 1D: North of Vail Lake: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion. Subunit 1E: South of Vail Lake/ Peninsula: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion. Subunit 1F: Temecula Creek East: We are excluding this subunit from the final designation of critical habitat under section 4(b)(2) of the Act (Table 1). See the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a discussion of this exclusion.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Berberis nevinii critical habitat consists of three components (73 FR 8412-8440):

(i) Low-gradient (i.e., nearly flat) canyon floors, washes and adjacent terraces, and mountain ridge/summits, or eroded, generally northeast to northwest-facing mountain slopes and banks of dry washes typically of less than 70 percent slope that provide space for plant establishment and growth;

(ii) Well-drained alluvial soils primarily of non-marine sedimentary origin, such as Temecula or sandy arkose soils; soils of the CajalcoTemescal-Las Posas soil association formed on gabbro (igneous) or latite (volcanic) bedrock; metasedimentary substrates associated with springs or seeps; and heavy adobe/gabbro-type soils derived from metavolcanic geology (Mesozoic basic intrusive rock) that provide the appropriate nutrients and space for growth and reproduction; and

(iii) Scrub (chaparral, coastal sage, alluvial, riparian) and woodland (oak, riparian) vegetation communities between 900 and 3,000 feet (275 and 915 meters) in elevation that provide the appropriate cover for growth and reproduction.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas within the geographical area occupied by the species at the time of listing contain the physical or biological features essential to the conservation of the species, and whether these features may require special management considerations or protection. As stated in the final listing rule (63 FR 54956, October 13, 1998), threats to the species and its physical and biological features include urban development, off-road vehicle use, human recreation (e.g., horseback riding), highway projects, fire management strategies (suppression measures, brush clearing) that alter natural fire processes to which native plant communities are adapted, and the introduction of invasive, nonnative plants that may compete with Berberis nevinii or contribute to combustible fuel loads (63 FR 54961). These threats can directly or indirectly result in the loss, modification, degradation, or fragmentation of B. nevinii habitat, thereby eliminating or reducing potential habitat for seed production and germination, seedling establishment, plant growth and maturation, and population growth. Individually or combined, these threats may require special management considerations or protection of the physical and biological features as addressed here and in more detail within the individual critical habitat unit descriptions that follow. Urbanization, flood control measures, road widening, and habitat degradation from extensive recreational use have contributed to the loss of Berberis nevinii habitat and have apparently resulted in the extirpation of several occurrences, particularly in the San Fernando Valley of Los Angeles County (63 FR 54961). Urban development is currently the primary threat to B. nevinii habitat and occurrences in the vicinity of Vail Lake and Oak Mountain in Riverside County. Urbanization may destroy, degrade, fragment, or otherwise alter the topography, soil, and vegetation community structure in ways that make areas less suitable for B. nevinii. Land grading for residential development and road projects may affect the topography of the site (PCE 1); alter soil composition and structure (PCE 2); change vegetation community composition and structure through clearing or thinning of vegetation and the introduction of nonnative plants (PCE 3); increase erosion potential (PCE 1 and 2); and change hydrological (drainage and water infiltration) patterns, thereby decreasing the quality and extent of available habitat for B. nevinii. Additionally, urban development within

or near B. nevinii habitat may increase the frequency of fire on the landscape due to increased combustible fuel loads that may result from the incursion and spread of annual nonnative grasses and an increased potential for fire ignition. In the February 6, 2007, proposed rule (72 FR 5552), we focused primarily on potential indirect impacts of urbanization on Berberis nevinii habitat and occurrences in the vicinity of Vail Lake and Oak Mountain (72 FR 5565– 5567). Urban development is not expected to directly impact the known occurrences of B. nevinii on Federal land in the Vail Lake and Oak Mountain area, although indirect impacts associated with increased urbanization may occur. On the other hand, B. nevinii habitat on private land in this area may be subject to some degree of residential development, as described below in the critical habitat subunit descriptions (see the Critical Habitat Designation section of this final rule). However, these private lands are located within the Criteria Area of the Western Riverside County MSHCP and are targeted, in whole or in part, for acquisition and inclusion in the MSHCP Conservation Area as Additional Reserve Lands. Specifically, the conservation objectives of the MSHCP include conservation and management of at least 8,000 ac (3,238 ha) of suitable habitat, including all known locations of B. nevinii in the Vail Lake area (see the Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act section below for a detailed discussion of the MSHCP). Recreational activities may also impact the physical and biological features essential to the conservation of the species by destroying, degrading, fragmenting, or otherwise altering the topography, soil, and vegetation community in ways that make areas less suitable for Berberis nevinii. For example, off-highway vehicle use, hiking, camping, horseback riding, and recreational facility development in or near B. nevinii occurrences could alter or destroy surface and subsurface structure through trampling and clearing or thinning of vegetation (PCE 3), the introduction of nonnative plants (PCE 3), soil disturbance or compaction (PCE 2), and increased erosion and changes to hydrological (drainage and water infiltration) patterns that may in turn affect the topography, soil, and vegetation of the site (PCE 1, 2, and 3). Activities associated with fire management, such as fuel treatments, prescribed burns, and wildfire suppression, may also impact the physical and biological features essential to the conservation of the species. The creation of fuel breaks, brush clearing or thinning, and the use of heavy equipment and off-road vehicles for fire management could physically remove or disturb soils and alter soil composition (PCE 2), remove or destroy vegetation (PCE 3), increase erosion, and alter the topography (PCE 1) and hydrologic patterns in or near Berberis nevinii occurrences. Fire management activities could facilitate the incursion or spread of invasive, nonnative plants by potentially dispersing seeds and creating (disturbance) conditions that increase the competitive edge of nonnative species over native species, thereby altering the composition of the vegetation community (PCE 3). As pointed out in the proposed critical habitat rule (72 FR 5552), vegetation community composition and structure could be altered by fire management activities such as prescribed fires that are too frequent or that occur at times of the year atypical of the natural fire regime, or by fire suppression that allows overgrowth of high canopy cover, limiting or eliminating plant species that require full or partial sun from the plant community (72 FR 5563). Berberis nevinii's life history characteristics indicate that it likely recruits into chaparral during fire-free periods and may require long intervals between fires for recruitment and population increases; thus, overly frequent fire is a substantial and immediate threat to this species (White 2007, p. 1). While highway projects were identified in the final listing rule (63 FR 54956, October 13, 1998) and proposed critical habitat rule (72 FR 5552; February 6, 2007) as a threat to Berberis nevinii, we do not anticipate that this activity will affect designated critical habitat in the foreseeable future. Specifically, the proposed critical habitat rule identified the proximity of Highway 79 as a potential threat to the B. nevinii occurrence and habitat on the CNF (Subunit 1B) in part due to proposed highway widening and realignment

activities (72 FR 5565). However, we no longer anticipate that these activities will affect Subunit 1B because: (1) There are currently no plans to widen the portion of State Route 79 closest to Subunit 1B, and (2) the revised subunit is now more than 525 ft (160 m) south of the highway, which is far enough away that impacts to the subunit from construction or widening activities are unlikely. Based on information provided for the economic analysis, nonnative Arundo donax (Arundo) and other invasive grasses are present in Subunit 1B, and the CNF anticipates an eradication effort based on the weed management strategy in the USFS' Revised Land Management Plan for the Four Southern California National Forests (USFS 2005). Additional information obtained on water storage at Vail Lake indicates that lake level fluctuations could affect proposed subunits bordering Vail Lake (specifically, proposed subunits 1D and 1E). While we revised proposed critical habitat boundaries for these subunits based on the currently permitted storage capacity of Vail Lake (see the Criteria Used to Identify Critical Habitat section in this final rule), fluctuating water levels that surpass permitted storage levels and lake storage capacity could still affect Berberis nevinii in subunits that border Vail Lake. However, the occurrences that are located closest to Vail Lake have not been inundated or affected by rising water levels and fluctuations in the recent past (Boyd 2007, p. 1), and we do not anticipate that any B. nevinii individuals in this area will be affected.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2009)

Lifespan

Adult: > 50 years (USFWS, 2009)

Breeding Season

Adult: March - April (USFWS, 2009)

Reproduction Narrative

Adult: This species flowers from March through April. Berberis nevinii shrubs are long-lived (more than 50 years) (Mistretta and Brown 1989, p. 5) with low reproductive rates likely due to sporadic production of fertile seed (Mistretta and Brown 1989, p. 5). Several occurrences of B. nevinii consist of only single plants that have existed for years or decades without reproducing sexually (Mistretta and Brown 1989, p. 5), suggesting a self-incompatible breeding system (White 2001, p. 36). Berberis nevinii likely does not reproduce by vegetative means (Mistretta and Brown 1989, p. 5; S. Boyd, Rancho Santa Ana Botanic Garden, in litt. 2006, p. 1) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alluvial shrub communities, chaparral (NatureServe, 2015); oak woodland, riparian scrub, riparian woodland (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 1,400 - 2,700 ft. elevation (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2009)

Habitat Narrative

Adult: This species is found in 2 habitat types: the margins of dry washes with sandy and gravelly substrates and alluvial shrub communities; and steep slopes with coarse soils and chaparral communities. The presence of groundwater flow may be a habitat requirement (NatureServe, 2015). This species generally grows on sandy soils in low-gradient washes, alluvial terraces, and canyon bottoms, along gravelly wash margins, or on coarse soils on steep, generally north-facing slopes in association with the following plant communities: alluvial scrub, cismontane (e.g., chamise) chaparral, coastal sage scrub, oak woodland, and/or riparian scrub or woodland. Berberis nevinii is a fire-adapted species, where mature individuals may survive and re-sprout following fire (Mistretta and Brown 1989, p. 5; White and Leatherman 2001, p. 36). Most native occurrences of B. nevinii are between 1,400 and 1,700 feet (427 to 518 meters) in elevation (Boyd 1987, p. 2; CNDDB 2008, pp. 1–34), although one native occurrence on the Oak Mountain summit north of Vail Lake is at approximately 2,700 feet (823 meters). Native occurrences are strongly associated with alluvial soils or soils derived from nonmarine sedimentary based substrates, especially sandy arkose (sandstone derived from granitic material) (Boyd 1987, p. 7; Boyd and Banks 1995, p. 24; Soza and Boyd 2000, p. 25). Berberis nevinii is considered a drought-tolerant species, but it will also tolerate large amounts of water in cultivation without apparent damage (Wolf 1940, p. 2; Lenz and Dourley 1981, p. 130; A. Sanders, University of California Riverside, in litt. 1997, p. 2) (USFWS, 2009).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Fruits are adapted for animal dispersal (USFWS, 2009).

Population Information and Trends

Population Trends:

Declining (inferred from NatureServe, 2015)

Number of Populations:

14 native (USFWS, 2009)

Population Size:

< 370 (USFWS, 2009)

Population Narrative:

Historically, the range of this species probably consisted of fewer than thirty scattered occurrences. At least seven populations of the thirtyish known occurrences have been extirpated (Fish and Wildlife Service 1998) (NatureServe, 2015). Currently, there are 14 extant, native occurrences of Berberis nevinii. The total number of native B. nevinii individuals across its range may be less than 370 (USFWS, 2009).

Threats and Stressors

Stressor: Urbanization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: A majority of the occurrences and individuals of B. nevinii are on private lands subject to urbanization. Urban development is the primary threat to Berberis nevinii and its habitat in the vicinity of Vail Lake (USFWS 2008a, p. 8423). Land grading for residential development and associated roads may affect the topography of the site; alter soil composition and structure; change vegetation community composition and structure through clearing or thinning of vegetation and the introduction of nonnative plants; increase erosion potential; and change hydrological (drainage and water infiltration) patterns, thereby decreasing the quality and extent of available habitat for B. nevinii. In addition, urban development may increase the frequency of fire on the landscape due to increased combustible fuel loads and potential for fire ignition resulting from the incursion and spread of annual nonnative grasses (USFWS, 2009).

Stressor: Recreation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, hiking, camping, and recreational facility development have been included with off-road vehicles and horseback riding as recreational activities that threaten Berberis nevinii (USFWS 2008a, p. 8423). These activities may alter or destroy surface and subsurface structure through trampling and clearing or thinning of vegetation, the introduction of nonnative plants, soil disturbance or compaction, and increased erosion and changes to hydrological (drainage and water infiltration) patterns (USFWS 2008a, p. 8423). Although not discussed in the listing rule, recreational uses associated with the Vail Lake Village Resort and Campground (private) and the Dripping Springs Campground (Cleveland National Forest) were identified as a threat to three Berberis nevinii occurrences (CNDDB 2008, EOs 2, 20, 24). Since listing, hiking and biking along an adjacent fire road was noted as threat to the Cobal Canyon occurrence consisting of a single individual (CNDDB 2008, EO 46). At least 36 percent (5 of 14) of Berberis nevinii occurrences are currently known to be threatened by recreational activities. Seven additional occurrences near urban areas are likely threatened by these activities due to lack of protection from off-road vehicle access and close proximity to roads (USFWS, 2009).

Stressor: Proposed road widening (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: A proposal to widen State Route 79 (SR-79) south of Vail Lake was noted as a potential threat as it may directly impact B. nevinii occurrences and promote development in the area (USFWS 1998, p. 54961). An occurrence consisting of two plants in Arroyo Seco Creek (Table 1) is in close proximity to SR-79. According to geographic information system (GIS) data provided by the County of Riverside, planned widening of SR-79 in that area partially overlaps one of the B. nevinii individuals mapped in CNDDB (Dudek 2003a, pp.7-25, 7-26, 7-31; USFWS GIS data 2008) (USFWS, 2009).

Stressor: Altered fire regimes (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Activities associated with fire management, such as fuel treatments, prescribed burns, and wildfire suppression, may impact the physical and biological features essential to the conservation of Berberis nevinii. The creation of fuel breaks, brush clearing or thinning, and the use of heavy equipment and off-road vehicles for fire management could physically remove or disturb soils and alter soil composition, remove or destroy vegetation, increase erosion, and alter the topography and hydrologic patterns in or near B. nevinii occurrences. Fire management activities could facilitate the incursion or spread of invasive, nonnative plants by potentially dispersing seeds and creating (disturbance) conditions that increase the competitive edge of nonnative species over native species, thereby altering the composition of the vegetation community (USFWS 2008a, p. 8423). increases in urbanization and human activity in or near B. nevinii habitat are generally accompanied by an increased incidence of accidental fires (USFWS 1998, p. 54964). Overly frequent fire on the landscape could potentially kill young B. nevinii before they reach their reproductive potential and may adversely affect mature B. nevinii by causing repeated resprouting that depletes stored resources faster than they can accumulate during fire-free periods (White 2007, in litt., p. 1). In addition, repeated burnings over short intervals could eventually lead to type conversion (wholesale replacement) of chaparral/shrublands with nonnative annual grassland (Keeley et al. 1999, p. 1831) (USFWS, 2009).

Stressor: Small population size and low reproductive output (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, the total number of native Berberis nevinii individuals across its range was reduced from 500 to fewer than 370 because of the reclassification of the San Francisquito Canyon occurrences from native to nonnative. In addition, 57 percent (8 of 14) of B. nevinii occurrences consist of three or fewer individuals, and 29 percent (4 of 14) of occurrences consist of only one individual. Low reproductive output of Berberis nevinii may be evidence of the potential impact of small population size on fitness described above. There appears to be little to no regeneration by seed occurring at most B. nevinii sites (Mistretta 1994, p. 186). Low seed set (including plants bearing fruits that lack seed) and lack of viable seed has been noted by both botanists and horticulturalists trying to obtain seed for propagation, even from within larger occurrences (Wolf 1940, p. 2; Boyd 1987, pp. 3, 44, 56; Mistretta and Brown 1989, pp. 4–5; Mistretta 1994, p. 186; Wall 2009, in litt., p. 5). In addition, several occurrences of B. nevinii consist of only a single plant that has existed for years or decades without reproducing (Mistretta and Brown 1989, p. 5; CNDDB 2008, EO 5). (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: One study predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Whether or not this would include Berberis nevinii is unknown. While the Service recognizes that climate change is an important issue with potential effects to listed species and their habitats, it lacks adequate information to make accurate predictions regarding its effects to B. nevinii at this time. Any changes in fire frequency resulting from climate change could directly threaten the persistence of the fire-prone occurrences of B. nevinii near Vail Lake in Riverside County (USFWS, 2009).

Stressor: Recreational activities (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: In the 2009 5-year review, we discussed recreational threats to Berberis nevinii at four locations (San Timoteo Canyon, Dripping Springs Campground, Vail Lake, and Cobal Canyon). Off-road vehicles, horseback riding, hiking, camping, and recreational facility development were all listed as threats to B. nevinii (USFWS 2009, p. 14). (USFWS, 2021)

Stressor: Urbanization (Residential development) (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: In the 2009 5-year review for Berberis nevinii, development was considered an immediate threat to the species, due to a proposal to develop the Vail Lake area (USFWS 2009, p. 13). In 2014, the Rancho California Water District (RCWD) acquired the lands encompassing the Vail Lake occurrences of Berberis nevinii, eliminating the immediate threat of residential development. The area is not under permanent conservation (for example, through conservation easement). However, RCWD management objectives for the area include habitat conservation and restoration (RCWD 2016, p. 6). We do not have information about other ownership or conservation status changes at other Berberis nevinii occurrences since 2009. (USFWS, 2021)

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Cooperate with the Western Riverside Regional Conservation Authority to acquire occupied Berberis nevinii habitat around Vail Lake, and to establish land management practices on

these lands that will benefit the species (USFWS, 2009).

- Determine causes and remedies of low reproductive output in Berberis nevinii. Investigate its breeding system; pollinators; seed dispersal mechanisms; and seedling requirements and establishment (USFWS, 2009).
- Work with partners to help conserve Berberis nevinii. Identify opportunities through the Service's Partners for Fish and Wildlife Program to seek habitat restoration and enhancement opportunities (USFWS, 2009).
- Identify partners to help support efforts to survey Berberis nevinii occurrences around Vail Lake, including occurrences within or partially within the perimeter of the 2004 Eagle fire (USFWS, 2009).
- Verify presence of the occurrence near the mouth of Scott Canyon in San Bernardino County (USFWS, 2009).
- Determine the genetic origins of cultivated specimens that are successfully reproducing, in particular, the Berberis nevinii in San Francisquito Canyon (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Monitor known occurrences of Berberis nevinii, with a focus on occurrences not monitored by the California Botanic Garden or the Western Riverside County Multiple Species Habitat Conservation Plan. Survey surrounding areas of suitable habitat for additional plants. 2. Collect additional B. nevinii seeds for ex situ storage at a certified Center for Plant Conservation facility. Focus collection efforts on occurrences that are not yet represented in conservation seed collections. 3. Work with the Rancho California Water District to conserve and enhance the Vail Lake occurrences of B. nevinii. For example, census the Vail Lake population, collect seed, and assess threats associated with recreational use. 4. Model B. nevinii habitat under a range of future climate scenarios and evaluate current and future areas of suitable habitat to identify opportunities for assisted migration. 5. Reintroduce B. nevinii to areas of suitable habitat within the species' range. 6. Augment B. nevinii occurrences where occurrence size is small. Increase occurrence size by planting additional B. nevinii. Work with conservation botanists to determine genetic management strategies for small occurrences. 7. Restore and enhance B. nevinii habitat where needed (for example, by controlling nonnative plants). (USFWS, 2021)
- Conservation Efforts As part of the genetics and breeding system study, California Botanic Garden botanists developed a propagation protocol for Berberis nevinii and obtained two conservation collections of B. nevinii seed from SFC (Washburn and Fraga 2017, p. 16). In addition to the two new seed collections from SFC, there are four other conservation collections of Berberis nevinii seed at California Botanic Garden (CBG 2020, unpaginated): 1. In 1990, B. nevinii was collected from SFC (accession number 16285). 2. In 2003, B. nevinii was collected from multiple plants within California Botanic Garden (accession number 21182). 3. In 1989 and 1990, B. nevinii was collected from CNDDB EO 16 (Vail Lake) (accession numbers 16073 and 16284, respectively). California Botanic Garden is working on a project to complete additional conservation activities for Berberis nevinii on the Angeles National Forest. The study includes 1) continued monitoring of B. nevinii at SFC, 2) a habitat suitability model to identify potential outplanting locations within the Copper Fire burn area, 3) a restoration out-planting, which will be documented over 5 years, and 4) additional ex situ seed conservation (Fraga 2019, unpaginated; Fraga 2020, pers. comm.). (USFWS, 2021)

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SPECIES ACCOUNT: *Berberis pinnata ssp. insularis* (Island Barberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An evergreen shrub with spreading stems that reach 2-8 m high and with glossy, compound leaves. Produces clusters of yellow flowers in March, followed by waxy-blue berries (NatureServe, 2015).

Taxonomy

Previously Mahonia pinnata (Lagasca) Fedde subsp. insularis (Munz) J.B. Roof. A member of the Barberry family (Berberidaceae). The taxon was first collected by Mason in 1927, but was first described by Munz (Munz and Roos 1950) based on a specimen collected by Wolf in 1932 "west of the summit of Buena Vista Grade (also known as Centinela Grade), interior of Santa Cruz Island." (USFWS, 2013).

Historical Range

Once thought to exist on three of the California Channel Islands (Anacapa, Santa Cruz, and Santa Rosa) (USFWS, 2013).

Current Range

Occurs on Santa Cruz Island (Channel Islands, CA) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: self-pollination (USFWS, 2013)

Lifespan

Adult: 80+ years (USFWS, 2013)

Breeding Season

Adult: February (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Bee pollinators, based on closely related species (USFWS, 2013)

Reproduction Narrative

Adult: Flowers are produced in February; each flower generally produces two or three ovules. The round grayish blue berries develop in late May. Island barberry reproduces through asexual reproduction (vegetatively) as well as through sexual reproduction, though the latter is rarely

achieved. Because it sprouts from an underground root stalk, or rhizome, a single plant can consist of several stems spread over many square meters and represent one genetic clone (Hochberg et al. 1980, California Native Plant Society 1984, Williams 1993). These clones are long-lived; one individual from Santa Cruz Island is likely more than 80 years old and presumed to be the same plant that Mason collected in 1927 (McEachern et al. 2007). Although pollinator studies have not been conducted specifically for island barberry, other species of Berberis in California have been observed to be pollinated by bees (Bombyliidae), particularly in the genus Andrenae (Moldenke 1976). Island barberry is genetically self-compatible (pollen from the same plant is able to produce fertile seeds); however, it still requires insect visitation for pollination to be achieved (Wilken 1996). Island barberry plants only produce a limited number of fruits each season, and many of these fruits do not make it to maturity. In addition to low seed production in island barberry, natural recruitment from seed is not occurring in the wild, and the cause or causes are unknown (Wilken 1996; McEachern and Chess 2006; McEachern et al. 2007) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, oak woodlands, pine forests (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Shady, mesic conditions (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 1,150 ft. elevation (USFWS, 2013)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2013)

Habitat Narrative

Adult: Inhabits moist, shaded canyons (NatureServe, 2015). It is associated with north facing, rocky slopes in chaparral, oak woodlands, and pine forests. Island barberry appears to favor shady, mesic conditions in closed-cone pine forest, oak woodland, and chaparral habitats below 350 meters (1,150 feet) (Williams 2012) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Because the fruits of Berberis species can be eaten and dispersed by birds (Martin et al. 1951), some predation by birds is likely part of the natural dispersal strategy of island barberry (USFWS, 2013).

Population Information and Trends

Population Trends:

Decline of 70-90% (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2013)

Population Size:

5 (USFWS, 2013)

Adaptability:

Very low (inferred from USFWS, 2013)

Population Narrative:

There are 3 known individuals, no seedlings observed in the wild, low seedling viability and slow seedling growth rate (Wilken, 2003). Over the last 20 years, the known population has declined from 20 to 3 individuals. This species has experienced a long-term decline of 70-90%. There are only 3 known individuals in the wild, although the it is likely more individuals will be found (D. Wilken, pers. comm.) (NatureServe, 2015). Each of the five remaining populations of island barberry is comprised of only one plant (McEachern et al. 2010). The extremely small population size, and limited range and distribution (five known individuals on one island) also make this subspecies susceptible to extinction by stochastic events such as fire, erosion, pests, and disease (USFWS, 2013).

Threats and Stressors

Stressor: Past habitat alteration (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time the subspecies was listed, sheep and most of the cattle had been removed from Santa Cruz Island. However, the listing rule did identify sheep as a major contributor to past alteration of the habitat, with sheep being one of the greatest contributors to soil erosion. Pigs continued to contribute to habitat alteration on Santa Cruz Island by rooting up native vegetation, causing massive erosion, and spreading invasive weeds (National Park Service 2005). The loss of canopy and understory plant species, due to rooting by feral pigs, resulted in a reduction of the mesic conditions on which island barberry depends (McEachern pers. comm. 2007a). Island barberry is not at risk from ongoing or threatened destruction of its habitat or range. However, native habitat for the subspecies is still recovering from past alteration (USFWS, 2013).

Stressor: Fruit predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation of island barberry fruits by island scrub jays (Aphelocoma insularis) has been observed in the wild (Wilken pers. comm. 2012). Insect predation on fruits and developing flower buds has been documented (McEachern et al. 2010), appears extensive (McEachern pers. comm. 2007a), and is a likely cause of fruit failure (McEachern pers. comm. 2007b). The limited fruit production (McEachern et al. 2010) is restricting island barberry from natural recruitment in the wild (USFWS, 2013).

Stressor: Limited distribution and small population size (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The loss of genetic diversity island barberry has suffered due to the extremely small number of extant individuals may be contributing to its reduced fitness and reduced reproductive vigor, and potentially a factor contributing to the demonstrated lack of recruitment in this subspecies (Wilken 1996; McEachern et al. 2007). Species with few populations and individuals are threatened by stochastic events in several ways: loss of genetic diversity, susceptibility to factors that inhibit the successful completion of their life cycle, and random natural events (62 FR 40970) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Island barberry's small and isolated range increases its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as can be brought about by climate change. It is unknown at this time if climate change will result in a warmer trend with localized drying, higher precipitation events, or other effects. Small-ranged species such as island barberry are more vulnerable to extirpations due to these changing conditions (Loarie et al. 2008) (USFWS, 2013).

Recovery

Reclassification Criteria:
1. Discover or establish five populations on Santa Rosa and Santa Cruz Islands, and two to three populations on Anacapa Island (USFWS, 2013).

2. Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (USFWS, 2013).

Delisting Criteria:
1. Discover or outplant five additional populations per island (USFWS, 2013).

2. No decline after downlisting for 10 years (USFWS, 2013).

Recovery Actions:
- Develop successful outplanting techniques (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the listed species and their habitats (USFWS, 2000).
- Conduct thorough surveys for all species in the recovery plan (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species in the recovery plan (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery prescriptions (USFWS, 2013).
- Study the predation of island barberry fruit and other potential sources of reproductive failure (USFWS, 2013).
- Restore native habitat at historical locations on Santa Cruz and Anacapa Islands (USFWS, 2013).
- Implement outplanting at historical locations on Santa Cruz and Anacapa Islands (USFWS, 2013).

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SPECIES ACCOUNT: *Blennosperma bakeri* (Sonoma sunshine)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/2/1992; Pacific Southwest (R8)

Physical Description

Blennosperma bakeri plants are less than 30 centimeters (cm) (11.8 inches (in)) tall with alternate, linear leaves (Ornduff 1977a, Baldwin 2012). The leaves have smooth margins and are 5.1 to 15.2 cm (2.0 to 6.0 in) long with zero to five lobes (Baldwin 2012). From March to May, the plants have a butter-yellow, daisy-like flower head at the tip of each branch. Each flower head is less than 1.5 cm (0.6 in) across. The 6 to 15 outer petals are 5 to 7 millimeters (mm) (0.20 to 0.28 in) long. Occasionally the flowers may be white instead of yellow. The pollen is white. The flowers produce tapered achenes (dry, one-seeded fruits) that are 3 to 4 mm (0.12 to 0.16 in) long and have 4 to 6 sharp angles along the sides. The achenes are covered with tiny bumps and become slimy when wet giving the species one of its common names, “Baker’s sticky seed” (Ornduff 1963, Munz and Keck 1968, Ornduff 1977a, Baldwin 2012). (USFWS, 2016)

Taxonomy

Blennosperma bakeri is an annual plant in the aster family. It has been known by the scientific name Blennosperma bakeri (Heiser) since it was first described by Heiser (1947). Two other species are recognized in this genus; B. nanum (dwarf blennosperma) grows in California and B. chilense (Chilean blennosperma) occurs in Chile (Baldwin 2012). (USFWS, 2016)

Historical Range

Sonoma County, California. (USFWS, 2016)

Current Range

Sonoma County, California. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016)

Lifespan

Adult: ~ 1 year (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Pollinators, such as Andrena blennospermatis (USFWS, 2016)

Breeding Season

Adult: March - April (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Heavy fall rains, insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Flower from March through April. The flowers of B. bakeri are self-incompatible, meaning that they can set seed only when fertilized by pollen from a different plant (USFWS, 2016). Blennosperma bakeri is an annual; its entire life cycle from seed germination to seed set is completed in a single growing season. In nature, B. bakeri seeds germinate in the fall following heavy rains, and the plants can grow even when submerged (Patterson et al. 1994). The most abundant native pollinator of B. bakeri was the solitary bee, Andrena blennospermatis. Other pollinators that visited B. bakeri included Apis mellifera (European honeybee), four species of generalist native bees, and syrphid flies. Under dry conditions, or in dense populations, B. bakeri may bear only a single flower head per plant (Patterson et al. 1994), thus producing a maximum of 15 achenes. However, when pools dry and fill repeatedly in a single growing season, each plant may produce as many as 20 flower heads (Patterson et al. 1994), with potential for 300 achenes per plant (USFWS, 2016).

Habitat Type

Adult: Wetland, aquatic (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pool, wet grassland (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 330 ft. elevation (USFWS, 2016)

Environmental Specificity

Adult: Very Narrow (Inferred from USFWS, 2016)

Habitat Narrative

Adult: Occurs predominantly on the Santa Rosa Plain, which is located in central Sonoma County, California, and is characterized by seasonal wetlands, predominately in the form vernal pools, and associated upland grassland habitat. Vernal pools form in depressions having a shallow, impermeable soil layer that restricts the downward movement of water. The pools have an outlet barrier that further causes ponding (CH2M Hill 1995) and may be connected and fed by shallow drainage pathways called “swales.” Vernal pools generally fill during winter rains and dry in late spring or summer. “Natural” vernal pools are those that are found occurring naturally in the landscape. “Created” vernal pools are those that have been constructed in an area that was not a vernal pool in the recent past (within the last 100 to 200 years) and that is isolated from existing vernal pools (Gwin et al. 1999 and Lewis 1989). This species grows only in seasonal wetlands. (USFWS, 2016)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal mechanisms for the achenes have not been studied. However, seed dispersal of B. nanum var. nanum, a species that occupies similar habitat to B. bakeri, was found by Ornduff

(1964) to be within a small radius of the parent plants based on the area occupied by flower-color variants. (USFWS, 2016)

Population Information and Trends

Population Trends:
Unknown (USFWS, 2016)

Species Trends:
Decreasing (USFWS, 2016)

Number of Populations:
18 (USFWS, 2016)

Population Size:
Variable among years; < 100 to > 1.5 million (USFWS, 2016)

Population Narrative:
After listing, the number of sites with many individuals decreased, and the number with less than 10 individuals increased. The percentage of sites with fewer than 10 individuals increased by 15 percent between the time of listing and 1994 (USFWS, 2008). The most current occurrence information documents the presence of 18 extant occurrences. Populations exhibit extreme fluctuations in size among years, often varying by one or two orders of magnitude (CNDDB 2013). Individual occurrence sizes ranged over time from fewer than 100 plants to more than 1.5 million plants (CNDDB 2013). Collection of annual abundance data has been sporadic; therefore, determination of population trends is difficult. A 2009 study by Sloop and Ayres found that moderate genetic diversity existed among the occurrences of Blennosperma bakeri on the Santa Rosa Plain (USFWS, 2016).

Threats and Stressors

Stressor: Development and conversion to agriculture (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality

Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

Stressor: Alteration of hydrology (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

Stressor: Off-highway vehicles (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Damage by off-highway vehicles was noted as a threat to Blennosperma bakeri. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

Stressor: Grazing managment and thatch accumulation (USFWS, 2016)
Exposure:
Response:
Consequence:

Narrative: Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (Phalaris aquatica), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

Stressor: Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:

Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including B. bakeri, L. burkei, and L. vinculans. (USFWS< 2016)

Stressor: Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Chance events constitute a serious threat to Blennosperma bakeri. Because the known occurrences of B. bakeri are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased

pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998). (USFWS, 2016)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

Stressor: Non-native invasive species (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

Recovery

Reclassification Criteria:
A/1: Eighty percent of extant, native occurrences, not protected as of December 2014, within each core area (Windsor Core Area, Alton Lane Core Area, and Blennosperma bakeri Southern Core Area) are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to preserve isolated and/or genetically unique occurrences. (USFWS, 2016)

A/2: The following additional habitat is needed in order to downlist B. bakeri. New preserves protect a minimum of 50 ac in the Windsor Core Area, a minimum of 500 ac in the Alton Lane Core Area, and a minimum of 300 ac in the Blennosperma bakeri Southern Core Area. These preserves consist of occupied habitat that is not currently protected. The ecological integrity (e.g., water quality, hydrology, uplands conditions) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to Blennosperma bakeri, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future. (USFWS, 2016)

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with native occurrences may be less than 10 ac. The preserves should be as near to new or existing preserves as possible .(USFWS, 2016)

A/4: The total new preserve acreage in core area includes no less than 175 ac of vernal pools and swales in the Alton Lane Core Area, no less than 105 ac in the Blennosperma bakeri Southern Core Area, and no less than 18 ac in the Windsor Core Area. However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: Native occurrences, extant as of December 2014, in (a) the Windsor Core Area, and (b) the Blennosperma bakeri Southern Core Area are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected sites. Extant native occurrences in the Alton Lane Core Area are replicated at 1:2 (tripled) in permanently protected appropriate sites24. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016)

E/2: The preserves noted in Factor A are occupied by Blennosperma bakeri seeds at a density of 2,500 seeds per square meter averaged over whole vernal pools and swales when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and address the effects of small occurrence size, and climate change, among other threats, are developed and are being effectively implemented. (USFWS, 2016)

Delisting Criteria:

A/1: At least 90 percent of all known native occurrences of Blennosperma bakeri that are extant as of December 2014, have been fully protected in perpetuity. (USFWS, 2016)

A/2: 100 ac of habitat containing Blennosperma bakeri is preserved and appropriately managed in the Sonoma Valley Management Area. (USFWS, 2016)

E/1: In addition to replication noted in E/1 of the downlisting criteria for Blennosperma bakeri, all occurrences in management areas have been replicated at 1:2 at appropriate locations. Bouverie Preserve, east of the Town of Glen Ellen, may be considered as part of the Sonoma Valley Regional Park Management Area and replicated at 1:2 if Blennosperma bakeri is still found there. This occurrence, if not already lost, could provide important genetic diversity and thus be valuable for the recovery of the species. The occurrences in the Sonoma Valley Management Area should be replicated at 1:3. (USFWS, 2016)

E/2: All replicate occurrences from E/1 have achieved the same rates of seed density (2,500 seeds per square meter), as the core area occurrences. (USFWS, 2016)

E/3: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ including: occurrences in Sonoma Valley Regional Park and the Wood Road area in the northern portion of the Alton Lane core area. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6 of the Recovery Plan. (USFWS, 2016)

Recovery Actions:

- 1. Protect extant occurrences and potential habitat for Blennosperma bakeri. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of Blennosperma bakeri including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).

- 3. Collect and store seed from all occurrences of Blennosperma bakeri. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
- 4. Survey historical locations and other potential habitat (not previously surveyed) where Blennosperma bakeri may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for Blennosperma bakeri. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on Limnanthes vinculans and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of Blennosperma bakeri, Lasthenia burkei, and Limnanthes vinculans. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for Blennosperma bakeri. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of

management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. Blennosperma bakeri and Limnanthes vinculans at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)

- 10. Engage and educate the public about Blennosperma bakeri recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)
- Recommendation for future action: In response to the recently discovered range expansion of Sonoma sunshine, the Service recommends surveying vernal pools in Mendocino County near the recent observation of Sonoma sunshine to search for additional occurrences. (USFWS, 2019)

References

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Lasthenia burkei (Burke's goldfields)

Limnanthes vinculans (Sebastopol meadowfoam)

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SPECIES ACCOUNT: *Boltonia decurrens* (Decurrent false aster)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/14/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A robust, short-lived perennial herb, up to 2 m tall, that produces numerous flower heads with white or pale violet ray flowers surrounding a yellow central disk (NatureServe, 2015).

Taxonomy

Formerly classified as Boltonia asteroides var. decurrens or B. latisquama var. decurrens; now recognized as a distinct species (B. decurrens) by Flora of North America (2006) and Kartesz (1994), the U.S. Fish and Wildlife Service, and the Illinois and Missouri Heritage Programs (NatureServe, 2015).

Historical Range

Historical collection records reveal that Boltonia decurrens once occurred in almost contiguous populations along a 400 km stretch between LaSalle, Illinois and St. Louis, Missouri within the Illinois and Mississippi River floodplain. A disjunct population, reported in 1976, but not found since, is known from Cape Girardeau, MO, about 195 km down the Mississippi River from St. Louis (Schwegman and Nyboer, 1985) (NatureServe, 2015).

Current Range

The species is currently limited to disjunct populations from Woodford County, Illinois to Madison County, Illinois. In some years, ephemeral populations occur in St. Charles County, Missouri, in the area of confluence of the Mississippi and Illinois Rivers (NatureServe, 2015). There is no apparent change in the distribution or range of the species. (USFWS, 2020)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative, sexual: self-pollination, cross-pollination (NatureServe, 2015)

Lifespan

Adult: 1 - 2+ years (USFWS, 2012)

Breeding Season

Adult: August - October (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Unshaded soil surface (NatureServe, 2015)

Reproduction Narrative

Adult: Vegetative reproduction occurs through shoots formed from a basal rosette (Smith and Keevin 1998). The species is primarily outcrossing, but some selfing occurs (Smith, 1995). Seed production is prolific with an average of ca. 50,000 seeds produced per plant (Smith & Keevin 1998; Smith, 1990). Seedling survival in the field is < 1%. However, under optimal conditions, the average plant produces 40,000 seedlings but the rate of seedling survival is low (Smith & Keevin 1998). Boltonia decurrens blooms from August through October throughout its range (Schwegman and Nyboer, 1985). Germination and seedling establishment do not occur where the soil surface is shaded, such as in places where natural succession has been uninterrupted for a period of 3 - 5 years. Seed germination is also inhibited by silt deposition (NatureServe, 2015). It is considered a perennial plant but also exhibits annual and biennial lifecycles (USFWS, 2012).

Habitat Type

Adult: Riparian, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forested wetland, herbaceous wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime, preferably flooding (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Successional vegetation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1990)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: It colonizes periodically disturbed riverine moist soil habitats (Smith et al. 2005). In general, sites where the species is successful in reproducing sexually and maintaining a self-sustaining population are characterized by moist, sandy soil and regular disturbance, preferably periodic flooding, which maintains open areas with high light levels. Analysis of 19th-century habitat data taken from herbarium sheets indicates that natural habitat was the shores of lakes and the banks of streams, including the Illinois River. In these habitats, regular flooding prevented succession, allowing sunlight to reach the seedlings. Boltonia decurrens is still found in these occasional natural habitats, but it is now primarily restricted to disturbed lowland areas, where it appears to be dependent on human activities (mowing, cultivation) for survival. Although prolonged flooding by extremely turbid water can damage a population (US Fish and Wildlife Service, 1990), the species is extraordinarily flood tolerant (Stoecker, Smith and Melton, 1995) and is known to survive several months of complete inundation by relatively clear groundwater (Smith, 1990). The palustrine habitat is characterized as forested wetland and herbaceous wetland (NatureServe, 2015). As many as 11 plants have been observed to grow

from a single stem of the previous year, giving a 2-year-old wild population a definite clumped appearance (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: It appears that one mechanism of long distance dispersal of B .decurrens seeds is by flood waters. There appears to be suitable habitat for the species in many areas on the flood plain of the Illinois River; however, dispersal has been prevented by the extensive levee system that has been constructed to reduce flood damage to agricultural fields. (USFWS, 1990)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2020)

Species Trends:

Unknown (USFWS, 2020)

Number of Populations:

43 (USFWS, 2012)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Like the numbers of populations, numbers of individuals of B. decurrens also fluctuate greatly from year to year. Larger stands sometimes have several thousand plants in good years, occasionally exceeding 10,000. Because of the vulnerability of this species to changes in flooding regime, population number is expected to continue to fluctuate in upcoming years. The short term population trend has been relatively stable to a < 30% decline. Preliminary isozyme data developed by Thomas Ranker (University of Colorado, Boulder) from seeds collected from three populations in Illinois in 1994 indicate that there is a high level of genetic diversity (Smith, 1995). This rare species is much more variable, by all the measures examined, than most rare or geographically-restricted plant species, and is even slightly more variable than the average plant species (NatureServe, 2015). Approximately 43 populations have been discovered and monitored intermittently from 1984 to present. Due to the intermittent nature of the available data, long-term trends are not readily apparent but appear to include a periodical expansion and contraction of populations (USFWS, 2012). Specifically, we cannot draw conclusions about individual populations at the site scale, or the population as a whole, at the species-wide scale. We can confidently say, however, that decurrent false aster was found at least once at more than half of the historically documented sites, and that the number of plants at a site often varied drastically, which is consistent with historical data. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat degradation (NatureServe, 2015 and USFWS, 1990)
Exposure:

Response:
Consequence:
Narrative: Boltonia decurrens is threatened primarily by anthropogenic disturbance of natural habitat. Principal threats include flood-control measures; agricultural use of marginal river-bottom land; increased siltation of floodwater, which decreases light availability and prevents germination and seedling establishment; herbicide use for weed control; and marina construction (NatureServe, 2015). Boltonia decurrens populations may also be vulnerable to destruction by discing and herbicide use in low-lying marginal lands for crop weed control. Nearly all stands are in habitats kept open by occasional cropping (USFWS, 1990).

Stressor: Hybridization (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Preliminary allozyme research has been conducted on the potential hybridization of B. decurrens and a related species in the genus, B. asteroides. Hybridization could pose a threat to the species through decreased fertility, genetic swamping, and ecological competition from hybrid individuals (DeWoody 2011). DeWoody et.al. (2011) tested for hybridization in sympatric populations using allozyme genetic marker data. The results revealed a very low rate of hybridization and introgression, indicating that cross-pollination and hybridization may not pose an immediate threat to the species. However, higher resolution genetic testing has yet to be performed, and therefore the level of threat posed by hybridization is currently indeterminable (USFWS, 2012).

Stressor: Prolonged flooding (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Prolonged flooding during the growing season appears to be a limiting factor. A flood in 1981 inundated most of the unleveed flood plain of the Illinois River with turbid flood water for an extended period during the summer. Shrubs such as Cephalanthus occidentalis were killed by the prolonged total inundation in some areas, and herbs were buried under heavy deposits of silt. Despite intensive searches, no B. decurrens was found for 2 subsequent seasons along the Illinois River. Such conditions severely limit natural reproduction and survival by B. decurrens (USFWS, 1990). The survey records examined for this review (2012-2018) indicate that many known sites were under water during the fall survey season, which precluded both plant survival and surveys. However, decurrent false aster seeds (“achenes”) remain viable even when buried in the soil for long periods (at least 88 months) of time (Baskin and Baskin 2002). Therefore, late season flood events do not necessarily mean that populations are locally extirpated if suitable growing conditions are present in subsequent years. However, as demonstrated by the population records for the species (see Appendix A) late flooding events on the Illinois River across the range of the species continue to appear to affect population growth, at least in the short term. (USFWS, 2020)

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:

1. A basic research program to determine the requirements of a naturally reproducing population must be completed (USFWS, 2012).

2. Twelve geographically distinct self-sustaining natural or established populations of the species must be protected through purchase in fee, easement, or by cooperative management agreements (USFWS, 2012).

3. Populations must be monitored for a period of five years to determine if they are self-sustaining. Self-sustaining is defined for recovery purposes as a population which is found to be stable or expanding during the five-year monitoring period (USFWS, 2013).

Recovery Actions:

- Survey suitable habitat for additional populations (USFWS, 1990).
- Protect existing and established populations (USFWS, 1990).
- Establish new populations (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Monitor natural and established populations (USFWS, 1990).
- Develop and maintain public support (brochure/display) (USFWS, 1990).
- Continue to monitor known B. decurrens sites and search for new populations annually, collecting GPS location and census data. Include survey efforts for B. decurrens in suitable habitat at the confluence of the Illinois River and Mississippi River to determine the extent of the species' southern range (USFWS, 2012).
- Finalize the draft cooperative management agreement between the ILDNR and the Service (USFWS, 2012).
- Establish a consensus among the workgroup regarding the core sub-populations that are important for the survival of the species during times of adverse hydrologic conditions. Also, normal, expected patterns of expansion and contraction of populations over time should be identified to facilitate the definition of population stability in the context of recovery (USFWS, 2012).
- Based on the results of the genetic primer research by Drs. Romano, explore genetic relationships between sub-populations and refine the metapopulation model for the species. Specifically, dispersal patterns and important source populations could be identified through microsatellite research in combination with spatial analysis (USFWS, 2012).
- Explore the phenomenon of hybridization between B. decurrens and B. asteroides using microsatellite genetic markers. Research should include a confirmation of hybridization between the two species and an analysis of the extent of hybridization in the population (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Continue to monitor known decurrent false aster sites and search for new populations annually, collecting GPS location and census data. Other survey methods, such as remote sensing, should be explored to increase the number of sites that can be surveyed annually. • Establish a consensus among the workgroup regarding the core sub-populations that are important for the survival of the species during times of adverse hydrologic conditions. Also, normal, expected patterns of expansion and contraction of populations over time

should be identified to facilitate the definition of population stability in the context of recovery. • Develop a sampling methodology to ensure comparable annual data (USFWS, 2020).

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SPECIES ACCOUNT: *Bonamia grandiflora* (Florida bonamia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/2/1987; Southeast Region (R4)

Physical Description

A perennial vine with appressed hairs and long prostrate stems a meter or more in length. It has a long, relatively slender tap root. The leathery sessile or subsessile leaves are up to 4 cm in length and ovate in shape. The flowers are solitary and sessile in the leaf axils. The funnel-shaped corolla is 7 to 10 cm long and 7 to 8 cm across. It has a deep blue or bluish-purple color with a white throat. The flowers open in the morning and are wilted by early afternoon (G. Romano, University of Florida, personal communication 1996). The fruits are capsules, normally containing four seeds. The seeds are smoothish, pale brown or greenish-brown, 5 to 8 mm long, and oblong (G. Romano, University of Florida, personal communication 1995). The outer face is convex, and the inner two faces are flat, forming an angle (Wunderlin et al. 1980). B. grandiflora is the only morning glory vine found in scrub areas with a large blue flower (Wunderlin et al. 1980), but could be confused with Stylisma villosa. (USFWS, 1999)

Taxonomy

Bonamia grandiflora was originally named by Asa Gray in 1880 as Breweria grandiflora. In 1897, Hans Hallier transferred it to the genus Bonamia. There have been no other taxonomic treatments of the species since then (Myint and Ward 1968). (USFWS, 1999)

Historical Range

Florida bonamia is found in herbaria with collection locations in Volusia and Marion counties south through Lake, Orange, Polk, Highlands, Hardee, and west to Hillsborough, Manatee, and Sarasota counties (Institute for Systematic Botany 2006). Of these records, three are historical (Sarasota County in 1878, Manatee County in 1916, and Volusia County in 1900) and no recent records exist. (USFWS, 2017)

Current Range

The South Florida multispecies Recovery Plan (1999) indicated that Florida bonamia was found in Charlotte, Hardee, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Osceola, and Polk counties in Florida. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 1999)

Lifespan

Adult: 3 or more years (USFWS, 1999)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Fire (NatureServe, 2015)

Other Reproductive Information

Adult: Seedling survival rates are not known but are currently being investigated (G. Romano, University of Florida, personal communication 1996). Due to the nature of Bonamia's growth, identifying seedlings from older individuals' stems that are actually connected to other stems below-ground can be difficult. However, it is possible to distinguish these two life phases. Hartnett and Richardson (1989) excavated several plants and found that the clumps of prostrate stems seen at the surface are all connected to a "large central and somewhat woody rootstock." They had no difficulty distinguishing such well-established older individuals from young single-stem plants that had grown from seed. According to Hartnett and Richardson (1989), fire stimulates seed production and germination as well as regrowth from clonal stems. The first season after a fire, clonal stem production is the greatest and then declines. However, seed production is greatest during the second season after a fire. The lag is probably due to the increased energy needed for regrowth following fire; seed production is postponed to conserve energy. New seed production replaces the seed banks that are often destroyed by fire. (USFWS, 1999)

Reproduction Narrative

Adult: Bonamia grandiflora grows for 3 or more years (50 FR 42068, Wunderlin et al. 1980), flowering from spring to summer (Small 1933). It has a mixed mating system; it is highly self-compatible, it can self-pollinate, and it can produce seeds without fertilization (G. Romano, University of Florida, personal communication 1998). Pollinators are essential, however, to ensure substantial seed production by self- as well as cross-fertilization. Bonamia grandiflora shows some inbreeding depression in selfed fruits and seeds but it does not appear to be enough to hinder the present populations (G. Romano, University of Florida, personal communication 1998). The seeds of Bonamia become dormant, but may not require dormancy to germinate, particularly if the seeds are planted immediately. Hartnett and Richardson (1989) observed that populations of this species have large seed banks of dormant seeds, mostly within 1 cm of the surface, distributed rather homogeneously, with no relation to the distribution of mature plants. The seedlings germinate throughout the summer until September. The necessity of fire for germination has not been studied; however, germination occurs on sites with sparse vegetation that have not burned recently (G. Romano, University of Florida, personal communication 1996). (USFWS, 1999)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Bonamia grandiflora is a scrub endemic of central Florida. All of its known populations occur within or near scrub or on the edge of scrub habitat in the white sands associated with the ancient Pleistocene dune systems of the central ridge system (Ward 1979). These sands are of the St. Lucie-Paola complex, highly porous, acidic (4.5 to 6.0) and containing few nutrients (Wunderlin et al. 1980). This substrate is associated with a sand pine scrub vegetation consisting of evergreen scrub oak (Quercus myrtifolia and Q. germinata) and sand pine (Pinus clausa) with openings between the trees and shrubs occupied by lichens and herbs. The openings are cleared by infrequent fires or by mechanical disturbance. Bonamia grandiflora is also known to live in disturbed areas near roadways and clearings caused by logging operations (50 FR 42068). This species is not found on altered soils such as the clay applied to logging roads (Miller 1989). As the scrub community reaches maturity, encroachment and shading from overstory pines and oaks cause the decline of this species as well as other associated endemics (Wunderlin et al. 1980). It seems that this species prefers an open canopy in full sunlight in order to avoid competition from the surrounding shrubs. For example, in Ocala NF, the Bonamia grows in a variety of growth stages of sand pine, but flowers profusely only in the open, sunny conditions of regeneration stands, and sparsely if at all in older stands. (USFWS, 1999)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown

Dispersal/Migration Narrative

Adult: Dispersal occurs via biotic and abiotic factors - specific factors are unknown.

Population Information and Trends

Population Trends:

Declining (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2017)

Resiliency:

Bonamia grandiflora is a long-lived perennial and can self-pollinate and produce seeds without fertilization, which affords the species some natural ability to withstand year-toyear variation in conditions. The distribution of the species includes 55 populations over 6 counties on lands that are managed for appropriate habitat. Many of these populations are within contiguous tracts of land that provide for connectedness between populations. In one study habitat disturbance (e.g., fire and mechanical) resulted in greater plant density, stem densities, seedling recruitment, flowering, and seed production than in habitat that had not been disturbed recently and that was considered successionally mature (Hartnett and Richardson 1989). Because of the disturbance-dependence of this species, some level of environmental stochasticity may not be detrimental and may actually be beneficial to the species. We believe these characteristics provide the species with sufficient and inherent resiliency (USFWS, 2023).

Representation:

Bonamia grandiflora is a scrub and sandhill endemic of central Florida. Because the species occurs in a limited range of habitats in central Florida, it may limit the species ability to adapt to changing conditions and therefore limit its representation. The species' ability to seed without fertilization and self-pollinate may also limit genetic diversity. However, the self-pollination and setting seeds without fertilization allows the species to persist during times or in areas where additional plants will be unavailable for crosspollination. Bonamia grandiflora has low genetic variability compared to other plants endemic to scrub in Florida, which is likely the result of a small initial gene pool and/or strong selection in the harsh scrub environment (Romano 1999). Habitat fragmentation and population isolation in some cases may contribute to limitations in genetic diversity (Romano 1999). The mode of dispersal is undocumented for this species, but seeds may be dispersed by animals (e.g., herbivores or insects), wind, or water dispersal as seen in other members of the morning glory family (Convolvulaceae; Austin 1997). In one study seed density in the soil of disturbed site (i.e., site was previously disked or plowed) was closely linked to the proximity of adult plants and in other sites (e.g., undisturbed or burned sites) seed density was not related to proximity to adult plants (Hartnett and Richardson 1989). Some of these characteristics may limit the species' representation but also allow it to persist when there are few nearby plants for cross-pollination. However, we do not feel that these characteristics will impact the species' viability in the foreseeable future (USFWS, 2023).

Redundancy:

As described in the information above, the species is known to occur in 55 managed, secured populations across six counties in the state. In addition to known, managed populations, there are an additional 16 populations on unsecured or unmanaged lands. In addition to the known populations, the species' condition in Ocala National Forest was described by USFS personnel as "widespread … it is in every scrub stand essentially" (Jay Garcia, USFS pers. comm.). This indicates to the Service that the species is likely much more widespread than we know and may be similarly more widespread on other protected and private lands. Because of the widespread nature of the species and its general biological characteristic, a single catastrophic event is unlikely to impact all individuals in all populations. and should have sufficient redundancy to be viable in the foreseeable future (USFWS, 2023).

Number of Populations:

95 (USFWS, 2023)

Additional Population-level Information:

Turner et al.'s (2006) assessment included locality records over the past 20 years and more recent observations and it is not evident from this database whether Florida bonamia is still found at each of the 66 locations. Therefore, without a comprehensive range-wide survey it is not possible to evaluate the spatial distribution and trends in spatial distribution of this species. Nonetheless, it is likely that some of the historic locality records on private lands have been lost due to habitat degradation (fire exclusion) and destruction. As a result, since its listing, the distribution of Florida bonamia has likely become more fragmented. (USFWS, 2017)

Population Narrative:

The status of Florida bonamia is largely unknown because repeated surveys have not been conducted at most known populations. However, available monitoring suggests that some populations may be in decline and others may be increasing, but this may be reflective of Florida

honmnia's typical boom and subsequent decline following fire. Use of periodic prescribed fire appears to be essential in maintaining suitable habitat. Sixty-six locality records existed for Florida bonamia in 2006, but the number of extant populations is not known because recent range wide surveys have not been conducted. Twenty-five locality records occur on public lands. (USFWS, 2017). Bonamia grandiflora formerly occurred in central Florida peninsula counties from Volusia and Marion south to Highlands and Charlotte as shown in Figure 1. (Wunderlin et al. 1980). The Florida Natural Areas Inventory's (FNAI) Element of Occurrence Records (EO) database listed 95 populations from nine counties in 2022 (e.g., Hardee, Highlands, Hillsborough, Lake, Manatee, Marion, Orange, Osceola, and Polk). An EO is considered a distinct population that is separated from another EO by a distance of 1 kilometer or greater. When assessing the species, there are currently 55 extant populations in six counties where they occur on managed, conservation lands (e.g., Highlands, Lake, Manatee, Marion, Orange, and Polk). Populations (i.e., EOs) in private ownership, historical EOs, extirpated EOs, or failed to find EOs are not included in the following table (USFWS, 2023).

Threats and Stressors

Stressor: Fire Suppression (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The most pervasive threat to Florida bonamia on public land is habitat degradation due to fire suppression, although off-road vehicle use on the ONF is likely to result in adverse impacts. Florida bonamia on private lands are also threatened long-term with fire suppression, but habitat destruction is a more immediate concern in many locations. Recent range wide surveys have not been conducted for this species so evaluating threats due to fire suppression and habitat destruction is problematic because in many instances we do not know if previously identified populations still exist. Nonetheless, most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2007; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of Florida bonamia habitat in some areas. Except for several privately owned conservation parcels, most other private landowners are unlikely to use habitat management techniques such as prescribed fire to maintain or enhance Florida bonamia habitat. At present, there are no incentives available that would encourage private landowners to undertake prescribed fire, especially for those who own relatively small parcels embedded in urban matrices. As a result, we believe that many locality records for Florida bonamia on nonconservation parcels in private ownership are threatened with habitat modification due to fire suppression. (USFWS, 2017)

Stressor: Urban Development (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Florida bonamia that occur on non-conservation private lands also are vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. Florida bonamia on

each private parcel is vulnerable to this threat at any time, however, we are not aware of any imminent loss of Florida bonamia due to development. (USFWS, 2017)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Overutlization is not currently thought be a significant risk factor to Florida bonamia; however, TNC reported two occasions of unauthorized plant removal on INC property since 1991 (TNC 2006). (USFWS, 2017)

Stressor: Disease or predation (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Florida bonamia may be affected by fungus, but no detailed investigations have been undertaken (Romano 1999). Insect herbivory has been observed, bu t is not thought to be a significant risk to Florida bonamia (Romano 1999). (USFWS, 2017)

Stressor: Disease or predation (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Florida bonamia may be affected by fungus, but no detailed investigations have been undertaken (Romano 1999). Insect herbivory has been observed, bu t is not thought to be a significant risk to Florida bonamia (Romano 1999). (USFWS< 2017)

Stressor: Inadequacy of existing regulatory mechanisms: Florida (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Existing regulatory mechanisms appear adequate to protect Florida bonamia on State and federally owned lands. Furthermore, we believe Florida bonamia on private conservation parcels are adequately protected because The Nature Conservancy would not authorize removal or destruction of Florida bonamia except for scientific or educational purposes. Even then, we anticipate that TNC would seek research permits from the Service to evaluate potential impacts resulting from proposed research or educational projects involving Florida bonamia. On private properties, Federal or State laws provide little protection for Florida bonamia. Since the majority of extant Florida bonamia populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species. e. Other natural or manmade factors affecting its continued existence: The 1999 South Florida Multi-species Recovery Plan (Service 1999) indicated that competition with non-native vegetation (e.g., cogon grass) may have been a management concern at ONF. Although ONF has an exotic vegetation management program in place, this threat is not entirely controlled and it is possible that unknown bonamia populations within the ONF may be affected by cogon grass or other exotic vegetation. We suspect that there are other locations containing Florida bonamia that also contain exotic vegetation, but we did not find current literature indicating this to be a significant

management problem. (USFWS, 2017)

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 8

Delisting Criteria:
1. The species is secure in Ocala National Forest and low-intensity monitoring must continue after delisting (USFWS, 2008).

2. Secure and monitor at least three sites in Highlands county; three sites in Polk county; and at least two sites in other counties (USFWS, 2008).

3. Provide at least five years of demographic monitoring at each of the sites identified in numbers 1 and 2 (USFWS, 2008).

In South Florida: Delisting can be achieved when: (1) sites, within the historic range of B. grandiflora, are adequately protected from habitat loss, degradation, and fragmentation; (2) when these sites are managed to maintain the seral stage of xeric oak scrub communities to support B. grandiflora; and (3) when monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Actions:
- Protect habitat through purchase and other means (including the Habitat Conservation Plan process for threatened animals in the Florida scrub habitat) (USFWS, 1996).
- Manage protected habitats (USFWS, 1996).
- Assess progress and plan post-recovery monitoring (USFWS, 1996).
- S1. Determine current distribution of B. grandiflora. Some portions of B. grandiflora's range have been well surveyed (Ocala NF and the southern Lake Wales Ridge), yet a distribution has not been ascertained for this species. Lack of survey knowledge in much of its range makes defining distribution difficult. (USFWS, 1999)
- S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- S3. Conduct research on life history characteristics of B. grandiflora. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed.
- S4. Monitor existing populations of B. grandiflora. Develop monitoring protocol to assess population trends for B. grandiflora. Develop a quantitative description of the population structure of B. grandiflora. (USFWS, 1999)

- S5. Provide public information about B. grandiflora. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of B. grandiflora and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999) (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- Recommendation for Future Action from 2017 5-Year Review: Revise the recovery criteria to establish measureable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, and the demographic performance levels/rates that should be met. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: A range wide survey should be conducted to determine the size and location of extant Florida bonamia populations and assessment of historic locality records. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Demographic monitoring of Florida bonamia populations should be initiated on public lands. Level 2 monitoring (Menges and Gordon 1996) includes sufficient detail to evaluate trends in population status over time. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Management activities should be implemented on public lands that contain Florida bonamia, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: An assessment of mechanical vegetation management (e.g., roller chopping, mowing, gyro-tracking, logging, and chain-saw felling) is needed to evaluate the response of Florida bonamia to various management alternatives. These data should be collected concurrently with level 2 monitoring. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Future land acquisition or other conservation measures should be taken to protect large Florida bonamia populations on unprotected lands. Protection should target bonamia populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Given the relatively large number of unprotected Florida bonamia populations, efforts should be explored to encourage private landowners to conserve and manage property known to contain this species.

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence wherever additional opportunities present themselves. • Encourage

landowners whose populations are under a habitat management plan to monitor occupied habitat for increased data of long-term trends (USFWS, 2023).

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SPECIES ACCOUNT: *Brickellia mosieri* (Florida brickell-bush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/6/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

Brickellia mosieri is a perennial herb. Mature plants are 0.3–1.1 meters (m) (1.0–3.5 feet (ft)) tall, slender, erect, and branching (Chafin 2000, page numbers not applicable). Leaves are 1–3 centimeters (cm) (0.4–1.2 inches (in)) long, alternate, narrow, linear, thick, usually spreading or curved downward, entire or slightly toothed, and resin dotted. The flower heads are in loose, open clusters at the ends of branches. Disk flowers are white in small, dense heads surrounded by hairy, slightly ribbed bracts; there are no ray flowers, although long-style branches (white, sometimes brown) may appear to be rays. (USFWS, 2013)

Taxonomy

Brickellia mosieri (Family: Asteraceae) was first described by Small in 1933 as Kuhnia mosieri. In 1970, Long called the species Kuhnia eupatorioides var. floridana, reducing it to a variety of a more widespread species occurring in the eastern United States. In 1971, Shinners included all members of the genus Kuhnia in Brickellia and restored the plant to species status, calling it Brickellia mosieri (USFWS, 2013). Kartesz (1999) lists B. mosieri as a synonym of Brickellia eupatorioides var. floridana. (NatureServe, 2015).

Historical Range

Brickellia mosieri is endemic to the pine rocklands of the Miami Rock Ridge in Miami-Dade County. It was historically known from central and southern Miami-Dade County from approximately Coconut Grove to Florida City, a range of approximately 45.0 km (28.0 mi), along the Miami Rock Ridge. (USFWS, 2014). The historical range of Florida brickell-bush is central and southern Miami-Dade County, covering approximately 22.5 miles (36.2 km) from South Miami to Florida City (Bradley and Gann 1999). At present, the northernmost extant population occurs at Ron Ehmann Park (10 miles south of the northernmost historic range) with the southern extent occurring in Florida City at Navy Wells Pineland Preserve (USFWS, 2023).

Current Range

Brickellia mosieri is currently distributed from central and southern Miami-Dade County from SW 120 St. to Florida City, suggesting its historical range has contracted at least 13.6 km (8.5 mi), or more than 30 percent. (USFWS, 2014). The historical range of Florida brickell-bush is central and southern Miami-Dade County, covering approximately 22.5 miles (36.2 km) from South Miami to Florida City (Bradley and Gann 1999). At present, the northernmost extant population occurs at Ron Ehmann Park (10 miles south of the northernmost historic range) with the southern extent occurring in Florida City at Navy Wells Pineland Preserve (USFWS, 2023).

Critical Habitat Designated

Yes; 9/16/2015.

Legal Description

On August 17, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 16, 2015) for Brickellia mosieri (Florida brickell-bush) under the

Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Florida (80 FR 49846-49886).

Critical Habitat Designation

The critical habitat designation for Brickellia mosieri includes six CHUs (40 sub-units) in Miami-Dade County, Florida. This species critical habitat encompasses approximately 2,624 acres (ac) (1,062 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 49846-49886).

Unit BM1: Trinity Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit BM1 consists of 18 ha (43 ac) in Miami-Dade County. Within Unit BM1, there are two subunits—BM1A (Countyowned) and BM1B (combination of State, County, and privately owned lands). The unit is comprised of State lands within Trinity Pineland County Park (4 ha (10 ac)); County lands primarily within A. D. ''Doug'' Barnes Park (6 ha (14 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 24 Street, on the south by the Snapper Creek Expressway (State Road (SR) 878), on the east by SW 67 Avenue, and on the west by SW 87 Avenue.

Unit BM2: Nixon Smiley Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit BM2 consists of approximately 108 ha (267 ac) of habitat in MiamiDade County. Within Unit BM2, there are seven subunits (BM2A–BM2G) comprising primarily conservation lands and including four larger areas plus three smaller areas. The unit is comprised of State lands within Camp Matecumbe, Tamiami Pineland Complex Addition, and Rockdale Pineland (49 ha (121 ac)); County/local lands primarily within Nixon Smiley Pineland Preserve, Tamiami #8 (Nixon Smiley Addition) Pineland, Pine Shore Pineland Preserve, Ron Ehman Park, and Rockdale Pineland Addition (59 ha (146 ac)); and small portions of parcels in private or other ownership (less than 1 ha (less than 1 ac)). This unit is bordered on the north by SW 104 Street, on the south by SW 152 Street (Coral Reef Drive), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit BM3: USDA Subtropical Horticultural Research Station and Surrounding Areas, Miami-Dade County, Florida: Unit BM3 consists of approximately 127 ha (315 ac) of habitat in MiamiDade County. Within Unit BM3, there are eight subunits (BM3A–BM3H), including two larger areas (U.S. Department of Agriculture (USDA) Subtropical Horticultural Research Station, and Deering Estate at Cutler) plus six smaller areas surrounding these. The unit is comprised of Federal lands within the USDA Subtropical Horticultural Research Station (59 ha (145 ac)); State lands within the R. Hardy Matheson Preserve, Ludlam Pineland, Deering Estate at Cutler, and Deering Estate South Addition (45 ha (112 ac)); County/local lands within Coral Reef Park, Ned Glenn Nature Preserve, and Bill Sadowski Park (15 ha (38 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 112 Street, on the south by the intersection of Old Cutler Road and Franjo Road (County Road (CR) 977), on the east by the Atlantic Ocean, and on the west by U.S. 1 (South Dixie Highway).

Unit BM4: Richmond Pinelands and Surrounding Areas, Miami-Dade County, Florida: Unit BM4 consists of approximately 395 ha (975 ac) in Miami-Dade County. Within Unit BM4, there are eight subunits (BM4A–BM4H), most within the Richmond Pinelands complex (made up of Federal and County-owned lands, as well as land owned by the University of Miami). The unit is comprised of Federal lands owned by the USCG (Homeland Security), U.S. Army Corps of

Engineers (ACOE; Department of Defense), U.S. Prison Bureau (Department of Justice), and the U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA) (75 ha (185 ac)); County/local lands within and adjacent to Larry and Penny Thompson Park, Martinez Pineland, Zoo Miami, and Eachus Pineland (239 ha (590 ac)); and parcels in private or other ownership (81 ha (200 ac)). This unit is bordered on the north by SW 152 Street (Coral Reef Drive), on the south by SW 200 St (Quail Drive/SR 994), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit BM5: Quail Roost Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit BM5 consists of approximately 96 ha (238 ac) in Miami-Dade County. Within Unit BM5, there are 11 subunits (BM5A–BM5K), including 4 larger areas plus 7 smaller areas surrounding these. The unit is comprised of State lands within Quail Roost Pineland, Goulds Pineland and Addition, and Silver Palm Groves Pineland (39 ha (97 ac)); County/ local lands including Black Creek Forest, Rock Pit #46, and lands owned by the School Board of Miami-Dade County (15 ha (37 ac)); and parcels in private ownership (42 ha (104 ac)), including Porter-Russell Pineland owned by the Tropical Audubon Society. This unit is bordered on the north by SW 200 St (Quail Drive/SR 994), on the south by SW 248 Street, on the east by the Florida Turnpike, and on the west by SW 194 Avenue.

Unit BM6: Camp Owaissa Bauer and Surrounding Areas, Miami-Dade County, Florida: Unit BM6 consists of approximately 112 ha (276 ac) of habitat in MiamiDade County. Within Unit BM6, there are 12 subunits (BM6A–BM6L), composed of 1 larger area (Camp Owaissa Bauer and its addition) and 11 smaller areas to the south. The unit is comprised of State lands within Owaissa Bauer Pineland Addition, Ingram Pineland, West Biscayne Pineland, and Fuchs Hammock Addition (20 ha (50 ac)); County/local lands including Camp Owaissa Bauer, Pine Island Lake Park, Seminole Wayside Park, and Northrop Pineland (63 ha (156 ac)); and parcels in private ownership (28 ha (70 ac)), including the private conservation area, Pine Ridge Sanctuary. This unit is bordered on the north by SW 248 Street, on the south by SW 312 Street, on the east by SW 112 Avenue, and on the west by SW 217 Avenue.

Unit BM7: Navy Wells Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit BM7 consists of approximately 206 ha (510 ac) of habitat in MiamiDade County. Within Unit BM7, there are eight subunits (BM7A–BM7H), including one larger area (Navy Wells Pineland Preserve) and seven smaller outlying areas. The unit is comprised of State lands within Palm Drive Pineland, Navy Wells Pineland #39, Navy Wells Pineland Preserve (portion), and Florida City Pineland (53 ha (132 ac)); County/ local lands including primarily Sunny Palms Pineland and Navy Wells Pineland Preserve (portion) (125 ha (309 ac)); and parcels in private ownership (28 ha (68 ac)). This unit is bordered on the north by SW 320 Street, on the south by SW 368 Street, on the east by U.S. 1 (South Dixie Highway), and on the west by SW 217 Avenue.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Brickellia mosieri critical habitat consists of three components (80 FR 49846-49886):

(i) Areas of pine rockland habitat that contain: (A) Open canopy, semi-open subcanopy, and understory; (B) Substrate of oolitic limestone rock; and (C) A plant community of predominately native vegetation that may include, but is not limited to: (1) Canopy vegetation dominated by Pinus elliottii var. densa (South Florida slash pine); (2) Subcanopy vegetation that may include,

but is not limited to, Serenoa repens (saw palmetto), Sabal palmetto (cabbage palm), Coccothrinax argentata (silver palm), Myrica cerifera (wax myrtle), Myrsine floridana (myrsine), Metopium toxiferum (poisonwood), Byrsonima lucida (locustberry), Tetrazygia bicolor (tetrazygia), Guettarda scabra (rough velvetseed), Ardisia escallonioides (marlberry), Psidium longipes (mangroveberry), Sideroxylon salicifolium (willow bustic), and Rhus copallinum (winged sumac); (3) Short-statured shrubs that may include, but are not limited to, Quercus pumila (running oak), Randia aculeata (white indigoberry), Crossopetalum ilicifolium (Christmas berry), Morinda royoc (redgal), and Chiococca alba (snowberry); and (4) Understory vegetation that may include, but is not limited to: Andropogon spp.; Schizachyrium gracile, S. rhizomatum, and S. sanguineum (bluestems); Aristida purpurascens (arrowfeather threeawn); Sorghastrum secundum (lopsided Indiangrass); Muhlenbergia capillaris (hairawn muhly); Rhynchospora floridensis (Florida white-top sedge); Tragia saxicola (pineland noseburn); Echites umbellata (devil's potato); Croton linearis (pineland croton); Chamaesyce spp. (sandmats); Chamaecrista deeringiania (partridge pea); Zamia integrifolia (coontie); and Anemia adiantifolia (maidenhair pineland fern).

(ii) A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat described in paragraph (2)(i) of this entry.

(iii) Habitats that are connected and of sufficient area to sustain viable populations of Brickellia mosieri in the pine rockland habitat described in paragraph (2)(i) of this entry.

Special Management Considerations or Protections

When designating critical habitat, the Service assesses whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of Brickellia mosieri and may require special management considerations or protection to reduce threats related to habitat loss, fragmentation, and modification primarily due to development; inadequate fire management; nonnative, invasive plants; and sea level rise. Destruction of the pinelands for economic development has reduced pine rockland habitat on the Miami Rock Ridge outside of ENP by over 98 percent, and remaining habitat in this area is highly fragmented. Brickellia mosieri occurs on a mix of private and publicly owned lands, only some of which are managed for conservation. Populations of the plants that occur on private land or non-conservation public land are vulnerable to habitat loss, while populations on conservation lands are vulnerable to the effects of habitat degradation if natural disturbance regimes are disrupted (e.g., through inadequate fire management). Prolonged lack of fire in pine rockland typically results in succession to rockland hammock, and displacement of native species by invasive, nonnative plants often occurs. Further development and degradation of pine rocklands increase fragmentation and decrease the conservation value of the remaining functioning pine rockland habitat. In addition, pine rocklands are expected to be further degraded and fragmented due to anticipated sea level rise, which would fully or partially inundate some pine rocklands along the coast and in the southern portion of Miami-Dade County (near Navy Wells Pineland Preserve), and cause increases in the salinity of the water table and soils resulting in vegetation shifts in additional pine rocklands across the Miami Rock Ridge. Many existing pine rockland fragments are also projected to be developed for housing as the human population grows and adjusts to changing sea levels. Special management considerations and protections that will address these

threats include increased coordination and conservation of these plants and their habitat on Federal lands, and improved habitat restoration and management efforts (including fire management and nonnative plant treatments) of high-priority and high-elevation sites. (USFWS, 2013)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2014)

Breeding Season

Adult: August - October (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Fire (USFWS, 2014)

Reproduction Narrative

Adult: While specific pollinators or dispersers are unknown, flower morphology suggests this species may be pollinated by butterflies, bees, or both (Koptur 2013, pers. comm.); wind is one likely dispersal vector (Gann 2013b, pers. comm.). (USFWS, 2014). Reproduction is sexual (Bradley and Gann 1999, p. 12). Flowering takes place primarily in the fall (August–October) (Bradley and Gann 1999, p. 12). Off-season flowering is usually the result of fire, and B. mosieri will flower within 1 to 2 months following a fire, regardless of the time of year (Possley 2013 pers. comm.) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (USFWS, 2014).

Habitat Vegetation or Surface Water Classification

Adult: Pine rockland (USFWS, 2014)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2014)

Environmental Specificity

Adult: Very narrow

Habitat Narrative

Adult: Grows exclusively in pine rockland (USFWS, 2014). Pine rockland is characterized by an open canopy of South Florida slash pine (Pinus elliottii var. densa). Subcanopy development is rare in well-maintained pine rocklands, with only occasional hardwoods, such as Lysiloma latisiliquum (wild tamarind) and Quercus virginiana (live oak) growing to tree size in Miami Rock Ridge pinelands (Snyder et al. 1990, p. 253). The shrub/ understory layer is a diverse mix of

species including both temperate and tropical shrubs and palms. The pine rocklands where Brickellia mosieri occurs are characterized by an open shrub canopy of Serenoa repens (saw palmetto), Myrica cerifera (wax myrtle), Metopium toxiferum (poisonwood), and Sideroxylon salicifolium (willow bustic) as well as species with more restricted distribution within pine rocklands including Sideroxylon reclinatum ssp. austrofloridense (Everglades bully), Callicarpa americana (beauty berry), Dodonaea angustifolia (varnish leaf), and Ilex cassine (dahoon holly) (Snyder et al. 1990, p. 254; Bradley and Gann 1999, p. 12). Populations are typically sparse and contain a low density of plants even in well-maintained pine rockland habitat (Bradley and Gann 1999, p. 12) (USFWS, 2014). The environmental specificity of this species is very narrow, as it is known only from pine rockland habitat in southern Florida, requiring fire to maintain the openings in which the plant occurs (NatureServe, 2015).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown (USFWS, 2014)

Dispersal/Migration Narrative

Adult: Wind is one likely dispersal vector (Gann 2013b, pers. comm.) (USFWS, 2014).

Population Information and Trends

Population Trends:

50% decline (USFWS, 2013)

Species Trends:

50 - 70% decline (NatureServe, 2015)

Number of Populations:

55 Historic and 14 Extant populations (USFWS, 2023)

Population Size:

All extant populations are estimated to have <1,000 individuals (USFWS, 2023).

Population Narrative:

Florida brickell-bush is a perennial herb that is endemic to pine rockland habitat outside of Everglades National Park in Miami-Dade County, Florida. There are 14 known extant populations, all with relatively small population estimates (<1,000). Of the 14 extant populations, one is on federal lands, one is on private lands, eight are Miami-Dade County owned, and four are on State of Florida land managed by Miami-Dade County. The status of 24 historic occurrences is unknown due to inaccessibility. There are 17 known extirpated occurrences of the species. Although the known extant populations occur mostly on county owned lands that are offered some protections, most of the data deficient occurrences are found on privately owned parcels that do not offer sufficient protection to the species (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The pine rockland community of south Florida, to which the species endemic, is critically imperiled globally (FNAI 2012, p. 27). Since the 1800s, residential and commercial development and agriculture have drastically reduced the habitat for these plants throughout pine rocklands in south Florida. Habitat loss continues to occur in its range, and most remaining suitable habitat has been negatively altered by human activity. Another human-related factor that can modify public and private lands alike is the potential for high levels of nutrients from agricultural and urban areas to enter into pine rockland systems. Such chemical alteration of pine rockland soil, which has naturally low amounts of phosphorus and nitrogen, can result in changes to vegetation composition and structure, at the expense of pine rockland endemics such as Brickellia mosieri. Effects of fragmentation on pollinators may include changes to the pollinator community as a result of limitation of pollinator-required resources (e.g., reduced availability of rendezvous plants, nesting and roosting sites, and nectar/pollen); these changes may include changes to pollinator community composition, species abundance and diversity, and pollinator behavior (Rathcke and Jules 1993, pp. 273–275; Kremen and Ricketts 2000, p. 1227; Harris and Johnson 2004, pp. 30– 33). As a result, plants in fragmented habitats may experience lower visitation rates, which in turn may result in reduced seed production of the pollinated plant (which may lead to reduced seedling recruitment), reduced pollen dispersal, increased inbreeding, reduced genetic variability, and ultimately reduced population viability (Rathcke and Jules 1993, p. 275; Goverde et al. 2002, pp. 297–298; Harris and Johnson 2004, pp. 33–34). Exclusion of fire for approximately 25 years will likely result in gradual hammock development over that time period, leaving a system that is very fire resistant if additional pre-fire management (e.g., mechanical hardwood removal) is not undertaken. Now, natural fires are unlikely to occur or are likely to be suppressed in the remaining, highly fragmented pine rockland habitat. The suppression of natural fires has reduced the size of the areas that burn, and habitat fragmentation has prevented fire from moving across the landscape in a natural way. Without fire, successional climax from pine rockland to rockland hammock is rapid, and displacement of native species by invasive nonnative plants often occurs. Understory plants such as Brickellia mosieri are shaded out by hardwoods and nonnatives alike (USFWS, 2013).

Stressor: Nonnative plants (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of Brickellia mosieri to some degree (Bradley and Gann 1999, pp. 15, 72; Bradley and Gann 2005, page numbers not applicable; Bradley 2007, pers. comm.; Bradley and van der Heiden 2013, pp. 12–16). As a result of human activities, at least 277 taxa of nonnative plants have invaded pine rocklands throughout south Florida (Service 1999, p. 3–175). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for Brickellia mosieri which responds positively to open conditions (USFWS, 2014).

Stressor: Small isolated populations (USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: Only small and fragmented occurrences of this plant remains. The current range spans such a small area that all populations could be affected by a single event (e.g., hurricane). Although robust population viability analyses (including minimum viable population calculations) have not been conducted for these plants, indications are that most existing populations for this plant are at best marginal (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Drier conditions and increased variability in precipitation associated with climate change are expected to hamper successful regeneration of forests and cause shifts in vegetation types through time (Wear and Greis 2012, p. 39). Although it has not been well studied, existing pine rocklands have probably been affected by reductions in the mean water table. Climate changes are also forecasted to extend fire seasons and the frequency of large fire events throughout the Coastal Plain (Wear and Greis 2012, p. 43). While restoring fire to pine rocklands is essential to the long-term viability of Brickellia mosieri populations, increases in the scale, frequency, or severity of wildfires could have negative effects on this species considering its general vulnerability due to small population size, restricted range, few colonies, and relative isolation (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 5

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.

Conservation Measures and Best Management Practices:
- RECOMMENDED FUTURE ACTIVITIES During this status review, we have utilized the recovery outline and also identified additional potential recovery activities which are included below. Recovery Activities • Implement, continue, or increase habitat restoration efforts (exotic species removal and prescribed fire) at all occurrences. • Pursue conservation agreements and/or acquire land where Florida brickell-bush occurs. • Continue to work with Miami Dade County to protect remnant patches of habitat. • Expand work on ex situ propagation and seed banks. • Support and expand upon the Connect to Protect imitative promoting Florida brickell-bush within its historical range. • Develop a reintroduction plan and conduct reintroduction and augmentation of the species in suitable pine rockland habitat and evaluate reintroduction techniques and success. Monitoring/Research Activities • Survey sites that have an undetermined population status if landowners allow access. • Census extant populations every three years. In the event of fire in a

population, conduct quarterly monitoring up to 2 years post-fire, noting any seedling recruitment. • Conduct demographic research including population assessments, such as phenology and lifeclass stage, population trends, and examining growth and establishment rates. • Conduct reintroduction feasibility studies and identify potential recipient sites. • Conduct research to examine the effects of growing season burns versus non-growing season burns on flowering, seed set, and establishment. • Evaluate how climate change may impact the species range. • Conduct genetic studies to examine diversity among sites that may be declining due to isolation and genetic drift. Outreach Activities • Promote additional partnerships to share information, conduct collaborative research on pine rockland and scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Attend relevant community events that will create and foster appreciation for endemic species in the pine rockland habitat (USFWS, 2023).

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SPECIES ACCOUNT: *Brighamia insignis* (Olulu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Brighamia insignis, a member of the bellflower family (Campanulaceae), is an unbranched plant 1 to 5 m (3 to 16 ft) tall with a succulent stem that is bulbous at the bottom and tapers toward the top. The fleshy leaves, which measure 12 to 20 cm (5 to 8 in) long and 6.5 to 11 cm (2.5 to 4.5 in) wide, are arranged in a compact rosette at the apex of the stem. Fragrant yellow flowers are clustered in groups of three to eight in the leaf axils (the point between the leaf and the stem), with each flower on a stalk 1 to 3 cm (0.4 to 1.2 in) long. The hypanthium (basal portion of the flower) has 10 ribs and is topped with 5 oval or loosely triangular calyx lobes (partially fused sepals) 0.5 to 1 mm (0.02 to 0.04 in) long. The yellow petals are fused into a tube 7 to 14 cm (2.8 to 5.5 in) long and 3 to 4 mm (0.1 to 0.2 in) wide, which flares into five elliptic lobes. The fruit is a capsule 13 to 19 mm (0.5 to 0.7 in) long which contains numerous seeds. (USFWS, 1998)

Taxonomy

Asa Gray (in Mann 1868) described Brighamia insignis based upon alcohol-preserved flowers and fruits collected by William Tufts Brigham on Molokai and a dried specimen collected on Kauai or Niihau by Ezechiel Jules Remy. Brigham's bottled material, since lost, would today be considered to be Brighamia rockii. Other published names that Thomas C. Lammers (1989), in the currently accepted treatment of the genus, considers to be synonymous with B. insignis include B. insignis f. citrina (Forbes 1917a), B. citrina (St. John 1958), and B. citrina var. napahiensis (St. John 1969b). (USFWS, 1998)

Historical Range

Historically, B. insignis was known from the headland between Hoolulu and Waiahuakua Valleys along the Na Pali Coast on the island of Kauai, and from Kaali Spring on the island of Niihau (HHP 1994). (USFWS, 1998)

Current Range

Range includes Na Pali and Hapuu areas of Kauai, current reports on Niihau but no specimens collected. (NatureServe, 2015)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Brighamia insignis on the islands of Kauai and Niihau, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for Brighamia insignis includes three units totaling 5,047 acres on the island of Kauai and one unit totaling 52,549 acres on the island of Niihau. The units are Kauai

6—Brighamia insignis—a, Kauai 7—Brighamia insignis—b, Kauai 11—Brighamia insignis—c, and Niihau 1—Brighamia insignis—a.

Kauai 6—Brighamia insignis—a: This unit is critical habitat for Brighamia insignis and is 63 ha (156 ac) on private land and contains a portion of Keopaweo Summit on the north side of Mount Haupu. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial Brighamia insignis and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 7—Brighamia insignis—b: This unit is critical habitat for Brighamia insignis and is 340 ha (843 ac) on private land. This unit contains the Haupu and Naluakeina Summits and Queen Victoria's Profile. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial Brighamia insignis and is currently occupied with one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—Brighamia insignis—c: This unit is critical habitat for Brighamia insignis and is 1,639 ha (4,051 ac) on State land (Hono o Na Pali NAR, Puu Ka Pele Forest Reserve, and Milolii, Nualolo Kai, and Na Pali Coast State Parks). This unit contains Alapii, Mukuaiki, and Puanaiea Points; Awaawapuhi, Honopu, Kalalau, Kawaiula, Makaha, Milolii, Nualolo, Paaiki, and Poopooiki Valleys; Hanakoa, Hoolulu, Kalalau, and Waiahuakua Streams; Kalalau Beach and Trail; Kanakou Summit and Nakeikionaiwi Pillar. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides habitat for seven populations of 300 mature, reproducing individuals of the short-lived perennial Brighamia insignis and is currently occupied with between 40 and 60 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. This unit provides for seven populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Niihau 1—Brighamia insignis—a: This unit is critical habitat for Brighamia insignis and is 144 ha (357 ac) on private land. This unit contains Puu Alala and Mokouia Valley. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in). This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial Brighamia insignis and is currently occupied with at least one plant. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. This unit provides for one population within this multi-island species' historical range on Niihau that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Rocky ledges with little soil or steep sea cliffs in lowland dry grasslands or shrublands with annual rainfall that is usually less than 170 cm (65 in) and containing one or more of the following native plant species: Artemisia australis, Chamaesyce celastroides, Eragrostis variabilis, Heteropogon contortus, Hibiscus kokio, Hibiscus kokio ssp. saintjohnianus, Lepidium serra, Lipochaeta succulenta, Munroidendron racemosum, or Sida fallax; and

(ii) Elevations between 0 and 748 m (0 and 2,453 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) and asexual (vegetative) (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: Pollination by sphingid moths is likely (David Lorence, NTBG, personal communication 1994). (USFWS, 1998)

Reproduction Narrative

Adult: Pollination by sphingid moths is likely (David Lorence, NTBG, personal communication 1994). Pollination failure is common, and may be due to a lack of pollinators or a reduction in genetic variability due to the few remaining individuals. The flower structure appears to favor outcrossing. Some vegetative cloning has been observed and flower and leaf size appear to be dependent on moisture availability (Takeuchi 1982, USFWS 1994a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, savanna (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moist, or rarely dry habitats (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from sea level to 400 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: This species if found in moist, or rarely dry habitats. Usually on steep cliffs, sparsely vegetated with native shrubs and grasses. Brigharnia insignis grows from sea level to 400 meters (1,300 feet) on rocky ledges with little soil or steep sea cliffs in lowland dry grassland and shrubland. This habitat has annual rainfall that is usually less than 170 centimeters (65 inches). Associated native plant taxa include Can thiurn odora turn (alahee), Charnaesyce celastroides (akoko), Eragrostis variabihis (kawelu), and Heteropogon contortus (pili grass) (USFWS 1994a). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds of this species are undoubtedly dispersed by gravity. Although they may be blown for short distances, they are not obviously adapted for wind dispersal, being ovoid to ellipsoid, smooth, and lacking any sort of wing or outgrowth (David Lorence, NTBG, personal communication 1994). (USFWS, 1998)

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Number of Populations:

0 wild (USFWS, 2022)

Population Size:

0 (USFWS, 2017)

Population Narrative:

Brighamia insignis occurs on a steep cliff face and the only known wild individual was last observed in 2012 via helicopter (PEPP 2014; Walsh 2016; Walsh 2017, in litt.). (USFWS, 2017); This species has declined to only one naturally occurring wild individual, and the distribution has declined from four populations on two mountain ranges to only one on the Na Pali Coast. Three additional plants have been outplanted by Hawaii Division of Forestry and Wildlife (National Tropical Botanical Garden 2006a). Probably less than 100 plants. (USFWS, 2008; NatureServe, 2015); Currently, there are no known wild individuals of Brighamia insignis on Kaua'i (USFWS, 2022).

Threats and Stressors

Stressor: Habitat degradation by animals (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: The major threats to Brigharnia insignis are predation and habitat degradation by feral goats and pigs. Other threats that affect B. insignis include: slugs and rats that eat seeds and leaves, carmine spider mites, and feral goats that are known to defoliate B. insignis. (USFWS, 2008)

Stressor: Small population size (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: Brigharnia ins ignis is threatened by stochastic extinction due to the small number of individuals and their restricted distribution. Small numbers may result in reduced reproductive vigor, and stochastic environmental disturbances, such as rock slides, are frequent in their cliff habitat (USFWS 1994a). Species like B. insignis that are very low in number and endemic to small portions of an island are inherently more vulnerable to extinction than widespread species because ofthe higher risks posed by genetic bottlenecks, random demographic fluctuations and localized catastrophes such as hurricanes. (USFWS, 1998; USFWS, 2008)

Stressor: Invasive plants (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: Habitat degradation and competition from invasive plants such as Mehinus minutiflora (molasses grass), Setaria gracihis (yellow foxtail), Sporobolus africanus (smutgrass), lantana, Psidium cattleianurn (strawberry guava), Psidiurn guajava (common guava), Kahanchoe pinnata (air plant), Ageratum conyzoides (maile hohono) and Stachytarpheta (NCN)) are threats to B. insignis. (USFWS, 1998)

Stressor: Fungal disease (USFWS, 1998)
Exposure:
Response:
Consequence:

Narrative: An unidentified fungal disease affected a number of cultivated B. insignis, causing a softening and collapse of the main stem tissue from the base (Factor C) (S. Perlman, National Tropical Botanical Garden, pers. comm. 2006). (USFWS, 2008)

Stressor: Pollination (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Pollination has been a problem for this species; it is presumed that the natural pollinator is a Sphingidae moth that now is either extinct or in extremely low numbers, which directly affects the amount of seed production for this species (Perlman 2006; K. Wood, pers. comm. 2006). (USFWS, 2008)

Stressor: Over-collection (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Some of the extirpated populations on the Na Pali Coast occurred near trails, which exposed the plants to overcollection and an increased likelihood of rock slides and invasive species introductions caused by hikers (Factor B) (USFWS 1995). (USFWS, 2008)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Brighamia insignis is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.867 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1998)

Recovery Priority Number: 5

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1998)

Recovery Actions:
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately. (USFWS, 1998)
- It also crucial to protect the remaining wild individuals from goats and alien weed threats. (USFWS, 1998)
- Protect current populations, control threats and monitor. (USFWS, 1998)
- Expand current populations. (USFWS, 1998)
- Conduct research essential to conservation of the species. (USFWS, 1998)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1998)
- Validate and revise recovery objectives. (USFWS, 1998)
- Devise and implement a public education program. (USFWS, 1998)
- Surveys and inventories—Survey for additional populations of Brighamia insignis in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Determine management needs of the immediate area of the one remaining wild individual and implement them to prevent extinction in the wild. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue to conduct research on outcrossing success, and collect seeds from living collections and handpollinations for adequate genetic representation. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents at the last known location. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)
- Genetic research—Review the complete living collections to determine origin of progeny, as plants with genetic representation from the Waiahuakua Valley population would provide the best source to increase genetic diversity within the species, based on the existing genetic studies. (USFWS, 2017)
- Population biology research—Conduct a more detailed genetic study of propagules from the wild individual and those in cultivation to determine genetic diversity between populations and individuals to assist in determination of suitable material to use in hand-pollination.

(USFWS, 2017)

- Determine management needs of the immediate area of the one remaining naturally occurring wild individual and implement them to prevent complete extinction in the wild. (USFWS, 2008)
- Increase the number of individuals in cultivation and genetic storage through controlled breeding. (USFWS, 2008)
- Reintroduce populations in areas of suitable habitat that can be protected from goats and other ungulates, rats, and human disturbance. (USFWS, 2008)
- Review the complete living collections to determine where progeny derived from crosses with the Waiahuakua Valley population still exist, as these plants would provide the best source to increase the genetic diversity within the species, based on the existing genetics work. (USFWS, 2008)
- Conduct a more detailed genetic study of the individuals in the wild and in cultivation to determine micro-level distinctions between populations and individuals, to assist in determining suitable material to use of hand pollinated crosses. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No new threats and no significant new information regarding the species' biological status have been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated or updated for the 5-year review for 2022. • Surveys and inventories—Survey for populations of Brighamia insignis in areas of potentially suitable habitat. • Ungulate monitoring and control—Determine management needs of the immediate areas of the last known wild individuals and outplanted individuals to provide protection from feral ungulates. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. • Predator and herbivore monitoring and control—Implement effective control methods for rats at outplanted and any new wild populations. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts when materials are available for maintenance of genetic stock and for reintroduction. o Continue to conduct hand pollination for outcrossing and adequate genetic representation. • Reintroduction and augmentation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy and to reduce impacts of hurricanes and landslides. • Pollination biology research—Conduct a more detailed genetic study of propagules from wild and outplanted sources to determine suitable materials for using in hand pollination (outcrossing) efforts. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2022).

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SPECIES ACCOUNT: *Buxus vahlii* (Vahl's boxwood)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/13/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree reaching 16 feet in height, with a stem diameter of 5 inches. The leaves are simple, opposite, and oblong to obovate (USFWS, 1987).

Taxonomy

A member of the boxwood family (Buxaceae). The type material was originally identified as Crantzia laevigata (USFWS, 1987).

Historical Range

Historical records of the species include only two locations within the karst region in Puerto Rico (USFWS, 1987).

Current Range

Vahl's boxwood is endemic to the islands of Puerto Rico and St. Croix, US Virgin Islands (USFWS, 2013).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: wind or insect pollinated, also possible self pollination (USFWS, 1987)

Key Resources Needed for Breeding

Adult: Unknown - possibly wind or insects (USFWS, 1987)

Reproduction Narrative

Adult: reproductive biology consists of capsules with tiny seeds that depend on mechanical dispersal (USFWS, 2019). Floral morphology suggests self-pollination is possible (USFWS, 1987).

Geographic or Habitat Restraints or Barriers

Adult: 33 - 984 ft. elevation (EPA, 2016)

Environmental Specificity

Adult: Moderate (inferred from EPA, 2016)

Habitat Narrative

Adult: Buxu vahlii is restricted to semievergreen forests of the subtropical moist forest zone, and has only been found below 330 feet (USFWS, 1987)

Dispersal/Migration

Population Information and Trends

Population Trends:
Increasing (USFWS, 2019)

Number of Populations:
10 (USFWS, 2019)

Population Size:
5,400 (USFWS, 2019)

Population Narrative:
The species status is overall increasing. Currently overall, the Service knows of ten populations with over 5,400 individuals estimated, including 100 trees identified on a new site in March, 2018. This reflects an increase since the time of listing and a 20% overall increase since 2013 (USFWS, 2013; 2019).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013; 2019)
Exposure:
Response:
Consequence:
Narrative: The Rincón population is located on land owned by PREPA (a public corporation) adjacent to the long defunct BONUS nuclear reactor. However, there is no evidence that PREPA manages the area in any way. There is no fence or other access limitations. Breckon and Kolterman (1993) documented damage to this area and to plants of B. vahlii due to the apparent incursion of undocumented aliens and to presumably anthropogenic fires. In the case of Rincón, the boundaries of the property are not clearly defined and it is not possible to determine if part of the population lies within private land. The properties adjacent to this population have a great potential for urban and tourism development, which could result in further encroachment of the population and the modification of suitable habitat for the expansion of the population. For the Peñuelas-Ponce area the greatest threat is urban development (quarries, landfills, telecommunication towers, and residential housing and tourist development projects). All the populations within this area lie within private lands with no protection; the same applies to two of the St. Croix populations, as evidenced from the access road constructed through the center of the population. The native forest that harbors one of the populations at Ponce has been severely fragmented for housing lots (Omar Monsegur, Service, pers. obs. 2011). Furthermore, the general area that harbors suitable habitat for the species between Ponce and Peñuelas has been proposed for the construction of several infrastructure projects (Gasoducto del Sur and Vía Verde Gas Pipeline). In fact, one of the populations at Peñuelas lies within the boundaries of a rock quarry (Cantera Valdivieso; José Sustache, PRDNER, per. comm. 2011). Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011) (USFWS, 2013; 2019).

Stressor: Other natural or manmade factors (USFWS, 2013; 2019)
Exposure:
Response:
Consequence:
Narrative: Vahl's boxwood may be further threatened by fires, hurricanes and climate change, although these are considered low and non-imminent threats to the species. Climate change is predicted to increase the frequency and strength of tropical storms, which could possibly impact the Rincón and Sandy Point "St. Croix" populations. The cumulative effect of coastal erosion due to severe hurricanes, plus the habitat modifications for urban and tourism development can further diminish the availability of suitable habitat, and therefore, limit the population expansion and colonization of new areas at Rincón and St. Croix. Hurricane Maria in 2017 devastated most habitats in Puerto Rico and St. Croix in 2017 and likely impacted this species. Human-induced fires may lead to destruction of the native vegetation seed bank and create favorable conditions for non-native plant species to out compete Buxus vahlii, particularly those populations occurring near forests where accidental or deliberate forest fires occur. In addition, the possibility of severe droughts may contribute to an increase in the quantity and frequency of fires on the Island. We have observed unusual shifts on dry and rainy seasons. In some cases these events have produced an overload of fuel (primary by exotic grasses) that when burned during the next dry season or drought produces severe damage to the native vegetation and seed bank (USFWS, 2013; 2019).

Stressor: Disease or predation (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: In 2013, the presence of the insect lobate lac scale Paratachardina lobata, was found in Bayamon and Ricon. Infestation in Buxus vahlii was more than 50% of the population. Although there is not enough evidence about the effect of this disease on the species, such pest may compromise the photosynthetic rate of the species and result in low reproductive output (reduced production of flowers and fruits).

Recovery

Reclassification Criteria:
1. The two known populations at Hato Tejas (Bayamon) and Punta Higüero (Rincon) are placed under protective status (USFWS, 2013).

2. At least three new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Vega or Cambalache forests) (USFWS, 2013).

Delisting Criteria:
1. The five (5) existing population on private land (Rincon, Bayamon, Penuelas-Ponce, Aguadilla, and St Croix) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and are protected via a conservation mechanism (USFWS, 2019).

2. Within the historic range and in protected suitable habitat, establish and manage four (4) additional population with a stable or increasing trend, evidenced by natural recruitment and

multiple age classes (USFWS, 2019).

3. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (USFWS, 2019).

Recovery Actions:

- Prevent further habitat loss and population decline (USFWS, 1987).
- Continue to gather information on the distribution and abundance of Buxus vahlii in northern Puerto Rico (USFWS, 1987).
- Research (USFWS, 1987).
- Refine recovery goals (USFWS, 1987).
- Long-term protection and management of existing populations, including land acquisition, conservation easements, private landowner agreements and habitat restoration practices (USFWS, 2019).
- Establish four (4) new self-sustaining populations with genetics representation from each site within protected suitable habitat in Puerto Rico and USVI (USFWS, 2019).
- The recovery of the species should focus on the protection of the known populations and its habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations (USFWS, 2013).
- The land on which the Rincón population of B. vahlii occurs should be transferred from PREPA either to PRDNER or to the Puerto Rico Conservation Trust. Then, a management plan for the conservation of the species should be developed and implemented. The Service will start to advise PREPA on the benefits for the ecosystem and for the species by protecting this natural area (USFWS, 2013).
- The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species (USFWS, 2013).
- The efforts by José R. Roman and Michael Morgan to germinate and to propagate the species need to be coordinated toward the recovery (ensuring that propagated material is used for the establishment and enhancement of populations) of the species (USFWS, 2013).
- The Bayamón, Peñuelas-Ponce, and St. Croix populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to determine their impacts on the populations (USFWS, 2013).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).
- Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species germplasm (USFWS, 2013).
- Rincón has one of the most active “environmentalist” communities in Puerto Rico, which might well be recruited to assist in the species’ conservation. In fact, B. vahlii may well be the only endangered plant species with a major population located at Rincón, so it may be proposed as an iconic species for environmental education among school children and the general public at a local level (USFWS, 2013).

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SPECIES ACCOUNT: *Callicarpa ampla* (Capa rosa)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 4/22/1992

Physical Description

An evergreen shrub or small tree reaching up to 15 meters (in) in height, with stout, tetragonal or subterete branches, and internodes of up to 6.5 centimeters (cm) long. Young branches are tetragonal, purplish-black in color, white scurfy, and glabrescent. The leaves are simple, opposite, decussate, and extipulate, dark shiny green above and pale green with white scurfy and raised veins and midveins below. The leaves are membranaceous or rarely subcoriaceous, measuring 8-35 cm long, and 3.5-8 cm wide; the leaf blade is elliptic to oblong, with an acute to acuminate apex, and with margins entire or slightly sinuate or dentate. The inflorescence is an axillary, corymbose cyme about 11 cm long. The cymes are densely whitish scurfy, with peduncles of 1-6.5 cm long. The flowers are actinomorphic and hermaphroditic. The species has a four-lobed, campanulate to subentire, lepidote or puverulent calyx which is 0.6-1.8 millimeters (mm) long and 1.3- 1.4 mm wide. The white four-lobed corolla is broadly tubular, measuring about 1.8 mm long and 1.7 mm wide. The four stamens of the flower measure 5.2 mm long, and are exerted and epipetalous at the base of the corolla. The four-lobed and four-celled ovary is subglobose, measuring about 1 mm in diameter. The fruit is a fleshy four-seeded drupe, about 6 mm in diameter. The fruit is whitish when young and becomes purple when ripe (Little et al. 1974). (USFWS, 1993)

Historical Range

Not Available

Current Range

Known from the lower montane forests of Puerto Rico (Ewel and Whitmore 1973) and one from St. Thomas, U.S. Virgin Islands (Vivaldi and Woodbury). (USFWS, 1993). As of 2019, predominantly restricted to El Yunque National Forest (EYNF) in northeastern Puerto Rico. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. Although adults in all populations of Callicarpa ampla were seen in either flower or fruit during February of 1991, seedlings have been seen in only one locality (Garcia and Laboy 1991). Fruits are present in Holdridge herbarium specimen number 245, collected in September of 1940 (Vivaldi and

Woodbury 1981a) (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander at al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of Callicarpa ampla and Styrax portoricensis, and some localities of Ternstroemia luquillensis and Ternstroemia subsessilis occur within the palo colorado vegetation type. Some localities of Ternstroemia luquillensis and Ternstroemia subsessilis, and all the localities of Ilex sintenisii occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (Inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

5 (USFWS, 2015)

Population Size:

~15 total individuals (USFWS< 2015)

Population Narrative:

Callicarpa ampla: When the recovery plan was approved in 1995, the number of individuals of this species was known to be approximately 14 distributed within five localities in the Palo Colorado Association Forest Type in the Luquillo Mountains (USFWS 1995). During the interagency assessment in 2011, a total of 15 individuals where identified in only two natural populations within El Yunque National Forest (Table 1). From two localities reported in the Recovery Plan in the Rio Blanco Ward, municipality of Naguabo, only one site with three individuals was located by USFS personnel in 2011 (Luis Rivera, USFS, 2011, pers. comm.). A previously reported site at Mameyes II Ward, municipality of Rio Grande, was not located, and in the Jimenez Ward, also in Rio Grande, only one of the two populations identified in the recovery plan was located. The Jimenez population consists of 12 individuals (27 stems). The site with three planted individuals at El Portal Visitor Center also was recorded by USFS during the assessment (Table 1). These individuals are the product of one air layer (asexual propagation) from the Rio Blanco Ward site in Naguabo (USFS 1985) that was not located in 2011 and two additional artificial air layers produced from the Jimenez Ward site near Sonadora Creek (Luis Rivera, USFS, 2011, pers. comm.). There is no long term monitoring of the natural populations, and the USFWS does not have accurate location for most of the historical populations of C. ampla. It is possible that some of the populations not found during the 2011 assessment may be extirpated (e.g., by landslides) (see factor D). The USFWS suspects that additional populations of these species may occur within the El Yunque National Forest, and probably in some remnants of native forest in the Carite and Guilarte Commonwealth Forests. However, if present we anticipate low number of individuals and little recruitment, similar to the originally known populations in El Yunque (USFWS, 2015). Out of the three species, Styrax portoricensis and Callicarpa ampla appears to be persisting, although, their population numbers and individuals per populations are very low, and no recruitment was observed during the assessments conducted by PRDNER. As for Ilex sintenisii, a new population was found and the number of individuals are higher than the other two species, but the assessment showed a decline in individuals compared to the numbers from the 2015 5-year status review, in addition no recruitment was observed in these populations. Although we do not have new data for Ternstroemia luquillensis and T. subsessilis, their population levels were low at the time of listing, and individuals were not found during the 2011 surveys. (USFWS, 2021)

Threats and Stressors

Stressor: Forest management (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some

populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of I. sintenisii, S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to I. sintenisii, S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in the final rule.

As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, I. sintenisii seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for I. sintenisii is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of I. sintenisii, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of I. sintenisii as well as S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of viability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of I. sintenisii, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:
An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis , and Ternstroemia subsessilis within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:
1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).

2. Establish or discover four (4) additional populations each of Callicarpa ampla within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish or discover two (2) new populations of Callicarpa ampla outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved "Revised Land and Resource Management Plan" (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).
- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).
- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating Styrax portoricensis. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting Styrax portoricensis (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated Callicarpa ampla by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (Ilex sintenisii, Ternstroemia luquillensis and Ternstroemia subsessilis) (USFWS, 2015).
- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- New in 2019 2: A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild

Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).

- 2019 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).
- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of I. sintenisii. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus Ilex in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations are additional to the recommendations provided in the 2015 5- year status review for these species. 1. Search for the species outside the trails where the historic populations are located, and within suitable habitat in private lands adjacent to EYNF. 2. Conduct genetic studies to determine the viability of these species into the future. 3. Conduct a seed viability study particularly for Callicarpa ampla and Styrax portoricensis to determine if that is a factor that could be affecting their recruitment. 4. Develop a propagation and reintroduction protocol for all five species in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza, and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species. 5. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside the boundary of EYNF to safeguard these

lands since they share similar vegetation and habitat characteristics. (USFWS, 2021)

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Southeast Region, Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Callirhoe scabriuscula* (Texas poppy-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/12/1981; Southwest

Physical Description

A perennial herbaceous plant found in deep, loose, sandy soils near the Colorado River in west Texas. The fleshy taproots extend about 45 centimeters (cm) (18 inches (in)) deep before branching. During the winter, the plants form rosettes of 3 to 8 basal leaves that have 3 to 5 palmately-arranged lobes. Flower stalks emerge in the spring, reaching up to 45 cm (18 in) tall. The stems and leaves have a rough texture due to a covering of stellate pubescence (star-shaped hairs). Flowers have 5 reddish-purple petals, about 3.8 cm (1.5 in) long, arranged in the form of a cup, with dark maroon centers. This species is distinguished from others in the Genus by its linear involucellar bractlets, valvate calyx lobes that form an apiculate or acuminate point in bud (cover photograph), indehiscent mericarps, stiffly erect stems, and 6- to 8-rayed stellate hairs. (USFWS, 2019a)

Taxonomy

Robinson (1895–1897, p. 302) described Callirhoe scabriuscula as a new species in the Malvaceae (Mallow Family), based on a single specimen collected by Dr. Sutton Hayes. Robinson distinguished this from other species in the genus by its densely pubescent carpels with short beaks and involucel of 3 linear bractlets (figure 1.e.a). Callirhoe leiocarpa (tall poppymallow) and C. involucrata (winecup) occur near C. scabriuscula. These are distinguished by smaller flowers with white petal bases and the absence of stellate pubescence; additionally, C. leiocarpa is an annual species and lacks an involucel, and C. involucrata has a prostrate rather than erect habit. (USFWS, 2019a)

Historical Range

Historically known from Runnels County, Texas.

Current Range

In four counties in Texas: Runnels, Coke, Mitchell, and Scurry. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: short-lived perennial (USFWS, 2019a)

Breeding Season

Adult: Flowers from late April to mid-June (USFWS, 2019a).

Key Resources Needed for Breeding

Adult: Insects for pollination (USFWS, 1985).

Reproduction Narrative

Adult: Texas poppy-mallow flowers from late April until mid-June (Amos 1979, pp. 8–10; USFWS 1985, pp. 7–9). Flowers open 2 to 3 hours after sunrise and close before sunset. If pollinated, flowers close within 30 to 90 minutes. Un-pollinated flowers continue to open for 6 to 8 days. Anthers of individual flowers mature prior to stigmas (figure 1.d), releasing their pollen about 36 hours before stigmas emerge. Less than 1 percent of flowers from which insects were excluded produced seeds. Conversely, 85 percent of open-pollinated flowers produced seeds; therefore, Texas poppy-mallow is a predominantly out-crossing species. Plants produced an average of 41.4 fruits per plant per year, and fruits averaged 19 seeds each; thus, individuals produced an average of 878 seeds per year. Three species of bees, Diadasia afflicta, Melissodes intorta, and M. tepanica, forage for nectar and pollen in Texas poppy-mallow flowers and use the staminal column as a landing and take-off platform; the foraging behaviors of these bees indicates that they are likely to be effective pollinators. D. afflicta and M. intorta are oligolectic species that forage primarily within the genus Callirhoe. Seeds mature and dehisce from 10 to 18 days after flowering and fertilization. Flowering ceases by late June, as the weather becomes increasingly hot and dry, and the stems die by late July. New rosettes emerge from the taproots in late August and September. (USFWS, 2019a)

Habitat Type

Adult: Terrestrial (USFWS, 2019a)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands, shin oak shrublands, or open oak or mesquite woodlands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Deep sandy soil blown from alluvial deposits along the Colorado River (USFWS, 2019a)

Environmental Specificity

Adult: Very Narrow (USFWS, 2019a)

Habitat Narrative

Adult: Texas poppy-mallow occurs in deep, loose sands of the Tivoli and Brownfield Soil Series (USFWS 1985, pp. 3–4). These sands are carried by wind from alluvial formations in the Colorado River flood plain and deposited on the lee (north and east) side of the river (USDA Soil Conservation Service 1970, p. 26). The difference between Tivoli and Brownfield soils is that the former lacks a distinct B horizon, while the latter has a sandy clay subsoil at a depth of about 0.51–1.02 m (20–40 in). Dunes up to 9 m (30 ft) high and 61 m (200 ft) wide form to the lee of cultivated fields. These soils have very rapid rainfall infiltration rates, very little runoff, and low water holding capacity. Cruze (1991, pp. 12, 15) found 159 Texas poppy-mallow plants within an area of 225 m2 (2,422 ft2) at the study site at EO3. About 80 percent of Texas poppy-mallow plants occurred on 1-m2 (10.76 ft2) plots that had from 3 to 16 percent cover of forbs and grasses; 79 percent of plots were within this range of vegetative cover (p. 12). This demonstrates that occupied habitats have sparse vegetative cover . (USFWS, 2019a)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Cruze (1991) investigated the soil seed reserve of the Runnels County population mentioned above (EO3). She recovered 325 seeds from 6,583 soil samples totaling 1.7 m3 (60.0 ft3) of soil (pp. 6, 9). Seed distribution was uneven, with 91 percent of recovered seeds in the uppermost 5 cm of the soil; 85 percent of seeds were found within 1 m (3.28 ft) in horizontal distance of an established individual (pp. 9–11), indicating that seeds have very limited dispersal. Seed viability, tested with tetrazolium chloride, was 16.3 percent (p. 12); on this basis, the author concluded that seed viability declines rapidly in the soil (p. 19). (USFWS, 2019a)

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Not available.

Number of Populations:

10 (USFWS, 2019a)

Population Size:

Approximately 2800 individuals (USFWS, 2019a)

Minimum Viable Population Size:

1,300 mature, reproductive individuals (USFWS, 2019a)

Population Narrative:

The Texas Natural Heritage Program conducted extensive surveys for Texas poppy-mallow from 1987 through 1989 at 143 sites in 37 counties (Poole (1990). This project documented 9 new populations at 6 sites in Runnels, Coke, and Mitchell counties, totaling 2,817 individuals, and reported an additional population discovered in Coke County in 1990 by an environmental consultant (Poole 1990, pp. 1, 3). All populations were found in areas of intact native vegetation on deep, loose, sandy soils of the Tivoli and Brownfield Series near the Colorado River (note that Likes and Heatly are alternate names for the Tivoli and Brownfield soil map units, respectively). The species has now been documented in four counties—Runnels, Coke, Mitchell, and Scurry (Amos 2008, 2019). The most recent censuses (TXNDD 2019) for all known EOs totals less than 3,000 individuals; however, we have no survey data more recent than 2001. All known populations of Texas poppy-mallow occur in Tivoli (Likes) and Brownfield (Heatly) fine sands (NRCS 2019c) in Runnels, Coke, Mitchells, and Scurry counties. Although we do not have geographic data for populations in Scurry County, Amos (2008, 2019) confirmed that at least one population extends from northern Mitchell County into southern Scurry County. The known populations span a linear distance of about 155 km (96 mi) from northwest to southeast. Within the counties mentioned, NRCS (2019c) classifies 16,987 ha (41,975 ac) as Tivoli (Likes) or Brownfield (Heatly) fine sands. (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 1981)

Exposure:
Response:
Consequence:
Narrative: Much of the natural habitat of Callirhoe scabriuscula has been disturbed. The present-range is limited to one Texas county, much of which is no longer suitable habitat for the plant. The actual area covered by the plant is very small. The range is dissected by a four-lane divided highway (Highway 67) and two frontage roads. All of the land on which the plants now occur is in private ownership. Cultivation, establishment of rural residences, and development of roads and a railway have reduced the range and the size of the populations. An imminent threat to all existing populations is commercial sand mining within the plant's habitat (USFWS, 1981).

Stressor: Overutilization (USFWS, 1981)
Exposure:
Response:
Consequence:
Narrative: If exact localities were published, the plant's conspicuous and showy blooms could cause it to be threatened by amateur gardeners wildflower enthusiasts, and commercial horticultural collecting. Since all the populations occur on privately owned land, taking of these attractive plants could not be prohibited (USFWS, 1981).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction; however, the known populations of Texas poppy-mallow occur almost entirely on privately-owned land (as well as a small amount of state highway ROW). Federally-listed plants occurring on private lands have limited protection under the ESA, unless they are protected by state laws; the State of Texas also provides very little protection to listed plant species on private lands. It is reasonable to assume that any undiscovered populations are also likely to be privately owned. Therefore, none of the species' populations and habitats are subject to federal protection unless there is a federal nexus, such as provisions of the Clean Water Act, or a federally-funded project, for example, a new highway or water treatment plant. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally listed with these statuses. The State of Texas listed Texas poppy-mallow as endangered on April 29, 1983. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. Texas Parks and Wildlife Department requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to state endangered species regulations, other state laws may apply. For example, state law prohibits the destruction or removal of any plant species from state lands without a Texas Parks and Wildlife Department permit. (USFWS, 2019a)

Stressor: Demographic and genetic consequences of small population sizes (USFWS, 2019a)
Exposure:
Response:
Consequence:

Narrative: Small populations are less able to recover from losses caused by random fluctuations in recruitment (demographic stochasticity) or variations in rainfall (environmental stochasticity) (Shaffer and Stein 2000, pp. 308-310). In addition to population size, it is likely that population density also influences population viability, since successful sexual outcrossing—necessary to maintain genetic diversity in populations—requires genetically distinct individuals to be in sufficiently close proximity for cross-pollination to occur. Small, reproductively isolated populations are also susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding depression. The combined demographic and genetic consequences of small population sizes may reduce population recruitment, leading to an extinction vortex of even smaller populations, greater isolation, decreasing genetic diversity, and loss of viability. These factors may already have contributed to the restriction of Texas poppy-mallow to its current state of extreme endemism in the Tivoli (Likes) and Brownfield (Heatly) sands along the Colorado River of Texas. (USFWS, 2019a)

Recovery

Reclassification Criteria:

1. Texas poppy-mallow is documented in 10 or more protected, viable populations, with at least 3 viable populations in each of 3 recovery units. Populations and metapopulations are delineated by unpopulated gaps of at least 1 km (0.6 mi). However, viable populations that expand and merge with other populations may be counted as separate populations for the specific purpose of meeting this criterion. (USFWS, 2019b)

2. Viable populations have 1,600 or more mature individuals. Mature individuals have flowered at least once or are judged capable of flowering. Population surveys should be conducted during the peak of flowering and fruiting, from April through June. (USFWS, 2019b)

3. Protected populations occur on lands that are legally protected and managed to conserve the Region's native flora and fauna, including Texas poppy-mallow, its habitats, and its pollinators. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, publicly-owned land managed for conservation purposes, and legally binding long-term management agreements with private landowners. (USFWS, 2019b)

Delisting Criteria:

1. Periodic monitoring indicates that the downlisting criteria have been met, and that demographic trends have subsequently remained stable or have increased over a period of 25 years. Ideally, monitoring (censuses) of each protected population should be conducted during years of above-average April–May rainfall; trend detection should be based on the largest populations observed during each 5-year period. (USFWS, 2019b)

Recovery Actions:

- Manage presently known individuals and habitat for maintenance and expansion of existing wild populations.. A crucial step in recovery is to protect existing populations and the habitat upon which they depend. All populations are threatened by expansion of commercial sand mining and development. The land presently inhabited by the Texas poppy-mallow is under private ownership. The Endangered Species Act is most effective in protecting populations on Federal lands. Immediate protection of the habitat and

cooperation with landowners is essential to recovery of the species. (USFWS, 1985)

- Sustain healthy populations in their natural habitat at existing sites. In order to develop management plans for sustaining healthy populations, it may be necessary to learn more about the Texas poppy-mallow. (USFWS, 1985)
- Search potential habitat for additional populations. Other windblown sand deposits similar to the habitat presently occupied by Texas poppy—mallow exist on the upper Colorado River between Ballinger and Colorado City (a distance of about 80 miles). These areas need to be thoroughly searched for new populations. Additionally, deep sands are extensive in Jones, Haskell, Knox, Foard, Hardeman, and adjacent counties north of the presently known populations. Suitable habitat may exist in some of these counties and they should also be searched for presence of the species structure. (USFWS, 1985)
- Establish additional populations within the historic range. If searches fail to locate enough new populations to ensure safety for the species, expanding present populations within the essential habitat and introducing the species into new areas within its historic range would diminish the risk of extinction. (USFWS, 1985)
- Develop public awareness, appreciation, and support for presentation of the Texas poppy-mallow. Education and cooperation of the public is a vital part of the recovery process. Enlist the support of public interest groups such as the Texas Organization for Endangered Species, The Nature Conservancy, and local garden clubs. The visibility of this support can be instrumental in shaping public opinion. Useful tools in this endeavor would include talks and slide presentations to local interest groups and articles on the Texas poppy-mallow in newspapers and nature magazines. (USFWS, 1985)
- Recommendation for Future Action (USFWS, 2019a): Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria (U.S. Fish and Wildlife Service 2017). Use the MVP level and population delimitation distances described in this review as components of recovery criteria that address resilience and redundancy. Adopt the provisional recovery units discussed in this review to develop recovery criteria that address the species' ecological and genetic representation.
- Recommendation for Future Action (USFWS, 2019a): Promote awareness and conservation of Texas poppy-mallow in Runnels, Coke, Mitchell, and Scurry counties.
- Recommendation for Future Action (USFWS, 2019a): Seek permission to survey and monitor populations on private land.
- Recommendation for Future Action (USFWS, 2019a): Conduct up-to-date censuses of the accessible populations and revise the TXNDD EO records.
- Recommendation for Future Action (USFWS, 2019a): Work cooperatively with private landowners who are interested in conserving and managing the species on their lands. Consider voluntary measures to confer long-term protection for populations on private lands, such as conservation agreements and conservation easements.
- Recommendation for Future Action (USFWS, 2019a): Propagate the species, using seeds in the Lady Bird Johnson Wildflower Center seed bank, to establish seed production plots, renew the seed bank, and reintroduce populations in appropriate sites that can be protected.
- Recommendation for Future Action (USFWS, 2019a): Recommendation for Future Action (USFWS, 2019a): Obtain support for conservation actions from the Cooperative Endangered Species Conservation Fund (Section 6) or other grant sources.
- Not available.

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SPECIES ACCOUNT: *Calyptranthes thomasiana* (Thomas' Lidflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/18/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree that may reach 10 meters (30 feet) in height and 13 centimeters (5 inches) in diameter. Leaves are opposite, obovate to oblong, 2 to 4 centimeters long, blunt at the apex, and short pointed at the base. The leaves are coriaceous, with gland dots, shiny on the upper surface, and dull on the lower surface. The inflorescences are subaxillary and the cymes trichotomous. Flower-buds are obovoid, apiculate, and 3 millimeters long. Flowers have four small, spatulate petals. The fruit has not been described (Liogier 1994) (USFWS, 1997).

Taxonomy

It may be pointed out that the recovery plan for Calyptranthes thomasiana (USFWS, 1997) cites "no common name" but Thomas' Lidflower seems well established: Lidflower is the common name in English for other Calyptranthes species and Thomas is an appropriate geographical reference. This common name has been adopted by both the USDA PLANTS database and the IUCN Red List (USFWS, 2013).

Historical Range

At the time of listing, Thomas' Lidflower was reported from small populations from four islands: Vieques (PR), St. John and St. Thomas (USVI), and Virgin Gorda (BVI) (Clubbe et al. 2003) (USFWS, 2013).

Current Range

Currently, the species is known only from St. John and Virgin Gorda (USFWS, 2013). As of 2019: The known species occurrence is restricted to the USVI and BVI: St. John and St. Thomas (USVI), and Virgin Gorda and Tortola (BVI) (USFWS 2013). The species is estimated to be between 1,000 and 2,000 mature individuals and all sub-populations are suspected of having less than 1,000 mature individuals (IUCN 2018). In St John, the species is located within the Virgin Islands National Park managed by the U.S. National Park Service. (USFWS, 2019). In St. Thomas, the species was rediscovered by local plant experts and occurs at possibly two locations with an estimated population of 30 to 45 individuals between the two sites (IUCN 2018). (USFWS, 2019b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Bats have been observed feeding on the fruits. Fruit dispersal also potentially occurs via abiotic factors (EPA, 2016).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2013)

Species Trends:

Unknown (USFWS, 2013)

Number of Populations:

2 (USFWS, 2013)

Population Size:

59 (USFWS, 2013). At present time, between 1,000 and 2,000 mature individuals are known to occur in four sites: St Thomas, St. John, Virgin Gorda and Tortola (IUCN 2018). (USFWS, 2019).

Population Narrative:

The species status is unknown; the populations of Thomas' Lidflower have been poorly monitored and no information on population trends and demographic features are currently available. New information on the Thomas' Lidflower indicates that the species' population has decreased since the time of listing in 1994. Clubbe et al. (2003) cited that work in the BVI has documented a single locality on Virgin Gorda that comprises two subpopulations, one with 34 and another with 25 mature individuals, making a total population size for Virgin Gorda at 59 individuals within Gorda Peak National Park. With respect to the population from Vieques, recently, species' experts excluded the species from that island. Limited distribution suggests this species has low genetic variability (USFWS, 2013).

Threats and Stressors

Stressor: Exotic mammals (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Exotic mammals such as white-tailed deer (Odocoileus virginianus) and wild domestic mammal such as feral goats (Capra aegagrus hircus), pigs (Sus scrofa), and donkeys (Equus asinus) are found throughout the range of the Thomas' Lidflower on St. John and Virgin Gorda (Carlos Pacheco, USFWS, 2012, pers. obs.). Clubbe et al (2003) also mentioned loose cattle trampling through the Gorda Peak National Park may pose a threat to individuals in Virgin Gorda. It is expected that, due to their abundance, these exotic mammals are modifying the forest structure through overgrazing or altered seed dispersal mechanisms (Chakroff 2010). This may imply changes to microhabitat conditions that are necessary for seed germination and seedling recruitment of the specie (USFWS, 2013).

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Thomas' Lidflower population in Virgin Gorda lies within the Gorda Peak National Park. Clubbe et al (2003) cited that some developments are occurring close to the Park boundary that may negatively affect the species' habitat and could result in loss of mature individuals. The author also mentioned increase of visitation by hikers (locals and tourist) through the walking trails and human trampling through the Park to exploring new areas may result in loses of individuals in Virgin Gorda. Proctor (1992) stated that although Thomas' Lidflower had not been found on St. Thomas since 1980, deforestation at the collection area for residential and tourist development may pose imminent threats to the survival of the species, if present (USFWS, 2013).

Stressor: Limited distribution (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Thomas' Lidflower is vulnerable to extinction due to its limited distribution and highly specialized ecological requirements. The low population number and restricted distribution (i.e., only 2 populations reported), coupled with habitat alteration or loss may also exacerbate its vulnerability to natural or anthropogenic events such as hurricanes, compromising the continued existence of this species (USFWS 1997). Given the extremely limited geographic distribution of Thomas' Lidflower, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn, 2007) (USFWS, 2013).

Stressor: Invasive species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The most comprehensive forest inventory of the U.S. Virgin Islands indicate that three most common plant species are the invasive exotic plants, Leucaena leucocephala, Tecoma stans and Megathyrsus maximus (Chakaroff 2012). Any disturbance on vegetation along the road may create conditions favorable for the establishment of invasive species that may outcompete with native plants species changing vegetation structure. Invasive species (e.g. Leucaena leucocephala and Megathyrsus maximus) may spread and colonized the Thomas' Lidflower habitat, and it could alter fire regimes, microclimate, and nutrient cycling of the habitat that the species depend (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: As a species endemic to the Lesser Antillean, the Thomas' Lidflower should be adapted to hurricanes, but its occurrence at the highest elevations of St John and Virgin Gorda, where winds may be stronger, may place it at increased risk, especially as climate change is predicted to increase the frequency and strength of hurricanes. Hurricane winds often lead to tree defoliation, loss of small and large branches, and up-rooted resulting in damage to adjacent

trees and understory plants when trees or branches fall, and ultraviolet damage to leaves of understory juveniles exposed to high light levels (Brokaw and Walker 1991). Additionally, high rainfall associated with tropical storms and hurricanes, sometimes about 24 inches (2 feet) of rain in a single storm event, can cause floods and interacting with topography and geologic substrate may induce mass wasting events, e.g. land, mud and debris slides (Lugo 2000). An expected effect of the climate change is the increase in intensity of hurricanes and tropical storm, followed by extended period of drought (IPPCC 2012). This climate change may alter (modify) the surrounding vegetation around the populations of the Thomas' Lidflower. Hurricane effects followed by extended period of drought may result in changes in soil conditions and microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000) (USFWS, 2013).

Recovery

Reclassification Criteria:
1. An agreement between the U.S. Fish and Wildlife Service and the U.S. Navy has been prepared and implemented for the protection of the known population on Vieques (USFWS, 2013). Criteria deemed obsolete in 2019. (USFWS, 2019).

2. An agreement between the U.S. Fish and Wildlife Service and the National Park Service has been prepared and implemented for the protection of the known population on St. John (USFWS, 2013).

3. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established in protected areas such as other areas on Vieques or St. John (USFWS, 2013).

Delisting Criteria:
1. The two (2) existing populations on the U.S. Virgin Islands, and two (2) existing populations on the British Virgin Islands show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019b).

2. Populations that exists on privately owned lands on St. Thomas are protected and managed through a conservation mechanisms (addresses Factor A). (USFWS, 2019b).

3. Establish two (2) new populations on lands protected by a conservation mechanism, and these populations show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019b).

4. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor C). (USFWS, 2019b).

Recovery Actions:
- Protect the existing population and its habitat through an agreement with the U.S. Navy and National Park Service (USFWS, 1997).
- Develop a management plan for the species in cooperation with these entities (USFWS, 1997). Refinement in 2019: The Service and the National Park Service should develop a plan with specific actions for the management and enhancement of existing populations

within the Virgin Islands National Park. (USFWS, 2019, Recommended Action 7).

- Monitor known populations (USFWS, 1997). Refinement in 2019: The population should be monitored on a regular basis, and additional survey visits should be made after hurricanes, landslides, or other major disturbances. The known population at St. John should be monitored on a long term basis to determine the species' trends. (USFWS, 2019, recommended action #6).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1997).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1997). Refinement in 2019: Studies should be conducted on the species' phenology and reproductive biology. (USFWS, 2019, Recommended Action 3).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1997). Refinement in 2019: Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service taking into consideration if the species continues to be viable, existing threats to the species, genetic variations and if we can find ways to propagate without seeds. (USFWS, 2019, Recommended action 5).
- New in 2019: The status (distribution, abundance, possible threats) of Thomas'Lidflower in the U.S. and BVI should be ascertained. Mechanisms should be developed to share information on this and other Puerto Rican Bank species, and to coordinate conservation plans and activities. (USFWS, 2019, Recommended Action 1).
- New in 2019: Field surveys on Thomas' Lidflower should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence of this species. (USFWS, 2019, Recommended action 2)
- New in 2019: Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm. (USFWS, 2019, Recommended Action 4).
- New in 2019: As new information becomes available, when individuals are documented, and the Service works further with partners like the National Park Service, the recovery plan should be revisited and possibly revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species. (USFWS, 2019, Recommended action 8).
- The status (distribution, abundance, possible threats) of Thomas' Lidflower in the U.S. and BVI should be ascertained. Mechanisms should be developed to share information on this and other Puerto Rican Bank species, and to coordinate conservation plans and activities (USFWS, 2013).
- Field surveys on Thomas' Lidflower should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence of this species (USFWS, 2013).
- Studies should be conducted on the species' phenology and reproductive biology (USFWS, 2013).
- Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2013).
- Propagation and reintroduction of the species should be conducted in order to strengthen the existing population. This action should be carefully evaluated by the Service taking into consideration if the species continues to be viable, existing threats to the species, genetic variations and if we can find ways to propagate without seeds (USFWS, 2013).

- The population should be monitored on a regular basis, and additional survey visits should be made after hurricanes, landslides, or other major disturbances. The known population at St. John should be monitored on a long term basis to determine the species' trends (USFWS, 2013).
- The Service and the National Park Service should develop a plan with specific actions for the management and enhancement of existing populations within the Virgin Islands National Park (USFWS, 2013).
- As new information becomes available, when individuals are documented, and the Service works further with partners like the National Park Service, the recovery plan should be revisited and possibly revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).

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Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Calyptridium pulchellum* (Mariposa pussypaws)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

The plants have fleshy, hairless stems that are spreading rather than upright and can be as small as a penny (2 centimeters [0.8 inches] in diameter), and even the largest individuals reach only 7 centimeters (2.8 inches) in diameter. The plants bloom in April and May and each plant has two or more dense flower clusters (USFWS, 2023).

Taxonomy

U.S. FWS uses the name Calyptridium pulchellum. (NatureServe, 2015). Calyptridium pulchellum is an annual member of the Portulacaceae (purslane family). (USFWS, 2007)

Historical Range

No evidence exists that the historical range of Calyptridium pulchellum was ever wider than the current range. (USFWS, 2007)

Current Range

At the time of listing, the species was only known from seven locations in Mariposa, Madera, and Fresno Counties (Element Occurrences 1 – 6 and 8; Service 1998, p. 49023). Since listing, five new occurrences have been discovered in 2000, 2003, 2005, and 2022 (Service 2008, p. 11; J. Clines in litt. 2023, pp. 1–2). One of these five occurrences was found on private land near the community of Coarsegold (Element Occurrence 9), one on the Sierra National Forest (Element Occurrence 10), and one on Pacific Gas and Electric land bordering the Sierra National Forest (Element Occurrence 11). The two remaining new occurrences consisting of several populations within ¼ mile of each other were recently found in 2022 on private land near the town of Ahwahnee, within the known range of the species, and near another known occurrence (Element Occurrence 3; J. Clines in litt. 2023, pp. 1–2; J. Medley, U.S. Forest Service, in litt. 2023). These new 2022 locations have not been recorded in the Diversity Database. Three known occurrences may be extirpated since no plants have been observed in many years, and the status of Element Occurrence 3 is uncertain (Element Occurrence 1, 4, and 5; Table 1; J. Clines, in litt. 2021a and b). Further, no information has been recorded from Element Occurrence 8 since 2008 when no plants were observed (Diversity Database 2023). Most plants occur on private land with two occurrences on federal land. Although there are now a total of 12 occurrences, when the extirpation at three occurrences is considered (potentially four if Element Occurrence 3 is also included), the overall known occurrences have not substantially increased since the time of listing, nor has the species range. The plant is rare, and its range is well understood and established by species experts (C. Winchell, consultant, pers. comm. 2022). The occurrences are spread over a range of approximately 64 kilometers (40 miles) but are not evenly spaced within that range. Several surveys occurred in suitable habitat within the range of the species near the towns of Mariposa and Ahwahnee in Mariposa and Madera Counties with no plants observed (Service 2018; S. Cordier, California Department of Forestry and Fire Protection, in litt. 2021 and 2023). Extensive surveys have also occurred on the Sierra National Forest since the 1980s with no new observations (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Spring and summer. (Nature Serve, 2015)

Reproduction Narrative

Adult: Loose inflorescences (generally 2+ per rosette), made up of head-like clusters of rose-colored flowers bloom in the spring and summer. (Nature Serve, 2015)

Habitat Type

Adult: Terrestrial (USFWS, 2007)

Habitat Vegetation or Surface Water Classification

Adult: Granite domes and gravelly openings (J. Clines, Sierra National Forest, in litt. 1998; CNDDB 2006). (USFWS, 2007)

Dependencies on Specific Environmental Elements

Adult: Sparsely-vegetated (J. Clines, Sierra National Forest, in litt. 1998; CNDDB 2006) and sandy soils (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Sparsely vegetated areas, 400-1100 m elevations (USFWS, 2007)

Spatial Arrangements of the Population

Adult: Colonial (inferred from USFWS, 2007)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2007)

Dependency on Other Individuals or Species for Habitat

Adult: Calyptridium pulchellum typically grows in association with the rare species Lupinus citrinus. (USFWS, 2007)

Habitat Narrative

Adult: Calyptridium pulchellum is an annual member of the Portulacaceae (purslane family) that grows in sparsely-vegetated areas such as granite domes and gravelly openings within foothill woodland communities (J. Clines, Sierra National Forest, in litt. 1998; CNDDB 2006). (NatureServe, 2015). Occurrences range in elevation from a low of 442 meters (1,450 feet) in Mariposa County to a high of 1,097 meters (3,600 feet) in Fresno County (D. Hamon, Sierra National Forest, in litt. 1980; CNDDB 2006). Populations, individuals, or colonies located within one-fourth of a mile of each other generally constitute a single occurrence (CNDDB 2006). Calyptridium pulchellum typically grows in association with the rare species Lupinus citrinus. (USFW, 2007). Calyptridium pulchellum co-occurs with L. citrinus var. citrinus (orange lupine) at

five locations and with L. citrinus var. deflexus (Mariposa lupine) at two locations. Mimulus layneae (Layne's monkeyflower) is the second most common associate, occurring with C. pulchellum at four sites. (USFWS, 2007). The Mariposa pussypaws is an annual member of the Portulacaceae (purslane family) that grows in sparsely-vegetated areas such as granitic and gravelly openings within foothill woodland communities (J. Clines, U.S. Forest Service, unpubl. data 2023). Known occurrences of the plant range from 442 meters (1,450 feet) to 1,097 meters (3,600 feet), but most occurrences are between 610 meters (2,000 feet) and 762 meters (2,500 feet; Diversity Database 2023) (USFWS, 2023).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

5 unknown, 2 declining, and 1 fluctuating (CNDDB 2006). (USFWS, 2007)

Species Trends:

5 unknown, 2 declining, and 1 fluctuating (CNDDB 2006). (USFWS, 2007)

Number of Populations:

12 (9 extant) (USFWS, 2023)

Population Size:

1,000's (USFWS, 2023)

Population Narrative:

Approximately 1680-1690 plants; the bulk is found in two occurrences; 874 (may be divided into 2 subpopulations) and 701 plants (NatureServe, 2015). Calyptridium pulchellum is reported from 9 or 10 occurrences in Mariposa, Madera, and Fresno Counties, occurring within a range of approximately 64 kilometers (40 miles) (CNDDB 2006). Seven occurrences in three central California counties (one may be extirpated). Currently, the population trends for occurrences that have been reported to the California Natural Diversity Database are: 5 unknown, 2 declining, and 1 fluctuating (CNDDB 2006). (NatureServe, 2015; USFWS, 2007). At the time of listing, the species was only known from seven locations in Mariposa, Madera, and Fresno Counties (Element Occurrences 1 – 6 and 8; Service 1998, p. 49023). Since listing, five new occurrences have been discovered in 2000, 2003, 2005, and 2022 (Service 2008, p. 11; J. Clines in litt. 2023, pp. 1–2). One of these five occurrences was found on private land near the community of Coarsegold (Element Occurrence 9), one on the Sierra National Forest (Element Occurrence 10), and one on Pacific Gas and Electric land bordering the Sierra National Forest (Element Occurrence 11). The two remaining new occurrences consisting of several populations within ¼ mile of each other were recently found in 2022 on private land near the town of Ahwahnee, within the known range of the species, and near another known occurrence (Element Occurrence 3; J. Clines in litt. 2023, pp. 1–2; J. Medley, U.S. Forest Service, in litt. 2023). These new 2022 locations have not been recorded in the Diversity Database. Three known occurrences may be extirpated since no plants have been observed in many years, and

the status of Element Occurrence 3 is uncertain (Element Occurrence 1, 4, and 5; Table 1; J. Clines, in litt. 2021a and b). Further, no information has been recorded from Element Occurrence 8 since 2008 when no plants were observed (Diversity Database 2023). Most plants occur on private land with two occurrences on federal land. Although there are now a total of 12 occurrences, when the extirpation at three occurrences is considered (potentially four if Element Occurrence 3 is also included), the overall known occurrences have not substantially increased since the time of listing, nor has the species range. The plant is rare, and its range is well understood and established by species experts (C. Winchell, consultant, pers. comm. 2022). The occurrences are spread over a range of approximately 64 kilometers (40 miles) but are not evenly spaced within that range. Several surveys occurred in suitable habitat within the range of the species near the towns of Mariposa and Ahwahnee in Mariposa and Madera Counties with no plants observed (Service 2018; S. Cordier, California Department of Forestry and Fire Protection, in litt. 2021 and 2023). Extensive surveys have also occurred on the Sierra National Forest since the 1980s with no new observations (USFWS, 2023).

Threats and Stressors

Stressor: Human populations (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The human populations of Madera and Mariposa Counties are expected to increase by 49 percent and 20 percent, respectively, between 2000 and 2020 (Hickey et al. 2005). The region of Madera County covered by the Coarsegold Area Plan (Madera County 2006), which provides the framework in which development will occur, contains about 60,000 acres and at least 4 of the occurrences of C. pulchellum. The habitat for this species located near Coarsegold, in Madera County, will likely continue to be fragmented due to increased infrastructure associated with the need for housing and services for this area, and the construction of a gaming casino and hotel on the Chukchansi Tribal Lands (Madera County 2006). Activities associated with residential development such as landscaping, dirt bike riding, or foot traffic are a threat at Element Occurrence 3 near Ahwahnee and Element Occurrences 4 (if extant) and 5 (if extant) in Madera County, all of which are in residential subdivisions (CNDDB 2006).(USFWS, 2007)

Stressor: Competition (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Competition from nonnative plants and native live oak potentially threatens Calyptridium pulchellum at four sites. (USFWS, 2007)

Stressor: Small population size
Exposure:
Response:
Consequence:
Narrative: small population size increases the susceptibility of a population to extirpation from random demographic, environmental and/or genetic events (Shaffer 1981, 1987; Lande 1988; Primack 2006; Groom et al. 2006). The combination of few populations, small range, and restricted habitat still renders Calyptridium pulchellum highly susceptible to extirpation due to

random events, such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Recovery Actions:

- There is no recovery plan for this species.
- Protect the extant occurrences of Calyptridium pulchellum through mechanisms such as conservation easements. (USFWS, 2007)
- Complete and publish the draft recovery plan, and approve a final recovery plan. (USFWS, 2007)
- Map the potential habitat for Calyptridium pulchellum using the indicators mentioned in II.C.1.d. and survey for additional populations. (USFWS, 2007)
- Monitor the status and trend of Calyptridium pulchellum in order to estimate current population sizes, the number and distribution of populations, and whether the species is stable, increasing, or declining. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Mariposa pussypaws. Some of these recommendations have already been discussed in our previous status review (Service 2008, pp. 11–12) and remain valid. 1. Increase research in breeding system genetics and pollinator studies to better understand gene flow given populations are separated by considerable distances. 2. Finalize a recovery plan or work with other agencies to finalize a conservation assessment for the species. 3. Map potential habitat and conduct more surveys for additional populations within potential habitat on private land and scattered federal land parcels throughout the range of the species. 4. Implement more fuels reduction treatments near known occurrences and in potential habitat that include prescribed fire to prevent encroachment from other plant species and create openings the plant requires. 5. Monitor population abundance more regularly at all known occurrences and ensure surveys include both drought and non-drought years. 6. Protect and preserve more suitable habitat for the species in Mariposa, Madera, and Fresno Counties through mechanisms such as conservation easements. 7. Ensure any field observations are entered into the Diversity Database to track population status more effectively (USFWS, 2023).

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SPECIES ACCOUNT: *Calystegia stebbinsii* (Stebbins' morning-glory)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; Pacific Southwest (R8)

Physical Description

A leafy herbaceous perennial (persisting or living for several years with a period of growth each year) in the morning-glory family (Convolvulaceae). Its stems, which range up to 1 meter (3.3 feet) in length, generally lie flat on the ground. The leaves are palmately lobed (lobing radiating from a common point) with the two outermost lobes (major expansion or bulge) being divided again. The leaf lobes are narrow and lance-shaped. White flowers are on stalks 3 to 13 centimeters (1 to 5 inches) long and bear two leaf-like bracts. The fruit is a slender capsule. Calystegia stebbinsii flowers from May through June. Calystegia occidentalis (chaparral false bindweed) and C. purpurata ssp. saxicola (Pacific false bindweed) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). Calystegia stebbinsii can be distinguished from other California morning-glories by its distinctively shaped leaves, each having 7 to 9 narrow lance-shaped lobes. (USFWS, 2002)

Taxonomy

Brummitt (1974) described Calystegia stebbinsii (Stebbins' morning-glory) from the type collection made by G. Ledyard Stebbins in 1970, 17 kilometers (10 miles) west of Placerville in El Dorado County, California. (USFWS, 2002)

Historical Range

In western El Dorado County that includes the Pine Hill formation (northern and southern portions). (USFWS, 2002)

Current Range

On the Pine Hill formation in western El Dorado County, California; a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Lives for several years (USFWS, 2002).

Breeding Season

Adult: May through June (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Insect pollinators; disturbance (USFWS, 2002)

Reproduction Narrative

Adult: The fruit is a slender capsule. Calystegia stebbinsii appears to emerge from a dormant seed bank or rootstock after disturbance. The plants grow and begin to flower in the year following germination or re-emergence. While an above-ground shoot may appear in the same spot for only several years, other portions of this plant's extensive root system might survive much longer (L. Eng in litt. 1999). Pollination studies showed that animal vectors were needed for successful seed set. Observations showed that Calystegia stebbinsii is only pollinated by insects. Eighty percent of all visits were made by Hymenoptera, the Halictidae (solitary bees) and Apidae (honey bees) being the most important families (Nosal 1997). Seedproduction ranged from an average of 20.6 seeds per square meter (1.9 seeds per square foot) at Grass Valley to 380 seeds per square meter (35.3 seeds per square foot) at Salmon Falls. (USFWS, 2002)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Shrubland/ chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seeds require heat or scarification for germination. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Well-burned areas; shade intolerant (USFWS, 2002)

Spatial Arrangements of the Population

Adult: Discontinuously scattered (USFWS, 2002)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2002)

Habitat Narrative

Adult: Calystegia stebbinsii prefers mixed chaparral communities on gabbro-derived and serpentine-derived soils (NatureServe, 2015). Most occurrences of C. stebbinsii are discontinuously scattered within two population centers in the northern and southern portions of the Pine Hill formation. Calystegia stebbinsii produce fire adapted: seeds need heat or scarification for germination; plants grow well in burned-over areas, but are eliminated when surrounding chaparral grows tall enough to shade them. (NatureServe, 2015). Calystegia stebbinsii seems to be shade intolerant and does not occur beneath a closed canopy of vegetation (Baad and Hanna 1987). (USFWS, 2002)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

3 known extant; 8 presumed extant; 3 possibly extirpated; 1 extirpated. (USFWS, 2019)

Population Size:

Greater than 9800 individuals (USFWS, 2019)

Population Narrative:

At the time of listing Stebbins' morning-glory occurred primarily on the Pine Hill formation an area of approximately 10,400 hectares (ha) (25,700 acres (ac)), in western El Dorado County, California, ranging in elevation from 138 to 628 m (453 to 2,060 ft). In addition, Stebbins' morning-glory had "a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties" (Service 1996). Today, the species continue to occur primarily at the Pine Hill Preserve, but Stebbins' morning-glory has a few known occurrences in Nevada County near Grass Valley. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances. (USFWS, 2002)

Stressor: Other species-specific threats (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Calystegia stebbinsii is threatened by altered periodicity of fire (either too frequent or fire suppression), competition with invasive alien vegetation, herbicide spraying, and unauthorized dumping. There is an increased risk of extinction due to environmental, demographic, or genetic random events due to habitat fragmentation (USFWS, 2002).

Stressor: Alteration of the natural fire regime (USFWS, 2019)

Exposure:
Response:
Consequence:
Narrative: The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for Stebbins' morning-glory establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The State's authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: the California Endangered Species Act, the Native Plant Protection Act, the California Environmental Quality Act, and the Natural Community Conservation Planning Act. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. Landowners are exempt from the prohibition for plants to be taken in the process of habitat modification. Protection of listed species through California Environmental Quality Act isdependent upon the discretion of the lead agency involved. The National Environmental Policy Act (NEPA) does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. More details about existing protections are provided in the 2019 5-Year Review. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. Secure and protect specified recovery areas from incompatible uses: (a) Cameron Park preserve north of Highway 50; (b) Cameron Park preserve south of Highway 50; (c) Salmon Falls/Martel Creek preserve; (d) occurrences in Nevada County; along with sufficient adjacent unoccupied habitat for fire management and a 150-meter (500-foot) buffer. (USFWS, 2002)

2.Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective for all populations recommended for protection and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

3. Monitoring in all recommended preserves shows: (a) Populations stable or increasing over one fire cycle (about 30 years) (subject to modification depending on results of fire management studies). (b) Habitat monitoring shows a mosaic of multiage -class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserve over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats; (b) Fire management studies; (c) Research on genetics of Nevada County population; (d) Seeds of disjunct populations stored in at least two Center for Plant Conservation certified facilities; (e) Research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary (f) Maintain metapopulation dynamics of at least 2 very large, 7 medium, and 4 small occurrences

throughout the northern and southern portions of the Pine Hill formation; and of at least 1 medium and 5 small occurrences near Grass Valley in Nevada County. (USFWS, 2002)

Delisting Criteria:

1. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all occurrences and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

2. Monitoring in all recommended preserves shows: (d) No population decline after downlisting during two additional fire cycles (about 60 years); if declining, determine cause and reverse trend. (e) Habitat monitoring continues to show a mosaic of multi-age class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions. (f) Spatially and temporally, the establishment of occurrences must continue to be greater than the extirpation of occurrences. (USFWS, 2002)

3. Other actions: (g) Ameliorate or eliminate threats. (USFWS, 2002)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3)

whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)

- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Nevada County on gabbro and serpentine soils. Reproduction and Demography Research: Including determining limiting life stages, seed production, and survival in soil to determine appropriate fire return period. Genetics research. Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; seed banking for disjunct populations. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Preserves must include sufficient habitat to allow for expansion or shifts in occupied habitat.
- In addition to securing and protecting habitat, maintenance of the metapopulation dynamics will be important for survival and recovery.
- Unless the metapopulation analysis shows otherwise, at least two very large occurrences each greater than 128 hectares (315 acres); seven medium occurrences each between 4 and 40 hectares (10 and 100 acres); and four small occurrences each smaller than 4 hectares (10 acres), are to be maintained at any given time throughout the northern and southern portions of the Pine Hill formation. In addition at least one medium and five small occurrences are to be maintained at any given time at the metapopulation near Grass Valley in Nevada County.
- In addition to securing and protecting habitat, directed surveys for Calystegia stebbinsii should be conducted on gabbro and serpentine soils in Nevada County. If plants (or additional populations) are discovered in Nevada County, they should be secured through land acquisition, conservation easements, or other means. (USFWS, 2002)

- In addition, unoccupied habitat that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected along with sufficient adjacent unoccupied habitat for fire management, and a 150-meter (500-foot) buffer for fire safety. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019)

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SPECIES ACCOUNT: *Campanula robinsiae* (Brooksville bellflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4)

Physical Description

Campanula robinsiae is an annual herb, with stems 1-15 cm2 (0.5-6 in.) tall, very slender, simple or branched, faintly winged or 4-angled. The stems are glabrous except for a few trichomes in the angles (Morn 1987). The plant may be submerged for part of its life, which may affect its growth. Some stems root at the nodes (Morn 1987). The leaves are alternate, the blades varying in size and shape on different parts of the plant and from plant to plant (Morn 1987). Open flowers are solitary, 3-10 mm long, bell-shaped, “deep purple” (Morn 1987). Steven Leonard (under contract to The Nature Conservancy; report at Florida Natural Areas Inventory) discovered in 1983 that the plant has cleistogamous (closed, self-pollinating) flowers, which are quite small. This is the only North American Campanula with cleistogamous flowers (Morn 1987). The fruit is a subglobose capsule about 2 mm in diameter (Wunderlin et al. 1 980a). The seeds are about 1 mm long, the smallest of any North American member of the genus (Shetler and Morn 1986; description adapted from Wunderlin et al. [1980a] and other sources as noted). Leonard observed only cleistogamous flowers on February 8 and 11, 1983, and did not see a chasmogamous flower until February 23 (letters from Leonard to Morn in Morn 1987). Flowering specimens have also been collected March 11, 1983; April 13, 1983; and April 26, 1958. Seed production proceeds while flowering continues. Campanula robinsiae may be confused with Campanula floridana, but the latter species has very different seeds and leaves that are “much firmer than those of C. robinsiae” (Morn 1987). (USFWS, 1993)

Taxonomy

Small (1926) formally published the species, but later (Small 1933) transferred the species to his new genus Rotantha, along with Campanula floridana, based on the shared character of their rotate corollas’ (Small 1933). Later workers (Shetler 1963, Wunderlin et al. 1 980a) determined that these two species are not closely related, so Rotantha is an artificial genus; the two species are retained in Campanula (USFWS, 1993).

Historical Range

All historically known sites of C. robinsiae occurred within approximately 2-3 square miles centered on Chinsegut Hill, which is located 5 miles north of Brooksville, in Hernando County, Florida. (USFWS, 2019)

Current Range

Hernando and Hillsborough Counties, Florida. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from EPA, 2016); asexual (EPA, 2019)

Breeding Season

Adult: March - April (EPA, 2016)

Key Resources Needed for Breeding

Adult: rainfall (USFWS, 2010)

Reproduction Narrative

Adult: Flowering specimens have been collected March-April. Capable of self-pollination.Seeds germinate in winter or spring. Seed production occurs while flowering continues (USFWS, 2019). It was determined that water levels from rainfall rather than time of year may be a critical factor controlling germination (Williams 1998) (USFWS, 2010).

Habitat Type

Adult: Palustrine, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, forest (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Campanula robinsiae was originally found in a seepage area on the north facing slope of Chinsegut Hill surrounded by pasture used for animal husbandry. It has since been found within an oak/palm hydric hammock along the edge of an elongated maidencane (Panicum hemitomom) marsh at Burns Prairie (Laundry 1996). Typically this species is found along the margins of ponds and marshes with fluctuating water levels and moist seepage areas, both surrounded by pastures. C. robinsiae is associated with other wetland plants, such as mosquito fern (Azolla carolinaiana), hair sedge (Bulbostylis spp.), coinwort (Centella asiatica), button snakeroot (Eryngium spp.), pennywort (Hydrocotyle spp.), rush (Juncus spp.), pimpernel (Anagallis minima), pearlwort (Sagina decumbens), and maidencane (Panicum hemitomom). (USFWS, 2019)

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2019)

Number of Populations:

7 (USFWS, 2024)

Population Size:

~5,000 individuals (USFWS, 2024)

Population Narrative:

Seven populations. All extant populations occur on publicly-owned lands, not necessarily conservation lands. The Brooksville Sec 24 (EO 1) and Chinsegut Hill (EO 3) populations occurred on private lands. The former population no longer has suitable habitat present and the latter population's marginal habitat has degraded to what appears unsuitable. Surveys performed at this location have not detected species presence for many decades (USFWS, 2024).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: This species is threatened by habitat destruction and degradation on its six extant sites due to the lack of habitat management and development of the land surrounding protected sites. Previously, conversion of existing sites to residential and agriculture was determined to be the primary threat and resulted in the need to list the species (USFWS 1994). Since all six known extant populations now occur on public land, the threat of conversion of known sites to residential land use has been significantly reduced. The lack of habitat management has resulted in the disappearance of the Chinsegut Hill and Young populations and may be affecting other populations, such as the introduction and Burns Prairie. At Chinsegut Hill and the Young site, C. robinsiae was likely outcompeted by dense vegetation due to lack of disturbance, which was previously created by mowing or trampling by cattle. In addition, at Chinsegut Hill, the death of an oak tree that provided shade to C. robinsiae likely affected moisture levels (Service 2010). It is important to consider overstory composition when managing habitat. The introduction at the Blackwater Creek Preserve failed due to lack of habitat management that would have allowed cattle to graze the site. In 2012, Burns Prairie lost its grazing cattle and the only management that has taken place is that overgrown competing vegetation was removed in 2015 (Peterson, BTG pers. comm. 2019a). It is possible that this population will disappear if grazing or other habitat management is not continued. More research is needed to determine which methods are effective at managing habitat. Development of the land surrounding protected lands may alter hydrology by increasing runoff to C. robinsiae sites. This runoff may also contain fertilizers and herbicides that may affect growth and germination of the plants. C. robinsiae occurs in the Central Region of Florida, which is projected to experience the greatest population growth in the state in the near future. By 2070, the percentage of developed land is expected to double from 25% in 2010 to almost 50% (Carr and Zwick 2016). Due to modeling efforts (Lewis 2010, 2011), unknown populations and suitable habitat for introductions likely exist on private land and may be at risk to development. It is likely that agricultural lands will be converted to residential land uses in the near future (Carr and Zwick 2016). This conversion may negatively affect C. robinsiae habitat because cattle may benefit the species by providing the disturbance necessary to reduce competition from other plants. (USFWS, 2019)

Recovery

Reclassification Criteria:
Not developed

Delisting Criteria:
Not developed - Plausible criteria for recovery might include securing at least 10 viable and self-sustaining populations of Brooksville bellflower in pond margin habitats, consisting of approximately 10,000 individuals during prolific years (USFWS, 1993).

Recovery Actions:

- Develop management and protection criteria for populations on current managed areas (includes collection of biological/systematic data and control of exotic plants) (USFWS, 1993).
- Acquire additional habitat, or protect habitat through conservation easements and/or regulation. Sufficient information is available to proceed immediately (USFWS, 1993).
- Conduct additional surveys for new populations of the species (USFWS, 1993).
- Augment existing cultivated populations, including establishment of a germ plasm bank (USFWS, 1993).
- Develop plans for possible (re)introduction of plants into suitable habitats (includes 10-year monitoring of existing and/or reintroduced populations) (USFWS, 1993).
- Enforce protective legislation (USFWS, 1993).
- Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2010).
- Support further research on: a. Effects of cattle grazing on this species. b. Life history needs. c. Microhabitat requirements of this species. d. Effect of severe changes in temperatures (freezing) on germination. e. Drought and fluctuating water levels and their effect on germination. f. Transplant experiments, long-term seed viability trials, and optimizing germination protocols (USFWS, 2010).
- Continue working with public land managers to increase management efforts to benefit C. robinsiae. No management plans have been developed for this species but are necessary. Minimal management has been taking place at some sites. Once disturbance has been removed from some sites, populations have disappeared. Burns Prairie especially needs additional management because competing vegetation has taken over since grazing cattle were removed from the site. (USFWS, 2019)
- Continue conducting surveys at known sites of occurrence and expand surveys to other suitable areas in Hillsborough and Hernando Counties. This information is necessary to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites. BTG has continued conducting surveys at known sites of occurrence. This work has been made possible through annual grants from the State of Florida, Department of Agriculture and Consumer Services, Division of Plant Industry, which funds the basic operations of BTG's Rare Plant Conservation Program. Surveys have been expanded to other sites determined by a GIS model to have suitable habitat. However, due to either flood or drought conditions during the survey periods, no plants were found. One introduction took place in 2013, but no plants were found the following year due to overgrowth of competing vegetation. No plants have been found at the introduction site since. Habitat management is necessary to control competing vegetation. (USFWS, 2019)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES The same future recommendation from previous 5-year reviews remain valid. The following recommendations are a brief summary from those prior reports. A. Support research on: • Effects of cattle grazing, • Life history needs, • Microhabitat requirements, • Temperature effects on germination, • Drought and fluctuating water levels on germination. B. Transplant experiments, long-term seed viability trails, and optimizing germination protocols. C. Collaborating with land managers to increase beneficial habitat management. D. Continue conducting surveys at known locations and expand surveys to included potential suitable areas (USFWS, 2024).

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SPECIES ACCOUNT: *Cardamine micranthera* (Small-anthered bittercress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/23/1989; Southeast Region (R4)

Physical Description

It is an erect slender perennial herb with fibrous roots and one (or rarely more) simple or branched stem(s) growing 2 to 4 decimeters tall. Basal leaves are 1 to 5 centimeters long (occasionally longer), 0.5 to 2.0 centimeters wide, crenate, with one (or rarely two) pairs of small lateral lobes or leaflets. The stem leaves are alternate and mostly unlobed, 1 to 1.5 centimeters long, crenate and cuneate. Flowering and fruiting occur in April and May. The flowers, subtended by leafy bracts, have four white petals, six stamens, and small, round anthers. The fruit is a silique, 0.8 to 1.2 centimeters long and approximately 1 millimeter in diameter, with a beak 1 to 1.2 millimeters long. The brown seeds are approximately I millimeter long. Cardamine micranthera can be distinguished from its most similar relative, Cardamine rotundifolia, by its much smaller, nearly orbicular (instead of oblong) anthers, smaller flowers, and more angulate and nonclasping leaves. In Cardamine micranthera, the anthers are about 0.5 millimeter long, and the petals are 1.2 to 2 millimeters wide. Stem leaves of Cardamine micranthera are typically broadly cuneate (rarely narrowly cuneate, oblique, or cordate) and never cordate-clasping. Cardamine micranthera is typically erect, or occasionally has decumbent stems, but these do not develop proliferating branches. C. micranthera has only one to two pairs of lateral leaflets (or none), with the terminal leaflet being nearly one-half the total length. Cardamine micranthera has pedicels 9 to 15 mm long and siliques 14 to 22 mm (pods only one and one-fourth to one and one-half times the length of the stalks). The beak of the fruit corresponds to the style in the flower and is that portion of the pod extending beyond the seed-bearing part. Cardamine micranthera's beak is about 2 mm long and can be readily seen as a sharp, spindle-like tip on the pod (T. Wieboldt, personal communication, 1991). (USFWS, 1991)

Taxonomy

Cardamine micranthera was first described by R. C. Rollins (1940) from material collected in North Carolina in 1939. (USFWS, 1991)

Historical Range

Native to the Dan River drainage of the North Carolina and Virginia piedmont. Historically found in Stokes and Forsyth Counties (USFWS, 1991).

Current Range

Stokes County, North Carolina and Patrick County, Virginia. (USFWS, 2016)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Ants have been observed visiting the flowers (USFWS, 1991).

Habitat Type

Adult: Palustrine, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial shade (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Seepages, wet rock crevices, streambanks, sandbars, and wet woods along small streams (Murdock and Weakley 1991). The environmental specificity of this specie is narrow; C. micranthera occupies moist soils of the upper Piedmont that are fully to partially shaded (Murdock and Weakley 1991). More specifically, it is typically found in wet, boggy soils of deciduous woodlands and moist to wet soils along the edge of small to intermediate sized streams (NCA 1996). Within the stream bed plants also inhabit sand and gravel bars and wet rock crevices (Murdock and Weakley 1991) (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

29 (13 North Carolina. 16 Virginia) (USFWS, 2023).

Population Size:

Annual fluctuation; < 23,000 (USFWS, 2016)

Population Narrative:

Cardamine micranthera was federally listed in 1989, the listing rule described four populations all confined to the Dan River basin in North Carolina. In 1991 a recovery plan was developed for the species and by then five additional populations had been discovered in Patrick County, Virginia totaling nine extant populations (four in North Carolina and five in Virginia) (Service 1991). At the time of the 2016 5-year review, the number of known extant populations had increased from 9 to 32 (Service, 2016). New populations remained in the narrow range of the

Dan River system of Stokes County, North Carolina and Patrick County, Virginia. Estimates of abundance for the 32 extant populations of the species ranged from one plant (North Fork of South Mayo River, VA) to 8,000 – 10,000 plants (Peters Creek, VA) (Appendix A). Since the 2016 5-year review, three populations (Service populations 1, 25, and 32, Appendix A have been moved from a D-ranking (poor viability) to F (failed to find). Therefore, the current species range remains confined to 29 populations in the Dan River system in Stokes County, NC and Patrick County, VA. The 29 extant populations (13 in NC and 16 in VA) represented by current (within the last 5 years) population surveys ranged from 10 to 3,000 plants. New occurrences were identified in Patrick County, VA (Van Alstine 2018). One hundred and fifty-two new plants were found within Peters Creek and Little Peters Creek and one new plant in Russell Creek (Van Alstine, N.E. 2018). One new discrete site has been added to the Dan River, NC (NCNHP 2021). The EOs have been expanded to represent these increases. These 29 populations represent some 124 sites (28 in NC and 96 in VA). A historical review of extant populations and more current information is provided below (Tables 1 and 2). The number of populations in North Carolina has remained stable at 13 since 2016. Of these 13 populations, five were surveyed in 2013 and eight were surveyed in 2018 (NCNHP 2021). The number of extant populations in Virginia has declined from 20 to 16 (Van Alstine 2016, 2018). Of these 16 populations, 2 were surveyed in 2004, 6 in 2014, 4 in 2015, 2 in 2017 and 2 in 2020. Current estimates of abundance for the 29 populations range from ten plants (Dan River, NC) to 3,000 – 5,000 plants (Peters Creek, VA) (Appendix A). Nine of the 29 populations are in a decline, 4 are stable, 8 are increasing, and 8 are unknown. Survey data which post-dates the 2016 5-year review has been provided by the VADCR which completed population counts of C. micranthera in the area surrounding Patrick County, VA. This effort was accomplished with funds provided under Section 6 of the Act, and data includes both extant and extirpated populations. This monitoring revealed population sizes from 11 known sites. Six of the 11 populations declined, ranging from 19.29% to 100% population loss, two sites had a population increase of 68% and 90%, and three populations are extirpated. In North Carolina, nine surveys post-date the previous 2016 5-year review and include both extant and failed to find populations. Four populations declined, ranging from 28.26% to 90.38% population loss; one remains stable; and three have increased by an average of 217 plants and one population is considered a 'failed to find.' A summary of the current survey data is provided in Appendix A. Recent survey efforts find that the number of documented C. micranthera populations has decreased since the last 5-year review in 2016. Inconsistent and infrequent monitoring increases uncertainties associated with the species' status and trends and the status of individual populations cannot be adequately assessed at this time (USFWS, 2023).

Threats and Stressors

Stressor: Beaver dams (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Beaver dams have been observed to constitute a significant threat to Cardamine micranthera at some locations, with one knowledgeable observer regarding this as perhaps the most immediate threat to the species (Bridle 2009, pers. comm.). Bridle notes that beaver activity (especially in drought years) within main stream channels has flooded entire colonies of the species (USFWS, 2016).

Stressor: Habitat destruction and modification (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Habitat alteration remains the primary threat to Cardamine micrantera, with impoundment, channelization, conversion associated with agriculture or silviculture, flooding, and encroachment of exotic species as threats affecting the species. Cattle trampling and downstream beaver impoundments have also been noted as threatening C. micranthera habitat (USFWS, 2016).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: State statutes primarily regulate collection and trade in listed species, and do not prohibit land owners from neglecting or otherwise impacting such species on their own properties or in conjunction with otherwise legal activities (USFWS, 2016).

Stressor: Timber Harvest/Invasive species (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Disturbances to the floodplain, tributaries, and river basins due to timber harvesting further support erosion and sedimentation loss while also removing the canopy over stream banks where C. micranthera is often located. Additionally, these disturbances present a risk of common invasive species which were found in the Gilbert Mills, Peters Creek North, and Peters Creek Central Sites of Virginia. Microstegium vimineum (Japanese stiltgrass) was commonly found on the silt/sand bars, Lonicera japonica (Japanese honeysuckle) and Rosa multiflora (multiflora rose) were occasionally present on streambanks and Murdannia keisak (marsh dewflower) was also noted (VanAlstine, 2018). Three site records, Gilbert Mills, Peters Creek North, and Peters Creek Central Sites of Virginia, specifically note that one or more of these threats are either ongoing or imminent, further noting the need for active intervention to address them (USFWS, 2023)

Recovery

Reclassification Criteria:
Not defined (USFWS, 1991)

Delisting Criteria:
1. It has been documented that at least six populations are self-sustaining and that necessary mangement actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 1991).

2. All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 1991).

Recovery Actions:

- Protect existing populations and essential habitat. Only nine populations of small-anthered bittercress are currently known to exist, all in the piedmont of North Carolina and Virginia. Until more is known about the species' biology and specific habitat requirements, and about the measures necessary to protect occupied sites, all existing populations should be protected. The long-term survival of six populations is believed to be essential to the recovery of the species as a whole. (USFWS, 1991)
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Protection of the species' habitat is the obvious first step in ensuring its long-term survival, but this alone may not be sufficient. Since very little is known about this species, information on its population biology and ecology is necessary before effective management guidelines can be formulated and implemented.
- Develop a cultivated source of plants and provide for long-term seed storage. There are presently no cultivated sources of this species. Techniques for seed storage, germination, and maintenance of cultivated specimens must be developed. (USFWS, 1991)
- Enforce laws protecting the species and/or its habitat. The Endangered Species Act prohibits taking of Cardamine micranthera from Federal lands without a permit and regulates trade. Section 7 of the Act provides additional protection of the habitat from impacts related to federally funded or authorized projects. In addition, the 1988 amendments to the Act prohibit (1) the malicious damage or destruction of listed plants on Federal lands and (2) the removal, cutting, digging, damaging or destroying of such plants in knowing violation of any State law or regulation, including State criminal trespass law. The State of North Carolina prohibits taking of the species without a permit and the landowner's written permission and regulates trade in the species (North Carolina General Statute 19-B, 202.12-202.19). The State of Virginia prohibits taking and trade of listed species without a permit (Code of Virginia 39:3.1-1020 to 31-030). Federal and State enforcement agents whose jurisdiction includes the known range of small-anthered bittercress should be made aware of the threats to the species and be able to identify specimens. (USFWS, 1991)
- Develop materials to inform the public about the statu of the species and the recovery plan objectives. Public support for the conservation of small-anthered bittercress could play an important part in encouraging landowner assistance and conservation efforts. Information materials should not identify the plant's locations so as not to increase the threat of taking or vandalism. Annually assess success of recovery efforts for the species. Review of new information, evaluation of ongoing actions, and redirection, if necessary, is essential for assuring that full recovery is achieved as quickly and efficiently as possible. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Continue to pursue follow-up information from stream restoration project on Snow Creek (involving a portion of one population of this species) from appropriate state, federal and private parties. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Communicate existing habitat protection priorities (VDCR 2007, Boyer 1996) to state agencies, local land trusts, and other conservation partners, to assess current and future options for protection. Encourage land protection strategies focused on headwater occurrences likely to serve as a seed source for recolonization of sites further downstream (Bridle 2009, pers. comm.). (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: Identify sites which have experienced recent disturbance, and evaluate the effects of ongoing and prior habitat

disturbance upon the species. (USFWS, 1991)

- Recommendation for Future Action from 2016 5-Year Review: Utilize information obtained from assessments of prior or ongoing habitat disturbance to devise and implement appropriate habitat management guidelines. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 5. Conduct site visits to determine if Boyer's (1996) long-term monitoring transects can be relocated and resurrected. If so, reinitiate monitoring efforts to learn more about the longevity and relative stability of populations of this short-lived species. If Boyer's (1996) monitoring transects cannot be resurrected, work to establish comparable monitoring (using Boyer's protocol or modifications thereof) at priority sites using standardized monitoring methods. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 6. Use monitoring data and other information to draft objective, measurable criteria for "selfsustaining" populations . (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 7. Determine the status of genetic material held in botanical gardens and other institutions, and work to ensure that the species is adequately represented in long-term storage. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 8. Pursue development of habitat predictability models for this species, and iteratively refine and use these to search for new populations and guide land protection efforts. (USFWS, 1991)
- Recommendation for Future Action from 2016 5-Year Review: 9. Identify landowners, obtain permission to visit populations, and provide information to landowners about voluntary protection measures that may be implemented to protect the species (including best management practices, NHP Registry programs, conservation easements, and fee simple purchase by cooperating land protection agencies). (USFWS, 1991)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The following activities are recommendations to improve recovery of the species. 1. Continue to pursue follow-up information from stream restoration projects on Snow Creek (involving a portion of one population of this species) from appropriate state, federal and private parties. (Recovery Task 4). 2. Communicate existing habitat protection priorities (VDCR 2007, Boyer 1996) to state agencies, local land trusts, and other conservation partners, to assess current and future options for protection. Encourage land protection strategies focused on headwater occurrences likely to serve as a seed source for recolonization of sites further downstream (Bridle 2009, pers. comm.) (Recovery Task 1.4). 3. Identify sites which have experienced recent disturbance and evaluate the effects of ongoing and prior habitat disturbance upon the species (Recovery Task 2.4). 4. Utilize information obtained from assessments of prior or ongoing habitat disturbance to devise and implement appropriate habitat management guidelines (Recovery Tasks 2.5 and 2.6). 5. Conduct site visits to determine if Boyer’s (1996) long-term monitoring transects can be relocated and resurrected. If so, reinitiate monitoring efforts to learn more about the longevity and relative stability of populations of this short-lived species. If Boyer’s (1996) monitoring transects cannot be resurrected, work to establish comparable monitoring (using Boyer’s protocol or modifications thereof) at priority sites using standardized monitoring methods (Recovery Tasks 2.1, 2.2, and 2.3). 6. Use monitoring data and other information to draft objective, measurable criteria for “self-sustaining” populations (Recovery Tasks 2.3, 2.4, and 2.5). 7. Determine the status of genetic material held in botanical gardens and other institutions, and work to ensure that the species is adequately represented in longterm storage

(Recovery Task 3). 8. Pursue development of habitat predictability models for this species, and iteratively refine and use these to search for new populations and guide land protection efforts (Recovery Tasks 1.2 and 1.3). 9. Identify landowners, obtain permission to visit populations, and provide information to landowners about voluntary protection measures that may be implemented to protect the species (including best management practices, NHP Registry programs, conservation easements, and fee simple purchase by cooperating land protection agencies) (Recovery Tasks 1.1, 1,2, 1.3, and 1.4) (USFWS< 2023)

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SPECIES ACCOUNT: *Castilleja affinis ssp. neglecta* (Tiburon paintbrush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/6/1995; Pacific Southwest (R8)

Physical Description

Castilleja affinis ssp. neglecta (Figure II- 5) is a semi-woody perennial of the snapdragon family (Scrophulariaceae), with erect, branched stems 30 to 60 centimeters (1 to 2 feet) tall and a sparse covering of soft, spreading hairs (Munz and Keck 1959). The lance-shaped leaves are 20 to 40 millimeters (0.8 to 1.6 inches) long and have 0 to 5 lobes (Hickman 1993). The conspicuous floral bracts are yellowish and sometimes red-tipped; the flowers are yellow to red and 18 to 20 millimeters (0.7 to 0.8 inch) long. (USFWS, 1998)

Taxonomy

Transferred to varietal rank by Egger (2008). Treated as Castilleja affinis ssp. neglecta by Kartesz (1999 Synthesis), by The Jepson Manual (Hickman, 1993) and by the U.S. Fish and Wildlife Service. Originally named as a species (Castilleja neglecta), and treated at that level by Kartesz (1994). Kartesz notes (pers. comm. to Larry Morse, 25Nov99) that his treatment of this as a subspecies is based on a 1992 personal communication with Chuang. (NatureServe, 2015)

Historical Range

Never widespread; in 1998, locations were on the Tiburon Peninsula in Main County, one population in Napa County, and one population in Santa Clara County (USFWS, 1998)

Current Range

Known from Marin, Napa, Santa Clara counties in California (USFWS, 2012)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2012)

Dependency on Other Individuals or Species

Adult: The yellow flowers of Castilleja affinis ssp. neglecta are pollinated by hummingbirds (County of Santa Clara et al. 2010). (USFWS, 2012)

Breeding Season

Adult: April to June (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Low temperatures and leaching (USFWS, 1998)

Reproduction Narrative

Adult: Castilleja affinis ssp. neglecta is a root parasite on other angiosperm (flowering plant) species. Castilleja affinis ssp. neglecta is a perennial, flowering from April to June (Munz and Keck 1959). The yellow flowers of Castilleja affinis ssp. neglecta are pollinated by hummingbirds (County of Santa Clara et al. 2010). Seed germination occurs in January or February and seems to be induced by leaching and low temperatures (5 to 15 degrees Celsius or 45 to 59 degrees Fahrenheit) (Martin 1989). The mean number of inflorescences per plant was 2.3, the mean number of capsules per inflorescence was 8.8, and the mean number of seeds per capsule was 82.3. Based on these figures, seed production for 1 year was calculated to be 1,666 seeds per plant (Martin 1989). The plant dies back to its woody base after seed dispersal and new growth occurs after the first winter rain. Heckard (1968) observed evidence that polyploidy leads to patterns of variation that can lead to hybridization while plants maintain differences in their appearance. (USFWS, 1998; USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Serpentine grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Leaching and low temperatures (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Grows at elevations between 75 and 400 meters (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Scattered colonies (USFWS, 2012)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012)

Site Fidelity

Adult: High (inferred from USFWS, 2012)

Dependency on Other Individuals or Species for Habitat

Adult: The primary advantage of the parasitic attachment in Castilleja and related plants in the figwort family is reportedly an increased water and mineral supply. Though the parasitic relationship is not obligate (hemiparasitic), benefits to species of Castilleja from the parasitic habit are manifested in increased vigor with more branching, greater height, and earlier flowering (Heckard 1962). Heckard (1962) showed that a host plant is beneficial to Castilleja affinis spp. neglecta and increases the species' chance for survival. (USFWS, 1998)

Habitat Narrative

Adult: Three scattered colonies of the occurrences of Castilleja affinis ssp. neglecta in Marin County occur on the Tiburon peninsula. Castilleja affinis ssp. neglecta occurs in serpentine bunchgrass communities typically on north to west facing slopes. Castilleja affinis ssp. neglecta grows on open, rocky, serpentine slopes within the serpentine grassland communities, between

about 75 and 400 meters in elevation in Napa, Marin, and Santa Clara Counties (Service 1998, Safford et al. 2005, LSA 2007, CDFG 2010). Seed germination occurs in January or February and seems to be induced by leaching and low temperatures (5 to 15 degrees Celsius or 45 to 59 degrees Fahrenheit) (Martin 1989). Castilleja affinis ssp. neglecta parasitic attachment increases water and mineral supply. Though the parasitic relationship is not obligate (hemiparasitic), benefits to species of Castilleja from the parasitic habit are manifested in increased vigor with more branching, greater height, and earlier flowering (Heckard 1962). Heckard (1962) showed that a host plant is beneficial to Castilleja affinis spp. neglecta and increases the species' chance for survival. (USFWS, 1998; USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal occurs from June to October. (USFWS, 2012)

Additional Life History Information

Adult: Seed dispersal occurs from June to October. (USFWS, 2012)

Population Information and Trends

Number of Populations:

8 (USFWS, 2012)

Population Size:

Approximately 2,000 plants (USFWS, 2012)

Population Narrative:

The distribution of C. affinis ssp. neglecta has never been widespread. Seven occurrences are described: five in Marin County (three of which occur on the Tiburon Peninsula), one near American Canyon in Napa County, and one in Santa Clara County (Service 1998, CDFG 2010). The CNDDB reports one additional occurrence in Santa Clara County (CDFG 2010) and one occurrence from Stinson Beach in Marin County that was last observed at 1965 with the exact location and number of plants listed as unknown (CDFG 2010). The range of C. affinis ssp. neglecta is approximately 50 kilometers (30 miles) from east to west, and 112 kilometers (70 miles) from north to south (Service 1995). (USFWS, 2012)

Threats and Stressors

Stressor: Residential Development (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: When Castilleja affinis ssp. neglecta was listed as endangered in 1995, residential development was identified as a primary threat to Marin County populations. It remains a significant threat today. At the time of listing, the St. Hilary's church occurrence on the Tiburon peninsula was threatened by a proposed residential development. A portion of the land supporting this population was purchased by the Marin County Open Space District and Town of Tiburon in 1997 as an open space preserve (the Old St. Hilary's Open Space Preserve), however, a

portion of the population remains on private land where residential development has been proposed on multiple occasions. Residential development on the Middle Ridge adjacent to Tiburon paintbrush habitat is anticipated to occur in the near future (S. Anderson personal communication 2009). (USFWS, 2012)

Stressor: Mining/Landfill (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Both Santa Clara County occurrences of Castilleja affinis ssp. neglecta occur on private land associated with the Kirby Canyon Landfill. However, both are located in areas currently managed as mitigation sites for landfill impacts. Both occurrences are monitored and managed by the Kirby Canyon Butterfly Trust, but neither site is permanently protected (County of Santa Clara et al. 2010). At the time of listing, the Napa County occurrence was threatened by the potential expansion of the American Canyon Quarry. In 1999 private landowners donated land supporting 5 to 10 percent of the Castilleja affinis ssp. neglecta occurrence to the City of American Canyon in order to create the Newell Preserve; the Land Trust of Napa County holds a conservation easement on the preserve land (Napa County Land Trust website). Currently, there are no active plans for quarry expansion on the land that supports the majority of this occurrence and quarry reclamation which was initiated in 2007 is not anticipated to affect this occurrence (D. Barrella personal communication 2011). However, the quarry property is in an area zoned for agriculture and low density residential and could potentially be developed in the future. (USFWS, 2012)

Stressor: Recreation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: At the time Castilleja affinis ssp. neglecta was listed, we cited pedestrian traffic associated with recreation activities as a Factor A threat for the Middle Ridge and Ring Mountain populations of C. affinis ssp. neglecta on the Tiburon peninsula. Currently, wayward trails continue to crisscross Ring Mountain Preserve resulting in a small reduction in available habitat. C. affinis ssp. neglecta is most likely to be negatively affected by hikers, cyclists, and equestrians if they stray from designated and social trails and trample plants or if new trails are established. C. affinis ssp. neglecta plants on the Middle Ridge of the Town of Tiburon faces threats from hikers and their dogs that trample plants and habitat despite posted signs warning sensitive plant habitat (E. Buxton personal communication 2009). (USFWS, 2012) Currently, visitors are only allowed to visit Newell Preserve in Napa County during docent-led tours. Therefore, trampling and habitat destruction from recreational hikers, dogs, cyclists, and equestrians is currently not a threat to this Castilleja affinis ssp. neglecta occurrence. However, a master plan is being developed for the preserve that will likely include allowing public access without docent supervision. (USFWS, 2012)

Stressor: Landslide/Erosion (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: At the time of listing, soil slumping was identified as a threat to the Castilleja affinis ssp. neglecta occurrence at Ring Mountain Preserve (Service 1995). The toe of the slope that supports the population was removed to accommodate residential development in Corte Madera in the 1960s and soil from the slope slips onto the street below. Some Town of Tiburon Open space parcels are mapped as being prone to landslides and erosion occurs along some trails and watercourses on open space parcels, but neither appears to be a major threat to C. affinis ssp. neglecta at this time (LSA 2010). (USFWS, 2012)

Stressor: Grazing (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Cattle grazing was cited as a factor C threat to Castilleja affinis ssp. neglecta at the time of listing. Improper grazing may remain a potential threat to the species, however, grazing can also be used as a management tool to reduce biomass of non-native vegetation and may actually be beneficial to the species if managed appropriately (County of Santa Clara et al. 2010). (USFWS, 2012)

Stressor: Herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Mammal herbivory by mule deer (Odocoileus hemionus) and black-tailed jackrabbits (Lepus californicus) may pose a threat to Castilleja affinis ssp. neglecta on the Ring Mountain Preserve. Results from 2007 monitoring showed that approximately 25 percent of the inflorescence branches in the 53 plants evaluated were removed by herbivory (LSA 2007). However, side branches developed when tips of branches were removed, so this type of herbivory may not pose a substantial threat. Disturbance from feral pig (Sus scrofa) rooting poses a threat to the Paintbrush Hill occurrence in Santa Clara County (County of Santa Clara et al. 2010). Cameras placed at the Santa Clara occurrences have documented rabbits and deer in the area and sharp incisions on the plants suggest that rabbits may be eating some C. affinis ssp. neglecta flowers and fruit at this location (C. Niederer personal communication 2011). It is not known whether any diseases threaten the species. (USFWS, 2012)

Stressor: Non-native Invasive Plant Species (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Competition from non-native invasive plant species continues to pose a serious threat to Castilleja affinis ssp. neglecta on the Tiburon peninsula. At the Ring Mountain Preserve, the Marin County Open Space District has been working to eradicate or control non-native invasive species for several years. The Ring Mountain Preserve Sensitive Resource Monitoring Plan (LSA Associates, Inc. 2007) provides a list of non-native invasive species that currently occur on Ring Mountain and describes treatment recommendations. Similarly, the Town of Tiburon has an Open Space Resource Management Plan (LSA 2010) that addresses invasive species that affect the Middle Ridge occurrence of C. affinis ssp. neglecta. Bull thistle (Cirsium vulgare), French broom (Genista monspessulana), and wild oats (Avena spp.), are problematic on parcels supporting C. affinis ssp. neglecta. Weed abatement is an ongoing activity that will likely need to

occur in perpetuity at these locations. (USFWS, 2012) Non-native invasive plant species occur to some extent in association with occurrences of Castilleja affinis ssp. neglecta outside the Tiburon peninsula as well. Point Reyes National Seashore is working to control an invasion of distaff thistle (Carthamus lanatus) in the vicinity of the Nicasio Ridge occurrence of C. affinis ssp. neglecta within the GGNRA and hand removal of tocolote (Centaurea melitensis) is conducted on Nicasio Ridge once or twice a year as funding allows. At this time, however, these non-native species do not appear to pose a serious threat to the Nicasio Ridge C. affinis ssp. neglecta occurrence (M. Chasse personal communication 2011). Treatments for barbed goatgrass (Aegilops triuncialis) have taken place on the Kirby Canyon Butterfly Preserve that supports Paintbrush Hill occurrence of C. affinis ssp. neglecta in Santa Clara County (Niederer 2008) and a number of non-native species occur in low densities within the North Canyon occurrence in Santa Clara County (C. Niederer personal communication 2009). At these two locations, efforts to control non-native plant species are necessary to keep them in control, but at this 14 time cattle grazing and current efforts appear to have prevented severe encroachment of non-native species (C. Niederer personal communication 2009). (USFWS, 2012)

Stressor: Nitrogen Deposition (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Air pollution and the resultant deposition of reactive airborne nitrogen has become a significant threat to many native California plants, in particular to those that occur in nutrient poor soils such those in serpentine areas (Weiss 1999). Increased nitrogen deposition allows nutrient-poor serpentine soils to be invaded by non-native annual grasses that displace the native forbs (Weiss 1999). Nitrogen deposition is especially high near urban areas where combustion sources produce substantial concentrations of nitrogen oxides (Weiss 1999). All occurrences of Castilleja affinis ssp. neglecta occur within or adjacent to urban areas with elevated levels of nitrogen deposition with particularly high nitrogen deposition levels occurring in Santa Clara County near San Jose (Weiss 2006). (USFWS, 2012)

Stressor: Stochasticity (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The limited number and small sizes of Castilleja affinis ssp. neglecta occurrences increase this species vulnerability to chance events such as fire, flood, drought, disease, and other natural and human-caused disasters (Brook et al. 2002). The occurrences of C. affinis ssp. neglecta on the Tiburon peninsula in particular are located in close proximity to dense, residential development placing them at risk of catastrophic events associated with human activity such as fire or vandalism. In addition, small populations are subject to inbreeding (mating between closely related individuals) resulting in a subsequent loss of genetic diversity (Spielman et al. 2004). Small populations are also more likely to experience extinction as a result of “stochastic” demographic fluctuations or other density-dependent effects (Avise 2004). (USFWS, 2012)

Stressor: Climate Change/Drought (USFWS, 2012)
Exposure:
Response:

Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. The models suggest that shifts in species ranges may break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). While it appears reasonable to assume that Castilleja affinis ssp. neglecta will be affected by climate change, we lack sufficient certainty regarding how and how soon climate change will affect the species. Because C. affinis ssp. neglecta is restricted to limited and patchily distributed serpentine soils, however, the species will likely have difficulty shifting its range to adjust to changing conditions. (USFWS, 2012)

Recovery

Reclassification Criteria:
1. Six (6) populations of Castilleja affinis ssp. neglecta are fully protected and managed with the primary intention of preserving the populations in perpetuity (USFWS, 1998)

2. Six (6) populations of Castilleja affinis ssp. neglecta are shown to be stable or increasing with evidence of recruitment over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 1998)

3. Seed collected from natural populations throughout the range of the species is stored at a minimum of two Center for Plant Conservation certified botanic gardens (USFWS, 1998)

4. Reliable seed germination and propagation techniques for the species are understood (USFWS, 1998)

Delisting Criteria:
1. Ten (10) populations throughout its range are shown to be fully protected and managed with the primary intention of preserving the populations in perpetuity. At least 2 of the 10 should occur in Santa Clara County. (USFWS, 1998)

2. Ten (10) populations of Castilleja affinis ssp. neglecta are shown to be stable or increasing with evidence of recruitment over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 1998)

3. Seed collected from natural populations throughout the range of the species is stored at a minimum of two Center for Plant Conservation certified botanic gardens (USFWS, 1998)

4. Reliable seed germination and propagation techniques for the species are understood (USFWS, 1998)

Recovery Actions:

- Protecting and managing the known populations. Protection and management of populations on public lands will involve working with Main Open Space District, the town of Tiburon, and the Golden Gate National Recreation Area to ensure the long-term survival of the species on their lands. The populations, or portions of populations, occurring on private lands should be protected by land acquisition, conservation easements, or other mechanisms. Among populations on private land, protection of the only known population in Santa Clara County is a particularly high priority because it is geographically disjunct from other populations. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In addition, other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing Castilleja affinis ssp. neglecta and other special status species in each location must be developed and implemented. The plans should include provisions for standardized monitoring of Castilleja affinis ssp. neglecta populations every other year to determine demographic trends. The plans should also include strategies to minimize known threats (e.g. foot traffic) at the sites as well as to identify new threats should they appear. Removal of nonnatives should be a high priority for management of sites on the Tiburon Peninsula such as those on Middle Ridge and in Main County Open Space near Old St. Hilary's Church. In addition, soil slumping at the Ring Mountain Preserve needs to be minimized. If new threats are identified or other new information becomes available, management plans need to be reevaluated and revised. For populations on public lands, any management plan developed should include an educational outreach program. (USFWS, 1998)
- Collection and banking of seed in Center for Plant Conservation certified botanic gardens. Seed banking guards against extinction of populations from chance catastrophic events and provides potential material for enhancement efforts in existing populations, repatriations, and/or introductions to new sites. In the absence of genetic data for Castilleja affinis ssp. neglecta, seed collection efforts should represent populations throughout the range of the species, including the Santa Clara County population that is at least 100 kilometers (62 miles) south of the other known populations (Elam in prep). Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
- Other potential serpentine habitat throughout the range of the species should be surveyed to determine if other populations exist. Santa Clara County, in particular, contains habitat that should be surveyed (e.g. to the south of the known occurrence and in Henry Coe State Park east of Anderson Reservoir) (California Department of Fish and Game 1 997a). If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. (USFWS, 1998)
- The effect of various vegetation management techniques (e.g. grazing, mowing, and burning) on Castilleja affinis ssp. neglecta needs to be evaluated, because (1) Castilleja affinis ssp. neglecta occurs approximately 100 to 250 meters (328 to 820 feet) from relatively good quality bay checkerspot butterfly habitat (N. McCarten, in litt., 1998) in Santa Clara County, and (2) bay checkerspot butterfly habitat benefits from vegetation management,. Although cattle and deer grazing of Castilleja affinis ssp. neglecta has not been observed (N. McCarten, in litt., 1998), evaluation of these techniques will ensure that managers select management strategies that maintain bay checkerspot butterfly habitat while not adversely affecting Castilleja affinis ssp. neglecta. Research on the effects of

grazing are also important in recovery efforts for Castilleja affinis ssp. neglecta because grazing is a concern at the Golden Gate National Recreation Area in Main County. In addition, because other Castilleja species appear to benefit from fire (R. Raiche. cited in California Department of Fish and Game 1997b, small scale experimental burning (e.g. using burn boxes) may reveal another possible management strategy. Any experimental burning should initially be limited to a very small area (e.g. 1 square meter [10.8 square feet]). (USFWS, 1998)

- Other research needs include germination and propagation techniques, taxonomic, demographic, and genetic studies as well as mating system and pollination studies. Demographic studies should include field studies of Castilleja affinis ssp. neglecta's hemiparasitic nature, the frequency of seed germination and seedling recruitment in nature. and identification of limiting life history stages. Martin (1989) observed no seedlings in the field during a 2-year study. Genetic studies should focus on whether, and to what extent, populations throughout the range of the species are genetically different from one another. These genetic data would be valuable guides as to which populations should be chosen as sources for enhancement of existing populations or introduction of new populations. (USFWS, 1998)
- Control and eradicate non-native, invasive plant species: continue to control non-native plant species at Ring Mountain Preserve and Town of Tiburon Open Space parcels according to existing management plans. Amend the Town of Tiburon Open Space Management Plan to include the Old Saint Hilary's Church Open Space parcel. Develop and implement management plans for controlling non-native invasive plant species in the area supporting the two Castilleja affinis ssp. neglecta occurrences on GGNRA land in Marin County, on the Newell Preserve in Napa County, and for the mitigation lands supporting the two C. affinis ssp. neglecta occurrences in Santa Clara County. (USFWS, 2012)
- Locations that should be targeted for protection in cooperation with willing landowners: in Santa Clara County, establish a conservation easement on the 250 acre Bay checkerspot butterfly reserve that supports the Paintbrush Hill C. affinis ssp. neglecta occurrence and on the entire mitigation parcel that supports the North Canyon occurrence. In Napa County, pursue opportunities to acquire or incorporate land supporting C. affinis ssp. neglecta in the former quarry area into Newell Open Space Preserve. In Marin County, establish a conservation easement on all remaining undeveloped serpentine habitat in the Old St. Hilary's Church area as mitigation for any development that takes place on private parcels in this location. (USFWS, 2012)
- Monitoring: Continue to monitor Castilleja affinis ssp. neglecta on the Ring Mountain Preserve using the 24 established 1m2 monitoring plots for three years using the same parameters as those used in 2007 thereafter, every two years as recommended by the 1998 Recovery Plan (Service 1998). Add a monitoring protocol for Castilleja affinis ssp. neglecta to the Town of Tiburon Open Space Management Plan. In Marin County on GGNRA land, continue monitoring Castilleja affinis ssp. neglecta at Nicasio Ridge and initiate monitoring at CNDDB occurrence 6. Include monitoring of grazing effects at these locations. (USFWS, 2012)
- Seeds from Castilleja affinis ssp. neglecta should be collected from populations throughout the range and banked in Center for Plant Conservation certified gardens. (USFWS, 2012)
- Other serpentine habitats with the potential to support Castilleja affinis ssp. neglecta should be surveyed to determine whether undiscovered populations exist. New populations should be noted with the appropriate County, California Department of Fish and Game, the Service

and the California Native Plant Society. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: In this section we propose recommendations which will aid in the recovery and conservation of Tiburon paintbrush. Some of these recommendations have already been discussed in previous recovery documents (Service 1998; Service 2012) and have been carried over into this status review. 1) Continue to control and eradicate non-native, invasive plant species. Use existing management plans or develop and implement management plants including controlling nonnative invasive species for all protected areas. 2) In cooperation with willing landowners, target protection of Tiburon paintbrush occurrences on unprotected lands. Continue to work with partners to protect occurrences on private lands, including buffers around them when possible. In particular, pursue opportunities to permanently protect land supporting Tiburon paintbrush in the former quarry area adjacent to the Newell Open Space Preserve in Napa County, and the area immediately east of the Golden Gate National Recreation Area land at Nicasio Ridge in Marin County. 3) Monitor or continue to monitor all existing Tiburon paintbrush occurrences using a consistent protocol. Implement survey protocols carefully to minimize damage to plants (e.g., if attempting to distinguish individual plants) or trampling from group visits. 4) Survey additional serpentine habitats with the potential to support Tiburon paintbrush to determine whether undiscovered populations exist. Habitat suitability studies or iterative niche modeling could be used to identify potential habitat areas. New populations should be noted with the appropriate County, California Department of Fish and Wildlife, the Service, and the California Native Plant Society. 5) Seeds from Tiburon paintbrush should be collected from populations throughout the range and banked in Center for Plant Conservation certified gardens. Priority should be placed on populations that do not yet have seeds banked. 6) Conduct or continue research on Tiburon paintbrush. Continue research on host plants, including testing additional species and host plant preference, and on seed germination. Identify environmental factors that might influence suitability of the habitat in occupied areas (and that might explain absence from other areas). Continue evaluation of exclosures to prevent grazing/rooting and, depending on results, consider additional exclosures or a fence around the Paintbrush Hill population. (USFWS, 2021)

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SPECIES ACCOUNT: *Castilleja campestris ssp. succulenta* (Fleshy owl's-clover)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/26/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A hemiparasitic annual herb, mostly 5-25 cm tall, with fleshy, somewhat brittle leaves. Produces dense inflorescences of yellow to white flowers subtended by green bracts. (NatureServe, 2015)

Taxonomy

Both Kartesz and the Fed. Reg. agree on the nomenclature of this element and now recognize it as part of the genus Castilleja (as opposed to Orthocarpus). (NatureServe, 2015)

Historical Range

The historical distribution between 1937 and 1986 was reported from 33 occurrences (Hoover 1937, 1968, CNDDB 2005), all in the Southern Sierra Foothills Vernal Pool Region (Keeler-Wolf et al. 1998). Sixteen of those occurrences, including the type locality, were in eastern Merced County. Six occurrences each were in Fresno and Madera Counties and five others were in Stanislaus County (CNDDB 2003). (USFWS, 2011)

Current Range

Succulent owl's-clover is geographically distributed in vernal pool complexes that are primarily along the lower foothill grasslands of the eastern San Joaquin Valley. Within the San Joaquin Valley, the succulent owl's-clover is distributed throughout five counties: San Joaquin, Stanislaus, Merced, Madera, and Fresno Counties. The species is also found in the southeastern Sacramento Valley within San Joaquin County. The current species range is approximately 50 kilometers (31 miles) wide from east to west, and 243 kilometers (151 miles) long from north to south. While the range of succulent owl's-clover has expanded since it was described at listing, the current species distribution is similar to what we described in our 2011 review (USFWS, 2023)

Critical Habitat Designated

Yes; 2/10/2006.

Legal Description

On August 6, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Castilleja campestris ssp. succulenta (Fleshy owl's-clover) (and other vernal pool species) under the Endangered Species Act of 1973, as amended (Act) (68 FR 46684 - 46867). On August 11, 2005, the Service issued a Final Rule that excluded some lands addressed in the 2003 rule from the final designation for economic reasons (70 FR 46924 - 46999). On February 10, 2006, the Service issued administrative revisions to the Final Rule (71 FR 7118-7316). The critical habitat designation for Castilleja campestris ssp. succulenta includes six critical habitat units (CHUs) in California.

Critical Habitat Designation

The critical habitat designation for Castilleja campestris ssp. succulenta includes six CHUs (some with multiple parts) in Fresno, Madera, Mariposa, Merced, San Joaquin, Stanislaus, and Tuolumne Counties, California. This species critical habitat encompasses approximately 175,873 acres (68 FR 46684 - 46867; 70 FR 46924-46999; 71 FR 7118-7316).

Unit 1: Sacramento and San Joaquin Counties, California. From USGS 1:24,000 scale quadrangles Clay and Lockeford.

Unit 2: Tuolumne and Stanislaus Counties, California. From USGS 1:24,000 scale quadrangles Keystone, La Grange, Cooperstown and Paulsell.

Unit 3: Mariposa and Merced Counties, California. (i) Unit 3A: Mariposa and Merced Counties, California. From USGS 1:24,000 scale quadrangles Merced Falls and Snelling.

Unit 3B: Mariposa and Merced Counties, California. From USGS 1:24,000 scale quadrangles Merced Falls, Snelling, Indian Gulch, Haystack Mountain, Yosemite Lake, Winton, Owen's Resevoir, Planada and Merced.

Unit 4: Madera and Merced Counties, California. (i) Unit 4A: Madera and Merced Counties, California. From USGS 1:24,000 scale quadrangle Raynor Creek.

Unit 4C: Madera and Fresno Counties, California. From USGS 1:24,000 scale quadrangles Millerton Lake West, Little Table Mountain, Daulton, Friant, Lanes Bridge and Gregg.

Unit 5: Fresno County, California. (i) Unit 5A: Fresno County, California. From USGS 1:24,000 scale quadrangles Friant and Round Mountain.

Unit 5B: Fresno County, California. From USGS 1:24,000 scale quadrangle Clovis.

Unit 6: Fresno County, California. (i) Unit 6A: Fresno County, California. From USGS 1:24,000 scale quadrangles Millerton Lake East and Academy.

Unit 6B: Madera County, California. From USGS 1:24,000 scale quadrangles North Fork and Millerton Lake East.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The primary constituent elements of critical habitat for Castilleja campestris ssp. succulenta (Fleshy owl's-clover) are the habitat components that provide:

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described in paragraph (c)(8)(ii) of this section, providing for dispersal and promoting hydroperiods of adequate length in the pools; and

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

Special Management Considerations or Protections

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/or primary constituent elements in adjacent critical habitat.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (annuals) (USFWS, 2011)

Breeding Season

Adult: April and May (USFWS, 2011)

Reproduction Narrative

Adult: Castilleja campestris ssp. succulenta is an annual plant. Seeds of the C. campestris ssp. succulenta do not require the presence of a host to germinate, as they form root connections only after reaching a seedling stage.

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Small, seasonal pools. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occur at elevations of 24 m (80 feet) to 700 m (2,300 feet). (USFWS, 2011)

Spatial Arrangements of the Population

Adult: Widely scattered (USFWS, 2011)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2011; NatureServe, 2015)

Habitat Narrative

Adult: Castilleja campestris ssp. succulenta is found primarily in vernal pools, and only in the lower rolling foothill areas of the eastern San Joaquin Valley in the Southern Sierra Foothills

Vernal Pool Region (Service Recovery Plan 2005). Soil textures at those sites range from extremely stony loam to loamy clay. At the U.C. Merced site and the surrounding community planning area, 81.4% of the individual pools where this taxon was found were on Redding gravelly loam, 9.5% were on Corning gravelly sandy loam, 6.4% were on Corning gravelly loam, 1.7% were on Keyes gravelly loam, 0.7% was on Keyes gravelly clay loam, and 0.3% was on Pentz loam (EIP Associates 1999). Self-pollinating species of Castilleja typically occur as widely scattered individuals, rather than dense colonies (Atsatt 1970). Populations of Castilleja campestris spp. succulenta have been reported from elevations of 24.0 m (80 feet) at the San Joaquin County site to 700.0 m (2,300 feet) at Kennedy Table in Madera County (CNDDB 2003). (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Number of Populations:

99 presumed extant occurrences (USFWS, 2023)

Adaptability:

Low (inferred from USFWS, 2011)

Population Narrative:

The Department (2020, pp. 9–10) defines an element occurrence (also known as an EO and hereafter, occurrence) in the Diversity Database as a specific location where a special status species has been known to occur. A single occurrence can contain multiple distinct sites (i.e., multiple interconnected pools within a single pool complex) where the species occurs. Generally, populations, individuals, or colonies located within a quarter mile of each other constitute a single occurrence. Geographic boundaries or polygons associated with each occurrence can change as additional data is received (Department 2020, p. 10). At the time of listing, the succulent owl's-clover was distributed over 36 extant occurrences throughout Merced, Fresno, Madera, Stanislaus, and San Joaquin Counties (Service 1997, p. 14349). The 2011 5-year review reported 99 occurrences throughout the same counties as those at listing but also included Mariposa County. Nine of those occurrences, which were not identified by occurrence number, were reported as extirpated and 90 were presumed extant (Service 2011, p. 6). The increase in occurrences was attributed to an increase in the number of surveys following listing (Service 2011, p. 8). In 2023, there are 99 reported occurrences that are presumed extant, two of which are possibly extirpated (occurrence numbers 1 and 7) (Diversity Database 2023, pp. 1, 8). None of the current occurrences are described as extirpated and it is unclear which occurrences were previously described as extirpated or why their status was changed. Since the previous 5-year review, 12 new occurrences have been reported for succulent owl'sclover to the Diversity Database (occurrence numbers 100–111) and additional locations have been identified that are not currently in the Diversity Database. However, these additional occurrences are located within the existing range of the species and do not change our understanding of the species' distribution. Furthermore, three previous occurrences reported in 2011 (occurrence numbers 63, 81, and 82) have been added to nearby occurrences in the Diversity Database.

Number 63 has been added to occurrence number 27, number 81 has been added to occurrence number 79, and number 82 has been added to occurrence number 80 (Diversity Database 2023, pp. 25, 72, 73). Again, it is unclear why there is a discrepancy between the number of occurrences reported during the 2011 5-year review and the number of occurrences reported currently. Abundance: At the time of listing, there were 24 occurrences of succulent owl's-clover that had associated plant number estimates and approximately 10 of these occurrences contained fewer than 100 plants each at their peak size (Service 2011, p. 14). Occurrence data was not used in the 2011 5- year review to determine plant population trends due to inconsistently documented plant numbers recorded during surveys and fluctuations of data from year to year (Service 2011, p. 14). However, the 2011 5-year review noted that as of 2009, Diversity Database records showed that 35 occurrences contained plant number estimates with 16 occurrences having fewer than 100 plants and 17 occurrences with more than 100 plants (Service 2011, p. 14). According to the Diversity Database (2023) and additional sources (identified in Table 1), 17 out of 99 presumed extant succulent owl's-clover occurrences have been surveyed since the last 5-year review. Survey data for these occurrences are detailed below in Table 1 and summarized by county in the following subsections (USFWS, 2023).

Threats and Stressors

Stressor: Habitat degradation
Exposure:
Response:
Consequence:
Narrative: The 1997 final rule stated that nearly half of the extant Castilleja campestris ssp. succulenta occurrences are threatened by man-made activities such as urbanization, agricultural land conversion, discing, trampling due to overgrazing, mining, and a proposed road expansion project. The threats presented in the listing rule are still relevant. The habitat of this species has been reduced and fragmented throughout its range and vernal pools continue to be removed by the factors previously noted. Lands on the Central Valley floor are closer to existing cities and agricultural lands than the valley rim, which is steeper, less fertile and more removed from cities. As a result, valley floor vernal pools, along with open rangeland, have been and continue to be favored for urban and agricultural development. (USFWS, 2011)

Stressor: Stressor
Exposure:
Response:
Consequence:
Narrative: According to a University of California, Berkeley study, the native plants unique to California are vulnerable to global climate change and that two-thirds of these endemics could suffer more than an 80% reduction in geographic range by the end of the century (U.C. Berkeley Press Release, June 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). It is unknown at this time if climate change in California specifically will result in a warmer trend with localized drying, higher precipitation events, or other effects. (USFWS, 2011)

Stressor: Small population size
Exposure:

Response:
Consequence:
Narrative: Since the final listing rule, an additional threat to Castilleja campestris ssp. succulenta is that many of its populations are small in number. A small population size makes a population more vulnerable to extirpation from chance events as noted in the 2005 Recovery Plan. Among the 24 occurrences of C. campestris ssp. succulenta for which size estimates had been documented, ten consisted of fewer than 100 plants each at their peak size (J. Stebbins in litt. 2000b, CNDDB 2003). According to the 2009 CNDDB occurrences, 35 have population size estimates documented with approximately 16 occurrences with fewer than 100 plants and approximately 17 occurrences with more than 100 plants.

Stressor: Rainfall
Exposure:
Response:
Consequence:
Narrative: This taxon is very cyclical and is somewhat scarce in normal or below normal rainfall years but large populations may be evident in wet years at the known sites (J. Stebbins, pers. comm. 2009). (USFWS, 2011)

Stressor: Habitat Loss (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Of the three counties analyzed in the Vollmar et al. (2013, p. 28) study, vernal pool grassland habitats in Merced County have experienced the lowest loss of predicted extant habitat for succulent owl's-clover. This lower loss of predicted habitat is likely due to the relatively protected nature of the succulent owl's-clover's primary preferred habitat in high terrace terrain that is not as conducive to conversion for agriculture or development, such as the secondary preferred habitat in lower terrace terrain (Vollmar et al. 2013, p. 28). As of 2010, a total of 54,971 acres of extant succulent owl's-clover habitat was predicted to remain within the core recovery areas in Merced County, and a total of 5.6% (3,198 acres) of extant habitat is predicted to have been lost between 2005–2010 (Vollmar et al. 2013, p. 31). The primary cause of vernal pool habitat loss in Madera and Merced Counties is a result of conversion for agricultural uses and development (Vang et al. 2012, p. 30; Witham 2021, p. 8). However, outside of vernal pool preservation, there are some lesser-degree protections in place for the extant vernal pool habitat that lies within portions of the Great Valley. For example, while most private lands that contain high-quality vernal pool habitat adjacent to the Madera and Friant-Kern canals are not associated with conservation easements or other protections, most extant rangeland along the canals is under contracts with local government under the California Land Conservation Act of 1965 (also known as the Williamson Act), which means land use is restricted to agricultural or open space use and such restrictions can help to limit development and habitat loss (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:

Narrative: As described in the 2011 5-year review, climate change has the potential to alter the timing and synchronicity of ecosystem processes, including the germination, growth, and pollination of succulent owl's-clover. The core areas in the Recovery Plan were developed, in part, using current known habitat boundaries for the species; however, possible new areas of suitable habitat may eventually arise because of worsening climate change and altered weather patterns (Service 2005, p. I-25). This could in turn contribute to shifts in the abundance or composition of vernal pool plant communities. Over the 21st century, global climate models predict higher temperatures, increasing potential evapotranspiration from plants and soils, longer and more severe droughts, declining snowpack, more intense precipitation events, more frequent and extensive wildfires, and sea level rise (Fernandez-Bou et al. 2021, p. 17). Worldwide, plants with less static ecosystem requirements are generally responding to climate change patterns by redistributing to higher altitudes, cooler areas of higher latitudes, and areas with higher precipitation, to seek refuge from rising temperatures and drought conditions (Shay et al. 2021, p. 2). Data is limited on how vernal pool plant communities and distributions may respond to increasing threats from global climate change. However, studies have begun to expand focus to identify the possible effects to plant phenology and species ranges that could arise from climate change. Historical data in the San Joaquin Valley from 1961 to 1990 show an increase in average maximum temperatures by about 1 degree Fahrenheit (0.5 degree Celsius); temperatures in the Valley are projected to continue to increase 4 to 5 degrees Fahrenheit (2.2 to 2.7 degrees Celsius) by 2050, and 5 to 8 degrees Fahrenheit (2.7 to 4.4 degrees Celsius) by the end of the century, depending on what level of emissions are actively reduced over time (Fernandez-Bou et al. 2021, p. 18). Recent research was conducted using the creation of hydrology and vegetation models to predict how climate change will impact volcanic vernal pools in northern California (Montrone et al. 2019, pp. 9–23). Simulation output suggests that higher localized seasonal temperatures would contribute to increased evaporation and shorter hydroperiods in vernal pools. This effect could lead to declines of the long-term inundated plant community, and conversely, edge and shallow-tolerant plant communities would increase (Montrone et al. 2019, p. 27). Within the warmer San Joaquin Valley, shorter hydroperiods in vernal pools could lead to competition and encroachment on succulent owl's-clover from nonnative invasive annual grasses and forbs that are less adapted to periodic inundation (Rains et al. 2006, p. 20; Javornik and Collinge 2016, pp. 65–66). Restoration and conservation efforts conducted over the next century in the San Joaquin Valley will need to be sited (and timed within the growing season) to focus on how changes in local precipitation and temperature patterns can impact the success of these efforts (USFWS, 2023).

Stressor: Pesticide Use (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Because the agriculture industry is so prevalent throughout the southern Sierra foothills, research is becoming increasingly important to analyze potential effects of pesticide use on vernal pool grassland ecosystems and pollinators. The Environmental Protection Agency recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (EPA 2022a, entire; EPA 2022b, entire; EPA 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. All three pesticides were determined likely to adversely affect succulent owl's-clover, primarily due to expected indirect effects to pollinators. The three pesticides target insect species by acting on

their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. The three pesticides are highly toxic to bees and available data suggest that all three pesticides are likely to affect honeybee and bumblebee colonies through brood reduction and declines in numbers of adults. However, the overall importance of pollinating insects for succulent owl's-clover is poorly understood. Some aspects of succulent owl's-clover biology suggest that it may be selfpollinating, but many species related to this taxon are pollinated by generalist bees (Superfamily Apoidea) (Chuang and Heckard 1991, p. 648). Analysis of these insecticides' effects to vernal pool habitat and species is ongoing (USFWS, 2023).

Recovery

Reclassification Criteria:

1. Habitat protection - Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Reintroductions must be carried out and meet success criteria established in the Recovery Plan. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to the recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the Recovery Plan. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2011)

2. Adaptive habitat management and monitoring: Habitat management and monitoring plans that ensure maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected. Mechanisms are in place to provide for long-term management and monitoring. Monitoring indicates ecosystem function has been maintained in the areas protected. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recover criteria. (USFWS, 2011)

3. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated. (USFWS, 2011)

4. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species

biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully represented by populations protected in the Habitat Protection section. Research necessary to determine appropriate parameters to measure population viability for each species has been completed. (USFWS, 2011)

5. Participation and outreach: recovery implementation team is established and functioning to oversee range-wide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships. (USFWS, 2011)

Delisting Criteria:
Same as the reclassification criteria.

Recovery Actions:

- Conduct standardized vernal pool habitat site assessments for both the Southeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions. (USFWS, 2011)
- Establish management and monitoring plans which include criteria for frequent surveys in order to capture the blooming period for this species. The Castilleja campestris ssp. succulenta population numbers vary widely from year to year depending on habitat conditions and rainfall (Vollmar 2002). Therefore, the Service should encourage bank owners and preserve managers to perform surveys on a frequent schedule in order to gather additional data which will increase knowledge. The additional information will be utilized for future 5-year reviews. (USFWS, 2011)
- The Vernal Pool Regional working group should formulate a plan to reach out and educate private landowners as to the value of federally-listed species on their lands, with a particular focus on plants. The Vernal Pool Regional group also should provide guidance to assist landowners on how to better manage their lands for the overall benefit of this species. (USFWS, 2011)
- The Service should encourage collection of seeds and storage in approved seed banks from extant occurrences, in each core area, to aid in the establishment of a seed bank. (USFWS, 2011)
- The Service should encourage County and local governments to consider developing Habitat Conservation Plans (HCPs) to include vernal pool species. Take of a federally listed invertebrate species would be permitted on private land, and any habitat acquisition to compensate for invertebrate species could include the Castilleja campestris ssp. succulenta if appropriate. Fresno County has been awarded Federal funds for the development of an HCP and additional funds may be available in the future for counties who apply for them. (USFWS, 2011)
- Efforts to protect vernal pool species should include conservation efforts on a landscape scale (Vollmar 2002). Landscape Conservation Cooperatives provide Federal scientific and technical support for conservation on a landscape scale which is the entire range of an

identified priority species. These cooperatives also have a role in helping partners identify common goals and priorities to target the right science for efficient and effective conservation. (USFWS, 2011)

- Not available

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the succulent owl's-clover. Some of these recommendations have already been discussed in previous recovery documents (Service 2005, p. ix–xii) and the previous 5-year review (Service 2011, pp. 22–23) and remain valid. 1. Research. Research is needed to determine whether succulent owl's-clover is insectpollinated. If insects are found to be important to pollination and therefore to seed production, pollinator habitat must be protected in each core area to contribute to the recovery of the species (Service 2005, p. III-13). 2. Invasive plant management. Continue to control and eradicate non-native, invasive (noxious) grass and forb species. Use existing management plans or develop and implement management plans that include control of invasive plants for all protected areas. 3. Expand survey effort for succulent owl's-clover to determine whether undiscovered populations exist. Conduct standardized vernal pool habitat site assessments for both the Southeastern Sacramento Valley and Southern Sierra Foothills vernal pool regions. A standardized monitoring plan should be used to assess hydrology at the known extant occurrences throughout the species' range. Federal and State agencies, partners, and a San Joaquin Valley recovery team should create a forum of discussion with a prioritized goal of identifying updated conservation issues and potential incentives for private landowners to become more willing to participate in conservation and surveying efforts. 4. In cooperation with willing landowners, target protection of succulent owl's-clover occurrences on unprotected lands. Apply updated study methods for identification of key areas of remaining habitat and conduct floristic surveys in core areas of the succulent owl's-clover range. Develop predicted habitat maps for the entire range of succulent owl's-clover to aid in conservation planning and species recovery of this species. 5. Seed Banking. The Service should encourage collection of seeds and storage in approved ex situ seed banks (such as the Santa Barbara Botanic Garden) from extant occurrences, in each core area in each vernal pool region, to aid in the establishment of a seed bank (USFWS, 2023).

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SPECIES ACCOUNT: *Castilleja cinerea* (Ash-grey paintbrush)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada Region (R8)

Physical Description

Aa semi-parasitic perennial plant with several ascending to decumbent (reclining on the ground) grayish stems sprouting from the root-stem. These stems are 4-8 inches (in.) (10.2-20.3 centimeters (cm)) tall. The flower stalk is usually yellow-green (sometimes reddish-orange) with yellow hairs on the lower bracts. The calyx is almost equally divided into linear lobes; the corolla is yellowish (63 FR 49006). Ash-gray paintbrush is distinguished from other Castilleja in its range by short-haired stems and leaves, yellowish flowers, calyx lobes of equal length, and its perennial nature (63 FR 49006). (USFWS, 2008)

Taxonomy

At listing, ash-grey (Indian) paintbrush was considered to be in the Scrophulariaceae (figwort) family. Recent taxonomic studies have placed the genus Castilleja and other plant genera formerly in the Scrophulariaceae into the Orobanchaceae (broomrape) family (Olmstead et al. 2001). (USFWS, 2008)

Historical Range

See current range/distribution.

Current Range

Endemic to the San Bernardino Mountains, in San Bernardino County, California. (USFWS, 2013)

Critical Habitat Designated

Yes; 1/25/2008.

Legal Description

On December 26, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 25, 2008) for Castilleja cinerea (Ash-grey paintbrush) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 24 critical habitat units (CHUs), in California (72 FR 73092-73178).

Critical Habitat Designation

The critical habitat designation for Castilleja cinerea includes 24 CHUs in San Bernardino County, California. approximately 1,769 ac (722 ha) of Federal, State, and private land are being designated as critical habitat (72 FR 73092-73178). Units are grouped by pebble plain complexes (e.g., Arrastre/Union Flat) as identified in the USFS's 2002 Management Guide. Detailed coordinates and maps are provided in the Final Rule. The 24 units contain a total of 1,769 ac (722 ha).

Units CACI 1 and CACI 2. Arrastre/Union Flat, San Bernardino County, California. CACI 1 contains 69 ac (28 ha); CACI 2 contains 229 ac (93 ha); the landowner is the U.S. Forest Service. CACI 1 is USFS Pebble Plain Number 100; CACI 2 is USFS Pebble Plain Number 87.

Units CACI 3 and CACI 4. Big Bear Lake, San Bernardino County. CACI 3 contains 21 ac (9 ha); CACI 4 contains 6 ac (2 ha); the landowner is the U.S. Forest Service. CACI 3 is USFS Pebble Plain Number 248; CACI 4 is USFS Pebble Plain Number 254.

Units CACI 5 and CACI 6. Broom Flat, San Bernardino County, California. CACI 5 contains 58 ac (23 ha); CACI 6 contains 326 ac (132 ha);. The CACI 5 landowner is the U.S. Forest Service; the CACI 6 landowners are the U.S. Forest Service (255 ac) and a private landowner (71 ac). CACI 5 is USFS Pebble Plain Number 311; CACI 6 is USFS Pebble Plain Numbers 285 and 309.

Units CACI 7, CACI 8, CACI 9. Fawnskin, San Bernardino County, California. CACI 7 contains 15 ac (6 ha); CACI 8 contains 24 ac (10 ha); CACI 9 contains 2 ac (1 ha). The landowner is the U.S. Forest Service. CACI 7 is USFS Pebble Plain Number 301; CACI 8 is USFS Pebble Plain Number 302; CACI 9 is USFS Pebble Plain "Juniper Point".

Units CACI 10, CACI 11, CACI 12, CACI 15, and CACI 16. Gold Mountain and North Baldwin Lake, San Bernardino County, California. CACI 10 contains 62 ac (25 ha); CACI 11 contains 43 ac (17 ha); CACI 12 contains 0.3 ac (0.1 ha); CACI 15 contains 320 ac (129 ha); CACI 16 contains 4 ac (2 ha). The landowner for CACI 10, CACI 11, CACI 12, and CACI 15 is the U.S. Forest Service. The landowner for CACI 16 is the California Department of Fish and Game. CACI 10 is USFS Pebble Plain Number 188; CACI 11 is USFS Pebble Plain Number 192; CACI 12 is USFS Pebble Plain "South Baldwin Meadow"; CACI 15 is USFS Pebble Plain Number 128; CACI 16 is USFS Pebble Plain Number 168.

Units CACI 13 and CACI 14. Holcomb Valley, San Bernardino County, California. CACI 13 contains 28 ac (11 ha); CACI 14 contains 44 ac (18 ha). The CACI 13 landowners ares the U.S. Forest Service (22 ac) and a private landowner (6 ac); the CACI 14 landowner is the U.S. Forest Service. CACI 13 is USFS Pebble Plain Numbers 98 and 109; CACI 14 is USFS Pebble Plain Number 153.

Units CACI 17 and CACI 18. Sawmill, San Bernardino County, California. CACI 17 contains 36 ac (14 ha); CACI 18 contains 5 ac (2 ha). The CACI 17 landowners are the U.S. Forest Service (15 ac) and a private landowner (21 ac). The CACI 18 landowner is a private landowner. CACI 17 is USFS Pebble Plain Number 236; CACI 18 is USFS Pebble Plain Number 224.

Unit CACI 19. Snow Valley, San Bernardino County, California. CACI 19 contains 26 ac (10 ha); the landowner is the U.S. Forest Service. CACI 19 is USFS Pebble Plain Number 270.

Unit CACI 20: South Baldwin Ridge/Erwin Lake, San Bernardino County, California. CACI 20 contains 23 ac (9 ha); the landowner is the U.S. Forest Service. CACI 20 is USFS Pebble Plain Number 212.

Units CACI 21, CACI 22, CACI 23, and CACI 24. Sugarloaf Ridge, San Bernardino County, California. CACI 21 contains 127 ac (51 ha); CACI 22 contains 34 ac (14 ha); CACI 23 contains 76 ac (31 ha); CACI 24 contains 190 ac (77 ha). The landowner for these units is the U.S. Forest Service. CACI 21 is USFS Pebble Plain Number 294; CACI 22 is USFS Pebble Plain Number 289; CACI 23 is USFS Pebble Plain Number 286; CACI 24 is USFS Pebble Plain Number 293.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Castilleja cinerea critical habitat are those habitat components that provide (72 FR 73092-73178):

(i) Pebble plains in dry meadow-like openings, or non-pebble plain dry meadow margin areas, within upper montane coniferous forest, pinyonjuniper woodlands, or Great Basin sagebrush in the San Bernardino Mountains of San Bernardino County, California; at elevations between 5,900 to 9,800 ft (1,830 to 2,990 m) that provide space for individual and population growth, reproduction and dispersal.

(ii) Seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles, or seasonally wet silt or saline clay soils in non-pebble plain dry meadow margin areas that provide space for individual and population growth, reproduction and dispersal, adequate water, air, minerals, and other nutritional or physiological requirements to the species.

(iii) The presence of one or more of its known host species such as Eriogonum kennedyi var. austromontanum, E. kennedyi. var. kennedyi, and E. wrightii var. subscaposumon in pebble plain habitat and species such as Artemisia tridentata, A. nova, and E. wrightii var. subscaposumon in pebble plain and non-pebble plain meadow margin habitat that provide some of the physiological requirements for this species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Threats to listed pebble plains plants throughout their range include land development, off-highway vehicle (OHV) use off of designated routes, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, and nonnative plant species (63 FR 49006; September 14, 1998). Pebble plain habitat is also threatened by vegetation and fuels management, hazard tree removal, and wildfire suppression activities (Eliason 2006). However, of the above threats, land development remains the primary cause of habitat loss on private lands; while on Federal lands, OHV use off of designated routes has historically been, and continues to be, the most significant threat to pebble plains habitat. Increasing residential populations adjacent to pebble plains habitat on private and Federal lands has also resulted in degradation of habitat, as dispersed recreation and unauthorized OHV use increases (Eliason 2006). Also, while forest system road use and maintenance, mining activities, and dispersed recreation continue to have adverse ongoing effects to pebble plain habitat and the species it supports, the magnitude and severity of effects caused by these activities are relatively small compared to the effects of unauthorized motorized vehicle use (Eliason 2006). The primary constituent elements for the listed pebble plains plants may require special management considerations or protection to minimize impacts associated with, (1) vehicle use and road maintenance; (2) recreational activities; and (3) the presence of nonnative species (63 FR 49006, September 14, 1998; USFS 2002, p. 17; USFS 2005, pp. 207, 249, 293).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (USFWS, 2013)

Breeding Season

Adult: June through August. (USFWS, 2013)

Reproduction Narrative

Adult: Castilleja cinerea flowers from June through August (California Native Plant Society [CNPS] 2012). O'Brien has determined that Castilleja cinerea is outcrossing; covered flowers produced no seeds (O'Brien 1979, p. 69). (USFWS, 2013)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest - Conifer, Forest/Woodland, Shrubland/chaparral, meadows (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1800 and 2800 m on mountain slopes. (USFWS. 2013)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: As a hemiparasitic plant, C. cinerea produces haustoria (modified structures on the plant's roots that penetrate the root tissues of a host plant) to obtain nutrients and water. Host plants include Eriogonum kennedyi var. austromontanum, Eriogonum kennedyi var. kennedyi (Kennedy's wild-buckwheat), Eriogonum wrightii var. subscaposum (short-stemmed bastardsage), Artemisia tridentata ssp. tridentata (big sagebrush), Artemisia nova (black sagebrush), and other Artemisia taxa (USFS 2005d, no page number). (USFWS, 2013)

Habitat Narrative

Adult: The primary habitat for Castilleja cinerea is pebble plains, so described because of the layer of orange quartzite pebbles that are pushed to the clay soil surface by frost heaving and thawing (Krantz 1983, p. 10). Castilleja cinerea is found in the San Bernardino Mountains at elevations between 1,800 and 3,300 meters (m) (5,905 to 10,827 feet (ft)) (Wetherwax et al. 2012, p. 960). Within the San Bernardino Mountains, C. cinerea occurs on various benches and on all mountain slope aspects including both south-facing and north-facing slopes (CNDDB 2012; USFWS 2012). Castilleja cinerea occupies the meadow/forest ecotone (transitional area of vegetation between two different plant communities) of the San Bernardino Mountains and has been recorded in the following ecological communities: pebble plains, dry and wet forest meadows, mixed conifer forests, open pine forests, and pinyon-juniper woodlands (CNDDB 2012). As a hemiparasitic plant, C. cinerea produces haustoria (modified structures on the plant's roots that penetrate the root tissues of a host plant) to obtain nutrients and water. Host

plants include Eriogonum kennedyi var. austromontanum, Eriogonum kennedyi var. kennedyi (Kennedy's wild-buckwheat), Eriogonum wrightii var. subscaposum (short-stemmed bastardsage), Artemisia tridentata ssp. tridentata (big sagebrush), Artemisia nova (black sagebrush), and other Artemisia taxa (USFS 2005d, no page number). (USFWS, 2013)

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: It is likely that seeds are shaken loose from the erect seed capsules and drop short distances from the parent plant, and then dispersed short distances by the wind as observed in C. levisecta (golden paintbrush), a prairie species from the Pacific Northwest (USFWS 2010, p. II–34). (USFWS, 2013)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

55 occurrences (USFWS, 2021)

Population Narrative:

We also reviewed the status of all known Castilleja cinerea occurrences to identify whether the occurrences were extant, presumed extant, or possibly extirpated. Of the 48 occurrences known to us in 2013, we have changed the status of 22 occurrences due to the following new information: 1. Seventeen occurrences that were presumed extant in 2013 are now extant, because C. cinerea plants have been observed within the past 10 years. 2. Two occurrences that were presumed extant in 2013 (CNDDB EOs 33 and 38) are now possibly extirpated due to development. 3. Three former CNDDB occurrences are now included within other CNDDB occurrences (CDFW 2021, pp. 6, 23). In summary, 10 occurrences have been reported to us since 2013. However, because three 2013 occurrences were included in other CNDDB EOs, the number of occurrences has increased by 7, from 48 to 55. A total of 19 occurrences are extant, 33 presumed extant, and 3 possibly extirpated (Table 1, Table 2). (USFWS, 2021)

Threats and Stressors

Stressor: Urban Development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Much of the habitat of Castilleja cinerea historically found on private lands has been lost to residential and commercial development (USFS 2012c, p. 32). Urban development (primarily residences) and related recreational development on city, county or private lands within the Big Bear Lake and Baldwin Lake areas continue to represent an ongoing threat to Castilleja cinerea at seven of the pebble plain complexes. Threats and their effects on C. cinerea

and other pebble plain and meadow plants were recently described in a biological assessment for ongoing activities within the SBNF (USFS 2012d, pp. 61–63, 76–78). (USFWS, 2013)

Stressor: Roads and Trails (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: In our final listing rule, we described impacts from this threat under the category of ORV activity, citing over 7 miles (mi) (11 kilometers (km)) of Forest Service roads and 10 mi (16 km) of unauthorized routes that directly impact pebble plain sites (USFWS 1998, p. 49013, citing Odell 1988, p. 4). Approximately 2.5 percent of the SBNF acreage consists of roads (USFS 2005e, Vol. 1, p. 114). The SBNF implements a Roads and Trails Management Program that incorporates roads, motorized trails, motorized interpretive trails, and non-motorized trails found within the SBNF (USFS 2012d, pp. 9–10). (USFWS, 2013)

Stressor: Road Construction, Use, and Maintenance (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Threats to Castilleja cinerea from roads and trails include both direct effects, such as habitat alteration, and indirect effects, including alteration of water flow and drainage patterns, sedimentation, deposition of particulates (dust), and effects related to wildfire (USFS 2012d, pp. 21–24). Roads, road construction, and road maintenance can also facilitate the introduction and establishment of nonnative plants by creating open, continually disturbed habitat as well as disrupt hydrological processes within pebble plains habitats. Nonnative plants can be transported along these road corridors by equipment and vehicles, and are often more easily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005e, Vol. 1, p. 114). Open Forest Service roads present ongoing threats in the Baldwin Lake area (Sawmill pebble plain complex) and the Wildhorse Meadow area (Sugarloaf Ridge pebble plain complex) where Castilleja cinerea occurs, and the SBNF has installed fencing and signage to minimize impacts to the habitat, including effects related to crushing, uprooting, or burial of plants (USFS 2012d, pp. 77, 82). (USFWS, 2013)

Stressor: Recreational Use of Roads and Trails (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The high frequency of ORV activity was described as the most significant and persistent threat in the final listing rule for Castilleja cinerea and other pebble plain plants and was reiterated as such in our 2008 5-year review (USFWS 1998, p. 49013; USFWS 2008, p. 5). Threats also result from the effects of non-motorized trails and mountain biking due to the proximity of C. cinerea and its habitat to urban areas (USFS 2012d, pp. 60–61). Associated with ORV activity is unauthorized collection of wood for fuel including removal of downed vegetation or trees. The SBNF has an active, personal use fuel-wood program in which the public can purchase permits for cutting wood from marked, downed logs in designated areas (USFS 2012d, p. 30). (USFWS, 2013)

Stressor: Alteration of Hydrology (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: The listing rule identified alteration of hydrological conditions as a threat to Castilleja cinerea habitat, noting that the majority of pebble plain complexes are directly impacted by vehicle routes that may lead to alterations in the surface hydrology (USFWS 1998, p, 49013). This threat is often the result of unauthorized ORV activities and direct and indirect impacts from urbanization (USFS 2002, p. 25). Vehicle traffic within pebble plains habitats during the wet season is of particular concern because this activity creates deep ruts that change the hydrological patterns over the pebble plain (USFS 2002, p. 20). Alteration of hydrology can also result from land disturbance due to mining and fire suppression activities, which are discussed as separate threats to C. cinerea below. Our listing rule also highlighted activation or installation of wells within lower Holcomb Valley, Baldwin Lake (within the North Baldwin Lake complex) as a potential threat to pebble plains habitat through the alteration of hydrology in these areas (USFWS 1998, p. 49014). In an undisturbed condition, water generally flows evenly over the surface of pebble plains (Odell 1988, p. 19). However, disturbances to their surface can change hydrological patterns across these surfaces and can alter their soil composition through the erosion of clay sediments during rainfall events, leaving only large cobbles and pebbles (Neel and Chaney 1992, p. 1). These potential changes to soil morphology and composition can alter the vegetation structure and composition of the pebble plain, by creating favorable conditions for the invasion of both native and nonnative plant species that then out-compete Castilleja cinerea for space and resources, and further altering the soil composition by increasing the amount of organic debris (Derby 1979, pp. 72–73; USFS 2002, p. 15). (USFWS, 2013)

Stressor: Trampling of Habitat (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Moderate to heavy degradation of certain sites occupied by Castilleja cinerea from trampling by cattle has occurred in the past and some pebble plains and meadow complexes continue to be impacted by cattle, horses, and feral burros (USFWS 1998, p. 49016). However, we anticipated this threat would be reduced with the removal of feral burros from several pebble plain complexes under the provisions of the Big Bear Wild Burro Territory Management Plan (USFWS 1998, p. 49017). We also reported occasional trampling of C. cinerea from construction activities and trails near the Snow Valley Ski Area (USFWS 1998, p. 49016). (USFWS, 2013)

Stressor: Nonnative Plants (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Service identified exotic (nonnative) plants as a threat to Castilleja cinerea in the context of disturbances related to grazing, urban and rural development, and various recreational activities (USFWS 1998, p. 49017). These activities can threaten native plants by facilitating the establishment of nonnative species and resulting in the alteration of habitat through crowding or competition for resources (USFWS 1998, p. 49017). Bromus tectorum represents the primary species of concern for these pebble plain areas. This taxon, as well as Erodium cicutarium (filaree), represent very old invasions for the San Bernardino Mountains and are persistent threats within these complexes (Eliason 2012a, pers. comm.). More recent

invasions of nonnative plant species within some of these pebble plain complexes include Linaria dalmatica (dalmatian toadflax), Ranunculus testiculatus (bur buttercup), and Lepidium perfoliatum (clasping pepperweeed) (Eliason 2012a, pers. comm.). As with pebble plain habitat, ground disturbances by hikers, mountain bicyclists, and ORVs can create conditions favorable for the establishment and spread of nonnative plants into these areas. (USFWS, 2013)

Stressor: Mining (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Service indicated that mining activities had contributed to the decline of Castilleja cinerea due to effects from habitat destruction, degradation, and fragmentation of pebble plain habitats (USFWS 1998, p. 49013). We described mining as a secondary threat to habitat degradation (USFWS 1998, p. 49013). Mining claims on Forest Service lands were previously reported for five pebble plain complexes occupied by Castilleja cinerea: (1) Holcomb Valley (83 ac (33.6 ha), (2) Fawnskin (24 ac (9.7 ha)), (3) Arrastre Flats (69 ac (28 ha)), (4) North Baldwin Lake (62 ac (25 ha)), and (5) Broom Flat (0.2 ac (0.08 ha)) (USFS 2002, pp. 42, 46, 48, 57, 65). These claims continue to represent a potential threat of ground disturbance for C. cinerea, specifically, gold prospecting activities or mining operations related to the ownership of mineral rights. (USFWS, 2013)

Stressor: Fire Suppression (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Activities related to management of fire and fuels can also threaten Castilleja cinerea and its habitat. Though not recognized as a threat at the time of listing, fire suppression was known to impact one occurrence in 2008 when the previous status review was developed. However, fuelbreaks and vegetation treatment units are very rarely located in pebble plain habitat due to the scarcity of fuels (USFS 2005a, p. 255). Fire suppression activities typically include fire line construction; fire retardant and water drops; establishment of temporary fire camps, staging areas, parking sites, safety zones, and helipads; and post-fire rehabilitation (USFWS 2005, p. 27). Each of these activities can have negative impacts to C. cinerea and its habitat. (USFWS, 2013)

Stressor: Climate Change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Projected changes in April snow water equivalence across the Fawnskin, Holcomb Valley, and parts of Arrastre Flats pebble plains, under a low carbon emissions scenario (B1), indicate an 84 percent reduction in snow moisture; and a 92 percent reduction in snow moisture under a high emissions scenario (A2), between a baseline time period (1961 to 1990) and an end of century period (2070 to 2090). Similar reductions in snowpack are projected for the Bear Valley region and other parts of the SBNF. Projected changes in annual average in temperature for this region using the Cal-Adapt tool under the B1 scenario indicate a 3.9oF (2.1oC) increase in temperature, and 6.9oF (3.8oC) increase under the A2 scenario, between the baseline time period (1961 to 1990) and an end of century period (2070 to 2090). Although there is uncertainty

in predictions of downscaled climate change models, these projected climate change effects could significantly alter the hydrology and vegetation that sustain and characterize pebble plain and other habitats occupied by Castilleja cinerea. (USFWS, 2013)

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
Not defined; a Recovery Plan is not available for this species.

Recovery Actions:

- Recommendation for Future Action from 2013 5-Year Review: Work with biologists at the SBNF to reduce impacts from recreational use of roads and trails through uncontrolled access to pebble plain habitat occupied by Castilleja cinerea. Prioritize protective measures being implemented (or planned) for controlling access to areas occupied by Castilleja cinerea. (USFWS, 2013)
- Recommendation for Future Action from 2013 5-Year Review: Reduce current and future impacts to Castilleja cinerea (and other federally listed pebble plain plants) from roads and trails through coordination with staff at SBNF. Identify and implement a priority strategy to identify roads and trails for decommissioning within pebble plain habitats. (USFWS, 2013)
- Recommendation for Future Action from 2013 5-Year Review: Conserve or preserve Castilleja cinerea occurrences on private lands. Continue to work with the State and local groups to purchase C. cinerea habitat from willing sellers, particularly within the Sawmill pebble plain complex. (USFWS, 2013)
- Recommendation for Future Action from 2013 5-Year Review: Develop a monitoring plan to provide early detection of downward trends in the populations of pebble plain plants, such as Castilleja cinerea, and quality of pebble plain and montane meadows habitats (adapted from USFS 2005b, p. 125). This monitoring plan should identify and prioritize surveys of plant populations, including abundance, and habitat conditions, in those areas most vulnerable to threats (e.g., pebble plain complexes with high levels of recreational activity) and should include remote sensing and mapping of unauthorized ORV trails. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Castilleja cinerea and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Work with USFS land managers to reduce impacts to C. cinerea and its habitat from recreational and unauthorized Off-highway vehicle (OHV) use. Coordinate with USFS on implementation of the Pebble Plains Habitat Management Guide (USFS 2002). 2. Reach out to private landowners to identify opportunities for conservation on private lands. Work with private landowners, local governments, and conservation organizations to conserve and manage habitat. 3. Continue to monitor C. cinerea occurrences to provide early detection of downward trends in population numbers or quality of pebble plain habitat, or both. Regular monitoring of pebble plain

complexes can also help with early detection of increasing threats to specific areas (e.g., unauthorized OHV trails). 4. Study C. cinerea population genetics, including levels of genetic diversity and differentiation among and within occurrences. Determine levels of inbreeding, relatedness, and ploidy. This information will help us assess current levels of genetic diversity and gene flow and determine if genetic management is needed and assess appropriate seed sources for potential future reintroduction or augmentation activities. 5. Collect C. cinerea seed and conserve seed in an ex-situ (off-site) conservation seed bank, to preserve the genetic diversity in the species. (USFWS, 2021)

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SPECIES ACCOUNT: *Castilleja mollis* (Soft-leaved paintbrush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/31/1997; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A shrubby, hemiparasitic, perennial herb with soft-woolly, grayish-green foliage. The highly branched plants are somewhat prostrate, usually reaching only 3+ dm high. Inflorescences (April-August) have yellow bracts (the bracts much more conspicuous than the flowers). (NatureServe, 2015)

Taxonomy

This species was described by Pennell as Castitteja moltis in 1947, based on material collected on Santa Rosa Island in 1939 (Ingram 1990, Heckard et at. 1991). Hoover (1970) and Munz and Keck (1973) included plants of coastal sand dunes of San Luis Obispo County in the description of this taxon. (USFWS, 2000). Upon review and in agreement with available systematic and floristic literature and consultation with species experts, we intend to propose amending part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations to reflect the transfer of Castilleja taxa including C. mollis from the family Scrophulariaceae to the family Orobanchaceae. (USFWS, 2007)

Historical Range

See current range/distribution.

Current Range

Castilleja mollis (Orobanchaceae) is a perennial herb that occurs only on Santa Rosa Island in Santa Barbara County, California, about 25 miles (40 kilometers) from the mainland. Santa Rosa Island is owned by CINP and is managed primarily for natural resource conservation (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (hybridization) NatureServe, 2015)

Breeding Season

Adult: April to August (NatureServe, 2015)

Other Reproductive Information

Adult: This plant occasionally hybridizes with Castilleja affinis. (NatureServe, 2015)

Reproduction Narrative

Adult: This plant occasionally hybridizes with Castilleja affinis. Inflorescences (April-August) have yellow bracts (the bracts much more conspicuous than the flowers). (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sand/dune, Shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Soft-leaved paintbrush is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (Isocoma menziesii var. sedoides) (E. Painter in titt. 1995, M. Wetherwax in titt. 1995). (USFWS, 2000)

Habitat Narrative

Adult: It is well established that Castilleja mollis requires the coastal scrub bluff community, which includes goldenbush, to establish and survive (USFWS, 2000). Castilleja mollis requires stabilized and partially stabilized coastal dunes (NatureServe, 2015). Castilleja mollis is dependent on a host plant for water and dissolved resources. Some leaves have reduced chlorophyll and the plant compensates by parasitizing the roots of nearby vascular plants (Chuang and Heckard 1993). The most likely host is goldenbush (Isocoma menziesii var. sedoides) (E. Painter in titt. 1995, M. Wetherwax in titt. 1995). (NatureServe, 2015; USFWS, 2000)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Fluctuating populations (USFWS< 2023)

Population Growth Rate:

Slow decline (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2023)

Population Size:

>1000 (NatureServe, 2015)

Population Narrative:

Historically and currently, C. mollis has been found in two populations on the north side of Santa Rosa Island which are separated by about 10 miles (16 kilometers): Carrington Point and Jaw Gulch (Table 2). Identification by California Natural Diversity Database Element Occurrence Number (CNDDB EO #) has never been used by staff at CINP or USGS to identify the populations. The species has been extirpated from San Miguel Island, and two other locations reported by CNDDB are in error (USFWS, 2023).

Threats and Stressors

Stressor: Decline of plant host (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: We have information that indicates the direct dependency of Castilleja mollis on the coastal goldenbush scrub community (McEachern, pers. comm. 2006a). Before 1998, cattle grazing and ungulates rutting caused large gaps in the coastal goldenbush community. These gaps were then invaded by non-native grasses, inhibiting Castilleja mollis from making root connections with the goldenbush host plant. (USFWS, 2007)

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Competition with non-native plant taxa was also identified as a threat to Castilleja mollis in the final recovery plan (U.S. Fish and Wildlife Service 2000). Castilleja mollis is forced to compete with the invasive annual grasses for water and nutrients. This competition weakens the paintbrush, which may contribute to the failure of seedlings to make root connections with the goldenbush host plant (McEachern 2004a). (USFWS, 2007)

Stressor: Soil disturbance and trampling (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Although all cattle have been removed from Santa Rosa Island and deer numbers have decreased, elk numbers have increased since 2001 (see Figures 2 and 3). This is believed to be a continuing factor hindering Castilleja mollis recovery on the island (McEachern 2003). (USFWS, 2007)

Stressor: Habitat fragmentation (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Past habitat fragmentation that occurred as a result of grazing and trampling is still considered a major threat to the species. (USFWS, 2007)

Stressor: Predation (USFWS, 2007)
Exposure:
Response:

Consequence:
Narrative: The listing rule also noted cattle herbivory as a problem for the species, but cattle were removed from Santa Rosa Island in 1998. Cattle removal and the reduction in the number of deer have, so far, not resulted in substantial improvements in Castilleja mollis. (USFWS, 2007)

Stressor: Soil disturbance and trampling (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Trends in the number of inflorescences and percent cover suggest that a large-scale event, such as weather, may also influence flowering and growth (McEachern, in litt. 2006b; McEachern, pers. comm. 2006c). (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Due to the small population size of this species, the listing rule noted that Castilleja mollis would be vulnerable to stochastic events (including variable weather patterns such as drought), reduced genetic integrity of the species, and depressed reproductive vigor (62 FR 40957). (USFWS, 2007)

Stressor: Climate change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Changes in climate could threaten C. mollis in several ways. First, as vegetation shifts with climate change, the species might not be able to disperse to suitable germination or recruitment habitat, as is predicted to happen to island annuals (Levine et al. 2008 p. 796). Second, the proper combination of environmental cues for germination could occur less frequently or not at all, decreasing germination and causing declines in abundance and possible extirpations (Levine et al. 2008 pp. 800–805; Levine et al. 2011 pp. 2241–2246). Expected climate change for the geographic region of the islands predicts both rising annual temperatures (Langridge 2018 pp. 13–15) and less frequent, more episodic rainfall (Langridge 2018 pp. 16–17). Preliminary analysis of demography and environmental data (HasenstabLehman et al. 2022) show that the C. mollis individuals have lower survival in hotter years, with Jaw Gulch plants more negatively affected by higher temperatures than are Carrington Point plants, so climate change induced temperature rise is a threat to the species. Additionally, the species is found at less than 20 meters or 66 feet elevation. Sea level may rise by about 0.25 m (1 ft) by 2050 (Sweet et al. 2022 p. 19) and 1.0 m (3 ft) by 2100 (Sweet et al. 2022 p. 23). The low elevation habitat in which C. mollis is found is largely unprotected from the effects of rising sea level, and at least the lowest elevation plants might be threatened by inundation or removal by wave action in the future. Another prediction with increasing annual temperature in California is an increasing dominance by non-native annual grasses (Sandel and Dangremond 2012, entire) in certain situations. If nonnative grass cover increases further, the presumed competitive effects of increased grass cover would further threaten C. mollis. (USFWS, 2023)

Stressor: Increased visitor use (USFWS, 2023)

Exposure:
Response:
Consequence:
Narrative: Implementation of the preferred alternative in the Channel Islands General Management Plan (2015, pp. 165–173) would facilitate easier visitor access to the backcountry of Santa Rosa Island. If this results in increased hiker use of the relatively level and scenic marine terraces of the Jaw Gulch area, the genetically distinct and possibly declining population of C. mollis there could be detrimentally impacted by trampling by hikers or unauthorized camping in the area. Additionally, at Carrington Point the species has been recently found on both sides of a popular hiking trail (K. McEachern pers. comm.), and could be trampled by hikers. The final impact of increased visitor use will likely be determined by the CINP Backcountry Wilderness Management Plan, which is under development, and until it is finalized, the magnitude of the threat of increased visitor use to the species is unknown (USFWS, 2023).

Stressor: Insect damage to inflorescences (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Since introduced in the 2007 5-year review, no further work has been done on the effects of insect damage to C. mollis inflorescences, and the magnitude of this threat remains (USFWS, 2023).

Recovery

Reclassification Criteria:
1. Maintain the existing distribution with multiple colonies in each population on Santa Rosa Island. (USFWS, 2000)

2. Maintain stable or increasing population trends with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle. (USFWS, 2000)

3. Damage from normative mammals significantly reduced. (USFWS, 2000)

Recovery Priority Number: 2

Delisting Criteria:
1. Expansion of individuals into potential habitat within population boundaries. (USFWS, 2000)

2. No decline after downlisting for 10 years. (USFWS, 2000)

3. All potential habitat surveyed.

Recovery Actions:
- Provide protection and adaptive management of currently known (and in some cases historic) sites. (USFWS, 2007)
- Provide evidence that the populations at these sites are stable or increasing over a number of years, which is determined by the life history of the individual species. (USFWS, 2007)

- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists. (USFWS, 2007)
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. (USFWS, 2007)
- Seed is stored in Center for Plant Conservation cooperating facilities. (USFWS, 2007)
- Seed germination and propagation techniques are understood. (USFWS, 2007)
- Successful outplanting techniques are developed. (USFWS, 2007)
- Host plant and weed management plan are developed and implemented. (USFWS, 2007)
- Life history research is conducted that aids in the conservation and recovery of the species. (USFWS, 2007)
- Hybridization with Castilleja affinis is understood. (USFWS, 2007)
- If declining, determine the cause and reverse trend. (USFWS, 2007)
- Because the removal of cattle and the reduction in deer have had a positive effect on seedling recruitment, the program to eliminate ungulates from the island by 2011 should continue as planned. (USFWS, 2007)
- During the time that the special use permits are in effect, if targeted hunting of deer and elk is no longer effective, the NPS should consider other actions to reduce the threats of these animals to the species. (USFWS, 2007)
- Based on the reports produced by the Scientific Panel, indeterminate threats, in addition to ungulate herbivory, scraping and general presence are contributing to the decline in the amount of inflorescence and percentage cover of Castilleja mollis. Therefore, other parameters that influence the species' ability to recover should be tracked at both locations where the species is found. In particular, the following monitoring actions are recommended: (a) monitor community species composition and cover to indicate whether the habitat is improving; (b) monitor rate of hybridization with Castilleja affinis to understand the level of threat this poses on recovering the species; (c) monitor damage to inflorescence, stems, and leaves caused by insects; (d) monitor the number of plants, or seedlings and juveniles within the populations; and (e) monitor the rate of erosion using soil depth/amount of litter. (USFWS, 2007)
- The following downlisting measures outlined in the recovery plan should be implemented: (1) seed storage in a Center for Plant Conservation facility, and (2) development and implementation of host plant and weed management actions. (USFWS, 2007)
- To secure several populations of Castilleja mollis containing a minimum of 2,000 plants each, efforts should focus on restoring coastal goldenbush scrub habitat so that there is reduced fragmentation within populations of Castilleja mollis on the island. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue demographic monitoring of the two populations of C. mollis, and analyze longterm demographic and environmental monitoring data to determine trends. 2. Use morphological characters from the genetic study to define the geographic edges of the C. mollis populations. 3. Map the distribution of plants within the populations, including plants outside of the demography plots. 4. Augment current populations, especially Jaw Gulch, expand current populations, and establish new populations in areas above sea level rise effects. 5. Collect confirmed C. mollis seed from both populations for accession in conservation seed banks. 6. Ensure that visitor use does not impact C. mollis at the Jaw Gulch and Carrington populations (USFWS, 2023).

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SPECIES ACCOUNT: *Catesbaea melanocarpa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/17/1999; Southeast Region (R4) (USFWS, 2015)

Physical Description

A branching shrub that may reach approximately 9.8 feet (ft.) (3.0 meters (m)) in height. Spines are borne at every internode (space between nodes) and are from 0.39 to 0.78 inches (in) (1.00 to 2.00 centimeters (cm)) long. Leaves are small, from 0.19 to 1.0 in (5.00 to 25.00 millimeters (mm)) long, and 0.07 to 0.58 in (2.00 to 15.00 mm) wide, often opposite. The flowers are white, solitary or paired, and almost lacking a stalk in the axils (angle formed by a leaf or branch with the stem). The petals are united in the form of a funnel and measure from 0.31 to 0.39 in (8.00 to 10.00 mm) long. The fruit is black, spherical, and 0.19 to 0.23 in (5.00 to 6.00 mm) in diameter. The two-celled fruit contains five to seven seeds in each cell (Proctor 1991) (USFWS, 2005).

Taxonomy

Catesbaea melanocarpa, of the family Rubiaceae, belongs to a genus that consists of ten or more species of spiny shrubs confined to the Antilles, but some may extend into the Bahamas and the Florida Keys. Some authors have noted that C. melanocarpa may be a synonym or variant of C. parviflora and have recommended further review (Howard 1989, Proctor 1991). Dr. Frank Axelrod (personal communication (pers. comm.) 2004) of the University of Puerto Rico, however, does not believe that Catesbaea melanocarpa is a variety of C. parviflora (USFWS, 2005). C. melanocarpa is now being referred to by the English common name, Tropical Thorn Lily, by species experts (Morgan and Zimmerman, UVI, poster presentation, 2016). No common name in Spanish has been published. (USFWS, 2018).

Historical Range

Catesbaea melanocarpa was historically known from Puerto Rico, St. Croix in the U.S. Virgin Islands (USVI), Barbuda, Antigua, and Guadeloupe (Proctor 1991) (USFWS, 2011).

Current Range

Catesbaea melanocarpa is currently known from seven areas: the Guánica Commonwealth Forest in Puerto Rico, two privately owned localities in Puerto Rico (Peñones de Melones and Encarnación), one privately-owned locality in St. Croix in the U.S. Virgin Islands, Barbuda, Antigua, and Guadeloupe (USFWS, 2011).

Critical Habitat Designated

Yes; 8/28/2007.

Legal Description

On August 28, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Catesbaea melanocarpa (No Common Name) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in the Virgin Islands (72 FR 49212-49228).

Critical Habitat Designation

The critical habitat designation for Catesbaea melanocarpa includes one CHU in St. Croix, Virgin Islands. This species critical habitat encompasses approximately 10 acres (ac) (4.3 hectares (ha)) (72 FR 49212-49228).

Halfpenny Bay, St. Croix, U.S. Virgin Islands. (i) General description: The Halfpenny Bay unit consists of approximately 10.5 ac (4.3 ha) on privately owned property located about 2.48 mi (4 km) south of Christiansted, St. Croix, U.S. Virgin Islands. The designated unit is located east of South Shore Road, approximately 342 m (1,122 ft) south of Road 62, approximately 600 m (1,968 ft) north of the Halfpenny Bay coast, and 70 m (230 ft) west of a local road to Halfpenny Bay. This unit encompasses the habitat features essential to the conservation of Catesbaea melanocarpa within Estate Granard, Christiansted, St. Croix, and does not contain any manmade structures.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Catesbaea melanocarpa critical habitat consists of two components (72 FR 49212-49228):

(i) Single-layered canopy forest with little ground cover and open forest floor that supports patches of dry vegetation with grasses, and

(ii) Well to excessively drained limestone and serpentine-derived soils (including soils of the San Germa´n, Nipe, and Rosario series and Glynn and Hogensborg series).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing contain the PCEs that may require special management considerations or protection. As discussed in this section and in the unit description below, we find that all of the PCEs in Halfpenny Bay may require special management considerations or protection due to threats to the species or its habitat from periodic but intense grazing, humaninduced fires, and potential development for a tourist project (USFWS 2005, p. 8). Such management considerations and protections include fencing off forest patches to exclude cattle, developing fire-breaks adjacent to existing roads and farm boundaries during dry season, and establishing conservation agreements with landowners to protect habitat within the property.

Life History

Food/Nutrient Resources

Breeding Season

Adult: July (USFWS, 2005)

Reproduction Narrative

Adult: Biological and ecological information on Catesbaea melanocarpa is very scarce. In July of 1992, Breckon and Kolterman (1993) measured stem height and basal diameter for the 24 individuals known from St. Croix. Stem height ranged from 0.36 to 9.91 ft (0.11 to 3.02 m) and averaged 2.59 ft (0.79 m). Basal stem diameter ranged from 0.16 to 2.20 in (0.40 to 5.60 cm). The stem of the largest individual split into two at a height of 7.87 in (20.00 cm), and above that point, the two stems had diameters of 1.14 and 1.22 in (2.90 and 3.10 cm). Eleven of the 24

living individuals had green fruit and one had mature fruit. The reproductive condition of the plants was observed for several weeks after, and during this time, all reproductive stages were observed on the majority of plants. In December 1992, the reproduction was checked, and while no flowers were observed, many adults (greater than 1.64 ft (0.50 m) in height) were in fruit (Breckon and Kolterman 1993) (USFWS, 2005).

Habitat Narrative

Adult: Catesbaea melanocarpa occurs in the subtropical dry forest life zone. The subtropical dry forest is the driest life zone of Puerto Rico and the USVI. Ewel and Whitmore (1973) described the vegetation in this zone as deciduous on most soils with tree species dropping leaves during the dry season. The vegetation usually consists of a nearly continuous single-layered canopy, with little ground cover. The leaves of dry forest species are succulent or coriaceous (leathery), and species with spines and thorns are common. Tree heights usually do not exceed 49 ft (15 m) and crowns are typically broad, spreading and flattened. This life zone receives a mean annual rainfall ranging from 24 to 40 in (60 to 100 cm). Successional vegetation includes grasses and the accumulated organic debris serves as fuel for human-induced fires (USFWS, 2005).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2011)

Number of Populations:

5 (USFWS, 2023)

Population Size:

It currently occurs Territories in the Caribbean is 2,127 individuals: about 2,077 individuals in St. Croix, USVI, and about 50 individuals in Puerto Rico (USFWS, 2023).

Population Narrative:

Catesbaea melanocarpa is a small spiny shrub under the Rubiaceae family. It currently occurs on the island of St. Croix (Ha'Penny), USVI, and in Puerto Rico (i.e., two localities in Guánica, one in Peñuelas, and one in Cabo Rojo) and on the islands of Antigua, Barbuda, and Guadeloupe In 2019, one new population and an additional location for Guánica were discovered, one in Cabo Rojo in southwest Puerto Rico at El Conuco Natural Protected Area and an additional location in Ojo de Agua Trail in Guánica. One known population from Punta Melones, Cabo Rojo, Puerto Rico is currently considered extirpated. The current overall Catesbaea melanocarpa population estimate within the U.S. Territories in the Caribbean is 2,127 individuals: about 2,077 individuals in St. Croix, USVI, and about 50 individuals in Puerto Rico (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011)

Exposure:
Response:
Consequence:
Narrative: Deforestation for residential and tourist development may pose imminent threats to the survival of the species. In Puerto Rico, a single individual was reported on a privately-owned land known as Peñones de Melones. This locality was threatened with a proposed high density residential/tourist development. Visits by Service biologist Carlos Pacheco suggest that individuals may no longer exist in Peñones de Melones as deforestation and fires associated with human activity continue within this area. In St. Croix, approximately 100 individuals are present in a privately-owned land. This population is subject to impacts from grazing activities. Also, the development of a golf course has been proposed for the site (USFWS, 2011). Additional disturbances are caused by fire, illegal off-road racing, cattle, and hurricanes. (USFWS, 2018).

Stressor: Limited distribution (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Limited distribution of the species was also identified as an important factor affecting the species. Catastrophic natural events, such as hurricanes, may dramatically affect forest species composition and structure, felling large trees and creating numerous canopy gaps (USFWS, 2011).

Recovery

Reclassification Criteria:
1. The habitat known to support the two extant populations (St. Croix and Peñones de Melones) is enhanced and protected through landowner conservation agreements or easement (USFWS, 2011).

2. Extant populations are enhanced through the planting of additional propagated individuals to augment the number of adult individuals to at least 250 (USFWS, 2011).

3. At least one population within each of the following previously occupied habitat is found and/or established: Guánica Commonwealth Forest (PR), Susúa Commonwealth Forest (PR), Barbuda, Antigua, and Guadalupe (USFWS, 2011).

4. Research is conducted on key biological and genetic issues, including effective propagation techniques, and number of individuals within a population and number of populations needed for the establishment of self-sustaining populations and a viable overall population (USFWS, 2011).

Delisting Criteria:
1. A number of viable populations (to be determined following the appropriate studies) are protected by long term conservation strategies (USFWS, 2011).

2. viable populations (the number of which should be determined following the appropriate studies) are established in previously unoccupied but suitable habitat at Sandy Point National Wildlife Refuge (USVI), Cabo Rojo National Wildlife Refuge (PR), La Tinaja in Sierra Bermeja

(Laguna Cartagena National Wildlife Refuge, PR), and any other identified suitable conservation area within the dry forest zone (USFWS, 2011).

3. The numbers of populations, their sizes, genetic makeup and distribution needed to ensure self-sustainability are determined and achieved (USFWS, 2011).

Recovery Actions:

- Protect existing populations (St. Croix and Cabo Rojo) from current and future threats and/or limiting factors through landowner agreements and other conservation mechanisms (USFWS, 2005).
- Determine the distribution and population status of Catesbaea melanocarpa throughout its present and historic range, including Barbuda, Antigua, and Guadalupe (USFWS, 2005). Refinement in 2019: Conduct a full population assessment, including developing maps (GIS) with spatial information of the species for each area and information on recruitment. Historic data and observation records should be compiled into a single electronic database to inform a full population assessment. (USFWS, 2018).
- Evaluate techniques and develop a plant propagation program for Catesbaea melanocarpa (USFWS, 2005). Refinement in 2019: Establish a sound propagation protocol and subsequent plant production program; identity additional suitable habitat and develop partnerships to aid in the reintroduction of the species within its historic range in identified suitable habitat. (USFWS, 2018).
- Enhance existing populations and establish new self-sustaining populations (number of which should be determined by viability analysis) within protected areas by introducing additional individuals developed through propagation. Introduction sites may include, but are not limited to, the Guánica Commonwealth Forest, Susúa Commonwealth Forest, Sandy Point National Wildlife Refuge, and Cabo Rojo National Wildlife Refuge (USFWS, 2005).
- Conduct additional scientific research on Catesbaea melanocarpa (USFWS, 2005).
- Facilitate the recovery of Catesbaea melanocarpa through public awareness and education (USFWS, 2005).
- Provide technical assistance to Barbuda, Antigua, and Guadalupe for the development of conservation measures for the species (USFWS, 2005).
- Refine recovery criteria (USFWS, 2005).
- New in 2018: Further studies to confirm the presence or absence of C. melanocarpa at potential sites in Puerto Rico including an updated status on the population at the Guánica Commonwealth Forest. (USFWS, 2018).
- New in 2018: Identify Territorial and Commonwealth agencies able to monitor current populations and inform those agencies of the status and threats to the species. (USFWS, 2018).
- Initiate propagation efforts and establish new populations in protected areas (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES: • The Service and partners should expand habitat surveys within suitable habitat in the proximity of known localities (e.g., Sierra Bermeja, Guánica Commonwealth Forest and Ponte to Peñuelas). • To better understand the species viability, we recommend the long-term monitoring of known localities to address its long-term survival of individuals and to record any evidence of natural recruitment. • Evaluate the seed banking potential

of the species, and if feasible establish ex situ conservation efforts (seed bank) in collaboration with plant conservation institutions (e.g., Fairchild and Atlanta Botanical Gardens). • Refine propagation protocols from seed and cuttings to support ongoing and future reintroduction and population enhancement efforts. • Use trap cameras to evaluate the effects of fruit predation on Catesbaea melanocarpa and its relation to possible low recruitment of individuals, and to record evidence of seed dispersal by native birds (USFWS, 2023).

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SPECIES ACCOUNT: *Caulanthus californicus* (California jewelflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/19/1990; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

Caulanthus californicus is a glabrous decumbent to erect often branched annual, with whitish petals and spherical seeds. Leaves are less than 11 millimeters (mm) (0.4 inch (in.)) in length and are shallowly cut to wavy-dentate and tapered. Calyx petals (outer whorl) are generally spreading, 4–10 mm (0.15–0.4 in.) in length, maroon, keeled, and darker in bud stage. Corolla petals (inner whorl) are 6–11 mm (0.2–0.4 in.) long and whitish, with wavy margins (Buck 1993). (USFWS, 2013)

Taxonomy

USFWS tracks as synonym 01 - Caulanthus Californicus (8/93). (NatureServe, 2015)

Historical Range

Originally in San Joaquin and adjacent valleys. Once fairly abundant in appropriate habitat in Fresno, Kern, King, Santa Barbara, San Luis Obispo and Tulare counties. (NatureServe, 2015)

Current Range

Appears to be currently extant in Fresno, Kings, Kern, and Santa Barbara Counties (CalFlora Occurrence Database website Feb. 2, 2000). Extirpated from Kings County, but present in San Luis Obispo County (CNPS Inventory, 2001). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Environmental Specificity

Adult: Moderate (inferred from USFWS, 1998)

Habitat Narrative

Adult: Extant populations of California jewelflower occur in Nonnative Grassland, Upper Sonoran Subshrub Scrub, and Cismontane Juniper Woodland and Scrub(E. Cypher unpubl. data). Historical records suggest that California jewelfiower also occurred in the Valley' Saltbush Scrub community in the past (CDFG 1995). Herbaceous cover was dense at most California jewelfiower sites studied in 1993 (Cypher 1994a). Native plant species, such as annual fescue (Vulpia microstachys), clovers (Trifolium spp.), red maids (Calandrinia ciliata), and goldfields (Lasthenia californica) comprised a high proportion of the vegetation at many' of the known locations over several years. The exotic grass red brome (Bromus madritensis ssp. rubens) was a significant component of the vegetation only at the Carrizo Plain sites (Taylor and Davilla 1986, Lewis in litt. 1993, Cypher 1994a, E. Cypher unpubl. data). On the Carrizo Plain. California jewelfiower occurred primarily on the burrow systems of giant kangaroo rats (Dipodamvs

ingens), another endangered species (Cypher 1994a). Populations of California jewelfiower have been reported from elevations of approximately 75 to 900 meters (240 to 2,950 feet) and from level terrain to 25 percent slopes. Soils at known sites are primarily subalkaline, sandy loams (CDFG 1995, Taylor and Davilla 1986, Lewis in litI. 1993) (USFWS, 1998).

Dispersal/Migration

Population Information and Trends

Population Trends:
Decline (NatureServe, 2015)

Population Growth Rate:
Slowly declining (NatureServe, 2015)

Number of Populations:
37 (USFWS, 2020)

Population Narrative:
At the time of listing (1990), California jewelflower was known from three localized areas: the mouth of Santa Barbara Canyon in Santa Barbara County, the southern portion of the Carrizo Plain in San Luis Obispo County, and the Paul Paine Preserve (owned by The Nature Conservancy) in Kern County (Service 1990). At the time of our 2013 status review, there were 34 presumed extant occurrences: one introduced occurrence in Kern County; 7 occurrences in Santa Barbara County; 22 occurrences in San Luis Obispo County; 3 occurrences in Fresno County; and 1 occurrence in Kings County. A summary of past and current distribution can be found in Table 1 below. Four occurrences (numbers 81, 82, 83, and 84) have been added to the Diversity Database since our 2013 review (Diversity Database 2020). All four of these occurrences are in Kern County and do not extend the range of the species. The status of the one remaining extant occurrence in Kings County (occurrence number 5) has been changed to "possibly extirpated" since our last review. Table 1 in Appendix A summarizes the number of occurrences over time. Currently, there are 37 Diversity Database occurrences that are presumed extant. (USFWS, 2020)

Threats and Stressors

Stressor: Urbanization (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing the primary threats to C. californicus were the ongoing and threatened destruction and adverse modification of habitat due to agricultural land conversion and urbanization on the San Joaquin Valley floor (Service 1990). Non-urbanized or non-converted lands, which largely occurred in the neighboring foothills and valleys, were subject to livestock grazing, oil and gas exploration and development, off-road vehicle use, and mining (Service 1990). (USFWS, 2013)

Stressor: Agriculture (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: The CVP supplies water to more than 250 long-term water contractors in the Central Valley, Santa Clara Valley, and eastern San Francisco Bay Area. Agricultural conversions and related operations either directly or indirectly facilitated by the CVP include: conversion of native habitats to agricultural fields; conversion of land use to more water intensive purposes; disposal of agricultural drain water; application of pesticides; and other mowing and harvesting operations. Agricultural conversion and related operations have contributed to the loss and degradation of several habitat types, including grasslands and alkali scrub associated with declines of multiple listed species (Service 1998). (USFWS, 2013)

Stressor: Mining (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Mining presented a threat to C. californicus (Service 1990). On the Carrizo Plain National Monument (Monument), only valid leases, claims and other rights that existed as of the date of the Proclamation, January 17, 2001, may see mineral development on federal lands within the Monument (BLM 2010). (USFWS, 2013)

Stressor: Oil and Gas Exploration and Development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, oil and gas exploration and development presented a threat to C. californicus (Service 1990). Adverse effects of oil and gas development on C. californicus include the loss of habitat, changes in habitat quality, destruction of individuals or populations and their seed bank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. (USFWS, 2013)

Stressor: Off-road Vehicle Use (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, off-road vehicle use presented a threat to C. californicus (Service 1990). Off road vehicle use has been reported as a minor threat potentially affecting 7 occurrences on the Carrizo Plain National Monument where no off-road motorized or mechanized travel is legally permitted (BLM 2010). (USFWS, 2013)

Stressor: Solar Power Development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, solar power development did not present a threat to C. californicus. Solar power development projects pose potential threats to and may impact large amounts of habitat. These projects can destroy, fragment, or impact C. californicus habitat by: altering landscape topography, vegetation, and drainage patterns; and reducing habitat quality

through interception of solar energy normally reaching the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (Smith 1984; Smith et al. 1987 as cited in J.R. Single 2010). Moreover, recently proposed solar projects tend to be large contiguous blocks of disturbance in undeveloped habitat lands, ranging from hundreds to several thousand acres. (USFWS, 2013)

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, domestic livestock predation was thought to have extirpated colonies of C. californicus (Service 1990). On the Carrizo Plain, C. californicus is known to occur within and around the precincts or burrows of the endangered giant kangaroo rat (Dipodomys ingens). Giant kangaroo rats apparently seek out C. californicus, because stems of this species were clipped with equal frequency both on precincts (circular areas with a concentration of giant kangaroo rat burrows) and in interspaces of giant kangaroo rat burrows; however, directed research exploring interactions of plant and animal species in the community should be completed (Cypher 1994). (USFWS, 2013)

Stressor: Grazing (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Domestic livestock grazing has been used to reduce grass and forb competitors in endangered plant habitats; however, the use of domestic livestock grazing to benefit native plant species has had mixed results (Vesk and Westoby 2001; Floyd et al. 2003; Kimball and Schiffman 2003). Direct effects from cattle grazing are reported to be detrimental because cattle seek out and show preference for eating the plant (Service 1998). The habitat of C. californicus in Fresno County is grazed after the dispersal of its seeds in late spring and prior to the new growth of its basal rosettes in late winter. (USFWS, 2013)

Stressor: Competition from Nonnative Grasses (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The southern San Joaquin Valley of California, as with much of western North America, has been invaded by nonnative plant species during the past 100 to 200 years. These include the following species: Bromus rubens (red brome), Vulpia myuros (mouse tail fescue), Schismus arabicus (Arabian grass), Hordeum murinum ssp. glaucum (known locally as foxtail and elsewhere as smooth barley), Bromus diandrus (ripgut brome), and Bromus hordeaceus (soft chess) (Biswell 1956; Germano et al. 2001). Individual invasive species could modify ecosystem properties (Gordon 1998). (USFWS, 2013)

Stressor: Competition from Nonnative Plant Species Due to Fire Retardant Application (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Another threat to California jewelflower is invasion and competition from nonnative plant species; this threat could be exacerbated by the application of fire retardant, which can act as a nutrient source for nonnative invasives. California jewelflower habitat includes slightly alkaline sandy loams; the low nitrogen levels of these soil conditions are unfavorable for nonnative, which in turn provides a competitive advantage to species, such as the jewelflower, which have adapted to the nutrient-poor environment. Nitrogen and phosphorus could be increased in the soil through the application of ammonium-based retardants. (USFWS, 2013)

Stressor: Nitrogen Deposition (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Nitrification of soil was not considered a threat at the time of listing C. californicus, but should currently be considered a threat. There is little information regarding C. californicus and soil nitrogen levels in which it occurs (B. Delgado, BLM pers. comm. 2011), however some adverse soil conditions (low nutrients, low water holding capacity) exert stress on plant species and can reduce competition, particularly for species that are not tolerant of the soil stress factors (R. O'Dell pers. comm. 2011). Human activities have increased nitrogen availability throughout terrestrial systems (Suding et al. 2005). Three major producers of nitrogen emissions are transportation, agricultural production, and industrial activities including electricity production (Spiegel 2003). (USFWS, 2013)

Stressor: Pollinators (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the declines in the pollinators of all descriptions were not considered a threat to C. californicus. Since that time, the reduction to the population of the non-native honeybee (Apis mellifera), often referred to as colony collapse disorder, has been well documented. Native insects may pollinate the C. californicus, however a reduction in their abundance has been observed as well (United States 2007). (USFWS, 2013)

Stressor: Genetic Diversity (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Loss of genetic diversity was not considered a threat at the time of listing C. californicus. However, considering the reduction of the range of the C. californicus and fragmentation of habitat, lack of cross pollination between populations of the remaining localities may be a future threat. This may result in the loss of genetic diversity, which may reduce the adaptability of the plant to current and future environmental conditions and also increases the threat of inbreeding depression. Loss of genetic diversity and adaptability is likely to reduce the long-term survival of plant species (Huenneke 1991). (USFWS, 2013)

Stressor: Climate Change (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Climate change was not considered a threat to C. californicus at the time of listing; however, climate change is a potential threat to the species. Projected California temperature rise estimates range from an increase of 1.7° Celcius to 5.8° Celcius (3.0° Fahrenheit to 10.4°Farhenheit) for years 2000 - 2100 (Cayan et al. 2006). Climate change has the potential to alter the timing and synchronicity of ecosystem processes. The interactions between flower production and insect availability for pollination may be altered (Field et al. 1999; Cayan et al. 2006). Changes in temperature and precipitation likely will alter the structure, composition, and productivity of vegetation communities and wildfire may become more frequent and intense (Lenihan et al. 2006). (USFWS, 2013)

Recovery

Reclassification Criteria:
1. Secure and protect specified recovery areas from incompatible uses on ninety-five percent of occupied habitat on public lands; 75 percent of population and occupied habitat in Santa Barbara Canyon. (USFWS, 2013)

2. Management Plan approved and implemented for recovery areas that include survival of the species as an objective for all protected areas identified as important to continued survival. (USFWS, 2013)

3. Population monitoring for specified recovery areas shows that the populations are stable or increasing through the normal precipitation cycle. (USFWS, 2013)

Delisting Criteria:
Delisting criteria is not available.

Recovery Actions:
- Surveys will be necessary to determine whether natural populations remain in all target areas. (USFWS, 1998)
- Unoccupied habitat within metapopulations also should be protected to facilitate movement of pollinators and seed dispersers. (USFWS, 1998)
- The top-priority action for recovery of California jewelflower is to protect the plants on private land in Santa Barbara Canyon. (USFWS, 1998)
- Buffer zones of 150 meters (500 feet) or more should be protected beyond the population margins to reduce external influences and to allow for population expansion. (USFWS, 1998)
- Additional tasks are required to achieve recovery goals. These tasks include developing management plans, surveying for additional populations, banking seed, conducting research, and modeling population demographics using matrix projection modeling. (USFWS, 1998)
- Protection of extant populations and reintroductions as described in the 1998 Recovery Plan should be completed. Management on public lands should include provisions for suitable levels of sheep and cattle grazing. Protection of colonies on private lands or those to be re-established on private lands could result from partnering with landowners or offering conservation easements. (USFWS, 2013)
- Regular yearly surveys utilizing a standardized methodology should be conducted over the next five years at the Santa Barbara Canyon area in the Cuyama Valley in Santa Barbara

County, at the Carrizo Plain National Monument in San Luis Obispo County, and at the Kreyenhagen Hills in Fresno County so that the determination of what constitutes a sustainable population can be defined and environmental variables affecting abundance, such as precipitation and temperature, can be monitored. (USFWS, 2013)

- Successful re-establishment of populations will require an adequate understanding of the biology of the species and a robust seed collection. Studies should be conducted that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful re-establishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. Seeds should be collected from each of the three sites and banked at an appropriate depository. (USFWS, 2013)
- Threats such as loss and degradation of habitat should be eliminated, reduced, or ameliorated. The potential for habitat degradation due to nitrogen deposition and threats to pollinators from regional pesticide use should be analyzed and appropriate measures to ameliorate these threats should be implemented. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2013 5-year review (Service 2013), scientific literature, and as a result of discussions with species experts. 1. Protect existing habitat in the San Joaquin Valley for the California jewelflower. 2. A comprehensive evaluation should be completed for all known occurrences (both extant and extirpated). The site-specific evaluation should include, at minimum, whether the species is present, the estimated population/occurrence size, and an in-depth analysis of threats at that location. 3. Implement and/or continue yearly surveys utilizing a standardized methodology to determine trends in the range-wide status of the species as well as population/occurrence abundance. 4. Conduct studies that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful reestablishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. 5. Analyze the potential for habitat degradation due to climate change and nitrogen deposition, as well as threats to pollinators from regional pesticide use. Appropriate measures to ameliorate these threats should be implemented. (USFWS, 2020)

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SPECIES ACCOUNT: *Ceanothus ferrisae* (Coyote ceanothus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/03/1995; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

An evergreen shrub, 1-2 m tall. Leaves are < 3.2 cm long, rounded, tapering towards the base. The leaves are opposite and round with a dark green, hairless upper surface and a lighter green undersurface with minute hairs (Schmidt 1993). Leaf margins have short teeth or sometimes lack teeth; the leaf base is abruptly tapering or rounded. Small white flowers are borne in clusters 1.3 to 2.5 centimeters (0.5 to 1.0 inch) in length (McMinn 1933; Schmidt 1993). (NatureServe, 2015; USFWS, 2011)

Taxonomy

USFWS and CAHP tracks as synonym 01 - Ceanthous ferrisiae (9/93). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

At the time of listing and our 2011 5-year review, coyote ceanothus was only known from three locations in Santa Clara County, all within 6 km (4 miles) of each other (Service 1995, p. 6675; Service 2011). The current species distribution is similar to what was previously described, with three extant populations (Anderson, Llagas Road, and Kirby) distributed within an approximately 3-mile radius of Anderson Reservoir near the City of Morgan Hill (Vasey 2013, p. 1; CDFW 2021; Valley Water 2021, p. 4). The Kirby population and Anderson population are located on the eastern side of the Santa Clara Valley while the Llagas Road population occurs on the western side of the Santa Clara Valley. The 2011 5-year review further divided the Anderson population into two small subpopulations and one large population that are fragmented by Anderson Dam (Service 2011, p. 7). However, a genetic analysis conducted on all three extant populations did not support the dividing of the Anderson population into subpopulations (see Genetics subsection in the Coyote Ceanothus Population Creation Pilot Study section) (J. Hillman, Valley Water, in litt. 2013, p. 3; J. Hillman, Valley Water, in litt. 2021d; Potter 2012, p. 3; Honeycutt 2012, p. 5). There is an estimated 482 acres of occupied coyote ceanothus habitat range-wide: 400 acres in the Anderson population, 75 acres in the Llagas Road population, and 7 acres in the Kirby population (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2011)

Lifespan

Adult: 20 to 50 years (USFWS, 2011)

Breeding Season

Adult: January to March (USFWS, 2011

Key Resources Needed for Breeding

Adult: Possibly fire; require multiple, large populations within close proximity to allow genetic migration to occur via pollination (USFWS, 2011)

Reproduction Narrative

Adult: Ceanothus ferrisae is a perennial, flowering from January to May (Munz and Keck 1959). Ceanothus reach reproductive maturity after 5- 6 years. Will hybridize with other species or sub-species in situations where only one plant exists or there is genetic incompatibility with surrounding plants of the same species. (USFWS, 2011). The role of fire in the ecology of this plant remains unclear. Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks. C. ferrisae require multiple, large populations within close proximity to allow genetic migration to occur via pollination. The average lifespan for this species is estimated to range from 20 to 50 years (Keeley 1975; T. Parker, pers. comm., 2010; D. Wilken, pers. comm., 2010). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Possibly fire (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations < 300 m (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Colonial (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2011)

Dependency on Other Individuals or Species for Habitat

Adult: Rare species associated with Ceanothus ferrisae include the federally listed bay checkerspot butterfly (Euphydryas editha bayensis), Santa Clara Valley dudleya (Dudleya setchellii), and most beautiful jewelflower (Streptanthus albidus ssp. peramoenus) (Evens and San 2004). It is also associated with bigberry manzanita (Arctostaphylos glauca), California coffee berry (Rhamnus californica), California sagebrush (Artemesia californica), common yarrow (Achillea millefolium), foothill pine (Pinus sabiniana), leather oak (Quercus durata), and toyon (Heteromeles arbutifolia) (Corelli 1991; Evens and San 2004). Fire appears to destroy all mature and older plants, and stimulate regeneration from soil seed banks. (USFWS, 2011)

Habitat Narrative

Adult: Ceanothus ferrisae grows on arid slopes in mixed serpentine chaparral, valley, and foothill serpentine bunchgrass grasslands below 300 meters (about 1,000 feet) (Munz and Keck 1959; Hickman 1993). C. ferrisae is found in colonies at the Llagas Road location (CNDDB, 2010). Rare species associated with C. ferrisae include the federally listed bay checkerspot butterfly (Euphydryas editha bayensis), Santa Clara Valley dudleya (Dudleya setchellii), and most beautiful jewelflower (Streptanthus albidus ssp. peramoenus) (Evens and San 2004). It is also associated with bigberry manzanita (Arctostaphylos glauca), California coffee berry (Rhamnus californica), California sagebrush (Artemesia californica), common yarrow (Achillea millefolium), foothill pine (Pinus sabiniana), leather oak (Quercus durata), and toyon (Heteromeles arbutifolia) (Corelli 1991; Evens and San 2004). (USFWS, 2011)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining (USFWS, 2011)

Number of Populations:

4 (USFWS, 2011)

Population Size:

>188,000 (USFWS, 2023)

Minimum Viable Population Size:

5000 (USFWS, 2011)

Adaptability:

Low (inferred from USFWS, 2011)

Population Narrative:

Two of the four existing occurrences of Ceanothus ferrisae have population sizes greater than 2,000 individuals (3,600 and > 100,000, respectively). Information available to the Service suggests a minimum population size of 5,000 may be necessary to maintain 95 percent fitness for plants (Reed 2005). A genetic Allee effect may occurring as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). The survival and recovery of existing C. ferrisae populations may be threatened by limited genetic diversity as a result of small or declining population size, habitat loss and fragmentation, and geographic isolation that may limit insect-mediated gene flow. (USFWS, 2011). At the time of listing fewer than 6,000 coyote ceanothus plants were known to exist, with the largest population (Anderson) estimated at approximately 5,000 plants (Service 1995, p. 6675). The 2011 5-year review estimated the Anderson population consisted of over >100,000 plants, the Kirby population at

150 plants, and the Llagas Road population at 600 to 650 plants (CDFW 2021; Service 2011, pp. 7–8) (Table 1). A 2011 survey of the Llagas Road population estimated the size at 1,000–2,000 plants (Table 1) (CDFW 2021). No additional surveys have been conducted to estimate the size of three populations of coyote ceanothus (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Destruction and modification of habitat, and development on recreational and private lands continues to be a threat for Ceanothus ferrisae. Construction of a commercial landfill at Kirby Canyon beginning in 1986 (prior to the listing of C. ferrisae in 1995) may have resulted in the undocumented loss of thousands plants, as evidenced by the decline of this population from 5,000 in 1987 to about 100 individuals observed in 1992 (Freas, pers. comm. 1993; LSA Associates 1992). The remaining population is currently threatened by altered fire regime and lack of recruitment. Proximity to the commercial landfill and urban development may limit or prevent the use of fire for regeneration. The Llagas Road population exists on private land that is nearly surrounded by residential development. Future development could result in increased encroachment upon existing habitat necessary for expansion of the Llagas Road population to meet recovery goals. The proximity of urban development may limit or prevent the use of fire to regenerate this population as well. (USFWS, 2011)

Stressor: Cattle grazing (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Cattle have been grazing on the property for many years and may be negatively affecting the habitat and limiting recruitment for the Llagas Road population. The unprotected portion of the property where cattle grazing is permitted is nearly denuded of native chaparral vegetation with large areas of exposed soil and serpentine rocks evident (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). The cattle have gained access into the existing conservation easement through broken fencing thereby allowing them to browse on inflorescences of young C. ferrisiae plants before seed production can occur (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Heavy browsing by cattle and wild ungulates was observed among young, reproductive-age, plants during the fall 2010 survey at all sites (F. Gardipee pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman pers. comm., 2010). (USFWS, 2011)

Stressor: Dam activities (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The population located at Anderson Dam is threatened by loss and modification of habitat as a result of activities associated with the dam, actions to protect against damage from potential seismic activity, and un-regulated land management practices. Anderson Dam was constructed upon unstable materials and is positioned on a seismically active fault line (SCVHP

2010). (USFWS, 2011)

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Several insect species have been noted to infest Ceanothus species in California and predation in the form of herbivory by native ungulates and seed consumption by small mammals, insects, and birds is common (Deveny and Fox 2006). The western tent caterpillar (Malacosoma californicum) is known to construct large web-like tents on the branches of Ceanothus species (USDA 2006). Larvae feed on the leaves within the tent, often defoliating entire branches (USDA 2006). The western tussock moth (Orgyia vetusta) has been reported on Ceanothus species (USDA 2006). Large masses of cocoons may be observed on branches in late spring. Western tussock moth larvae feed on leaves and young growth, sometimes causing substantial defoliation and branch dieback. The western sycamore borer (Synanthedon resplendens) may attack Ceanothus species (USDA 2006). Adults emerge in May through early August and lay eggs within cracks, depressions, and injured tissues in the bark of old or slow-growing plants (USDA 2006). After hatching, larvae tunnel into the inner bark, creating winding tunnels that extend over 100 square centimeters (about 15.5 square inches). The amount of Herbivory may retard plant growth, destroy plants, and often reduces seed production (Boyd 2003; Deveny and Fox 2006). Black-tailed deer (Odocoileus hemionus columbianus) are primary browsers of C. ferrisae (Deveny and Fox 2006). Herds of black-tailed deer make their home in the Anderson Dam area. Evidence of browsing on fresh shoots, inflorescences, and leaves of young C. ferrisae plants was observed among all populations surveyed in mid-July and fall 2010 (F. Gardipee, pers. obs., 2010; T. Willsey, pers. obs., 2010; J. Hillman, pers. obs., 2010). Damage caused by western sycamore borers is generally considered to be insignificant (USDA 2006). (USFWS, 2011)

Stressor: Genetic Allee effect (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: A genetic Allee effect may occur as a result of limited availability of genetically suitable pollen mates in small populations of plants, thereby decreasing reproductive rates and increasing the risk of extinction (Berec et al. 2006; Wagenius et al. 2007). Habitat loss and fragmentation, small population size, and genetic isolation may increase the risk of a genetic Allee effect for self-incompatible species, such as Ceanothus ferrisae, and ultimately result in a subsequent loss of long-term population viability (Willi et al. 2005; Berec et al. 2006: Leimu et al 2006; Honnay and Jacquemyn 2007; Wagenius et al. 2007; Pickup and Young 2008). The subdivision of this population has resulted in possible isolation and reduced connectivity, thus increasing the risk of genetic Allee effects and decreased population viability. (USFWS, 2011)

Stressor: Fire management (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The proximity of Ceanothus ferrisae to residential development may preclude or limit the use of fire that may be necessary for stand regeneration. Further research regarding the role of fire for C. ferrisae is warranted to insure effective use of this management tool can be applied

to benefit the long-term conservation of this species. (USFWS, 2011)

Stressor: Global climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, altered fire regimes, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. However, climate change may exacerbate the effects of altered fire regimes on population viability of Ceanothus species endemic to California (Lawson et al. 2010). (USFWS, 2011)

Stressor: Fungal Pathogens (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: As mentioned previously, diseases were not considered a threat to the coyote ceanothus at the time of listing or the 2011 5-year review (Service 1995; Service 2011, p. 12). However, Fusarium oxysporum, a widespread taxa of fungus with both pathogenic and non-pathogenic strains, was identified as a potential weak root pathogen of nursery-grown coyote ceanothus as was observed during a wound inoculation test on terminal shoots for the coyote ceanothus population creation pilot study (Table 1) (Valley Water 2021, pp. 21–22). Although Fusarium proliferatum, another common fungal pathogen, was detected on the roots of coyote ceanothus that died at the introduction site along Coyote Ridge in the summer 2020 (Table 1), this taxa was not thought to be the cause of the die off based on the low virulence observed in a wound inoculation test on terminal shoots for the coyote ceanothus (Valley Water 2021, pp. 21–22). There is not sufficient data available to determine whether F. oxysporum or F. proliferatum is a threat to the health of coyote ceanothus in the wild (Valley Water 2021, p. 22). Botrytis, a common fungal pathogen that can be a problem under cool and moist conditions, was detected on coyote ceanothus container plants prior to outplanting at the introduction site on Coyote Ridge in late 2017 (Table 1); these infected seedlings exhibited leaf necrosis and wilted shoot tips (Valley Water 2021, p. 22). There is not sufficient data available to determine whether Botrytisis a threat to the health of coyote ceanothus in the wild; however, Valley Water is implementing measures to reduce the risk of spread (USFWS, 2023).

Stressor: Fire (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, fire was not considered to play an important role in the ecology of the coyote ceanothus and was considered a potential threat to the persistence of the species (Service 1995). However, the Recovery Plan and the 2011 5-year review identified an altered fire regime as a threat to the coyote ceanothus and reported the lack of natural recruitment without fire (Service 1998, pp. II-36, II-38, and II-39; Service 2011, pp. 17–18). An altered fire regime due to fire suppression continues to be a significant threat to the coyote ceanothus and a lack of fire is considered one of the biggest threats to the Llagas Road population (J. Hillman, Valley Water, in litt. 2021f). Valley Water observed the senescence of larger coyote ceanothus shrubs with a lot

of old, woody growth and dead branches on many of the larger plants in the Llagas Road population and recommended prescribed burning to remove dead wood and grass thatch, and promote the recruitment of new plants (J. Hillman, Valley Water, in litt. 2021f). Germination experiments at Stanford University demonstrated that under the right conditions coyote ceanothus can germinate without fire, but recruitment is less frequent and less abundant without fire (Service in litt. 2020a; J. Hillman, Valley Water, in litt. 2021c; Service 1998, p. II-36). As stated previously, there has been some natural recruitment of coyote ceanothus observed in the absence of fire above a perennial stream in the Kirby population, commonly along the exposed areas of the reservoir shoreline in the Anderson population, and many times over the years in the Llagas Road population (Valley Water 2021, pp. 29–30; J. Hillman, Valley Water, in litt. 2021d). In addition to a lack of fire, the species could also be threatened if fires occurred too frequently and increasing summer aridity is predicted to increase wildfire frequency and severity in the San Francisco Bay Area (see the Climate Change section below) (Williams et al. 2019, p. 892; Westerling 2018; Ackerly et al. 2018, p. 30, Figure 10). Additionally, the accumulation of biomass from invasive grasses in coyote ceanothus habitat facilitated by atmospheric N deposition increases the frequency and severity of wildfires (Rao et al. 2010 cited in Fenn et al. 2010, p. 2409; S. Weiss, Creekside Science Center for Earth Observation, in litt. 2021) (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: At the time of the 2011 5-year review, climate change was identified as a potential threat to the coyote ceanothus, but due to the uncertainty in predictions of climatic conditions for smaller subregions such as California, the Service lacked adequate information to make accurate predictions regarding its effects on the coyote ceanothus (Service 2011, p. 18). There is consensus that the increase in greenhouse gas emissions during the 20th century resulted in global climate change characterized by: warming atmospheric and ocean temperatures, diminishing snow and ice, and rising sea levels (Intergovernmental Panel on Climate Change 2014, pp. 2–3). While the influence of climate change on these highly localized features of the San Francisco Bay Area climate is poorly understood at this time, there is general agreement about increasing temperatures and increasing interannual variability of precipitation (Ackerly et al. 2018, pp. 6, 13). Further, warming near the San Francisco Bay Area coast will be affected by changes in fog and sea breeze (USFWS, 2023).

Recovery

Reclassification Criteria:
1. Protection and management of the four known occurrences of Ceanothus ferrisae by working with Santa Clara County, the SCVWD, and private landowners to ensure long-term survival of the species on their lands. (USFWS, 2011)

2. Survey of other potential serpentine habitats to identify potential habitat. (USFWS, 2011)

3. Seed collection and research. Collection and banking of seed in Center for Plant Conservation certified botanic gardens is prudent to guard against extinction of the species from catastrophic events and to provide potential material for enhancement efforts in existing populations,

repatriations, and/or introductions to new sites. All known populations should be represented in seed collections. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 2011)

4. Research on demography, fire ecology, and effects of grazing. Important research questions include how grazing impacts the reproduction, recruitment, and survival of the species, and why so little recruitment is observed in natural populations. (USFWS, 2011)

5. Establishment of new populations to meet recovery goal of eight populations representing the entire historic range. Ceanothus ferrisae should not be considered for delisting unless eight populations, consisting of at least, 2,000 individuals, within its historic range and representing its entire historic range. (USFWS, 2011)

Recovery Priority Number: 14

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Habitat conservation to support the survival and recovery of Ceanothus ferrisae should be accomplished through land acquisition and establishment of conservation easements where possible. Protection of C. ferrisae populations on private lands through additional conservation easements and land purchases, and restoration of additional populations within the historic range should be prioritized to minimize the likelihood of extinction. (USFWS, 2011)
- Research that will inform management decisions, conservation planning, and restoration efforts for Ceanothus ferrisae should be conducted. (USFWS, 2011)
- Establishment of additional Ceanothus ferrisae populations where appropriate serpentine chaparral habitat has been identified in the proposed SCVHP. Restoration efforts should target habitat sites that can support a minimum population of at least 5,000 individuals. (USFWS, 2011)
- Enhancement and regeneration of existing populations of Ceanothus ferrisae to achieve minimum populations of 5,000 plants through various strategies. For example, implementation of an optimal fire regime (determined through research) to stimulate seedling production from the soil seed bank may prove to be a successful strategy to increase small population sizes. Fire applied to small areas over several years may yield large, sustainable populations, consisting of a mosaic of age classes and genotypes, which may be less vulnerable to stochastic events and senescence. Translocation efforts may prove successful as well. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation, restoration, and Phytophthora avoidance recommendations that will aid in the recovery and conservation of the coyote ceanothus. 1. Research should further analyze the cause of the decline of the Kirby population. A restoration effort including the introduction of new genotypes should be conducted for the Kirby population since it has the lowest genetic diversity and shows evidence of

inbreeding (Honeycutt 2012; J. Hillman, Valley Water, in litt. 2013). 2. Public access should be restricted and trails rerouted away from all coyote ceanothus populations in order to prevent the introduction and spread of the plant pathogen Phytophthora. Specifically, public access should be prohibited near the Kirby population due to the detection of Phytophthora in a stream downhill from the Kirby population near the public entry point. 3. All work within or near coyote ceanothus habitat should follow the best management practices and updated guidance provided by the Working Group for Phytophthoras in Native Habitats available at https://www.suddenoakdeath.org/welcome-to-calphytos-orgphytophthoras-in-native-habitats/(e.g., Working Group for Phytophthoras in Native Habitat 2016). Any revegetation efforts within coyote ceanothus habitat should use only direct seeding instead of installing container plants unless the nursery can prove that the container plants are free of Phytophthora and all necessary best management practices are being implemented at the nursery to prevent the introduction and spread of Phytophthora consistent with the “Guidelines to Minimize Phytophthora Pathogens in Restoration Nurseries” (https://www.suddenoakdeath.org/wpcontent/uploads/2020/08/Restoration.Nsy_.Guidelines.final_.092216_rv_8.20.20.pdf, Working Group for Phytophthoras in Native Habitat 2020). 4. Efforts should continue to preserve the Anderson and Kirby populations of the coyote ceanothus with a minimum 1,000-foot buffer around the occurrences. 5. Any additional introduction or population creation efforts for coyote ceanothus should occur on the western side of Santa Clara Valley near the Llagas Road population, where the climate is more mesic and population genetic diversity is highest.The created population should be planted annually over a series of years from seed collected regularly from the Llagas Road population in order to mimic natural recruitment and allow the establishment of multiple age classes.Both direct seeding and installation of container plants following strict phytosanitary measures should be used for the population creation. 6. Coyote ceanothus seedlings and young plants should be caged in wide cages in the Llagas Road population to reduce browse/herbivory and set up wildlife cameras in extant occurrences of the coyote ceanothus to examine browse pressure and herbivory. A study should also be conducted comparing the abundance of rodents and rates of seed predation under browsed and unbrowsed coyote ceanothus. Vegetation cover (e.g., non-native grasses, sagebrush) near coyote ceanothus should be reduced if it is determined that the vegetation supports a high abundance of rodents that prey on the seeds and seedlings. 7. The Llagas Road population should be tested for the presence of Phytophthora pathogens. 8. Prescribed burning should be investigated as a management tool for regeneration in the Llagas Road population because it facilitates the removal of dead wood and grass thatch and promotes natural recruitment. 9. Research should further explore the soil microsymbiotic relationships such as Frankia and mycorrhizae in managed and created populations of the coyote ceanothus. 10. Research should further explore plant pathogen introductions and potential impacts on managed and created populations of the coyote ceanothus. This should include not just Phytophthora, but also Fusarium and Botrytis, which are known to affect seedlings. 11. Identify additional habitat suitability needs and potential locations for another population creation site for the coyote ceanothus while taking into consideration climate change and atmospheric N deposition. 12. An additional seed banking effort should be conducted for all three extant populations (USFWS, 2023).

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SPECIES ACCOUNT: *Ceanothus ophiochilus* (Vail Lake ceanothus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A rounded shrub, usually 1.2-1.5 m (4-5 feet) tall. The flat, dull green leaves are opposite, with knob-like stipules, narrowly oblanceolate (broadest above the middle and tapering toward the base) to obovate (eggshaped) in shape, glabrous (smooth), with obscure veins and blades 3 to 7 mm long and 1 to 3 mm wide; fruits are 3 to 3.5 mm wide, and without horns (Wilken 2012, p. 1158). Flowers are pale blue, occasionally pink, in bloom from mid-February to March. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Ceanothus ophiochilus is a narrow, edaphic endemic plant found only within 20 acres in Southwestern Riverside County, California (Fish and Wildlife Service 1998). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/27/2007.

Legal Description

On September 27, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Ceanothus ophiochilus (Vail Lake ceanothus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes obe critical habitat unit (CHU), in California (72 FR 54984-55010).

Critical Habitat Designation

The critical habitat designation for Ceanothus ophiochilus includes one CHU (2 sub-units) in Riverside County, California. This species critical habitat encompasses approximately 283 acres (ac) (115 hectares (ha)) (72 FR 54984-55010).

Unit 1: Western Riverside County Unit 1 is located near Vail Lake in southern Riverside County, California. The area was occupied at the time of listing and contains all of the primary constituent elements essential to the conservation of the species that may require special management considerations or protection for Ceanothus ophiochilus. Below, we present a brief description of subunit 1B, reasons why it meets the definition of critical habitat for C. ophiochilus, and our rationale for our final designation of critical habitat. Subunit 1B, Agua Tibia Mountains, Riverside County, California Subunit 1B (Agua Tibia Mountains) consists of 203 ac (82 ha) of land which is managed by the USFS. Subunit 1B contains two of the three CNDDB element occurrences (2 and 3) of Ceanothus ophiochilus, both known at the time of listing. The PCEs within this subunit may require special management considerations or protection to address the threats posed by short-interval fires, competing nonnative species, impacts to ridge tops (PCE 1) from grading associated with the creation of fuel breaks and impacts to the associated vegetation community (PCE 3) resulting from unnatural fire regimes. Subunit 1B is entirely within the Agua Tibia Wilderness of

the Cleveland National Forest. Recently the USFS completed the LMP for the Four Southern California National Forests. Implementation of the LMP was analyzed by the Service to address potential impacts to Ceanothus ophiochilus. This analysis found that impacts to C. ophiochilus would be minor or negligible upon implementation of appropriate minimization measures due to the lowimpact nature of activities planned (e.g., dispersed recreation, non-motorized trails) (Service 2005 p. 129–132). However, the LMP does not identify specific management measures to address the threat posed by shortinterval fires and by competing nonnative species (Keeley 2006, p. 367; Merriam et al. 2007, p. vi, v, 48, 61). Because the USFS does not have a management plan specific to C. ophiochilus that provides the same or better level of protection from adverse modification or destruction than that provided through a consultation under section 7 of the Act, we have determined that exclusion of these lands from the final designation of critical habitat pursuant to section 4(b)(2) of the Act is not appropriate for these Federal lands (please see ''Exclusions under Section 4(b)(2) of the Act'' for a detailed discussion). Therefore, we are designating the USFS lands containing features essential to the conservation of C. ophiochilus as critical habitat for this species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Ceanothus ophiochilus critical habitat consists of three components (72 FR 54984-55010):

(i) Flat to gently sloping north to northeast facing ridge tops with slopes in the range of 0 to 40 percent slope that provide the appropriate solar exposure for seedling establishment and growth.

(ii) Soils formed from metavolcanic and ultra-basic parent materials and deeply weathered gabbro or pyroxeniterich outcrops that provide nutrients and space for growth and reproduction. Specifically in the areas that Ceanothus ophiochilus is found, the soils are: (A) Ramona, Cienaba, Las Posas, and Vista series in the Agua Tibia Wilderness; and (B) Cajalco series in the vicinity of Vail Lake.

(iii) Chamise chaparral or mixed chamise-ceanothus-arctostaphylos chaparral at elevations of 2,000 feet to 3,000 feet (610 meters to 914 meters) that provide the appropriate canopy cover and elevation requirements for growth and reproduction.

Special Management Considerations or Protections

As stated in the final listing rule, threats to Ceanothus ophiochilus include habitat destruction, alteration, fragmentation, and degradation from urban development, as well as hybridization and fire at too frequent intervals to allow for sufficient seed bank replenishment in the soil (63 FR 54956, October 13, 1998). Threats to Fremontodendron mexicanum as cited in the final listing rule include altered fire regimes, indirect impacts from nearby urbanization, and increased competition from nonnative species (63 FR 54965, October 13, 1998). These threats could impact the PCEs determined to be essential for conservation of C. ophiochilus and F. mexicanum. Urban development near Ceanothus ophiochilus critical habitat units may alter the habitat characteristics required by the species. Land grading in and around occurrences of C. ophiochilus may affect the topography of the habitat and change the soil composition (PCEs 1 and 2) rendering the habitat unsuitable for species growth and reproduction. Urban development may also encourage invasion by nonnative plant species, changing the vegetation community and/or

directly impacting the vegetation community (PCE 3). In addition, urban development near this species may increase the frequency of fire. All identified private land is covered by the Western Riverside County MSHCP (MSHCP), and those lands have been excluded from the final designation (see ‘‘Relationship of Critical Habitat to Habitat Conservation Plan Lands—Exclusions Under Section 4(b)(2) of the Act’’ section for a detailed discussion). No urban development is expected to directly impact the occurrences of C. ophiochilus on land owned by the USFS. Therefore, we do not believe threats from urban development would require special management considerations or protection of the PCEs on designated critical habitat for this species. The management of both fire frequency and the placement of fuel breaks is important for the conservation of Ceanothus ophiochilus, and special management considerations or protection of the PCEs for C. ophiochilus may be required on USFS lands to address potential threats posed by fire management activities. In the past, fuel breaks have been placed on the ridgelines (PCE 1) in C. ophiochilus habitat and have caused soil disturbance (PCE 2). Studies of fuel breaks in the Cleveland National Forest near the critical habitat designation have demonstrated an increase in the density of competing nonnative species (Merriam et al. 2007, p. 48), and it has been hypothesized that fuel breaks promote the introduction and spread of nonnative plants (Merriam et al. 2007, p. vi). These nonnative invasive plants alter local fuel conditions and change fire behavior and frequency (Merriam et al. 2007, p. 61). Ceanothus ophiochilus is very sensitive to short-interval fires, which may extirpate the species from a site entirely (Keeley 2006, p. 367). Soil disturbance, caused by the creation of fuel breaks, has also led to increased hybridization between Ceanothus ophiochilus and C. crassifolius. However, the degree to which hybridization is impacting C. ophiochilus and its habitat is not yet known.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (hybridization) (USFWS, 2013)

Breeding Season

Adult: Mid-February to March (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Fire (USFWS, 2013)

Reproduction Narrative

Adult: Flowers are pale blue, occasionally pink, in bloom from mid-February to March (NatureServe, 2015). Hybridization is common among Ceanothus species (Wilken 2012, p. 1153; Fross and Wilken 2006, pp. 132–133). Ceanothus ophiochilus generally requires a firereturn interval between 10 to 20 years to adequately replenish the seed bank (Keeley and Davis 2007, p. 350). Ceanothus ophiochilus is an obligate seeder and therefore does not resprout following fire, but instead recovers through the germination of seeds stored in the soil (Boyd and Banks 1995, p. 28; Keeley 2006, p. 367). (USFWS, 2013)

Habitat Type

Adult: Terrestrial (NatureServe, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral

Dependencies on Specific Environmental Elements

Adult: Fire (USFWS, 2013)

Spatial Arrangements of the Population

Adult: Isolated patches (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Ceanothus ophiochilus is restricted to isolated patches of gabbro and pyroxenite-rich outcrops (Vail Lake), or within a mix of gabbro and sedimentary deposits (Agua Tibia Wilderness) (Boyd and Banks 1995, p. 15). It is generally found within chamise chaparral habitats on ridge tops and north- to northeast-facing slopes (USFWS, 2013). Ceanothus ophiochilus generally requires a firereturn interval between 10 to 20 years to adequately replenish the seed bank (Keeley and Davis 2007, p. 350). (USFWS, 2013)

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Many plant species with refractory seeds (i.e., seeds that need a fire-related stimulus, alone or in conjunction with other conditions; Keeley 1991, p. 87) have propagules that are not specialized for widespread dispersal and therefore have a relatively short dispersal distance (Keeley 1991, p. 105). Ceanothus plants have capsules that eject seeds and studies on two Sierra Nevadan Ceanothus species, C. cuneatus and C. leucodermis, found that most seeds fall beneath the canopy vegetation (Evans et al. 1987, p. 288); even on open sites, few seeds (less than 2 percent) reached a distance of 29.5 ft (9 m) (Evans et al., 1987, pp. 288–289). (USFWS, 2013)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

3 (USFWS, 2013)

Population Size:

~10,000

Population Narrative:

One populations consists of about 3,000-5,000 individuals and occupies about 8 hectares; the remaining two populations comprise over 4,000 individuals in a 12 hectare area (Fish and

Wildlife Service 1998). Known from only three occurrences near Vail Lake, California (Skinner 1997). (NatureServe, 2015).

Threats and Stressors

Stressor: Urban development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the Service indicated that much of southwestern Riverside County was expected to become more urbanized based on development trends and planned developments on private lands in the Vail Lake area (USFWS 1998, p. 54961). In the 2008 5-year review, the Service reevaluated the proposed developments for this area and stated that the most recently proposed, large-scale development (Specific Plan No. 324) for this area had not been acted upon and the project was inactive (USFWS 2008, p. 8). However, the Service concluded that urban development in the Vail Lake area remained a significant threat to the Vail Lake occurrence of Ceanothus ophiochilus since no assurances of the conservation of this species have been made (USFWS 2008, p. 8). In summary, the Service believes that urban development represents a potential threat to Ceanothus ophiochilus at two of the three occurrences. (USFWS, 2013)

Stressor: Recreational activities (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Dispersed recreation (e.g., camping, hiking, mountain bike activity) is an occasional, ongoing use at the Agua Tibia Wilderness occurrences (USFS 2012b, p.41). The use of exiting trails or the creation of new trails within the Agua Tibia Wilderness occurrences located on CNF lands represents a potential threat to Ceanothus ophiochilus primarily from soil compaction of habitat, although trampling of individual plants may also result from these activities. However, no designated USFS trails currently intersect with habitat occupied by C. ophiochilus (USFS 2012b, p. 41) and the recreational use, although allowed in or near the two Agua Tibia Wilderness occurrences within CNF by the public, is limited because access is controlled by adjacent private lands (USFS 2012b, pp. 40–41). (USFWS, 2013)

Stressor: Invasive non-native plants (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Invasive nonnative plants have been identified by the USFS as a threat to habitat quality for Ceanothus ophiochilus, particularly in those areas within the Agua Tibia Wilderness occurrences where recent wildland fire has exposed bare soils and created unclassified trails as a result of fire suppression activities (USFS 2005a, p. 259). Roads and road construction from grading of fuel breaks facilitate the introduction and establishment of invasive nonnative plants (discussed above) by creating open, continually disturbed habitat. Invasive nonnative plants can also be transported along these corridors by equipment and other vehicles, as well as recreational uses, and can become more readily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005e, Volume 1, p. 114). Activities conducted by the USFS

associated with the removal of invasive plants may have short-term adverse effects to Ceanothus ophiochilus. (USFWS, 2013)

Stressor: Wildland fire and fire Management (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: In the USFWS listing rule, the Service identified the change in fire cycle regimes (or fire frequency) as a threat to Ceanothus ophiochilus and other plants adapted to specific fire frequencies (USFWS 1998, p. 54964). Changes occurred from increased incidence of local accidental fires and less frequent natural fires resulting from human activity in fire prone areas (e.g., Vail Lake occurrence). The Service also highlighted fire management practices including grading of C. ophiochilus habitat for fire or implementation of fuel breaks as an important threat to this species for all three occurrences (Boyd 1991, pp. 2, 8; Boyd and Banks 1995, p. 16; USFWS 1998, p. 54961). Fire management and suppression activities including fire line construction, fire retardant and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation can affect Ceanothus ophiochilus habitat (USFWS 2005, p. 27). (USFWS, 2013)

Stressor: Hybridization and introgression (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Service identified hybridization and genetic introgression with C. crassifolius as a major threat to C. ophiochilus where the two species co-occur in our 2008 5-year review (USFWS 2008, p. 14). Without genetic evaluations and comprehensive surveys within the three occurrences, it is difficult to assess the nature and extent of hybrid individuals; thus, it is unclear if hybridization or introgression represents a current threat to C. ophiochilus at this time. Continued monitoring of disturbance to all three occurrences is needed in conjunction with additional genetic viability studies to better evaluate these two related threats to C. ophiochilus. (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Based on the best available information contained in model predictions for this general region of California, a change in temperature conditions resulting from climate change is considered a rangewide threat to Ceanothus ophiochilus due to predicted changes to its habitat. Climate model predications also indicate a slight increase in fire risk to the geographical range of C. ophiochilus, which, when combined with anthropogenic facilitation, can produce a shortening of the fire return interval and affect its ability to recover and maintain its viability in the chaparral ecosystem. (USFWS, 2013)

Stressor: Climate Change - New Information (USFWS, 2020)
Exposure:
Response:
Consequence:

Narrative: TEMPERATURE Temperature across southern California has increased over the past century. He and Gautam (2016) analyzed 1896–2015 temperature records for the region. They reported that annual average, maximum, and minimum temperature all increased by around 0.16 degree Celsius per decade (p. 11). Projected temperature increases differ spatially across southern California. The ocean buffers warming near the coast, so coastal areas are projected to experience relatively smaller temperature increases (Hall et al. 2018, p. 11). But inland areas—such as the range of Ceanothus ophiochilus in western Riverside County—are projected to have relatively larger temperature changes under both emissions scenarios (Hall et al. 2018, p. 11). Extremely hot days are also projected to become more frequent and intense, with the largest changes in interior regions (Hall et al. 2018, p. 11). For the range of Ceanothus ophiochilus in Western Riverside County, annual average maximum temperatures under RCP 4.5 are projected to increase from an observed historical (1961–1990) average of 77.2 degrees Fahrenheit (F) [25.1 degrees Celsius (C)] (range 75.8–80.0 degrees F, 24.3–26.7 degrees C), to a projected future (2070–2099) average of 82.9 degrees F (28.3 degrees C) (range 79.8 –86.0 degrees F, 26.5–30.0) (Cal-Adapt 2020). Under RCP 8.5, end-of-century (2070–2099) annual average maximum temperatures are projected to rise to 85.7 degrees F (29.8 degrees C) (range 81.4–90.6 degrees F, 27.4–32.5 degrees C). For projections of future temperature, RCP 4.5 and 8.5 scenarios are similar in the early and mid-21st century. Projections diverge in the second part of the century, as emissions continue to rise under RCP 8.5 (Hall et al. 2018, p. 10). PRECIPITATION Precipitation in southern California is highly variable from year to year (Kalansky et al. 2018, p. 24; Hall et al. 2018, p. 12). Models of future precipitation generally project small mean changes relative to the historical variability, and the overall direction of future precipitation is unclear (Hall et al. 2018, p. 13). Models do project increases in extreme precipitation frequency and intensity (Polade et al. 2017, p. 7; Swain et al. 2018, p. 428), including increases in the frequency of atmospheric-river storms, which deliver intense precipitation and can cause severe flooding (Dettinger 2011, p. 519). However, droughts are also projected to become more frequent and intense, and will be exacerbated by higher temperatures (Kalansky et al. 2018, p. 25). ATMOSPHERIC CO2 CONCENTRATION Since 1750, the atmospheric concentrations of greenhouse gasses (including carbon dioxide, methane, and nitrous oxide) have increased because of human activity (IPCC 2013, p. 11). In 2011, the concentration of carbon dioxide (CO2) was 391 parts per million (ppm), 40 percent higher than pre-industrial levels (IPCC 2013, p. 11). In 2018, the global average atmospheric carbon dioxide (CO2) concentration was 407.4 parts per million (ppm) (Lindsey 2020). Plants use CO2 and water to synthesize carbohydrates. Therefore, elevated CO2 concentrations can directly affect photosynthesis. FIRE California has a Mediterranean climate with cool, wet winters and hot, dry summers. Fire is an important part of California ecosystems. Fire behavior is influenced by topography, weather, fuel characteristics, and ignition sources (van Wagtendonk 2006, pp. 38–46). Santa Ana winds—strong, dry, and hot winds occurring mostly in September through December (Hughes and Hall 2010, p. 847; Jin et al. 2015, pp. 1–2)—are one feature of the southern California climate which can influence wildfire behavior and size. Wildfires driven by Santa Ana winds (Santa Ana fires) spread more quickly, and have higher intensity, than fires that occur outside the Santa Ana season (Jin et al. 2015, pp. 5–6). For California's Fourth Climate Assessment, Pierce et al. (2018) projected an increase in the driest of Santa Ana days (daily wind speeds greater than or equal to 8 meters per second, and less than or equal to 20 percent relative humidity), although the number of Santa Ana days and the days with the strongest wind speeds were projected to decrease (Pierce et al. 2018, p. 36; Kalansky et al. 2018, p. 27). There is uncertainty in future wildfire projections for southern California (Hall et al. 2018, p. 18), but wildfire risk will likely increase as climate warms (Kalansky et al. 2018, p. 6). Under RCP 8.5,

Westerling (2018, p. 19) projected an increasing tendency towards extreme wildfire events, rapidly accelerating after the mid-21st century. Statewide, the greatest increases in burned area were projected to be in forested areas of the state (Westerling 2018, p. 14). For southern California under RCP 8.5, Jin et al. (2015, p. 9–10) projected increases in burned area, number of fires, and fire size for both Santa Ana and non-Santa Ana fires. (USFWS, 2020)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Continue to work with the CNF to ensure that USFS guidelines and directives are being implemented for activities that might directly or indirectly impact Ceanothus ophiochilus habitat. This should include providing comment on biological assessments for proposed fire suppression activities and assistance in designing fuel breaks to protect populations of C. ophiochilus. (USFWS, 2013)
- Conserve or preserve Ceanothus ophiochilus occurrences on private lands, especially at Vail Lake. Pursue opportunities to purchase parcels through the Act's section 6 funding and other conservation partnership programs (i.e., Western Riverside County MSHCP) with willing sellers. (USFWS, 2013)
- Develop outreach or educational activities with the primary landowner adjacent to the Agua Tibia Wilderness–North occurrence to enlist their assistance in ensuring the survival and recovery of Ceanothus ophiochilus. (USFWS, 2013)
- Develop a monitoring plan for populations of Ceanothus ophiochilus, the quality of chamise chaparral habitats, and threats at the three C. ophiochilus occurrences. This monitoring plan should include surveys to detect abundance, habitat conditions, and potential threats to the taxon, particularly those related to the effects of fire and fire management activities. (USFWS, 2013)
- Determine the current level and pattern, extent, and impact of introgression of Ceanothus ophiochilus with C. crassifolius at all three occurrences. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Work with the Rancho California Water District to conserve and enhance the Vail Lake occurrence of Ceanothus ophiochilus. 2. Survey suitable habitat for new occurrences of C. ophiochilus. 3. Survey for nonnative invasive plants in the vicinity of C. ophiochilus occurrences. 4. Model C. ophiochilus habitat under a range of future climate scenarios, and evaluate assisted migration or translocation as a management strategy. 5. Determine the current level and extent of introgression of C. ophiochilus with C. crassifolius, and reexamine putative hybrids. 6. Collect additional C. ophiochilus seeds for ex situ storage at a certified Center for Plant Conservation facility. (USFWS, 2020)

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SPECIES ACCOUNT: *Ceanothus roderickii* (Pine Hill ceanothus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; California/Nevada Region (R8)

Physical Description

A prostrate evergreen shrub of the buckthorn family (Rhamnaceae) that generally grows to 3 meters (9.8 feet) in diameter. The smooth gray-brown branches radiate from a central axis and root when they come into contact with the ground. Its leaves are semi-erect with entire (smooth-edged) margins. Small whitish flowers tinged with blue appear from May through June. Its fruit is an inconspicuously horned, globe-shaped capsule. Ceanothus roderickii can be differentiated from its congeners (other species of the same genus, other related species) by a combination of its blue-tinged flowers, prostrate habit, and inconspicuously horned fruit. (USFWS, 2002)

Taxonomy

Walter Knight (1968) described Ceanothus roderickii as Ceanothus rodericki, naming it after Wayne Roderick, who first recognized the horticultural value of this endemic shrub. Due to an orthographic change, the correct spelling is Ceanothus roderickii. Knight (1968) considered C. roderickii to be most closely related to C. cuneatus (buckbrush), which also grows throughout the area. Ceanothus roderickii is suggested to resemble the sprawling C. fresnensis (Fresno mat), which grows a considerable distance to the south at higher elevations; plants of the two species grown in a regional park flowered at different times (Knight 1968). (USFWS, 2002)

Historical Range

Endemic to western El Dorado County, California. (USFWS, 2002)

Current Range

On the Pine Hill formation in western El Dorado County, California.(USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The pollination of Ceanothus roderickii is primarily by insects from the orders Diptera (flies and gnats) and Hymenoptera (bees and wasps). (USFWS, 2002)

Breeding Season

Adult: May to June (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Fire/heat (USFWS, 2002)

Reproduction Narrative

Adult: Flower/fruit development in this species is negatively affected by canopy shading (James 1996). Unlike most chaparral shrub species, Pine Hill ceanothus will not resprout from a caudex (woody axis comprising the stem and root) after a fire, and therefore, depends on nearby plants connected via branch layering for survival or the seedbank for re-establishment (Boyd 2007). There is reason to believe that seeds can survive at least 80 years in the seedbank (Ayres 2011; Boyd 2007). Hot/cold stratification, but not necessarily fire (Boyd 2007), seems to be required for germination (James 1996; Boyd 2007). Because juvenile plants do not begin flowering until 5-6 years after fire, populations need a fire-free period of at least six years to replenish the seed bank (Marsh and Ayres 2002; Ayres 2011), otherwise populations may be permanently lost. (USFWS, 2019)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Combination of heat and cold (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: Shading limits flower production (USFWS, 2002)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2002)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2002; NatureServe, 2015)

Habitat Narrative

Adult: Ceanothus roderickii is found in openings in chaparral communities on gabbro- or serpentinite- derived soils (NatureServe, 2015). Most occurrences are discontinuously scattered within two population centers in the northern and southern portions of the Pine Hill formation. The seeds treated with a combination of heat and cold have the best germination rate. Canopy shading was shown to negatively affect flower and fruit production in C. roderickii. (USFWS, 2002)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

2 known extant ; 7 presumed extant (USFWS, 2019)

Population Size:

Greater than 55,000 individuals (USFWS, 2019)

Population Narrative:

It is restricted to one localized area of approximately 10 occurrences discontinuously scattered in the Pine Hill formation in the north, central, and south areas (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range. (USFWS, 2002)

Stressor: Habitat fragmentation (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: The subsequent induced growth from water acquisitions would affect all six species on the Pine Hill formation and adjacent serpentine, either by further fragmenting the habitat or by directly destroying habitat. Habitat fragmentation and edge effects significantly affect gabbro plants. Habitat fragments are more susceptible to being burned in their entirety, with shorter than natural intervals between fires, relative to larger tracts of habitat. If an entire preserve burns more often than the natural fire frequency, the seed bank of certain chaparral shrub species may not be adequate to replace the population. Fragmentation splits habitat into smaller, more isolated units and has two primary effects. First, habitat fragmentation may alter the physical environment, changing the amount of incoming solar radiation, water, wind, or nutrients for the remnant vegetation (Saunders et al. 1991). Second, most of these fragmented natural areas are subject to influences from external factors (e.g., additional development, lawn and garden watering, herbicide drift, and off-road vehicular use) that disrupt natural ecosystem processes. (USFWS, 2002)

Stressor: Fire management (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Changes in fire frequency threaten Ceanothus roderickii. C. roderickii occur within a fire-adapted plant community, either within chaparral or on the ecotone between chaparral and woodland. Before the advent of fire suppression policies, chaparral stands may have burned at a frequency of roughly 3 to 5 times per 100 years (Boyd 1985). Longer than normal fire frequencies lead to the loss of some plant species from the chaparral plant community. (USFWS, 2002)

Stressor: Hydrologic changes (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: El Dorado Irrigation District, is attempting to get additional water from the South Fork of the American River through purchase of PG&E's Hydroelectric Project 184 and a storage contract with the Bureau of Reclamation utilizing Folsom Reservoir. This water is most likely to be used for developments in the extreme western part of El Dorado County, where the gabbro soil plants are found (A. Howard in litt. 1999). (USFWS, 2002)

Stressor: Development (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Mitigation for development often is by small "set asides" (small natural areas within the development), which increase habitat fragmentation, are difficult to manage for fire, and are subject to edge effect problems. Land development and multiple ownership complicate the planning and implementation of controlled burns at the appropriate fire frequency necessary for maintenance of chaparral. (USFWS, 2002)

Stressor: Road widening and maintenance (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Road widening occurs near development within El Dorado County threatens the habitat of Ceanothus roderickii at one site (California Natural Diversity Data Base 1994). (USFWS, 2002)

Stressor: Recreation (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Off-road vehicle use has adversely affected the habitat of Ceanothus roderickii at three sites in the northern part of the Pine Hill formation. Several hills are scarred with off-road vehicle tracks. Erosion promoted by scarring adversely modifies the habitat. (USFWS, 2002)

Stressor: Invasive plants (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). (USFWS, 2019)

Recovery

Reclassification Criteria:
1. Secure and protect specified recovery areas from incompatible uses: (a) Cameron Park preserve north of Highway 50; (b) Cameron Park preserve south of Highway 50; (c) Pine Hill preserve; Salmon Falls/Martel Creek preserve; (d) sufficient adjacent unoccupied habitat for fire management and a 150- meter (500-foot) buffer. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For preserves and any adjacent occupied or unoccupied habitat identified as necessary for continued survival and recovery (USFWS, 2002).

3. Monitoring in all recommended preserves shows: (a) populations stable or increasing over one fire cycle (about 30 years), (b) habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions, (c) spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats; (b) Fire management studies; (c) Research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary; (d) Maintain metapopulation dynamics of at least 2 very large, 2 large, 6 medium, and 7 small occurrences throughout the range of the species. (USFWS, 2002)

Delisting Criteria:
1. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all occurrences and any adjacent areas identified as necessary for continued survival and recovery. (USFWS, 2002)

2. Monitoring in all recommended preserves shows: (a) no decline after downlisting during two additional fire cycles (about 60 years); if declining, determine cause and reverse trend, (b) habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions, (c) spatially and temporally, the establishment of occurrences must be at least 10 percent greater than the extirpation of occurrences. (USFWS, 2002)

3. Ameliorate or eliminate threats; research on propagation techniques if repatriation, enhancement, or restoration are determined to be necessary. (USFWS, 2002)

Recovery Actions:
- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for

two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)

- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Reproduction and Demography Research: Including determining limiting life stages, seed production, and survival in soil to determine appropriate fire return period. Systematics research and genetic studies if repatriation is determined to be necessary. Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans.

(USFWS, 2002)

- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019)

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SPECIES ACCOUNT: *Centaurium (= Zeltnera) namophilum* (Spring-loving centaury (= Zeltnera namophila))

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/20/1985; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

The species is an upright, annual herb that grows 17.5 in (45 cm) tall with many flowering branches bearing many flowers measuring approximately 0.3 to 0.5 in (7 to 12 mm) in diameter (Reveal, Broome and Beatley 1973). Flowers are deep rose-pink with a yellowish throat and five dark purple spots below where adjacent petals attach to the body of the flower (Reveal, Broome and Beatley 1973). (USFWS, 2009)

Taxonomy

As treated here (following Kartesz, 1994 checklist and 1999 Floristic Synthesis), Centaurium exaltatum and C. namophilum are considered distinct species. An alternative treatment maintains C. namophilum with two varieties (vars. namophilum and nevadense). According to Kartesz (pers. comm. to Larry Morse, 25Nov99), there are three significant references for this group: C. R. Broome's 1973 Ph.D. dissertation (Systematics of Centaurium (Gentianaceae) in Mexico and Central America, Duke Univ., Durham, N.C.); B.L. Turner's treatment in Phytologia, 1973; and Pringle's unpublished work for the Flora of North America (FNA). After review of these works, Kartesz concluded that these taxa are best recognized as separate species. However, some others (e.g., J.L. Reveal) disagree, and further taxonomic study is needed. Larry Morse, 23Dec99. (NatureServe, 2015)

Historical Range

Historically in the Death Valley region, California and Ash Meadows in Nye County, Nevada (NatureServe, 2015)

Current Range

Ash Meadows in Nye Co., Nevada (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Centaurium namophilum (Spring-loving centaury) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Centaurium namophilum includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Centaurium namophilum critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include moist to wet clay soils along banks of streams or in seepage areas.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: July to September (USFWS, 2009)

Reproduction Narrative

Adult: The spring-loving centaury is an upright, annual herb. that flowers from July to September (Pavlik and Manning 1986). One plant can produce thousands of seeds. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 2,070 and 2,320 feet (630 to 707 m) above mean sea level (USFWS, 2009)

Environmental Specificity

Adult: Very Narrow (USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: The wet meadow ecosystem occupied by spring-loving centaury is typically dominated by saltgrass (Distichlis spicata) with scattered velvet ash (Fraxinus velutina) and screwbean mesquite trees (Prosopis pubescens). (USFWS, 2009)

Habitat Narrative

Adult: The spring-loving centaury grows between 2,070 to 2,320 feet (630 to 707 m) above sea level within the Mojave Desert Ecoregion. The species is adapted to clay soils of the Ash Meadows area, and water availability is a limiting factor to this species' distribution (Pavlik and Manning 1986). It typically grows in wet saltgrass meadows near springs and streams and occasionally in low uplands at seeps (Reveal, Broome and Beatley 1973). The wet meadow ecosystem occupied by spring-loving centaury is typically dominated by saltgrass (Distichlis

spicata) with scattered velvet ash (Fraxinus velutina) and screwbean mesquite trees (Prosopis pubescens). (USFWS, 2009)

Dispersal/Migration

Motility/Mobility

Adult: Likely to be low (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Given the small size of spring-loving centaury seeds, seed may be dispersed by small animals, wind, and water. Most seeds probably remain near the plant that produced it. (USFWS, 2009)

Population Information and Trends

Population Trends:

Increasing (USFWS, 2009)

Population Growth Rate:

Moderately fast (inferred from USFWS, 2009)

Number of Populations:

2 Population services (USFWS, 2020)

Population Size:

~4,593,971 (USFWS, 2020)

Population Narrative:

At the time of listing, a population estimate of spring-loving centaury was unknown (Service 1985, p. 20777–20794). In 1998, the spring-loving centaury population was estimated to be about 175,000 individuals (BLM and Service 2000, p. 3-5). Results from the 2008-2009 Refugewide survey estimated that 4,593,971 individuals are present on the Refuge (table 1 and figure 2; BIO-WEST 2011, p.105–106). Estimates of spring-loving centaury individuals on the BLM ACEC and private lands within the Refuge boundary do not exist. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat loss or degradation from groundwater pumping (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, groundwater development was a major threat to the entire Ash Meadows ecosystem. Prior to listing, local groundwater pumping within Ash Meadows was responsible for declines in the wetlands in this area. The spring-loving centaury depends on the outflow of springs and near-surface water for its survival. (USFWS, 2009)

Stressor: Habitat loss from surface mining (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: Mining for clay minerals occurs in the Ash Meadows area. Surface disturbance and impacts to rare species that do not have Federal protection are permissible as long as operations comply with Federal and State laws. Currently, there are no active mines or mineral claims within known spring-loving centaury habitat (BLM 2007). New mineral claims and subsequent mining could cause direct loss of spring-loving centaury habitat, as well as indirect impacts by diverting water away from occupied habitat. (USFWS, 2009)

Stressor: Non-native species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Over 100 non-native species, approximately 16 percent of the total flora, occur on the Refuge (Service 2006). Of these, salt cedar (Tamarix ramosissima), Russian knapweed (Acroptilon repens), five hook bassia (Bassia hyssopifolia), Malta star thistle (Centaurea melitensis), yellow star thistle (Centaurea solstitialis), and hoary cress (Cardaria draba) are noxious weeds that could potentially threaten the spring-loving centuary (Service 2006). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The spring-loving centaury is a wetland dependent species. Current climatic modeling predicts the southwestern U.S. is likely to experience increased frequency of regional drought in response to elevated levels of atmospheric carbon dioxide (Seager et al. 2007). The springs and surface streams that support the spring-loving centaury are perennial and they originate from a regional aquifer that includes runoff from the Spring Mountains approximately 100 mi to the northeast (USGS 2005). Other climate predictions suggest the intensity of precipitation events may increase in response to elevated atmospheric carbon dioxide (IPCC 2007). The potential effects of climate change to the regional aquifer that supports Ash Meadow is unknown. (USFWS, 2009)

Stressor: Feral Horses (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: We received a correspondence from Rancho Santa Ana Botanic Garden (2019). They state the spring-loving centaury in the lower Carson Slough in Inyo County, California (figure 1) was initially misidentified as the more common tall centaury (Zeltnera exaltata). They are still in the process of obtaining baseline information. Also, feral horses and off-road driving near and within occupied spring-loving centaury habitat remain a threat in California. We received a recent monitoring report from Ash Meadows NWR (Pyramid Botanical Consultants, 2019). The results indicate the species is still present at all previously known populations within the refuge, and species distribution remains the same as described in our most recent 5-year review (Service, 2008). (USFWS, 2020)

Recovery

Reclassification Criteria:
1. All non-native animals and plant species must be eradicated for essential habitat. These non-native species currently include sailfin mollies, mosquito fish, largemouth bass, black bullheads, crayfish, turban snails, wild horses, salt cedar, and Russian olive. (USFWS, 2009)

2. Secure and protect the Ash Meadow aquifer so that all spring flows return to historical discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer. (USFWS, 2009)

3. Reestablish water to historic springbrook channels, which are free to barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic ranges. (USFWS, 2009)

4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 2009).

Delisting Criteria:
1. Criteria for downlisting from endangered to threatened apply in the delisting objectives. (USFWS, 2009)

2. Secure, protect, and maintain natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat. (USFWS, 2009)

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats. (USFWS, 2009)

4. All of the listed species and the candidate plant species are present in all the sites that they have historically occupied as identified in the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population. (USFWS, 2009).

Recovery Actions:
- Recovery actions are not available.
- Clarify or resolve the uncertainties regarding the significance of the remaining threats to spring-loving centaury, i.e., groundwater pumping and surface mining. (USFWS, 2009)
- The Service and BLM should continue to work toward the completion of the land and mineral withdrawals for public lands within the Refuge and the ACEC. (USFWS, 2009)
- Research on the role of fire in maintaining habitat for spring-loving centaury is needed, including both wild fire and prescribed burning. (USFWS, 2009)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS: Because there is evidence to suggest that the threats to the population remain static, the Service should continue to: I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole.

Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service, 2009b) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service, 2020); and III. Support spring-loving centaury research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service, 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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SPECIES ACCOUNT: *Cercocarpus traskiae* (Catalina Island mountain-mahogany)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/07/1997; California/Nevada Region (R8)

Physical Description

An evergreen shrub or small tree, 3-8 m tall, with leathery leaves, 2-6 cm long, that are densely covered with white-woolly hairs on the undersides. The petalless flowers (March-May) are also white-woolly. Fruits have a long, plume-like style. (NatureServe, 2015)

Taxonomy

Cercocarpus traskiae has hybridized locally with C. betuloides var. blancheae, which also occurs on the island. The hybrids have been characterized on morphological bases as well as on allozyme differences (Martin 1988, Rieseberg et al. 1989, Rieseberg 1991). Morphological assessments of hybridization have not always agreed with the results of random amplified polymorphic DNAs (RAPDs) and allozyme studies (Rieseberg and Swensen 1996). (USFWS, 2007)

Historical Range

See current range/distribution.

Current Range

Cercocarpus traskiae is still known to occur naturally only in Wild Boar Gully on the southwestern coast of Santa Catalina Island off the coast of southern California. (USFWS, 2007)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2007)

Breeding Season

Adult: March to May (NatureServe, 2015)

Reproduction Narrative

Adult: Cercocarpus traskiae has hybridized locally with C. betuloides var. blancheae, which also occurs on the island. The petalless flowers appear from March to May and produce a single-seeded fruit. (USFWS, 2007; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 131 and 231 meters (430 and 700 feet) (USFWS, 2007)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2007)

Site Fidelity

Adult: High (USFWS, 2007)

Habitat Narrative

Adult: The known natural population is found on soils derived from igneous, saussurite gabbro rock (Knapp 2006), which is restricted to the southwestern coast of Santa Catalina Island. Cercocarpus traskiae are found slopes of a steep-sided, narrow, dry arroyo within a coastal sage scrub community. Plants are typically found on steep slopes and near drainage bottoms between 131 and 231 meters (430 and 700 feet) in elevation (the highest elevation on the island is 648 meters [2,125 feet]) (62 FR 42692). (USFWS, 2007; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Number of Populations:

1 (USFWS, 2021)

Population Size:

8-9 (USFWS, 2021)

Population Narrative:

Since the last status review, one additional tree appearing to be morphologically pure Cercocarpus traskiae was discovered in 2008 (named SR1) (CNDDB 2021), and one seedling that has not yet been morphologically or genetically described was discovered in 2011 (named SR2; Figure 1) (Kauppinen 2021a, in litt.). Therefore, the current number of C. traskiae trees is now eight (due to SR1) and could be up to nine (if including SR2); however, additional morphological and genetic analysis of newly discovered individuals is needed to confirm SR2 genetics. Additionally, a basal diameter measurement of SR2 is needed to confirm if this individual is large enough to now be considered an adult [3 cm (1.2 in)]. (USFWS, 2021)

Threats and Stressors

Stressor: Introduced herbivores (USFWS, 2007)
Exposure:
Response:

Consequence:
Narrative: Large introduced herbivores have historically altered the flora and the landscape of Santa Catalina Island. Goats, pigs, bison, and deer were noted at the time of listing. The small size of the current C. traskiae population is attributed to the historical presence of goats, deer, and pigs (Rieseberg et al. 1989, Knapp 2006). Goats are known to consume coarse vegetation, including shrubs and trees. This results in reduced vegetation cover and less of a mulch layer (dead herbaceous vegetation) to hold moisture and slow erosion (Coblentz 1980). Lack of plant cover can result in the formation of gullied badlands (Thorne 1967). Pigs create a network of bare trails with compacted soils. The vegetation loses its tiered overlapping structure as shrubs become isolated by the trail network (Martin 1988). In addition to retaining soil moisture for adult plants, surface litter may hold seeds on the steep slopes. We did not elaborate on the threats from bison and deer in the final listing rule. However, these animals are generally found in the area where C. traskiae grows. Goats have been eliminated from the island, pigs are nearly gone, and the fenced enclosure in the Wild Boar Gully watershed has greatly decreased the threat from deer and bison. This has allowed the C. traskiae plants and other vegetation cover to increase. (USFWS, 2007)

Stressor: Predation (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The fence erected in 1999 around the plants has reduced the incidence of direct browse damage to Cercocarpus traskiae (Knapp 2006). In addition to browsing impacts, the rooting activity of pigs was considered to be directly responsible for low numbers of C. traskiae plants (Rieseberg et al. 1989). Pigs uproot seedlings and churn up soil in some canyons (Thorne 1967). As noted above, the number of pigs has now been reduced to one to four animals (Knapp, pers. comm. 2007). A potential concern is that the fence does not completely exclude deer, because evidence of browsing on the Cercocarpus was seen in 2003. Seedling heights indicated that some browsing had taken place, and the California Department of Fish and Game was unwilling to issue a depredation permit to dispatch the deer (Knapp 2006). (USFWS, 2007)

Stressor: Fire (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The listing rule identified fire as a potential threat. Since listing, the construction of the enclosure fence has excluded herbivores and resulted in local increases of vegetative cover. In general, it is not known to what extent the resulting increase of vegetative cover within the fenced area poses a threat of increased fire frequency for Cercocarpus traskiae. Fire is likely infrequent on the island although lightning strikes are known. (USFWS, 2007)

Stressor: Hybridization (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Rieseberg and Gerber (1995) suspect that a critical factor leading to hybridization for a number of plants occurring on the Channel Islands has been habitat disturbance due to the introduction of non-native goats and pigs. We considered the potential for hybridization of

Cercocarpus traskiae with the more common C. betuloides var. blancheae to be a threat in the listing rule. Genetic swamping of C. traskiae was suggested as a possible outcome of this hybridization. We also stated that Rieseberg et al. (1989) recommended elimination of mature hybrids as a means to preserve the species. Rieseberg and Swensen (1996) considered hybridization a significant threat where the frequency of interspecific mating is high and the population at risk is numerically smaller than the congener. (USFWS, 2007)

Stressor: Stochastic events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Cercocarpus traskiae now has a population size of seven mature individuals. This is an increase in population size of one plant in the past 40 to 100 years. The greater vulnerability to extinction of small populations is generally attributed to demographic fluctuations, environmental variation, and loss of genetic variability and related problems of inbreeding depression and genetic drift; and/or to natural catastrophes (Primack, 2006; Barrett and Kohn 1991). (USFWS, 2007)

Stressor: Age disparities between individual plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: There is a disparity in numbers of individuals of different age classes; i.e., plants are either very old or very young with few age classes in between. There is the potential for mature plants to die naturally before an adequate number of younger reproductive adults are present to maintain even the current genetic diversity and reproductive output. (USFWS, 2007)

Stressor: Genetic diversity (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Limitations on the reproductive partners among the seven mature plants could be another considerable threat to the species' survival and may indicate lower genetic diversity among the mature individuals. (USFWS, 2007)

Stressor: Nonnative plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Invasive non-native plants pose perhaps a greater threat than at the time of listing. The balance between effective control of invasive exotic non-natives and increased density of vegetation due to fencing is unknown. The invasive non-native plant management is focused on target species rather than vegetation cover. (USFWS, 2007)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Establish an effective seed banking program for this species that includes maintenance of genetic diversity and plans to facilitate out-plantings, including ex-situ populations of the species to protect against detrimental stochastic events. (USFWS, 2007)
- Determine the incidence, nature, and management consequences of self-incompatibility in Cercocarpus traskiae. (USFWS, 2007)
- Determine the genetic identity of all of the Cercocarpus seedlings and saplings present in Wild Boar Gully, as well as that of plants recently deemed to be adults and plants at older outplantings. (USFWS, 2007)
- Determine the potential threat from continuing hybridization of Cercocarpus traskiae and co-occurring C. betuloides var. blancheae and implement management actions to alleviate the threat. (USFWS, 2007)
- Identify the micro-habitat requirements most conducive seedling production and establishment. (USFWS, 2007)
- Determine the best method for establishing additional populations that are self-sustaining and capable of participating in the evolutionary future of the species. Establish success criteria and remediation measures for these established populations. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The recommended actions listed below were identified in the 2007 status review (USFWS 2007, p. 12-13). The actions were intended to reduce threats to Cercocarpus traskiae and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of C. traskiae will require cooperation and coordination with partners (especially CIC) to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. We continue to believe the actions described in 2007 are relevant to the conservation of C. traskiae. Minor updates to the actions from 2007 are underlined below. 1. Establish an effective ex situ conservation program for this species (e.g., seed bank, germplasm or cryopreservation bank, or living collection) that includes maintenance of genetic diversity and plans to facilitate out-plantings, including ex-situ populations of the species to protect against detrimental stochastic events. 2. Determine the incidence, nature, and management consequences of self-incompatibility in Cercocarpus traskiae. 3. Determine the genetic identity of all of the Cercocarpus seedlings, saplings, and adults present in Wild Boar Gully, as well as plants at older outplanting sites. 4. Determine the potential threat from continuing hybridization of Cercocarpus traskiae and occurring C. betuloides var. blancheae and implement management actions to alleviate the threat. 5. Identify the micro-habitat requirements most conducive to seedling production and establishment. 6. Determine the best method (e.g., tissue culture propagation or cuttings) for establishing additional populations that are self-sustaining and capable of participating in the evolutionary future of the species. Establish success criteria and remediation measures for these established populations. We identified the following additional recommendation to supplement those described above from 2007: 7. Conduct surveys for Cercocarpus traskiae throughout potentially suitable habitat on Catalina Island, starting with areas near Wild Boar Gully with similar soils and environmental conditions as the

currently occupied location. A co-occurring endangered plant species, Sibara filifolia, has recently been detected to the west of the herbivore exclosure fence at Wild Boar Gully where similar gabbro soils are present, and surveys for C. traskiae should be considered in this location, as well as others, to ensure additional individuals have not gone undetected and therefore exposed to unmanaged threats (e.g., herbivory). 8. Complete updated inventory and monitoring of adults and recruits (i.e., seeds, seedlings, and saplings) at the Wild Boar Gully population. Locate, inventory, and monitor past outplantings. These efforts will update our understanding of the current species status. (USFWS, 2021)

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SPECIES ACCOUNT: *Cereus eriophorus var. fragrans* (Fragrant prickly-apple)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/2/1985; Southeast Region (R4)

Physical Description

Cereus eriophorus var. fragrans is a solitary tree cactus that may have from one to eight, spiny, cane-like, stout, and succulent stems. The columnar stems are 2.5 to 5.0 cm in diameter, and have 10 or 12 ridges alternated with deep, sharp grooves (Benson 1982). Stems may be erect, or for longer stems, the plant may recline over neighboring vegetation. The branching can be extensive, and the roots of this cactus are coarse, fibrous, and shallow (Small 1920). The spine-bearing regions (areoles) are aligned along its ridges about 2 cm apart. Each areole bears 9 to 13 spines, which are mostly grayish and yellowish at the tip, with one spine longer (2 to 4 cm) than the rest. Cereus eriophorus var. fragrans has initial flower buds that are 1 cm long, white, and exceedingly hairy. Buds often appear on the plant one to two months prior to flower growth. About 9 days after initiation of flower growth, the flower opens (Rae 1995). The flowers are fragrant, showy, solitary, and open only at night. The buds are 12 to 20 cm long when about to open and 7.5 to 10 cm in diameter when open. The ovary bears many lanceolate scales while the flower tube has only a few scattered scales. A tuft of long white hairs (10 to 15 mm long) protrudes from the axil beneath each scale. The sepals are narrowly linear, with green outer sepals and nearly white inner ones. There are numerous spatulate petals, white or pinkish, with unevenly toothed margins. The stamens are numerous and are composed of white filaments and yellow anthers. The style is elongate with 9 to 12 stigmas (FWS 1988). The fruits are attached at the narrower end. They average 4 to 6 cm in diameter and are a dull red. The fruit does not split and has long tufts of white hairs that remain persistent with the scale bases (Leon and Alain 1953). The fruits are swollen at the base and finely pitted; each contains approximately 1,500 black seeds that are about 3 mm long (Rae 1995). (USFWS, 1999)

Taxonomy

The type specimen was collected by John K. Small in 1917 along sand dunes approximately 6 miles (mi) south of Ft. Pierce, Florida, and treated as Harrisia fragrans (Britton and Rose 1920). It was separated from other species partly on the basis of having one longer spine than the other 9 to 13 spines per areole (Britton and Rose 1920). Austin (1984) followed the treatment of Lyman Benson (1982) in which Harrisia and other cacti were joined together in the genus Cereus. Since then, fragrant prickly-apple has consistently been referred to by its former name, Harrisia, in references to the flora of the United States and Florida (Chafin 2000; Gann et al. 2002; Flora of North America 2003; Wunderlin and Hansen 2003). The Integrated Taxonomic Information System (2010) was also checked while conducting this review and indicated that the accepted name is Harrisia fragrans. Because Harrisia fragrans is the name used in peer-reviewed literature and is accepted by the scientific community, we concur with this nomenclature. (USFWS, 2010)

Historical Range

Historically occurred on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties (USFWS, 2010)

Current Range

In Florida, in Volusia and St. Lucie Counties, projected to include Brevard and Indiana River Counties. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexually and by regeneration by vegetative reproduction

Breeding Season

Adult: Plants flower from April to September with two distinct peaks. (USFWS, 2016)

Reproduction Narrative

Adult: Fragrant prickly-apple reproduces sexually and by regeneration by vegetative reproduction. Plants flower from April to September with two distinct peaks. The first peak is in the spring with flowering starting in April and reaching a peak in May. Some sporadic flowering occurs in the summer. In September and October, another minor peak in flowering occurs. Flowering is uncommon in the late fall, and no flowering occurs from January through March. Fruit set follows flowering with a major peak in May and a minor peak in September. A large standing crop of fruit remains on plants for approximately 8 months of the year. According to Rae (1995), mature plants are greater than 41 cm in length. The smallest plant to flower was 14.5 cm in stem length and the smallest plant to set fruit was 41 cm in length. In his study, 63 percent of the mature plants flowered. At two sites in the Savannas State Preserve, in St. Lucie County, 38 and 60 percent of flowers successfully produced fruits and 44 and 61 percent of mature plants successfully set fruit. A positive relationship was observed between total length of the stems and branches of a plant and the total annual production of fruit. The means of seed dispersal are uncertain, but there is evidence that birds consume the fruit of fragrant prickly-apple. Additionally, most individuals of this species are found within the drip line of other plants, suggesting avian seed dispersal. Rodents or gopher tortoises may also distribute the seeds. In addition to sexual reproduction, long stems will occasionally snap off of existing plants. After falling to the ground, stems may re-root at several places creating a small group of genetically identical plants (Rae 1994a). Vegetative growth of this perennial species is slowest from November to March. Growth accelerates in April and May, with the fastest growth occurring from July through September. The growth rate drops off rapidly after September (Rae 1994a, 1995). The fragrant prickly-apple is characterized as a long-lived species with late maturity, low fecundity, and low adult mortality (Rae and Ebert 2002). Larger plants tend to have higher fecundity and lower mortality rates (Rae and Ebert 2002); therefore, the larger individuals in the population are extremely important to overall population health (Rae and Ebert 2002). (USFWS, 2016)

Habitat Type

Adult: Sand pine scrub habitat

Environmental Specificity

Adult: Narrow (USFWS, 2016)

Habitat Narrative

Adult: Fragrant prickly-apple occurs in a clumped distribution and prefers early-successional sand pine scrub habitat (Rae 1994b, 1995). The known sites are limited to St. Lucie sand which is excessively well drained (Watts and Stankey 1980), where the water table is normally deeper than 3 m. Water capacity, fertility, and organic matter content are all very low. The most common plant species in this community include sandhill jointweed (Polygonella fimbriata), hairy jointweed (P. ciliata), tall jointweed (P. gracilis), sand live oak (Quercus geminata), myrtle oak (Q. myrtifolia), cabbage palm (Sabal palmetto), and pricklypear (Opuntia humifusa). Much of the Atlantic Coastal Ridge was cleared in the 1880s for pineapple plantations, but commercial pineapple cultivation was abandoned by 1920. The vegetative community has yet to regain its previous level of diversity or productivity. The vegetative succession has been arrested and the plant community has not succeeded to the climax sand pine habitat type (Rae 1994a, 1995). This cactus prefers partial shade, which is often provided by surrounding plants that shelter it from sun for a portion of the day (Rae 1994b). Surrounding vegetation is often used for support by fragrant prickly-apple for its long stems. Other plants may serve as nurse plants for the seedlings, protecting them from direct sun, but this has not been studied. As the plant grows, the nursery plant may die, leaving the cacti exposed to a greater intensity of sunlight. Overgrowth and shading by sand live oaks and other species may cause reproductive failure and premature death. Growth and productivity seems to be greater for plants in areas that are partially shaded. (USFWS, 2016)

Dispersal/Migration

Population Information and Trends

Number of Populations:

7 (six natural and one introduced) (USFWS, 2021)

Population Size:

Less than 1,200 individuals (USFWS, 2021)

Population Narrative:

Fragrant prickly-apple was listed as endangered on November 1, 1985, following substantial losses of suitable habitat (50 FR 45621). At the time of listing, fragrant prickly-apple was only known from St. Lucie County (Service 1985). Historically, fragrant prickly-apple occurred in coastal hammock habitats on the east coast of Florida in St. Lucie, Indian River, Brevard, and Volusia Counties, although some accounts in other areas were erroneously reported due to misidentification with Simpson's prickly-apple (Cereus gracilis var. simpsonii) (Service 1985; Service 1999; Woodmansee et al. 2007). Fragrant prickly-apple was reportedly collected in Everglades National Park (ENP), but this is not confirmed (NPS 2007; Sadle 2009). Because Simpson's prickly-apple commonly occurs in ENP, there is much confusion over identification of these two species, there is no voucher specimen available in herbarium collections for confirmation, the fragrant prickly-apple is limited in distribution, and ENP lacks the habitats believed to support fragrant prickly-apple, it is thought that the species was misidentified (NPS 2007; Sadle 2009). The species is now known to occur on only 10 confirmed sites in Volusia and

St. Lucie Counties, primarily on or around Savannas Preserve State Park (SPSP) where the site covers an area approximately 10.0 mi long and 0.5 mi wide and is bisected by the Florida East Coast railway (Bradley et al. 2002; Bradley and Gann 2002; Woodmansee et al. 2007; Florida Natural Areas Inventory [FNAI] 2009). These cacti are often found to occur in distinct clusters (Bradley et al. 2002; Woodmansee et al. 2007). The occurrence of fragrant prickly-apple in Indian River County is yet unconfirmed because only a single sterile plant was observed on a coastal berm when surveys were conducted in 2006 (Woodmansee et al. 2007; FNAI 2009). Although only confirmed in Volusia and St. Lucie Counties, it is possible that the current range of the species includes Brevard and Indian River Counties, as these counties occur between confirmed locations and appropriate habitat is available (Woodmansee et al 2007).(USFWS,2016). Fragrant prickly-apple is a narrow-ranging species, occurring in just four Florida counties along the Atlantic Coastal Ridge (St. Lucie, Indian River, Brevard, and Volusia). There are currently only seven extant populations (six natural and one introduced) (Table 1). With the recent discoveries of the cacti in Indian River and Brevard counties, the number of known populations has increased; however, the sites where it occurs are fragmented, disjunct, and isolated from each other. Despite newly identified populations and a reintroduction effort, the total number of fragrant prickly-apples has declined from an estimated 3,000 individuals in 2007 (Service 2010) to fewer than 1,200 in 2020 (Table 1; Woodmansee et al. 2007; Kneifl 2020a; Moore 2020a, 2020b; Rogers 2020; van den Ende 2020a; Service unpublished data record). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of fragrant prickly-apple. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. For example, Woodmansee et al. (2007) suggested that the two extirpated sites in Brevard County were probably lost due to habitat alteration or destruction and severe freezes. Moore (2009) stated that another private site known to contain fragrant prickly-apple was to be sold for development a few years ago. After obtaining permission to salvage the cactus from the property, he returned to find that it had already been removed (Moore 2009). - Threats from development and habitat degradation on private sites are expected to continue and increase. Within the range of fragrant prickly-apple, the human population is predicted to grow from just below 500,000 to nearly 1,000,000 in Volusia County and from approximately 193,000 to more than 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Carr 2006). - Even though 63 percent of the sites around SPSP containing fragrant pricklyapple are publicly owned and not at risk of being developed, the plants on these sites may still be vulnerable to habitat degradation from encroachment of exotic plant species and lack of fire or other mechanical treatment. If sites are not properly managed, ecosystem health may deteriorate. Because the sites are fragmented on a developed landscape, fire management may not always be feasible and encroachment by exotic plant species from neighboring properties is likely. Because population densities tend to vary over time, even those sites with high population densities may be vulnerable if not monitored carefully (Rae in litt. 2010). Therefore, habitat loss, degradation, and fragmentation due to increasing development and lack of management in coastal scrub habitat and the

encroachment of exotic plants continue to threaten fragrant prickly-apple. (USFWS, 2010)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, overutilization was identified as a potential threat for fragrant prickly-apple, but indiscriminate collecting was not known to occur. Because it is limited in distribution and population sizes are relatively small, indiscriminate collecting could adversely affect the species. Like many other species of cacti, fragrant prickly-apple is vulnerable to unlawful exploitation and collection due to the activities of some collectors and hobbyists. Enforcement is difficult due to insufficient resources and the remoteness of the plants. There is minor horticultural interest in this species (Bradley and Gann 2002). During the 5 years of monitoring that took place at SPSP, there was no evidence of poaching (Bradley and Gann 2002). However, the salvage of a fragrant prickly-apple from a property slated to be sold for development was planned but never occurred because the plant was mysteriously removed before the rescue could be implemented (Moore 2009). The Service believes that there is a continuing threat from overutilization for commercial or recreational purposes. (USFWS, 2010)

Stressor: Disease or predation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: When the fragrant prickly-apple was listed as endangered, disease and predation were not known to be threats. However, insects may damage cacti. Moore (2009) noted that young seedlings were damaged when unidentified caterpillars ate the sprouts. A native scale insect, Diaspis echinocacti, has been found to destroy stems of the fragrant pricklyapple in SPSP; however, it does not appear to kill the host plant (Bradley et al. 2002a; Bradley and Gann 2002). Root parasitism may occur when fragrant 10 prickly-apple grows in association with tallow wood (Ximenia Americana) or graytwig (Schoepfia chrysophylloides) but has not been directly observed (Bradley and Gann 2002). Fragrant prickly-apple may also be parasitized by love-vine. There is evidence that birds eat the fruit and serve as a mechanism to disperse seeds (Service 1999). It is also thought that rodents or gopher tortoises may distribute seeds (Service 1999). These occurrences of predation and parasitism are not known to constitute serious threats to the fragrant prickly-apple. (USFWS, 2010)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The ESA provides limited protection for the species and its habitat. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. The fragrant prickly-apple is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. Title 62D2.013 of the Florida Administrative

Code prohibits the removal, destruction, or damage of plants from FDEP, Division of Recreation and Park properties. This regulation provides protection for much of the population where it occurs on SPSP. - Existing regulatory mechanisms do not appear to be adequate, as several properties with fragrant prickly-apple on private lands have been developed. Fragrant prickly-apple was potentially impacted in 2005 when heavy equipment was used to push debris into habitat where the species was presumed to occur along the railroad right-of-way (Kaufmann 2005). Multiple portions of potential habitat along the railroad tracks are being purchased and used to dump dredged material from the Intracoastal Waterway along the Indian River. - Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable for development and other uses due to its elevation, it remains vulnerable to development pressures where it occurs on private property. Where the species occurs on public land, there is protection from development but not necessarily from habitat degradation. (USFWS, 2010)

Stressor: Prescribed fire (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Land management practices such as prescribed fire are important to maintaining the scrub ecosystem. However, the fragrant prickly-apple is intolerant of fire (Bradley and Gann 2002). Because it is thought that the species was historically located along the perimeter of scrub habitat in xeric hammocks, it may not have been affected as frequently by fires that were occurring in adjacent scrub (Bradley and Gann 2002). (USFWS, 2010)

Stressor: Invasive nonnative plant species (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A large source of habitat degradation is the establishment of invasive plant 11 species such as Brazilian pepper (Schinus terebinthifolius), rosary pea (Abrus precatorius), white cypress pine (Callitris glaucophylla), golden trumpet (Allamanda cathartica), cathedral bells (Kalanchoe pinnata), chandelier plant (K. tubiflora), swamp mahogany (Eucalyptus robusta), guinea grass (Panicum maximum), and Crow's foot grass (Dactyloctenium aegyptium) (Bradley and Gann 2002; Bradley et al. 2002b). These invasive species may impact fragrant prickly-apple growth, reproductive potential, and recruitment by competing for space and nutrients and blocking sunlight (Bradley and Gann 2002). The species frequently grows beneath the canopy of these invasives to take advantage of partial shade and also can be crushed beneath falling limbs or trees not able to withstand hurricane winds (Bradley and Hines 2007). However, herbicides used to control overgrowth, if not properly applied, also pose a threat to the fragrant prickly-apple. Bradley and Hines (2007) noted mortality as a result of off-target herbicide application at SPSP. (USFWS, 2010)

Stressor: Feral hogs, tortoise, and inadequate land management (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Degradation to habitat can also occur from damage by feral hogs (Engeman et al. 2003, 2004). Bradley and Hines (2007) recorded an incident in which feral hog damage killed a fragrant prickly-apple plant. Gopher tortoises may also bury small cacti at the mouth of burrows

(Bradley and Gann 2002). Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management even on protected lands remains an imminent, though moderate, threat. (USFWS, 2010)

Stressor: Climatic events (USFWS 2010)
Exposure:
Response:
Consequence:
Narrative: The species' restriction to specialized habitat, its limited distribution, and its limited reproductive capacity also renders it vulnerable to random natural events, such as freezes and hurricanes. Sea level rise may also threaten cacti on sites with low elevation, such as those at Canaveral National Seashore (Woodmansee et al. 2007). Woodmansee et al. (2007) suggested that freezing temperatures may have led to the extirpation of the species at one location in Brevard County. Although the species did well through the Category 1 hurricane in 2000 and the Category 2 and 3 storms in 2004 and 2005 (Bradley and Gann 2002; Woodmansee et al. 2007), specific conditions such as storm surge and amount of debris dumping following the event vary greatly with each hurricane and may render sites with few plants vulnerable to destruction. Hurricanes have the potential to adversely affect fragrant prickly-apple populations in other ways. High winds can bring surrounding vegetation crashing down on top of individual cacti, injuring or killing them. Bradley and Hines (2007) found that mortality rates more than tripled at SPSP as a result of hurricane impacts. One colony that was particularly affected was located beneath invasive white cypress pine trees which were not equipped to handle hurricane winds and either fell or lost numerous branches that crushed the cacti below (Bradley and Hines 2007). However, hurricanes also open hammock canopies, allowing light to penetrate and stimulating flowering activity, thus providing conditions that may be favorable to cactus regeneration (Bradley and Gann 2002; Woodmansee et al. 2007). (USFWS, 2010)

Recovery

Reclassification Criteria:
Not defined; 1999 Recovery Plan provided only "stabilization" criteria. (USFWS, 1999)

Delisting Criteria:
1. When at least 15 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. When populations (as defined in criterion 1) in coastal sand pine scrub habitat are distributed across the historical range of the species. (Factors A and E) (USFWS, 2019)

3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed (e.g., appropriate burn intervals) such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, B, D, and E) (USFWS, 2019)

Recovery Actions:
- 1. Determine distribution of C. e. var. fragrans. Known C. e. var. fragrans populations occuron well-drained soils indicative of xeric upland plant communities. Much of the xeric upland habitat of Indian River and St. Lucie counties remains botanically unsurveyed and

threatened with destruction. Efforts to survey and assess the xeric vegetative communities for C. e. var.fragrans are needed to ensure the survival of this species. (USFWS, 1999)

- 2. Protect and enhance existing populations. Of the three populations known, one occurs on private land in residential areas and two occur in Florida's Savannas State Preserve. Additional protection at each of these sites is needed. (USFWS, 199)
- 3. Conduct research on the biology of C. e. var. fragrans. Much of the basic biology and ecology of this species remains poorly understood. If we are to effectively recover the species, more specific biological information will be needed. (USFWS, 1999)
- 4. Monitor C. e. var. fragrans populations. Maintain an inventory of naturally reproducing populations to help determine habitat characteristics and natural environmental changes affecting C. e. var. fragrans. (USFWS, 1999)
- 5. Provide public information about the fragrant prickly-apple cactus. It is important, and perhaps crucial, to the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and landowners be appropriately informed about this species. Informing the conservation organizations such as the Cactus and Succulent Society is appropriate, but care is needed to avoid unnecessarily revealing localities and to avoid stimulating demand for the species. Efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of C. e. var. fragrans and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- 6. Establish delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFS, 1999)
- Habitat-level Recovery Actions: - Protect, manage and enhance habitat. None of the habitat for C. e. var. fragrans on private land is secure at this time. Efforts to protect these sites are essential since many of the remaining plants occur on private land. - Monitor habitat and ecological processes. Little is known regarding response of C. e. var. fragrans to land management actions used in coastal xeric communities. The effects of fire, vegetative cutting, or other measures must be monitored to determine biological and ecological consequences. - Continue public information efforts about xeric vegetative communities and their unique biota. Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about xeric plant communities to the public. (USFWS, 1999)
- Surveys: • Continue monitoring the SPSP and Volusia County populations on an annual basis and after stochastic events, such as fires. 13 • Conduct additional surveys on other parts of Hutchinson Island South in St. Lucie County, Sebastian Inlet State Park in Brevard and Indian River Counties, spoil islands in Indian River and St. Lucie Counties, Pelican Island National Wildlife Refuge and the southern end of Pine Island in Indian River County, and other potential locations within the historic range. • Re-survey the Pine Island location to confirm the identity of the plant in question. (USFWS, 2010)
- Management: • Continue management actions to remove invasive species with particular care in using mechanical means and herbicide application that may damage cacti; control public access to these areas to avoid human disturbance and to improve habitat conditions. • Continue application of prescribed fire to habitats that support the species while maximizing the number of burn units rather than applying fire to large expanses of habitat. • Consider reducing the canopy in areas where cacti are impacted by too much shade. •

Restore coastal hammocks along the eastern slope of the Atlantic Coastal Ridge. • Where unable to restore coastal hammocks, maintain the threeawn (Aristida gyrans)/ Sabal palm (Sabal palmetto) habitat that fragrant prickly-apple now occupies for the long-term existence of the species. • Control public access and eliminate dumping in areas where fragrant prickly-apple occurs. • Focus conservation efforts on marginal and small sites to preserve the genetic diversity of the species. • Evaluate the feasibility of acquiring private property in Brevard County for reintroduction of the species, identify suitable habitat for additional reintroduction sites in protected areas, and establish reintroduced populations. • Increase the genetic diversity of the species at existing and reintroduced locations. (USFWS, 2010)

- Research: • Conduct demographic studies using a metapopulation approach to understand spatial and temporal variation. Incorporate surveys to evaluate flower and fruit production. • Develop a model to evaluate long-term population growth in relationship to microhabitat conditions (i.e., shade, partial shade, and sun). • Develop mechanisms to improve seedling survival and continue to study seed germination to determine habitat preferences of the species. Evaluate the role of nurse plants that provide shade in the early development of seedlings. • Conduct research on recruitment, mortality, seed bank characteristics, and soil moisture. • Conduct parallel studies on the other two similar cacti in Florida, Simpson's pricklyapple and Aboriginal pricklyapple (Harrisia aboriginum), to gain additional insight into fragrant prickly-apple biology and to delineate these species. • Continue genetic research and appropriately apply these results to listing status of all Harrisia species in Florida. • Conduct a population-level genetic study using microsatellite markers to determine genetic variation within the species and gene flow in and among sites and to better understand the reproductive mode at low population densities. • Conduct research on the response of fragrant prickly-apple to fire and fire prescriptions necessary to benefit the species. • Identify pollinators and evaluate impacts to insect pollinators from aerial mosquito spraying. • Continue propagation efforts and collect germ plasm from the remaining sites not currently represented in the CPC's National Collection of Endangered Plants, primarily from the Volusia County population. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2010)
- Other: • Pursue conservation agreements/implement management recommendations and/or acquire land and investigate incentives to encourage land managers to manage habitat for ecosystem health and listed species. • Acquire private inholdings within the SPSP when willing sellers are identified. • Consider acquiring the Pine Island tract in Indian River County and determine the status of Fairchild Tropical Botanic Garden's ex situ population of plants from this site. • Promote partnerships to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Consider nomenclatural changes to officially designate the name of the fragrant pricklyapple as Harrisia fragrans. • Conduct an ad hoc meeting to compile new information, discuss recovery actions, share land management strategies, and set and prioritize 5- and 10-year goals. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). In the

course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Continue management actions to remove invasive species at CNS, ACNWR, SPSP with particular care when using mechanical means and herbicide application that may damage cacti. • Control public access to populations on public lands to avoid human disturbance. • Continue application of prescribed fire to pyric habitats that support the species at SPSP and ACNWR while using protection measures (e.g., clearing leaf litter away from cacti, creating more burn units for small, patchy fires, etc.) to prevent harming these populations. • Reduce the canopy cover only when the cacti become impacted by too much shade, but leave enough vegetation to protect from desiccation. • Move fallen trees and woody debris away from fragrant prickly-apples to reduce chances of termite damage. • Restore coastal hammocks along the Atlantic Coastal Ridge for potential introduction sites. • Identify suitable areas of protected xeric and coastal hammock for introductions and establish new populations. • Focus conservation efforts (habitat management, augmentations, etc.) on small populations (CNS, ACNWR, Central SPSP) to reduce inbreeding depression and preserve the genetic diversity of the species. • Consider translocating the CNS population to a higher elevation to prevent further decline due to sea level rise and storm surge. • Continue propagation efforts and collect and bank germplasm and seed from the remaining sites not currently represented in the CPC's National Collection of Endangered Plants, primarily from the Volusia, Brevard, and Indian River County populations. • Acquire private inholdings within the SPSP when willing sellers are identified. • Acquire the Pine Island tract in Indian River County if the species is still present. • Work with private land owner(s) (Roseland population) and Indian River County staff to translocate individuals in undeveloped lots as that portion of the property is developed. Monitoring/Research Activities • Conduct a scientific review (e.g., SSA) of the new entity and evaluate its listed status under provisions of the ESA. • Continue monitoring the SPSP and CNS populations on an annual basis and after stochastic events, such as freezes, fires, and hurricanes. • Begin annual monitoring efforts for the ACNWR, Roseland, and HBOI populations to assess status and trends. • Re-survey the Pine Island (Indian River County) location to confirm the identity and status of the plant in question. • Conduct additional surveys on other parts of the barrier and spoil islands along Brevard, Indian River, and St. Lucie counties, as well as other potential locations on the mainland within the historical range. • Conduct surveys in suitable habitat within Martin, Palm Beach, and Broward counties to look for fragrant prickly-apple populations that may occur between the fragrant pricklyapple and populations formerly known as Simpson's prickly-apple. • Assess the status of the populations formerly known as Simpson's prickly-apple in Miami-Dade and Monroe counties in preparation for evaluating the status of and threats to the synonymized species. • Conduct research on the response of fragrant prickly-apple to fire and fire prescriptions necessary to benefit the species. • Identify pollinators and evaluate impacts to insect pollinators from aerial mosquito spraying. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. • Increase outreach efforts to raise awareness of this native species, the natural scrub, xeric hammock, coastal strand, and coastal hammock habitats, and the work needed to recover the species. (USFWS, 2021)

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SPECIES ACCOUNT: *Chamaecrista glandulosa var. mirabilis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/5/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

A prostrate, ascending, or erect shrub which may reach up to 1 meter in height. The branches are slender, straight, and wire-like. Leaves are alternate, evenly one-pinnate, 1 to 3 centimeters long, 0.5 to 1 centimeter wide, with some scattered whitish hairs. The stipules are persistent, striate, and about 2 millimeters long. The leaflets are membranaceous, usually in 18 pairs, 3 to 6 millimeters long and 0.5 to 1.5 millimeters wide. The petioles have one to two stipitate glands. The flowers are solitary, with a pedicel about as long as the leaves. The corolla is yellow, about 2 centimeters in diameter, with one petal much larger than the others. Mature fruits (legumes) are glabrous, linear, 2.5 to 4 centimeters long, 3 to 4 millimeters wide, flat, elastically dehiscent, and 12 to 15 seeded (Vivaldi and Woodbury 1980). (USFWS, 1994)

Taxonomy

A member of the Fabaceae family, was first collected by Dr. Agustin Stahl in the mid-nineteenth century. In 1899, Mr. Edward Heller collected the species in Vega Baja. Chamaecrista glandulosa var. mirabilis has been placed by various authors in the genus Cassia as a species (Cassia mirabilis) and in the genus Chamaecrista both as a species and a variety (Charnaecrista glandulosa var. mirabilis). Liogier (1988), in the "Descriptive Flora of Puerto Rico and Adjacent Islands," place the taxon as a variety in the genus Charnaecrista. (USFWS, 1994)

Historical Range

It is known from the coastal white or siliceous sands in north central Puerto Rico in areas adjacent to the Tortuguero Lagoon Natural Reserve. The species is commonly considered as endemic to mainland Puerto Rico (Axelrod 2011) (USFWS, 2015).

Current Range

Chamaecrista glandulosa var. mirabilis occurs in the north central coastal plain of Puerto Rico (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Hymenoptera spp. (USFWS, 2015)

Breeding Season

Adult: Year round (USFWS, 2015)

Reproduction Narrative

Adult: Flowering and fruiting occurs for most of the year, with peaks in February and March. Hymenopterans are pollinators (USFWS, 2015). López-Colon et al. (2007) found that the species does not depend on autogamy for pollination. Moreover, López-Colon et al. (2007) reported various pollinators for the species (i.e., Hymenopterans), suggesting that the species reproduction is dependent on interaction with pollinators (USFWS, 2015).

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: 44 - 88 in. annual rainfall (USFWS, 2015)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Habitat Narrative

Adult: Chamaecrista glandulosa var. mirabilis occurs in the north central coastal plain within the subtropical moist forest life zone, where rainfall ranges from 1,100 to 2,200 mm (44-88 in) per year (Ewel and Whitmore 1973). As a coastal species, it is found in the lower rainfall range of this life zone in well-drained substrate. Chamaecrista glandulosa var. mirabilis is limited to coastal habitats consisting on white siliceous sands adjacent to wetland areas (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (USFWS, 2015).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

2 (USFWS, 2022)

Population Size:

500-600 total (USFWS, 2022).

Population Narrative:

In 1994, the species' Recovery Plan reported approximately 150 C. glandulosa var. mirabilis individuals from the TLNR and an additional population was reported in private land in the nearby municipality of Dorado (Service 1994). The Dorado population was estimated between 20 to 50 individuals (Service 1994), but that area is currently occupied by urban developments, and the Service did not find any new information regarding the current status of the species within this locality. In the 2015 5-year status review, we reported a rapid assessment was conducted in TLNR by Service biologists to determine the overall status of that population. At that time, the biologists confirmed the presence of C. glandulosa var. mirabilis in the reserve but were not able to obtain an accurate estimate of the number of individuals during the rapid assessment. From 2019 to 2021, López-Colón conducted a comprehensive survey of the C. glandulosa var. mirabilis population within TLNR. He reported a total 628 individuals in two locations: 434 individuals in Location 1, and 194 individuals in Location 2 (López-Colón 2021 pers. comm.). Both locations are about 1 mile (mi) (1.6 kilometer (km)) from each other (Figure 1). However, López-Colón (2021, pers. comm.) mentioned that in 2019 a fire burned more than 80 individuals in Location 1. In 2022, López-Colón estimated that the whole population at TLNR is currently between 500-600 individuals (López-Colón 2022 b, pers. comm.). At the time of this review, the Service considers a population with two locations in TLNR to be extant with one (Location 2) being approximately half the size of the other (Location1). The second known population in Dorado discussed in the Recovery Plan is likely extirpated or if still present may be a remnant population in the matrix of surrounding developed land uses and a golf course with limited habitat for the species remaining in the area (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The northern coast of Puerto Rico between San Juan and Arecibo represents perhaps the most developed and disturbed area on the Island. This zone includes areas that harbors suitable habitat for the species. A variety of development activities (e.g., residential, commercial, highways, etc.) are ongoing, and protected areas on the northern coast are few and most are small. ATV and mountain bikes tracks have been found along the habitat. Human-induced fires could modify the landscape by promoting nonnative trees and grasses, and by diminishing the seed bank of native species (Brandeis and Woodall 2008). In some cases, fires may maintain extensive areas of young forest and grasslands, slowing the recovery (regeneration) of ecosystems, and therefore, impairing the delivery of ecosystem services (Brandeis and Woodall 2008) (USFWS, 2015).

Stressor: Limited distribution (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Other than the Tortuguero Lagoon Natural Reserve, there is no other natural reserve that includes siliceous sands habitat. Therefore, the limited distribution of C. glandulosa var. mirabilis and its substrate (suitable habitat), makes the species vulnerable to habitat destruction and modification (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Climate change is predicted to increase the frequency and strength of tropical storms and also to lead to a gradual rise in sea level. Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Therefore, shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario, the populations of C. glandulosa var. mirabilis may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Even a small rise in sea level could represent a very serious threat to the taxon. Sea level rise will also compromise natural recruitment by affecting seed germination and/or the survival of seedlings. Due to its limited range and limited substrate availability, flooding and climate change could likely have an adverse impact on the species as there may not be other areas that harbors suitable habitat for the displacement or colonization by the species (USFWS, 2015).

Stressor: Invasive species (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In 2013, the USFWS documented areas that harbor habitat for the taxon, are being lost due to changes in the structure of the vegetation. For example, areas that were open white sands with herbaceous vegetation in the 1990s are currently covered by tree species (i.e., Anacardium occidentale and Chrysobalanus icaco). Chrysobalanus icaco is a native species characteristic of coastal vegetation (including sand dunes). However, A. occidentale is native to northern South America and Brazil, and is showing an invasive pattern within C. glandulosa var. mirabilis habitat in Tortuguero Lagoon. Melaleuca quiquenervia is another exotic tree species that is already established on the reserve and poses a risk for the ecosystem (Hamilton 2013) (USFWS, 2015).

Stressor: Seed predation (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: From 2016 to 2017, López-Colón (2017) observed that seed predation activity by a larva of a micro-lepidopteran (unidentified) was about 35% in Location 1, whereas it was not detected in Location 2. López-Colón (2017) believed that predation may occur only in Location 1 because the species in this area is more exposed to insects due to the open canopy caused by frequent habitat disturbance (e.g., fires), and the presence of exotics grasses, contrary to Location 2, which has a secondary forested structure mostly dominated by native vegetation. Nonetheless, in December 2021, López-Colón (2022b, pers. comm.) conducted a rapid assessment of the population and did not observe any larval seed predation activity in neither of the locations. Currently, we don't know the implications of these observations and whether this represents a normal periodic predation event, but given the limited distribution and number of plants any significant impact on reproduction could have lasting effects to the species' viability (USFWS, 2022).

Stressor: Herbivory (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Recently, López-Colón and Santiago-Rosario (2022, unpublished data) observed herbivory activity directly on the reproductive structures (flowers and buds) of C. glandulosa var. mirabilis by a butterfly (Phoebis sennae) that in its larval stage uses plants of the genus Chamaecrista as hosts (Hall et al. 2019). This may represent a new threat and risk to C. glandulosa var. mirabilis because herbivory activity in flowers may cause less attractiveness to pollinators, reducing the frequency of pollinator visits, low fruit production, hence, a negative impact on the reproductive success of the species (USFWS, 2022)

Stressor: Human-induced fires (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Fire is not a natural event in subtropical dry or moist forests in Puerto Rico. The vegetation in the Caribbean is not adapted to fires, because this disturbance does not naturally occur on these islands (Brandeis and Woodall 2008, Santiago-García et al. 2008). Native plants and endemic species with limited distribution are particularly susceptible to human-induced fires. Restoring native plant communities is challenging where invasive plants have altered fire regimes and ecosystem properties (Brooks et al. 2004). In 2019, a fire at Location 1 within TLNR burned about 80 individuals of C. glandulosa var. mirabilis (López-Colón 2021, pers. comm.). This location is near State Road PR687, making it more accessible to people that can ignite fires intentionally or accidentally. Because this area has the largest concentration of C. glandulosa var. mirabilis individuals, human-induced fires can have a profound effect on the species. Although the number of C. glandulosa var. mirabilis individuals has increased, the species still occurs in limited areas susceptible to human-induced fires, and in areas that receive impacts from human trampling and vehicles like ATVs and bicycles. Furthermore, exotic grasses and parasitic plants are affecting the species by suppressing native vegetation and changing the habitat conditions. Impacts from climate change could also alter habitat conditions for the species. Thus, we consider Factor E is still a threat to C. glandulosa var. mirabilis (USFWS, 2022).

Recovery

Reclassification Criteria:
Not available

Recovery Priority Number: 5

Delisting Criteria:
1. The known populations are given protected status (USFWS, 2015).

2. At least 3 new populations capable of self-perpetuation are established within protected areas. These should be minimum requirements, and could be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. On the other hand, if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than on propagation, in order to achieve a minimum

number of plants (USFWS, 2015).

Recovery Actions:

- Monitor existing populations (USFWS, 1994).
- Provide protection, through acquisition or conservation easements, for existing populations (USFWS, 1994).
- Conduct research on aspects of the life history of the species and evaluate propagation techniques (USFWS, 1994).
- Conduct propagation and enhance existing populations or establish new ones (USFWS, 1994).
- The recovery of the species should focus primarily on the protection of natural known populations and its habitat. Studies and surveys should be conducted to locate and determine the current status of additional wild populations (USFWS, 2015).
- Efforts should be made to identify existing fragments of siliceous sands and to ensure their preservation and ecological restoration (i.e., through USFWS funded projects via the Coastal Program and Partners for Fish and Wildlife Program) should also be undertaken if appropriate sites are found (USFWS, 2015).
- A long term monitoring program should be established to determine population trends of the known populations (USFWS, 2015).
- Since the population dynamics of the species are poorly known, and we do not have enough information to determine what constitutes a viable population. Additional studies should be conducted on the species' phenology, reproductive biology and population structure (USFWS, 2015).
- Studies should be conducted on the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm (USFWS, 2015).
- A signage and outreach program should be implemented to educate the users of the Tortuguero Lagoon Natural Reserve about the species and its habitat (USFWS, 2015).

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SPECIES ACCOUNT: *Chamaecrista lineata keyensis* (Big Pine partridge pea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Southeast Region (R4) (USFWS, 2016)

Physical Description

Chamaecrista lineata var. keyensis is a small, prostrate to ascending, perennial, herbaceous shrub that is 10– 80 centimeters (cm) (3.9–31.5 inches (in)) tall, with yellow flowers and pinnately compound leaves (each leaf consists of a main stem with multiple leaflets lined up along on each side). It has one to several branched stems arising from a contorted rootstock. New branches are covered in soft, fuzzy hairs. The leaves are 1.7–4.0 cm (0.7–1.6 in) long, with 5 to 9 pairs of leaflets. Flowers consist of five sepals 9–20 mm (0.4–0.8 in) long that are fused together near their bases; five yellow petals 11– 15 mm (0.4–0.6 in) long, with one slightly larger than the others; 10 reddish-purple stamens; and a single, elongate style. The fruit is an elongate pod, roughly similar to that of a pea, 33– 45 mm (1.3–1.8 in) long and 4.5–5.0 mm (0.19–0.17 in) wide, with a soft fuzzy texture, which turns gray with age and eventually split open to release seeds (Irwin and Barneby 1982, p. 757; Small 1933, pp. 662–663) (USFWS, 2015).

Taxonomy

John Loomis Blodgett was the first to collect Chamaecrista lineata var. keyensis, sometime between 1838 and 1852, on Big Pine Key (Bradley and Gann 1999, p. 17). Pollard (1894, p. 217) assigned the plants on Big Pine Key to the existing taxon Cassia grammica. John K. Small (1903, p. 587; 1913, p. 58) followed this usage, but used the genus Chamaecrista (considered a subgenus within Cassia or a genus unto itself variously by many authors). In 1917, Pennell (p. 344) recognized the Big Pine Key plant as a distinct endemic species, naming it Chamaecrista keyensis. This name was retained by Small (1933, p. 663) in his Manual of the Southeastern Flora. In an exhaustive study of Cassia and Chamaecrista, Irwin and Barneby (1982, p. 757) assigned plants in Florida and parts of the West Indies to the existing taxon Chamaecrista lineata, and assigned the Big Pine Key plants to var. keyensis, retaining them as endemic to the Florida Keys. Isely (1990, p. 33), Wunderlin (1998, p. 348), and Wunderlin and Hansen (2003, p. 441) have followed this treatment. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2014, p. 1) uses Chamaecrista lineata var. keyensis. The Integrated Taxonomic Information System (2015, p. 1) uses the name Chamaecrista lineata var. keyensis and indicates that this taxonomy is accepted. Based upon the best available scientific information, Chamaecrista lineata var. keyensis is a distinct taxon, endemic to the lower Keys in Monroe County, Florida. Synonyms are Cassia keyensis (Pennell) J.F. Macbr and Chamaecrista keyensis Pennell. Chamaecrista lineata var. keyensis is related to, and superficially resembles, Chamaecrista fasciculata, the partridge pea, a common species which occurs throughout Florida. (USFWS, 2015)

Historical Range

Chamaecrista lineata var. keyensis is endemic to the lower Florida Keys in Monroe County, Florida. Historical records exist for occurrences on five islands: Big Pine Key, No Name Key, Ramrod Key, Cudjoe Key, and Sugarloaf Key (Hodges and Bradley 2006, pp. 20– 21) (USFWS, 2015).

Current Range

Florida, Monroe County, on Big Pine Key and Cudjoe Key. (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual

Dependency on Other Individuals or Species

Adult: Pollinators

Key Resources Needed for Breeding

Adult: Open canopy

Reproduction Narrative

Adult: Requires pollintors.

Habitat Type

Adult: Pine rockland vegetation; roadsides; cleared lots adjacent to pine rockland (USFWS, 2015).

Dependencies on Specific Environmental Elements

Adult: Most likely to be found in canopy openings and requires full sun to partial shade (USFWS, 2013).

Geographic or Habitat Restraints or Barriers

Adult: Closed canopy, hardwood cover (USFWS, 2013)

Environmental Specificity

Adult: very

Habitat Narrative

Adult: Big Pine partridge pea occurs primarily in pine rockland vegetation. Some populations can be found on roadsides (Hodges and Bradley 2005, p. 22) or in cleared lots adjacent to pine rockland. Pine rocklands in the lower Florida Keys are dominated by a canopy of Pinus elliottii var. densa (South Florida slash pine). The subcanopy is composed of Thrinax morrisii (brittle thatch palm), Psidium longipes (longstalked stopper), Metopium toxiferum (poisonwood), Byrsonima lucida (locustberry), Pithecellobium keyense (blackbead), and Coccothrinax argentata (silver palm) (Bradley 2006, p. 25). Ross and Ruiz (1996, p. 5) found that it occurs primarily in areas where hardwoods are relatively unimportant, and where understory and overstory palms are important. Bradley (2006, p. 26) also found that it preferred open sunny areas, but in contrast to Ross and Ruiz (1996, p. 5) found a negative correlation with palm cover. Big Pine

partridge pea is most likely to be found in canopy openings and requires full sun to partial shade (Muir and Liu 2003, p. 3). It is capable of colonizing disturbed areas within pine rockland habitat, such as dirt roads. It does not persist in damp soil or depressions (Muir and Liu 2003, p. 3). Pine rockland is maintained by relatively frequent fires, which keep the understory woody plants at shrub height (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; 2005b, p. 71). In the absence of fire, many areas become wooded, eventually succeeding to rockland hammock (i.e., hardwood forest) (Snyder et al. 1990, p. 260). As with other pineland plants, Big Pine partridge pea is shade intolerant, and requires periodic burning to reduce competition from woody vegetation (e.g., shading, leaf litter accumulation) (Carlson et al. 1993, p. 922; Liu et al. 2005a, p. 210; 2005b, p. 71) (USFWS, 2013). Chamaecrista lineata var. keyensis occurs in pine rocklands of the lower Florida Keys, and adjacent disturbed sites, including roadsides (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2023)

Species Trends:

Declining (USFWS, 2023)

Number of Populations:

1 small re-introduced populations (USFWS, 2023)

Population Narrative:

The population size of Big Pine partridge pea is apparently much smaller than it was historically. In addition to a reduction in the amount of available habitat, there has also been a reduction in density. Total population size within the Big Pine Key public pine rockland study area (1,181 acres [478 ha]) was estimated to be 816,833 to 1,709,994 in 2005 (pre-Hurricane Wilma, 297 plots) and 178,543 to 458,227 in 2007 (post-Wilma, 285 plots) (Bradley and Saha 2009, p. 12). Since 82 percent of the pine rockland on Big Pine Key is publicly owned, this estimate likely accounts for the majority of the population. Big Pine partridge pea density and percent cover was significantly higher in 2005 compared to 2007 in all plots combined, as well as, separately for northern and southern plots. In 2005, a total of 1,540 plants were counted in 297 plots, whereas in 2007 only 584 plants were counted in 285 plots. In surveys collected immediately after Hurricane Wilma, island-wide population sizes were 38 percent lower than in plots sampled prior to the hurricane (Bradley 2006, p. 35). Mortality rates varied geographically. Small areas of pine rockland were not flooded at all, while in many areas salt water pooled for several days. Bradley (2006, p. 13) sampled 60 plots both before and after the hurricane. These plots were all at the northeast end of the island in a low-lying area. Only 6.25 percent of the plants that were found prior to the hurricane were found after the storm, indicating a major population decline. Similarly, at TNCs Terrestris Preserve, counts of Big Pine partridge pea declined greatly between 2003 and 2006 in all three study units (Slapcinsky and Gordon 2007, p. 9) (USFWS, 2013). Population data for Chamaecrista lineata var. keyensis have been collected periodically on Big Pine Key since 1955. Because of the size of Big Pine Key, sample study plots were used, as opposed to a complete search of all potential habitat. Multiple indicators show

that the population on Big Pine Key has declined over the past 60 years (Bradley 2006, p. 35). Dickson (1955) and Alexander and Dickson (1972) reported densities of C. lineata var. keyensis from plots they established on Big Pine Key in 1951 and 1969, respectively. Dickson (1955) reports a mean density of 10,764 plants/ha (26,599 plants/ac). Alexander and Dickson (1972) report a mean density of 27,871 plants/ha (68,872 plants/ac). In 2005, Bradley (2006, p. 35) recorded 2,339 plants/ha (5,780 plants/ac), 23.4 percent and 9.0 percent of the 1955 and 1972 estimates, respectively. Hurricane Wilma, which passed over Big Pine Key on October 24, 2005, generated storm surge in the lower Keys of up to 10 feet (Bradley 2006, p. 11; Hodges 2010, p. 4). In 2007, density had dropped to 820 plant/ha (2,026 plants/ac) and had not fully rebounded after 9 years (Bradley et al. 2015, pp. 21–22). By 2013, density had fallen to 657 plants/ha (1,624 plants/ac) (Bradley et al. 2015, p. 21). In summary, the data from 2005 to 2013 demonstrate a 63.8 percent decline in the density of C. lineata var. keyensis on Big Pine Key (Bradley et al. 2015, p. 48). A second indicator, the frequency which Chamaecrista lineata var. keyensis occurred in sample plots on Big Pine Key from data collected in 2005, 2007, and 2013, also show a decline. Chamaecrista lineata var. keyensis was present in 37 percent of plots in 2005, and 19 percent of plots in 2013, respectively. This represents a 49 percent reduction in the species frequency in study plots (Bradley et al. 2015, p. 48). A third indicator, total population size for Chamaecrista lineata var. keyensis on publicly owned pine rocklands on Big Pine Key (478 ha (1,181 ac)), was estimated to be 866,659 plants in 2005 (pre-Hurricane Wilma), 391,944 in 2007 (2 years post-Wilma), and 313,914 in 2013 (8 years postWilma). This represents a population decrease of 64 percent (Bradley et al. 2015, p. 21). The most recent estimate (2013) of the Chamaecrista lineata var. keyensis population on Big Pine Key is 313,914 plants (Bradley et al. 2015, p. 21). Since 82 percent of the pine rocklands on Big Pine Key are publicly owned, this estimate likely accounts for the majority of the population. The most recent estimate of the population on Cudjoe Key is 150 plants (Hodges and Bradley 2006, p. 21). The decline in Chamaecrista lineata var. keyensis can be largely attributed to loss of pine rocklands habitat to development and modification of this habitat due to inadequate fire management. Folk (1991, p. 188) estimated that pine rocklands historically covered 1,049 ha (2,592 ac), about 44 percent of Big Pine Key. Pine rocklands now cover approximately 582 ha (1,438 ac) of Big Pine Key, 56 percent of the historical estimate by Folk (1991) (Bradley 2006, p. 4). Hurricanes and associated storm surge have also impacted population levels (USFWS, 2013). Big Pine partridge pea is a perennial herb that is endemic to pine rocklands in the Lower Keys of Monroe County, Florida. Historically, Big Pine partridge pea was known from five islands. At the time of listing (Service 2016) it was only known to occur on Big Pine and Cudjoe Keys. Most recent surveys indicate it now only occurs naturally on Big Pine Key and as a small, reintroduced population on No Name Key (USFWS, 2023).

Threats and Stressors

Stressor: Fire suppression (USFWS, 2015; USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Fire is required to maintain the pine rockland community (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; Liu et al. 2005b, p. 71). With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like Big Pine partridge pea. Fire suppression reduces the size of the areas that do burn, and habitat fragmentation prevents fire from moving across the landscape. Accordingly,

in the absence of fire, pine rockland communities tend toward becoming tropical hardwood hammock communities. Complete implementation of a prescribed fire program in the lower Keys has been hampered by an incomplete understanding of the fire ecology in the area, and by public opposition to burning (USFWS, 2015; USFWS, 2013).

Stressor: Pesticide application (USFWS, 2015; USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Application of pesticides to control mosquitoes may be impacting populations of Big Pine partridge pea by limiting pollinator populations. The flowering season of the species overlaps with the peak of mosquito activity and pesticide application to control mosquitoes in June and July (Liu 2003, p. 7). Liu (2003, p. 14)found declines in the population of one genus of pollinator after spraying events. There were no declines with the second known pollinator genus (Liu 2003, p. 14). Reduced pollinator visits likely accounted for lower fruit production (Liu 2003, pp. 16-17). The pesticide application on Big Pine Key will continue to impactpollinator populations and thus the population of Big Pine partridge pea. At present, even with reduced pollinator populations, the species still has a strong reproductive output (Liu et al. 2005a, pp. 205-216). Liu and Koptur (2003, p. 1186) recommended limiting pesticide applications to control mosquitoes to no more than weekly. However, at this time, the likelihood of implementing this reduction is unlikely (USFWS, 2015; USFWS, 2013).

Stressor: Exotic plants (USFWS, 2015; USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Exotic plants have significantly affected pine rocklands. At least 277 taxa of exotic plants are now known from pine rocklands in south Florida (Service 1999, p. 3-175). Bradley (2006, pp. 25-26) found that 12.1 percent of pine rockland plots on Big Pine Key had exotic plants, and that Big Pine partridge pea had a significant negative correlation with exotic species richness in sample plots. The most frequent exotic plant species recorded were Schinus terebinthifolius (Brazilian pepper), Fimbristylis cymosa (hurricane sedge), Swietenia mahagoni (West Indian mahogany), and Stenotaphrum secundatum (St. Augustine grass). Some of these may compete directly with Big Pine partridge pea for space and resources, while others have a profound effect on community structure and responses to fire. Brazilian pepper is the most widespread and one of the most invasive species. If left uncontrolled in a fire-suppressed pineland, it will form a dense monospecific canopy almost completely eliminating native vegetation. It will also affect the characteristics of a fire when one does occur. Fires that once burned fairly coolly with mostly pine needle duff for fuel may now burn much hotter and affect the vegetation that develops following fire. For instance, under some post-fire circumstances, Pteridium aquilinum var. caudatum (dense bracken fern) thickets develop (Ross and Ruiz 1996, p. 4). Therefore, in the presence of exotic species, additional factors must be accounted for in order to manage fire for the benefit of Big Pine partridge pea. At present, Brazilian pepper is largely under control in intact pine rockland on NKDR lands and the Terrestris Preserve (USFWS, 2015; USFWS, 2013).

Stressor: Sea level rise (USFWS, 2015; USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: Climate change is likely to increase the occurrence of saltwater intrusion into coastal aquifers as sea level rises and that sea-level rise is projected to extend areas of salinisation of groundwater and estuaries, resulting in a decrease of freshwater availability for humans and ecosystems in coastal areas (IPCCC 2008, pp. 3, 103). From the 1930s to 1950s, increased salinity of coastal waters contributed to the decline of cabbage palm forests in southwest Florida (Williams et al. 1999, pp. 2056-2059), expansion of mangroves into adjacent marshes in the Everglades (Ross et al. 2000, pp. 9, 12-13), and loss of pine rockland in the Keys (Ross et al. 1994, pp. 144, 151-155). Hydrology has a strong influence on plant distribution in these and other coastal areas (IPCC 2008, p. 57). Such communities typically grade from salt to brackish to freshwater species. Human developments will also likely be significant factors influencing whether natural communities can move and persist (IPCC 2008, p. 57; CCSP 2008, p. 7-6). In the Keys, not only are elevation differences between such communities very slight (Ross et al. 1994, p. 146), but the horizontal distances are small as well. Sea level rise poses a significant threat to the species and its habitat. There has been a 15 cm (5.9 inch [in]) rise in sea level over a 70-year period in the vicinity of Big Pine Key (Ross et al. 1994, p. 145). The pine rockland community in the Keys has undergone a reduction due to sea level rise (Ross et al. 1994, p. 149). For example, the pine rockland area on Sugarloaf Key covered 217 acres (88 ha) prior to 1935, and was reduced to 114 acres (46 ha) by 1935 and 74 acres (30 ha) by 1991 (Ross et al. 1994, p. 149). The loss of pine rockland communities was correlated with elevated ground- and soil-water salinity, and loss of upland plant diversity was inferred (Ross et al. 1994, pp. 150-151). In areas affected by sea level rise, communities of halophytic plants replaced pine rockland communities (Ross et al. 1994, p. 152). Sea level rise of the same order likely occurred among the nearby Big Pine and Cudjoe Keys, but the effects have yet to be quantified on those keys. Based on IPCC and other predictions of sea level rise, Clough (2008, p. 23) concluded that a significant proportion of upland habitat will be lost on Big Pine Key by 2100 (USFWS, 2015; USFWS, 2013).

Stressor: Stochastic events (USFWS, 2015; USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Hurricanes and tropical storms are an additional threat, particularly to the extent that they yield storm surges with salt-water overwash. Hurricane storm surges can inundate landscapes with saltwater for varying durations. Klimstra (1986, p. 3) stated, The effects of salt water on pinelands is well established as a consequence of hurricane Betsy, September 8, 1965. After 20 years the site where waters were entrapped for several hours has not yet fully recovered from complete loss of Pinus, Ernodea, Randia, Pisonia, and Metopium seedlings. The small area of occupancy and somewhat patchy distribution of Big Pine partridge pea renders it susceptible to extinction through such stochastic events. Hurricane Wilma in 2005 resulted in substantial reductions in population size and distribution. The surge reduced the population by as much as 95 percent in some areas (Bradley 2006, p. 13). The long term impacts of this hurricane are uncertain. However, slash pine needle-fall (litter) appears to provide for fire advancement in pine rockland communities. Because large areas of slash pine are dead since Hurricane Wilma, and may remain so, fire may no longer occur and provide important functions that enable the persistence of Big Pine partridge pea and other flora in these communities (USFWS, 2015; USFWS, 2013).

Recovery

Reclassification Criteria:
Not defined.

Recovery Priority Number: 6

Delisting Criteria:
Not defined.

Recovery Actions:

- Not defined.
- Increase prescribed fires across all pine rockland areas in NKDR and other portions of Big Pine Key, Cudjoe Key, and on islands that formerly has populations of this taxon. (USFWS, 2013)
- Limit pesticide applications to control mosquitoes to once a week to allow pollinator populations time to recover between applications events. Assess and reduce the use of truck-delivered adulticides (permethrins) from roadsides with NKDR lands adjacent. (USFWS, 2013)
- Consider management tools that mimic fire by opening up the pine rockland canopy (e.g., limb cutting, selective thinning). (USFWS, 2013)
- Continue exotic plant control programs in pine rockland habitat. Exotic plants densities in most pine rocklands areas on Pig Pine Key are currently low; management should continue to prevent spread of aggressive exotics. (USFWS, 2013)
- Big Pine partridge pea should be outplanted to islands where it formerly occurred (Muir and Liu 2003, p. 6). Bradley and Saha (2009, p. 4) surveyed No Name and Little Pine Keys in 2007 and 2008. However, Big Pine partridge pea was found to remain extirpated. If it is not found on those islands, outplantings should occur in open understory areas on both islands, which are part of the species historic range. (USFWS, 2013)
- Engage stakeholders to protect the small population on Cudjoe Key that resides strictly along a roadside. Notify Monroe County road maintenance and law enforcement personnel about the location and specific problems that need to be prevented. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES This species does not have a final recovery plan. While completing this status review, we have identified the following potential recovery activities which are included below. Recovery Activities • Conduct or continue to conduct habitat maintenance or restoration at occupied areas, including removal of native hardwoods and non-native invasive plants and prescribed burns every 5-7 years. • Protect parcels on Big Pine Key that are occupied by the species. • Continue monitoring the reintroduction on No Name Key and augment as needed, until population is established. • Develop a translocation/reintroduction plan to identify other potential recipient sites for reintroducing or establishing populations. Any future introductions in the Lower Keys should include deer exclusions to protect plants, at least during the establishment phase, and potentially in the longer-term as well. Monitoring and Research Activities • Conduct regular monitoring and assessments of the status of the Big Pine Key population. • Conduct research on viability of seeds in long-term cold storage to determine storage lifespan and the rate at which stores should be replenished. • Collect and bank wild seeds at an appropriate ex

situ facility at least once per decade, or more often if indicated by results of research on viability in storage. • Identify the best management regimes for Big Pine partridge pea along roadsides. • Research the effects of Key deer browsing on Big Pine partridge pea abundance and fitness. • Continue research on the effects of mosquito spraying on Big Pine partridge pea fruit set and plant fitness. Outreach Activities • Increase public education and outreach about native plants and habitats in the Lower Keys community, involve local schools and residents in habitat conservation and restoration efforts geared toward Big Pine partridge pea and other rare species and habitats. • Conduct public outreach on Big Pine Key and No Name Key aimed at improving residents' opinions about prescribed fire and its ecological importance (noting that poststorm-surge recovery of the Big Pine partridge pea is greater in areas that have recently burned) (USFWS, 2023).

References

USFWS. 2015. Endangered Species Status for Chamaecrista Lineata Var. Keyensis (Big Pine Partridge Pea), Chamaesyce Deltoidea Ssp. Serpyllum (Wedge Spurge), and Linum Arenicola (Sand Flax), and Threatened Species Status for Argythamnia Blodgettii (Blodgett's Silverbush)

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USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Chamaecrista lineata keyensis (Big Pine Partridge Pea). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

22 p.

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Species Status for Chamaecrista Lineata Var. Keyensis (Big Pine Partridge Pea), Chamaesyce Deltoidea Ssp. Serpyllum (Wedge Spurge), and Linum Arenicola (Sand Flax), and Threatened Species Status for Argythamnia Blodgettii (Blodgett's Silverbush)

Proposed Rule. FR Vol. 80, No. 188. Pages 58536-58567

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22 p. USFWS. 2023. Chamaecrista glandulosa var. mirabilis (no common name) 5-Year Status Review: Summary and Evaluation. USFWS. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 11 pp.

USFWS. 2023. Chamaecrista glandulosa var. mirabilis (no common name) 5-Year Status Review: Summary and Evaluation. USFWS. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 11 pp.

SPECIES ACCOUNT: *Chamaesyce deltoidea pinetorum* (Pineland sandmat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

Physical Description

Chamaesyce deltoidea ssp. pinetorum is an ascending to erect perennial herb. The stems are hairy and often reddish. The leaf blades range from kidney-shaped or triangle-shaped and elliptic to oval. The fruit is a 2-mm broad, pubescent capsule. The seeds are 1 mm long, transversely wrinkled, and yellowish in color. Fruit production is year-round, with a peak in the fall. (USFWS, 2017)

Taxonomy

Chamaesyce deltoidea ssp. pinetorum was first described by Small in 1905, based on specimens collected in eastern Miami-Dade County. Initially, Small referred to these specimens as C. pinetorum but recognized that it was closely related to Chamaesyce deltoidea. Herndon (1993, included C. pinetorum within the C. deltoidea complex, which is composed of three other taxa, two occurring farther north on the Miami Rock Ridge, and one occurring on Big Pine Key in the lower Florida Keys (Monroe County). The three taxa on the Miami Rock Ridge have distinct, but adjacent, ranges. Subsequently, Herndon (1993) has placed all four taxa at the same taxonomic level, treating each as a distinct subspecies under Chamaesyce deltoidea (C. deltoidea ssp. pinetorum, C. deltoidea ssp. serpyllum, C. deltoidea ssp. adhaerens, and C. deltoidea ssp. deltoidea). Chamaesyce deltoidea ssp. deltoidea and C. deltoidea ssp. adhaerens occur north of known C. deltoidea ssp. pinetorum populations, while Chamaesyce deltoidea ssp. serpyllum is endemic to Big Pine Key. Wunderlin and Hansen (2016) follow Herndon's treatment in using C. deltoidea ssp. pinetorum. Some modern authors place the genus Chamaesyce into the genus Euphorbia sensu lato. If placed into the genus Euphorbia, the correct name of pineland sandmat is Euphorbia deltoidea ssp. pinetorum. The online Atlas of Florida Vascular Plants uses the name Chamaesyce deltoidea ssp. pinetorum (Small) Herndon (Wunderlin and Hansen 2016, p. 1). NatureServe (2016, p. 1) and FDACS (Coile and Garland 2003, p. 11) indicate that C. deltoidea ssp. pinetorum is accepted. However, the Integrated Taxonomic Information System (ITIS 2016, p. 1) accepts Euphorbia deltoidea ssp. pinetorum as the scientific name for the subspecies (Gann 2015, p. 168). We have carefully reviewed all taxonomic data to determine that C. deltoidea ssp. pinetorum is a valid taxon. (USFWS, 2017)

Historical Range

Chamaesyce deltoidea ssp. pinetorum occurred historically only with the southern portion of the Miami Rock Ridge, from Homestead to the Long Pine Key region of Everglades National Park, a range of approximately 42 mi (67.6 km). (USFWS, 2017)

Current Range

The current range of Chamaesyce deltoidea ssp. pinetorum is similar to the historical range, although 98 percent of the pine rocklands (the species' only habitat) outside of the Everglades National Park has been lost to development. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2017)

Lifespan

Adult: Somewhat long-lived; 88 percent of plants survived more than 3 years. Extensive root system (USFWS, 2017)

Dependency on Other Individuals or Species

Adult: Pollinators may include bees, flies, ants, and wasps (USFWS, 2017)

Breeding Season

Adult: year-round

Other Reproductive Information

Adult: This species is known to flower and fruit year round. Peaks in fruiting for C. deltoidea ssp. pinetorum occur in the fall and are stimulated by fire. (USFWS, 2017)

Reproduction Narrative

Adult: Reproduction is sexual, but little is known about the reproductive biology and ecology of the subspecies. Some of the plants recorded as dead during surveys may have instead been in a cryptic phase . Pollinators are unknown; some other species of Chamaesyce are completely reliant on insects for pollination and seed production, while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps. (USFWS, 2017)

Habitat Type

Adult: Pine rockland in pockets of clayey marl or on oolitic limestone

Dependencies on Specific Environmental Elements

Adult: Fire is an important element in maintaining the pine rockland habitat.

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2017)

Tolerance Ranges/Thresholds

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

Habitat Narrative

Adult: Chamaesyce deltoidea ssp. pinetorum occurs in pine rocklands. Pine rocklands are maintained by regular fire, and are prone to annual flooding for several months during the wet season. However, C. deltoidea ssp. pinetorum generally occurs in higher elevation pine

rocklands at Long Pine Key in Everglades National Park, in areas rarely subject to flooding. See detailed description of Pine Rockland habitat in Additional Habitat Information (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal is unknown for Chamaesyce deltoidea ssp. pinetorum; however, many seed capsules in similar Chamaesyce species are explosively dehiscent, a form of dispersal that flings seeds far from the parent plant. Chamaesyce deltoidea ssp. pinetorum is thought to have a similar, but reduced, level of dispersal (USFWS, 2017)

Population Information and Trends

Number of Populations:

3 extant populations (2 wild, 1 reintroduced) (USFWS, 2023)

Population Size:

>313,000 (USFWS, 2023)

Population Narrative:

The total population size of Chamaesyce deltoidea ssp. pinetorum is estimated to be 14,500-146,000 individuals, with the majority of the population occurring on Long Pine Key. However, while Chamaesyce deltoidea ssp. pinetorum is most abundant within Everglades National Park, pine rockland fragments outside of the Everglades represent about half the subspecies' extant range. (USFWS, 2017). Though it was historically known from five islands (No Name Key, Big Pine Key, Ramrod Key, Cudjoe Key, and Lower Sugarloaf Key), only two populations were extant at the time of listing (Big Pine Key and Cudjoe Key; Service 2016). The Cudjoe Key population was not found during recent surveys despite habitat remaining in the area (Lange 2022) and is now considered potentially extirpated since seeds may persist in the soil seed bank for up to three years (Liu and Menges 2005). A translocation of plants and seeds sourced from Big Pine Key were used to reestablish a population on No Name Key in 2019 (Lange et al. 2019; Cuni et al. 2020; Figure 1). The species was extirpated from this area due to lack of habitat management, but restoration with mechanical treatment and prescribed fire occurred prior to reintroduction (Lange et al. 2019). In 2019, 48 individuals were transplanted to No Name Key (Cuni et al. 2020). Within a year after transplanting, over 300 first generation seedlings had recruited, and 220 seedlings were documented three years after transplanting (Fairchild unpublished data). Also in 2019, 720 seeds were sown in 36 seed plots at No Name Key (Cuni et al. 2020). One and half years after sowing, average emergence rates ranged from 31 to 53 percent and average survival rates ranged from 24 to 48 percent (USFWS, 2023).

Threats and Stressors

Stressor: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range
Exposure:
Response:
Consequence:
Narrative: Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as

remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands.

Stressor: Inadequacy of Existing Regulatory Mechanisms
Exposure:
Response:
Consequence:
Narrative: This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence
Exposure:
Response:
Consequence:
Narrative: Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

Recovery

Reclassification Criteria:
Not defined.

Recovery Priority Number: 9

Delisting Criteria:
Not defined.

Recovery Actions:

- Not defined.
- Conserve pine rocklands and suitable habitat through purchase or conservation easements (Wendelberger 2003, p. 182).
- Remove exotic plants or hardwoods. Use manual labor, herbicides, and prescribed fire, and once cleared, use proper management to reduce costs of control and to maintain the site free of exotics (Bradley and Gann 1999, p 26.). Control seed sources in small, fragmented areas surrounded by urban development (Bradley and Gann 1999, p. 26).
- Implement regular, prescribed burns to create or maintain suitable habitat conditions. In general, a mosaic of burns should be used, and the recommended burning regime is 3 to 7 years with summer burns generally preferred to winter burns (Bradley and Gann 1999, p. 26). Where fire has been suppressed for long periods of time, reintroduce fire in a step-wise manner (Bradley and Gann 1999, p. 26; Wendelberger 2003, p. 182). Include a monitoring program to determine effectiveness of the fire prescription (Bradley and Gann 1999, p. 26).
- Monitor and manage pine rockland fragments in Miami-Dade County.
- Continue monitoring rare plants at Long Pine Key (Gann et al. 2006, p. 2). It is important to determine effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes.
- Resurvey known locations and compare those data with current location data to better understand the stability and size of the population (Wendelberger 2003, p. 183; Maschinski et al. 2005, p. 163).
- Consider ex situ collections (Maschinski et al. 2005, p. 163).
- Assess the need for studies to determine current level of genetic variation remaining in extant occurrences.
- Assess the need to augment the population (Wendelberger 2003, p. 183).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES This species does not have a final recovery plan. While completing this status review, we have identified the following potential recovery activities which are included below. Recovery Activities • Conduct or continue to conduct habitat maintenance or restoration at occupied areas, including removal of native hardwoods and non-native invasive plants and prescribed burns every 5-7 years. • Protect parcels on Big Pine Key that are occupied by the species. • Continue monitoring the reintroduction on No Name Key and augment as needed, until population is established. • Develop a translocation/reintroduction plan to identify other potential recipient sites for reintroducing or establishing populations. Any future introductions in the Lower Keys should include deer exclusions to protect plants, at least during the establishment phase, and potentially in the longer-term as well. Monitoring and Research Activities • Conduct regular monitoring and assessments of the status of the Big Pine Key population. •

Conduct research on viability of seeds in long-term cold storage to determine storage lifespan and the rate at which stores should be replenished. • Collect and bank wild seeds at an appropriate ex situ facility at least once per decade, or more often if indicated by results of research on viability in storage. • Identify the best management regimes for Big Pine partridge pea along roadsides. • Research the effects of Key deer browsing on Big Pine partridge pea abundance and fitness. • Continue research on the effects of mosquito spraying on Big Pine partridge pea fruit set and plant fitness. Outreach Activities • Increase public education and outreach about native plants and habitats in the Lower Keys community, involve local schools and residents in habitat conservation and restoration efforts geared toward Big Pine partridge pea and other rare species and habitats. • Conduct public outreach on Big Pine Key and No Name Key aimed at improving residents' opinions about prescribed fire and its ecological importance (noting that poststorm-surge recovery of the Big Pine partridge pea is greater in areas that have recently burned) (USFWS, 2023).

References

USFWS. 2017. Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-clover), and Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS. 2016. Proposed Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat) and Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-Clover). Proposed Rule. 81 FR 70282 - 70308 (October 11, 2016).

USFWS. 2017. Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-clover), and Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017). USFWS. 2023. Big Pine Partridge Pea (Chamaecrista lineata var. keyensis) 5-Year Status Review: Summary and Evaluation. USFWS. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 11 pp.

USFWS. 2017. Endangered Species Status for Dalea carthagenensis var. floridana (Florida Prairie-clover), and Threatened Species Status for Sideroxylon reclinatum ssp. austrofloridense (Everglades Bully), Digitaria pauciflora (Florida Pineland Crabgrass), and Chamaesyce deltoidea ssp. pinetorum (Pineland Sandmat). Final Rule. 82 FR 46691-46715 (October 6, 2017).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form For Chamaesyce deltoidea pinetorum (Pineland Sandmat). U.S. Fish and Wildlife Service Region 4 (Southwest Region), 03/26/2013. 18 p.

USFWS. 2023. Big Pine Partridge Pea (Chamaecrista lineata var. keyensis) 5-Year Status Review: Summary and Evaluation. USFWS. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 11 pp.

SPECIES ACCOUNT: *Chamaesyce deltoidea serpyllum* (Wedge spurge)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Southeast Region (R4) (USFWS, 2016)

Physical Description

Wedge spurge is a small, prostrate perennial herb. The stems are slender and numerous, radiating out from the tap root. The leaves are more or less triangular. The flowers are cyathia, the specialized inflorescences characteristic of the genus Euphorbia and its close relatives. Reproduction is sexual. Some species of Chamaesyce are completely reliant on insects for pollination and seed production while others are self pollinating (Bradley and Gann 1999, p. 32). Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979, pp. 95-97). No studies of reproductive biology or ecology have been conducted and these topics are poorly known for Chamaesyce in general. (USFWS, 2015; USFWS, 2013).

Taxonomy

John K. Small collected plants on Big Pine Key and first described C. deltoidea ssp. serpyllum as C. serpyllum. The taxon was later found to be related to the C. deltoidea complex, and subsequently ascribed to it. That complex includes several additional taxa found in the pine rockland flora of Miami-Dade County (Bradley and Gann 1999, p. 31). Chamaesyce is distinguished by having the main stem abortive just above the cotyledons. Synonyms include: Chamaesyce serpyllum Small and Euphorbia deltoidea Engelm. ex Chapman var. serpyllum (Small) Oudejans (U.S. Department of Agriculture, Natural Resources Conservation Service 2011, p. 1) (USFWS, 2015; USFWS, 2013).

Historical Range

Florida: Big Pine Key, Monroe County. (USFWS, 2015)

Current Range

Florida: Big Pine Key, Monroe County. The current range of is on Big Pine Key. Small groups of plants are scattered widely across the island (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2013; USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979, pp. 95-97) (USFWS, 2015)

Reproduction Narrative

Adult: Some species of Chamaesyce are completely reliant on insects for pollination and seed production while others are self pollinating (Bradley and Gann 1999, p. 32). No studies of reproductive biology or ecology have been conducted and these topics are poorly known for Chamaesyce in general (USFWS, 2013).

Habitat Type

Adult: Pine rocklands (USFWS, 2015).

Dependencies on Specific Environmental Elements

Adult: Pine rockland is maintained by relatively frequent fires (every 2-3 years to a maximum of 15 years), which maintain the understory woody plants at shrub height (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210, Liu et al. 2005b, p. 71). In the absence of fire, many areas become wooded, eventually succeeding to rockland hammock (i.e., hardwood forest) (Snyder et al. 1990, p. 260) (USFWS, 2013).

Environmental Specificity

Adult: High

Habitat Narrative

Adult: Chamaesyce deltoidea ssp. serpyllum occurs in pine rocklands and adjacent disturbed sites on Big Pine Key, including roadsides. It most often grows directly from crevices in the oolitic limestone substrate (Bradley and Gann 1999, p. 31). Pine rocklands are described in detail for Chamaecrista lineata var. keyensis, above. Within pine rocklands, Chamaesyce deltoidea ssp. serpyllum is associated with areas of relatively higher elevation, extensive exposed rock substrate, where the understory is open, hardwood and palm density is low, and native herbaceous species cover and richness are high (Bradley and Saha 2009, p. 26; Ross and Ruiz 1996, p. 6; Bradley 2006, p. 27). Roadsides dominated mostly by native herbs and grasses where exotic lawn grasses are not established are a potentially important habitat for C. deltoidea ssp. serpyllum (Bradley 2006, p. 37). (USFWS, 2015). Wedge spurge is historically known only from pine rockland vegetation on Big Pine Key (Bradley and Gann 1999, p. 31). Pine rocklands in the lower Florida Keys are dominated by a canopy of Pinus elliottii var. densa (South Florida slash pine). The subcanopy is composed of Thrinax morrisii (brittle thatch palm), Psidium longipes (longstalked stopper), Metopium toxiferum (poisonwood), Byrsonima lucida (locustberry), Pithecellobium keyense (blackbead), and Coccothrinax argentata (silver palm) (Bradley 2006, p. 25). There is also a rich herbaceous layer composed of grasses and herbs. Limestone bedrock and exposed calcareousrubble are prominent features associated with pine rockland communities (Snyder et al. 1990, pp. 235236; Ross and Ruiz 1996, p. 4). In addition to the more common associates, wedge spurge can grow in association with other rare taxa, including Linum arenicola (sand flax), and Chamaecrista lineata var. keyensis (Big Pine partridge pea) (Bradley and Gann 1999, p. 32) (USFWS, 2013).

Dispersal/Migration

Motility/Mobility

Adult: Low

Population Information and Trends

Population Size:

368,557 (USFWS, 2015)

Population Narrative:

Total population size for Chamaesyce deltoidea ssp. serpyllum on publicly owned pine rocklands on Big Pine Key (478 ha (1,181 acres)) was estimated to be 352,993 plants in 2005 (preHurricane Wilma), 343,255 in 2007 (post-Wilma), and 368,557 in 2013. This represents a slight (4.4 percent) increase in the known population size of from 2005 to 2013 (Bradley et al. 2013, p. 21) (USFWS, 2015).

Threats and Stressors

Stressor: Fire suppression (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At present, fire suppression may be one of the greatest threats to wedge spurge. While fires may have occurred at least once per decade in the past, the fire frequency since about 1950 has been sharply reduced throughout the island, despite occasional prescribed burns conducted by the Service and TNC (Bergh and Wisby 1996, p. 1). While fire suppression has occurred mostly adjacent to developed areas, all pine rockland areas on Big Pine Key have suffered from lack of fire, including pine rockland within the NKDR. Because of this drop in burn frequency, habitat characteristics have changed Fire is required to maintain the pine rockland community (Snyder et al. 1990, pp. 257-263; Carlson et al. 1993, p. 915; Bergh and Wisby 1996, p. 1; Liu et al. 2005a, p. 210; Liu et al. 2005b, p. 71). With fire suppression, hardwoods eventually invade pine rocklands and shade out understory species like wedge spurge. Fire suppression reduces the size of the areas that burn, and habitat fragmentation prevents fire from moving across the landscape. Accordingly, in the absence of fire, pine rockland communities tend toward becoming tropical hardwood hammock communities. In many areas, pine rockland communities have been succeeded by tropical hardwood hammock flora (USFWS, 2013).

Stressor: Sea level rise (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Sea level rise is a significant threat to the species and its habitat. There has been a 15 centimeter (5.9 inch) rise in sea level over a 70-year period in the vicinity of Big Pine Key (Ross et al. 1994, p. 145). The pine rockland community in the Keys has undergone a reduction due to sea level rise (Ross et al. 1994, p. 149). For example, the pine rockland area on Sugarloaf Key covered 217 acres (88 ha) prior to 1935, and was reduced to 114 acres (46 ha) by 1935 and 74 acres (30 ha) by 1991 (Ross et al. 1994, p. 149). The loss of pine rockland communities and upland plant diversity was correlated with elevated ground- and soil-water salinity (Ross et al. 1994, pp. 150-151). In areas affected by sea level rise, communities of halophytic plants replaced pine rockland communities (Ross et al. 1994, p. 152). Based on IPCC and other predictions of sea level rise, Clough (2008, p. 23) concluded that a significant proportion of upland habitat will be lost on Big Pine Key by 2100 (USFWS, 2013).

Stressor: Nonnative invasive plants (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: Exotic plants have detrimental impacts on pine rocklands. Some of these are a threat to wedge spurge because they alter community structure and composition or even form dense monocultures in habitats otherwise used by wedge spurge. Some exotic species invade pine rocklands and edge habitats that are otherwise suitable for wedge spurge. Some of these may compete directly with wedge spurge for space and resources, while others have a profound effect on community structure and responses to fire. When habitats are infested by invasive exotics, lack of control (particularly if in conjunction with fire suppression) may result in dense foliage and high fuel loads. If left uncontrolled in a fire-suppressed pineland, invasive species such as Brazilian pepper may form a dense monospecific canopy almost completely eliminating native vegetation. They will also affect the characteristics of a fire when it occurs, and or the structure and composition of plant communities after fire occurs. This results in additional threats to wedge spurge. Where exotic plants are present, the known benefits of prescribed fire for wedge spurge are less certain to occur. When there are fires in infested areas, instead of being relatively cool fires that consume light fuels (e.g., pine needle litter) as in the past, they may burn much hotter and have detrimental effects on the vegetation that develops following fire (USFWS, 2013).

Stressor: Catastrophic events (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Hurricanes and tropical storms are an additional threat, particularly to the extent that they yield storm surges with salt-water overwash. Hurricane storm surges can inundate landscapes with saltwater for varying durations. Klimstra (1986, p. 3) stated that the effect of salt water on pinelands is well established as a consequence of hurricane Betsy, September 8, 1965. After 20 years the site where waters were entrapped for several hours has not yet fully recovered from complete loss of Pinus, Ernodea, Randia, Pisonia, and Metopium seedlings. The small area of occupancy and somewhat patchy distribution of wedge spurge renders it susceptible to extinction through such stochastic events. In 2005, Hurricane Wilma resulted in a storm surge that covered most of Big Pine Key with seawater (USFWS, 2013).

Stressor: Demographic and genetic factors (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The small area, few occurrences, and somewhat patchy distribution of wedge spurge renders it susceptible to extinction risks associated with stochastic demographic, genetic, and environmental events, including catastrophic storms. Further reduction of population size would likely enhance threats associated with genetics and demographic stochasticity (Caughley 1994, p. 217) (USFWS, 2013).

Recovery

Reclassification Criteria:
Not defined.

Delisting Criteria:
Not defined.

Recovery Actions:

- Not defined.
- Increase prescribed fires. Prescribed fires should be conducted across all pine rockland areas in NKDR and other portions of Big Pine Key. NKDR has revised its Comprehensive Conservation Plan; this plan calls for a revised Fire Management Plan. (USFWS, 2013)
- Mechanical treatments to control understory can be effective in preparing for prescribed fires. These techniques will probably be most beneficial in pine rockland areas that have undergone long periods of fire suppression. There are many such areas in the southern half of Big Pine Key.(USFWS, 2013)
- Conduct further research into fuel reduction and fire-wedge spurge interactions, including the effects of mechanical treatments. (USFWS, 2013)
- Establish and maintain fire breaks; quantify before the outcome is determined. (USFWS, 2013)
- Given the large impact of Hurricane Wilma, monitor wedge spurge and community characteristics that are positively correlated with wedge spurge occurrences on multiple spatial scales. (USFWS, 2013)
- Continue exotic plant control programs in pine rockland habitat. Exotic plant densities in most pine rockland areas on Big Pine Key are currently low, and management should continue to prevent spread of invasive exotic plants. (USFWS, 2013)
- NKDR should institute an integrated program of adaptive management in order to prioritize and optimize efforts and objectives pertaining to pine rockland viability, fire regimes, and fuel reduction relative to wedge spurge and other endemic plants. (USFWS, 2013)
- Develop sea level rise and hurricane impact models, and encourage the integration of these models in management efforts in order to enhance their effectiveness. (USFWS, 2013)
- Conduct studies on reproductive biology and ecology of wedge spurge. (USFWS, 2013)
- Consider the need to establish and maintain an ex situ collection of wedge spurge in the future to reduce its vulnerability to catastrophic events, if the trend in population continues to decline. (USFWS, 2013)

References

USFWS. 2015. Endangered Species Status for Chamaecrista Lineata Var. Keyensis (Big Pine Partridge Pea), Chamaesyce Deltoidea Ssp. Serpyllum (Wedge Spurge), and Linum Arenicola (Sand Flax), and Threatened Species Status for Argythamnia Blodgettii (Blodgett's Silverbush)

Proposed Rule. 80 FR 58536 - 58567 (September 29, 2010).

USFWS 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Chamaesyce deltoidea serpyllum (Wedge Spurge). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

21 p.

Proposed Rule. 80 FE 58536 - 58567 (September 29, 2015).

USFWS. 2015. Endangered and Threatened Wildlife and Plants

Endangered Species Status for Chamaecrista Lineata Var. Keyensis (Big Pine Partridge Pea), Chamaesyce Deltoidea Ssp. Serpyllum (Wedge Spurge), and Linum Arenicola (Sand Flax), and Threatened Species Status for Argythamnia Blodgettii (Blodgett's Silverbush)

Proposed Rule. Vol. 80, No. 188. Pages 58536-58567.

USFWS. 2013. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Chamaesyce deltoidea serpyllum (Wedge Spurge). U.S. Fish and Wildlife Service, Region 4 (Southeast Region), March 26, 2013

SPECIES ACCOUNT: *Chamaesyce deltoidea ssp. deltoidea* (Deltoid spurge)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/19/1985; Southeast Region (R4)

Physical Description

Chamaesyce deltoidea ssp. deltoidea is a small, monoecious, prostrate to decumbent herb occurring in mats over exposed limestone. The stems are terete (circular although slightly oblong) in cross section, brown, and 0.3 to 0.6 mm in diameter. The leaves are smooth above to slightly hairy below, with an obtuse apex, cordate base, margins entire; stipules laciniate, brown to reddish brown with light tips, and smooth. The inflorescence is found singly, in leaf axils, with a short peduncle (1 mm long). The cyathium is 1.2 mm long, 1.0 mm wide and smooth (glabrous). It is green and ovate in shape with four glands and minute appendages. The fruit is a capsule, 1.0 mm long and 1.0 mm wide, and completely glabrous. The pedicel is also glabrous. It is fully exerted at maturity. There are three seeds, 1.0 mm long and 0.5 mm wide, ovate in shape and glabrous. The seeds are laterally four-ridged and yellowish-white (Remus 1979). The leaves and stems of the subspecies Chamaesyce deltoidea ssp. adhaerens are appressed to the ground surface and the plants form mats. In some cases the stems will ascend and form tufts (Herndon 1993). The inflorescence is solitary, terminal, pedunculate (1.5 mm long), and glabrous proximally to pilose distally. The main distinction between the two subspecies is their pubescence. The pubescence of the subspecies C. deltoidea ssp. adhaerens is appressed on the leaves and on the stems it is spreading or appressed (Herndon 1993). The pubescence for C. deltoidea ssp. deltoidea is sparse, appressed on the leaves and the stems are glabrous or thinly pubescent (Herndon 1993). (USFWS, 1999)

Taxonomy

Deltoid spurge was first described as Euphorbia deltoidea by Engelman (Chapman 1883). In 1903, Small transferred the species to the genus Chamaesyce, a natural genus distinguished from Euphorbia by having the main stem abortive just above the cotyledons, making the aerial portion of Chamaesyce homologous to the inflorescence of Euphorbia subgenus Esula (Webster 1967). Burch (1966) treated C. deltoidea as a complex of three taxa endemic to South Florida: C. deltoidea, C. adhaerens Small, and C. serphyllum Small, treating deltoid spurge as C. deltoidea (Engelman ex Chapman) Small subsp. deltoidea var. deltoidea without comment. In Herndon's (1993) revision of the C. deltoidea complex, he recognized four subspecies endemic to South Florida: ssp. deltoidea, ssp. adhaerens, ssp. pinetorum, and ssp. serphyllum. The taxonomy of this complex is difficult and some follow Burch's 1966 treatment and others follow Herndon's 1993 treatment. The final rule as listed in the Federal Register applies to the taxa deltoidea and adhaerens, which are restricted to Miami-Dade County, Florida. According to this, all members of the C. deltoidea complex that are restricted to Miami-Dade County are considered endangered species by the FWS. For purposes of clarity, Herndon's treatment will be used for this recovery plan. Synonyms: Euphorbia deltoidea Engelman ex Chapman; Chamaesyce deltoidea (Engelman ex Chapman) Small ssp. deltoidea var. deltoidea; Chamaesyce adhaerens Small; Chamaesyce deltoidea (Engelm. ex Chapman) ssp. deltoidea var. adhaerens (Small) Burch. (USFWS, 1999)

Historical Range

In Florida, endemic that was historically known to occur in pine rocklands from the Goulds area north to the center of the city of Miami (USFWS, 1999)

Current Range

In Florida, from south Miami to the Homstead area (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers from April through November, peaking in July. (USFWS, 1999)

Reproduction Narrative

Adult: Studies into the life history of the deltoid spurge have only recently begun and little is known about its reproduction. It is a perennial that flowers from April through November, peaking in July. Its extensive root system gives evidence that it is a long-lived plant (DERM 1994). The reproductive ecology in Chamaesyce has been poorly studied but it is known to be highly variable (Ehrenfeld 1976, 1979; Webster 1967). Some species are completely reliant on insects for pollination and seed production, while others are self-pollinating. Pollinators may include bees, flies, ants, and wasps (Ehrenfeld 1979). Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988). (USFWS, 1999)

Habitat Type

Adult: Pine rocklands (USFWS, 1999)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 1999)

Habitat Narrative

Adult: The deltoid spurge tends to occur in areas with an open shrub canopy, exposed limestone (oolite), and minimal litter (pine needles, leaves, and other organic materials). It is most often found growing at the edges of sand pockets with plants growing both in sand (sometimes in association with the endangered Polygala smallii) and on oolitic limestone. The soils in which it grows are classified as Opalocka-Rock Outcrop soils. The subspecies C. deltoidea ssp. adhaerens occurs in fine, reddish sandy loam over limestone. Dense colonies are sometimes found in pinelands that have undergone a slight mechanical disturbance, where little or no topsoil is formed and where productivity is low. The shrub canopy in this disturbed habitat is often poorly developed providing high light levels and low organic litter accumulation rates. The pine rocklands are often considered a fire subclimax, and are maintained with periodic fires (3 to 7 years). These periodic fires keep the shrub canopy down and eliminate the litter accumulations. (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed capsules of many Euphorbiaceae are explosively dehiscent, ejecting seeds a short distance from the parent plant. The seeds of some species are dispersed by ants (Pemberton 1988).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

15 sites (USFWS, 2023)

Population Size:

~16,000 to 20,000 individuals (USFWS, 2019)

Population Narrative:

The current known populations of deltoid spurge include 13 public and 2 private sites (Table 1). The largest populations of this subspecies were recorded at Zoo Miami with 10,000 plants, followed by Larry and Penny Thompson Park with 5,300 plants and 808 plants at Ludlam Pineland (Appendix A). These three locations account for over 80 percent of the total known density of the deltoid spurge plant population. Eight populations have been extirpated due to habitat fragmentation, degradation, and fire suppression (Service 2019). Seven of the extirpated populations occurred on public conservation lands. The Bill Sadowski Park population had three plants in a 2016 population estimate (Bradley, pers. comm 2010, Lange pers comm 2017, and Possley pers. comm 2017a). However, a Fairchild survey in 2023 could not find any deltoid spurge at this location, and it is now presumed extirpated (Possley pers. comm 2023). Fairchild reintroduced seeds in one known extirpated location (Trinity Pineland) in summer 2023 (Possley, pers comm 2023). It is too early at the time of this review to determine successful reestablishment, and therefore we continue to assume extirpation at this location (USFWS, 2023).

Threats and Stressors

Stressor: Habitat loss and fragmentation
Exposure:
Response:
Consequence:
Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside of ENP (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Nonnative invasive plants

Exposure:
Response:
Consequence:
Narrative: Invasion by exotic plant species continue to affect this species (Factor E)Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree. (USFWS, 2019).

Stressor: Inadequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire suppression continues to affect this species (Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of these species are affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: Regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated this species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but notrequire private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Climate change will impact pine rockland habitat through sea level rise, variability in precipitation and temperature that can cause shifts in vegetation types, increases in freezing conditions, and increase in intensity and frequency of storm and fire events (Wanless et al. 2008, Wear and Greis 2012, Intergovernmental Panel on Climate Change 2021, Runkle et al. 2022). By 2100, direct losses of pine rockland plant populations are expected due to habitat loss and successions caused by sea level rise (Vargas-Moreno and Flaxman 2010, Zhang et al. 2011, Park and Sweet 2015, Rahmstorf et al. 2015, University of Florida Geoplan Center 2015, Sweet et al.

2022). Additionally, changes in regional hydrology may have impacts on the pine rockland habitats. Increased and longer-duration hydroperiods in the areas inhabited by endangered pine rockland species may lead to a reduction in the amount of suitable habitat, a potential reduction in the area occupied, and a reduction in the number of deltoid spurge individuals found (USFWS, 2023).

Stressor: land modification for development (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Extensive land modification for development throughout the species historic range has led to habitat loss, fragmentation, and alterations that render the habitat unsuitable for deltoid spurge (Factor A). Due to land modifications of pine rocklands, suitable habitat for deltoid spurge outside of protected areas is limited, severely fragmented, isolated, and degraded. These characteristics contribute to the species low resiliency (ability to withstand stochastic events), low redundancy (ability to recover from catastrophic events), and low representation (low genetic dispersal) (USFWS, 2023)

Recovery

Reclassification Criteria:
1. Enough demographic data are available to determine the appropriate numbers of self sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 2010)

2. When these populations, within the historic range of deltoid spurge are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression (USFWS, 2010)

3. When these sites are managed to maintain the pine rocklands to support deltoid spurge (USFWS, 2010)

4. When monitoring programs demonstrate that populations of deltoid spurge on these sites support sufficient populations sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 2010)

Recovery Priority Number: 6C

Delisting Criteria:
1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

2. A network of 6 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)

4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:

- Conduct surveys to determine distribution of pine rockland plants. Pine rockland plants were thoroughly surveyed in Miami-Dade County; however, the status of C. deltoidea is not known over its entire range. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of pine rockland plants that additional populations not be lost. (USFWS, 1999)
- Collect biological information important to species recovery. Additional information on the ecology and life history of pine rockland plants needs to be collected. The size and viability of known populations of C. deltoidea needs to be evaluated. (USFWS, 1999)
- Monitor C. deltoidea populations. Use existing standardized monitoring protocols developed by the Florida Natural Areas Inventory to record baseline data regarding the biology and ecology of C. deltoidea. Determine the effects of management actions on C. deltoidea. Initiate quarterly monitoring programs. (USFWS, 1999)
- Continue implementation of the fire education program and modify as necessary any fire management education program that has been developed. Future modifications to this program may include tri-lingual distribution (Spanish, English, and Haitian Creole). (USFWS, 1999)
- Habitat-Level Recovery Actions: Continue to protect pine rockland plant habitat in order to prevent degradation. Restore areas to suitable habitat. Conduct habitat-related research. (USFWS, 1999)
- Habitat degradation continues to be a moderate threat because vegetation restoration and management programs are costly and depend upon availability of funding (Service 2006).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1999) and the Recovery Plan amendment (Service 2019). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Implement, continue, or increase habitat restoration efforts (exotic species removal and prescribed burns/similar disturbance) where deltoid spurge is located (recovery criteria 4). • Identify and pursue conservation agreements or other agreements that protect pine rocklands and deltoid spurge populations (recovery criteria 2 and 3). • Identify and restore patches of pine rocklands that have been historically occupied by deltoid spurge (recovery criteria 1). • Additional partnerships should be promoted to share information, conduct collaborative research, and provide land managers and interested public with information (recovery criteria 1 & 4). • Develop a translocation/reintroduction plan to identify potential recipient sites for reintroducing or establishment of populations within the historical range (recovery criteria 2). Monitoring and Research Activities • Evaluate ‘unknown’ population locations to determine number of individuals or extirpation of the species at those locations (recovery criteria 1). • Monitor extant populations annually and document individual number estimates to determine population trends (recovery criteria 1). • Survey areas that have suitable habitat for the species to identify new populations and/or translocation sites (recovery criteria 2). • Research ex situ propagation and seed bank viability (recovery criteria 2). • Examine the demography and reproductive biology of the deltoid spurge to determine population trends and growth and establishment rates (recovery

criteria 1). • Study individual populations to determine genetic diversity (recovery criteria 1). • Research management techniques and impacts particularly with prescribed fire impacts on the biology and life history of deltoid spurge (recovery criteria 4). Outreach Activities • Increase public awareness and appreciation for native plants and habitats. • Attend public events when appropriate to improve the communities understanding of management techniques and policies, such as prescribed fire, in pine rockland habitats (USFWS, 2023).

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SPECIES ACCOUNT: *Chamaesyce garberi* (Garber's spurge)

Species Taxonomic and Listing Information

Listing Status: Threatened; 7/18/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

A prostrate herb with pubescent stems. Leaves are ovate and 4-9 mm long. Flowers are conspicuous. (NatureServe, 2015)

Taxonomy

The treatment of the clade to which Garber's spurge belongs has historically been a subject of disagreement among botanical authorities. While many (Burch 1965; Hassall 1977; Herndon 1993) have recognized Chamaesyce as a distinct and separate genus within the Euphorbiaceae family based on morphological characters, more recent molecular phylogenetic evidence suggests that this taxon is more appropriately treated as a subgenus within Euphorbia (Yang and Berry 2011; Horn et al. 2012). The Integrated Taxonomic System (2022), the Flora of North America (2022), the Atlas of Florida Plants (Wunderlin et al. 2022), and the Flora of the Southeastern United States (Weakley 2022) all accept this treatment. This represents a change in nomenclature for the species compared to its listing name in 1985 from Chamaesyce garberi to Euphorbia garberi but does not change the circumscription of the species or its status as a distinct, threatened taxon (USFWS, 2022).

Historical Range

Garber's spurge is endemic to South Florida (USFWS, 1999). It formerly occurred in Dade and Monroe counties, Florida, from Miami to the lower Florida Keys. Has disappeared from much of its historical range. (NatureServe, 2015)

Current Range

The current range of Garber's spurge has decreased compared to its historic range due to a few extirpations on the peripheries. Notably, the species was previously known to occur in Collier County (although from only one collection) but was not found there or in surrounding suitable habitat in more recent surveys and is presumed extirpated at this location (Green at al. 2008). Additionally, in MiamiDade County the species had formerly occurred from the vicinity of the City of Miami south of the Miami River to the Cutler area. However, three populations are now extirpated and only two Garber's spurge populations are known to be extant in Miami-Dade County. The Everglades Garber's spurge populations at Long Pine Key (Pine Blocks B and C) and Northwest Cape Sable were estimated to have over 1,000,000 individuals each in 2007, though the latter has declined dramatically since this time (Lange et al. 2020) and the former has not been resurveyed. In the Keys, Garber's spurge still occurs throughout its entire historical range since populations are extant at the western and eastern boundaries, from Key Largo to the Marquesas Keys. Extant populations are known from at least 21 islands in the Florida Keys though this range characterization may be an overestimation considering that most populations have not been revisited in 10-15 years and some of the smaller populations would be especially vulnerable to stochastic change and extirpation. Twelve populations in the Keys have been extirpated from 9 islands (5 of which had no other Garber's spurge populations) (Green et al. 2008; FNAI 2022). Although these extirpations don't represent a decrease in range for Garber's spurge (i.e., they occur within the interior of its range), they do represent a decrease in area of

occupancy and an increase in fragmentation. See Figure 1 for a map of both extant and extirpated populations throughout this species' range (USFWS, 2022).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, barrens, forest, grassland, dune, shrubland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fires (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Dry, sandy soil in ecotones between hammocks and pinelands or coastal hammocks and sea-oats dunes. Requires periodic burning or is shaded out as succession occurs (NatureServe, 2015). Garber's spurge occurs at low elevations either on thin sandy soils composed largely of Pamlico sands or directly on limestone. It is found in a variety of open to moderately shaded habitat types. In pine rocklands, it grows out of crevices in oolitic limestone. On Cape Sable, Everglades NP, it has been reported from hammock edges, open grassy prairies, and backdune swales. In the Florida Keys, it grows on semi-exposed limestone shores, open calcareous salt flats, pine rocklands, calcareous sands of beach ridges, and along disturbed roadsides. Soils are composed largely of Pamlico sands or directly on limestone.

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (inferred from USFWS, 2007)

Species Trends:

Unknown (USFWS, 2007)

Number of Populations:

~31 (USFWS, 2022)

Population Size:

Unknown (NatureServe, 2015)

Population Narrative:

Garber's spurge is estimated to occur in 31 populations in Monroe and MiamiDade Counties, though many of them (24) have not been surveyed for 10-15 years. The previous status review (Service 2007) reported 17 populations, but only two new populations have been discovered since then. The main difference in the number of populations is how they were grouped together in the previous review. Some islands in the Keys have more than one population, or clusters of plants more than 1.0 kilometers (0.62 miles) from other clusters (NatureServe 2020), but the previous review counted them as one population since they occurred on one island. Also, the previous review grouped all the Cape Sable populations into one instead of counting each Cape as a separate population. General population abundance, trends, and demography are unknown since no population has been monitored consistently on an annual or semi-annual basis to track this information. The current status of many populations of Garber's spurge is also unknown due to a lack of surveys since Green's extensive range-wide status survey in 2006-2007. Population sizes for most occurrences are still based on Green's work and presume that these populations are still extant, though updated surveys are needed to confirm this. Green's report revealed that Garber's spurge population sizes vary widely, ranging from over 1,000,000 plants in two locations (at the time) to less than 10 plants at other sites (Green et al. 2008). For populations that have been monitored more recently, only two are estimated to be stable, one may be increasing, and two are likely decreasing (Table 1). Twentyfour are presumed extant with an unknown trend due to lack of recent surveys. Approximately 16 have been extirpated and 2 have an unknown status (no plants observed in 2006-2007 surveys but had potential to re-appear) (Green et al. 2008; FNAI 2022). Only two populations occur in Miami-Dade County (the Long Pine Key area of ENP and CDE). In Monroe County extant or presumed extant Garber's spurge populations are reported from the mainland in the Cape Sable area of ENP, as well as 21 islands in the Florida Keys (Table 1). In mainland Monroe County, the species was historically known from all three Capes on Cape Sable (ENP), representing three distinct populations (though grouped as one population in the previous review [Service 2007]). In 2006, it was found on only the Middle and Northwest Capes (Green et al. 2008). Although it was thought to be extirpated in the previous status review (Service 2007), the population on East Cape was only temporarily eliminated by hurricane damage incurred in 2005. In 2013, a small population of Garber's spurge was discovered on East Cape Sable by the ENP botanist, but it is unknown if this is the same location where it was documented in 2005 (Gann 2015). One of the largest documented populations was that in Northwest Cape Sable where over 1,000,000 plants were estimated to occur in 2007 (Green et al. 2008; Lange 2017). This is the only population where a thorough, updated survey has taken place which showed an approximate 86 percent decrease in the number of plants observed along transects used in both the 2007 and 2017 surveys (Lange et al. 2020). Extrapolated out to the whole population, this means that there may be about 90,000 plants remaining at this location. While this still represents one of the largest and most robust populations of this species, the rapid and steep decline in abundance is still great cause for concern. The decline is most likely due to a lack of fire on the landscape, as evidenced by a significant increase in tree and shrub cover in what should be open habitat (Lange et al. 2020). Within Long Pine Key there may still be over 1,000,000 plants (Green et al. 2008; Lange 2017), but an updated survey is needed. The sub-populations at this location have apparently undergone a large expansion since previous reports did not indicate large population numbers (Bradley 2007; Green et al. 2008). The surveys in 2006 estimated 600-700 individuals in Deer Hammock (Pine Block A) and approximately 1,250,000 in Pine Blocks B and C (Green et al. 2008). Because of the number of plants, geographic size, favorable management activities at ENP, and,

for the interior Long Pine Key site - distance from the coast, the populations within ENP may be the most secure of the known extant Garber's spurge populations. However, careful surveys have not been completed here since 2006 and only continued presence of the populations has been noted (Sadle 2022). At the CDE, Miami-Dade County's Department of Environmental Resource Management (DERM; 1993) reported a population size of 250-500 plants based on four days of searches specifically for this species. Herndon (2002) estimated a population size of 600-6,000 plants. In contrast, Possley (2007) suspected that only 100-200 plants were present in 2004, but estimated approximately 50-100 plants at this site in 2017 and 2021 (Possley 2017, 2022a), but emphasized the important caveat that dedicated species-specific surveys have not been completed for Garber's spurge in many years and this is only an approximate number based on site visits for monitoring of other species. The largest populations occurring in the Keys are located on Vaca, Bahia Honda, Big Torch, Woman, and Marquesas Keys (Table 1), but updated population estimates were not available for this review. Similar to the largest mainland populations, these mostly occur in protected areas or on remote islands. Many smaller populations occur throughout the Keys and some of them were observed to still have plants within the last 6 years (Long Key State Park, No Name Key, Big Munson, and Boca Grande), but have not been thoroughly surveyed since 2006-2007. Additional populations may occur in the Keys on private properties with fragments of suitable habitat where botanists have not yet been able to obtain access. For example, Boot Key is mostly privately owned and was noted for having suitable habitat, but permission was not granted to conduct a thorough survey of the island (Green et al. 2008). However, plants were found along an accessible right-of-way and so it is entirely plausible that additional Garber's spurge exists within the privately-owned areas. Other islands with intact habitat may harbor additional populations as well (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Development is a concern for this species mainly in the Keys. Without intervention, areas on private land that may contain Garber's spurge will most likely be altered. Some sites are threatened by fire suppression and/or exotic plants that have been managed insufficiently (USFWS, 2007).

Stressor: Key deer (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Dooley (1975) reported Garber's spurge as a food plant of Key deer. The Key deer population increased 240% between 1971 and 2001 (Lopez et al. 2004), and this increase has probably had a significant impact on the vegetation in the deer's range (USFWS, 2007).

Stressor: Recreation (USFWS, 2007)
Exposure:
Response:
Consequence:

Narrative: Populations on dunes have the potential to be threatened by trampling from beach goers (USFWS, 2007).

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Because populations are very small, they are subject to extirpation as a result of human or natural stochastic events. Sea level rise may become a significant threat in coming decades. Populations typically occur at elevations less than 0.50 meters; recent estimates for sea level rise through 2100 range from 0.28 - 0.34 meters (Church and White 2006) (USFWS, 2007).

Recovery

Reclassification Criteria:
1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 95% probability of persistence for 100 years (USFWS, 2007).

2. When these populations within the historic range of Garber's spurge are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression (USFWS, 2007).

3. When these sites are managed to maintain the pine rocklands to support Garber's spurge (USFWS, 2007).

4. When monitoring programs demonstrate that populations of Garber's spurge on these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 2007).

Recovery Priority Number: 8

Delisting Criteria:
Not available

Recovery Actions:
- Determine the distribution of the species in South Florida (USFWS, 1999).
- Protect and enhance populations (USFWS, 1999).
- Conduct research on biology/ecology (USFWS, 1999).
- Monitor populations (USFWS, 1999).
- Inform and involve stakeholders and the general public in the recovery process (USFWS, 1999).
- Acquire privately owned properties where the species occurs, including coastal rock barrens on Long Key and Crawl Key (USFWS, 2007).
- Where present on roadsides, maintain an infrequent mowing regime to allow plants sufficient time to flower and disperse seeds. Do not plant turf grasses in or next to roadside

populations. Trim hardwoods from edges of population to prevent shading. Communicate these road maintenance guidelines with road maintenance crews (USFWS, 2007).

- Implement a prescribed fire program at the Deering Estate at Cutler with a fire return interval of 3 - 7 years (USFWS, 2007).
- Ensure that Monroe county regulators can identify Garber's spurge to ensure that developers pay proper mitigation fees when applying for building permits (USFWS, 2007).
- Continue or initiate exotic plat control at all sites where populations occur (USFWS, 2007).
- Initiate long-term monitoring of presence or population sizes of all populations, or at a minimum, at a subset which includes the geographic range of the species and a variety of habitat types (USFWS, 2007).
- Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, coastal habitats, and disturbed areas (USFWS, 2007).
- Reintroduce populations to stations where formerly present (USFWS, 2007).
- Conduct studies of coastal rock barren habitat to determine successional processes and management needs of the ecosystem (USFWS, 2007).
- Remove hardwoods from disturbed area where Garber's spurge occurs at Crocodile Lake National Wildlife Refuge, and use this population as a source of germplasm for reintroductions into natural habitats in the Key Largo area (USFWS, 2007).
- Conduct genetic studies to clarify relationships with C. porteriana, determine if patterns of morphological variation reported by Herndon (1993) are genetically based, and determine if inbreeding depression is occurring within any populations (USFWS, 2007).
- Develop population viability and risk assessments for all populations, based on monitoring and demographic studies (USFWS, 2007).
- Conduct seed bank studies to determine longevity of seed bank and viability under different conditions (USFWS, 2007).
- Study relationship of fire to population demography of Garber's spurge to determine potential impacts of sea level rise (USFWS, 2007).
- Search recently burned pine rocklands in the lower Florida Keys for Garber's spurge (USFWS, 2007).
- Study impacts of hurricanes on Garber's spurge populations in coastal habitats (USFWS, 2007).
- One recovery criteria that should be modified states that sites must be managed to maintain pine rocklands to support Garber's spurge. Because pine rockland is not the primary habitat for the species in much of its range, this criterion should be updated to additionally require that dunes, coastal grasslands, and coastal rock barrens be managed to support the species (USFWS, 2007).
- Determine if Key deer forage significantly on Garber's spurge (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1999). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Implement prescribed fire at sites with Garber’s spurge where needed (ENP, CDE, NKDR). Consider manual hardwood removal/thinning if prescribed burning is not possible based on landscape context. • Continue invasive species removal at conservation areas with Garber’s spurge. Apply herbicides carefully to reduce risk of non-target damage. • Reintroduce/augment populations to

sites where the species is extirpated (Green et al. 2008) or has low numbers (Crocodile Lake NWR, Lignumvitae Key Botanical State Park, Long Key State Park, Big Pine Key, Wells Key, Boca Chica Key, Marquesas Key – Short Beach,) and habitat remains or can be restored. • Acquire or pursue conservation agreements for privately-owned properties where the species occurs (Vaca Keys, Boot Key, Big Munson Island). Where present on roadsides, maintain an infrequent mowing regime to allow plants sufficient time to flower and disperse seeds. Do not plant turf grasses in or next to roadside populations. Apply herbicides carefully to reduce non-target damage. Trim hardwoods from edges of population to prevent shading. Communicate these road maintenance guidelines with road maintenance crews. • Expand ex situ propagation and seed banking. Specifically, seeds should be stored within at least one more seed bank in addition to NLGRP for safety duplication. Additionally, seeds have only been collected from one population for long-term storage, but more populations should be safeguarded in ex situ collection for sufficient genetic representation. Seed collections for long-term storage should be made on a regular basis since it is unknown how long Garber's spurge seeds retain viability. Monitoring/Research Activities • Initiate long-term, detailed demographic studies in a subset of populations which includes the geographic range of the species and a variety of habitat types, including pine rockland, coastal habitats, and disturbed areas. • Conduct monitoring to document presence on protected lands at least every five years. • Develop population viability and risk assessments for all populations, based on monitoring and demographic studies. • Determine the condition of populations on private land whose status is currently unknown. • Survey potential habitat within the species historic range on both public and private lands (where access is permitted) for presence of Garber's spurge. • Conduct studies of Keys tidal rock barren habitat to determine successional processes and management needs of the ecosystem. • Conduct genetic studies to clarify relationships with C. porteriana, determine if patterns of morphological variation reported by Herndon (1993) are genetically based, and determine if inbreeding depression is occurring within any populations. • Conduct seed bank studies to determine longevity of seed bank and viability under different conditions, such as presence/absence or intensity of fire. • Conduct research to evaluate reproductive biology, including potential pollinators, insect visitation rates, etc. • Examine the effects of fire (growing season versus non-growing season, various firereturn intervals, etc.) on Garber's spurge flowering, seed set, establishment, reestablishment, etc. • Study impacts of stochastic events (hurricanes, storm surge, tidal flooding, wildfires) on Garber's spurge populations (USFWS, 2022).

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SPECIES ACCOUNT: *Chamaesyce hooveri* (Hoover's spurge)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/26/2016; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

Chamaesyce hooveri forms gray-green mats from a few inches to a few feet across. The flowering structure is a small, highly simplified cup-like "cyathium," as in all other spurges (Chamaesyce and Euphorbia). The flowering structure in C. hooveri has petallike glands that are red to olive in color. Flowers bloom in July. (USFWS, 2009)

Taxonomy

This plant was originally named Euphorbia hooveri, based on a specimen collected by Hoover in Yettem, Tulare County (Wheeler 1940). At that time, the genus Euphorbia was viewed as comprising several subgenera, including Chamaesyce and Euphorbia. Webster (1975) subsequently elevated the subgenus Chamaesyce to the rank of genus based on growth patterns and physiology. The currently accepted scientific name, Chamaesyce hooveri, was validated when Koutnik (1985) published the new combination. (USFWS, 2009)

Historical Range

For decades, Chamaesyce hooveri was known from only three localities: near Yettem and Visalia in Tulare County, and near Vina in Tehama County. Collections were made from these three areas in the late 1930s and early 1940s (Wheeler 1941, Munz and Keck 1959, Stone et al. 1988). From 1974 through 1987, 21 additional occurrences of C. hooveri were reported. The majority of these (15) were in Tehama County. One to three occurrences were discovered during this period in each of Butte, Merced, Stanislaus, and Tulare Counties (Stone et al. 1988). The historical localities for this species were in the Northeastern Sacramento Valley, San Joaquin Valley, Solano-Colusa, and Southern Sierra Foothills Vernal Pool Regions (Keeler-Wolf et al. 1998). (USFWS, 2005)

Current Range

Of the 26 occurrences presumed to be extant, only 3 have been observed within the past decade (California Natural Diversity Data Base 2003). The main remaining area of concentration for Chamaesyce hooveri is within the Northeastern Sacramento Valley Vernal Pool Region. The Vina Plains of Tehama and Butte Counties contain 14 (53.8 percent) of the 26 known extant occurrences for C. hooveri (California Natural Diversity Data Base 2003) in an area of about 91 square kilometers (35 square miles; Stone et al. 1988). One other site in the same region is near Chico in Butte County. Seven of the extant occurrences are in the Southern Sierra Foothills Vernal Pool Region, including five in the Visalia-Yettem area of Tulare County and two in the Hickman-La Grange area of Stanislaus County. Three other occurrences are on the Sacramento National Wildlife Refuge in Glenn County, which is in the Solano-Colusa Vernal Pool Region. The one other extant occurrence is on the Bert Crane Ranch in Merced County, which is within the San Joaquin Valley Vernal Pool Region (Keeler-Wolf et al. 1998, California Natural Diversity Data Base 2003). (USFWS, 2005)

Critical Habitat Designated

Yes; 2/10/2006.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chamaesyce hooveri (Hoover's spurge) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in California (71 FR 7118-7316).

Critical Habitat Designation

The critical habitat designation for Chamaesyce hooveri includes seven CHUs in Merced, Stanislaus, Tehama, Tulare, and Tuolumne Counties, California. This species critical habitat encompasses approximately 114,713 acres (71 FR 7118-7316).

Unit 1: Tehama County, California. From USGS 24,000 topographic quad Acorn Hollow, Richardson Springs NW

Unit 2: Butte County, California. From USGS 24,000 topographic quad Hamlin Canyon

Unit 4: Stanislaus and Tuolumne Counties.

Unit 5: Stanislaus and Merced Counties. (i) Unit 5A: Stanislaus and Merced Counties. From USGS 24,000 topographic quads Paulsell, Cooperstown, Le Grange, Montpelier, Turlock Lake, Snelling, Merced Fall. (ii) Unit 5B: Merced County. From USGS 24,000 topographic quad Turlock Lake. USGS 24,000 topographic quads Paulsell, Montpelier.

Unit 6: Merced County. (i) Unit 6A: Merced County. USGS 24,000 topographic quads Stevinson, San Luis Ranch. Unit 6B: Merced County. From USGS 24,000 topographic quad Stevinson, Arena, San Luis Ranch, Turner Ranch. Unit 6C: Merced County. From USGS 24,000 topographic quad Arena, Turner Ranch. Unit 6D: Merced County. USGS 24,000 topographic quad Turner Ranch, Sandy Mush. Unit 6E: Merced County. USGS 24,000 topographic quad Turner Ranch, Sandy Mush.

Unit 7: Tulare County. (i) Unit 7A: Tulare County. From USGS 24,000 topographic quads Stokes Mtn., Ivanhoe. Unit 7B: Tulare County. From USGS 24,000 topographic quads Ivanhoe. (iii) Unit 7C: Tulare County. From USGS 24,000 topographic quads Stokes Mtn., Auckland, Ivanhoe, Woodlake. Unit 7D: Tulare County. From USGS 24,000 topographic quad Woodlake. Unit 7E: Tulare County. From USGS 24,000 topographic quad Monson. Unit 7F: Tulare County. USGS 24,000 topographic quad Monson. Unit 7G: Tulare County. USGS 24,000 topographic quad Monson.

Unit 3: Glenn and Colusa Counties, California. This unit was excluded from the designation pursuant to Section 4(b)(2) of the Act (see Exclusions under 4(b)(2) in the final critical habitat rule (70 FR 46924).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chamaesyce hooveri critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described below in paragraph (2)(ii), providing for dispersal and promoting hydroperiods of adequate length in the pools;

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands;

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be essential for conservation may require special management considerations or protections. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species. Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Many of the factors that cause the decline and localized extirpation of vernal pool species can be avoided. Actions that should be avoided include the following: (1) Actions that increase competition from invasive species as many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDB 2001). (2) Alteration of natural hydrology such as construction of dams or other structures that artificially increase the length of vernal pool inundation or construction of ditches that artificially drain vernal pools. (3) Human degradation of vernal pools such as off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (annual) (USFWS, 2005)

Dependency on Other Individuals or Species

Adult: Beetles (order Coleoptera), flies (order Diptera), bees and wasps (order Hymenoptera), and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of Chamaesyce hooveri and may potentially serve as pollinators (Stone et al. 1988, Alexander and Schlising 1997). (USFWS, 2005)

Breeding Season

Adult: Late May to October (USFWS, 2005)

Reproduction Narrative

Adult: Chamaesyce hooveri is a summer annual, but few details of its life history are known. Populations in Merced and Tulare Counties typically flower from late May through July, whereas those farther north in Stanislaus County and the Sacramento Valley flower from mid-June into October (Alexander and Schlising 1997, J. Silveira in litt. 2000, California Natural Diversity Data Base 2003). Beetles (order Coleoptera), flies (order Diptera), bees and wasps (order Hymenoptera), and butterflies and moths (order Lepidoptera) have been observed visiting the flowers of Chamaesyce hooveri and may potentially serve as pollinators (Stone et al. 1988, Alexander and Schlising 1997). (USFWS, 2005)

Habitat Type

Adult: Temporary pool (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pools (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2005)

Site Fidelity

Adult: High (inferred from USFWS, 2005)

Habitat Narrative

Adult: Chamaesyce hooveri is restricted to vernal pools (Stone et al. 1988, Koutnik 1993, Skinner and Pavlik 1994). Deeper pools apparently provide better habitat for this species because the duration of inundation is longer and the deeper portions are nearly devoid of other vegetation, thus limiting competition from other plants (J. Stebbins in litt. 2000a, Stone et al. 1988). However, the plant appears to adapted to a wide variety of soils, which range in texture from clay to sandy loam. (USFWS, 2005)

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

25 (USFWS, 2023)

Population Size:

100-2,500 (USFWS, 2009)

Population Narrative:

Population numbers have ranged from less than 100 plants seen in 2001 to over 2,500 plants seen in 1993 (J. Silveira, in litt. 2009). Of the 31 known occurrences and sites, 27 are presumed to be extant (LSA 2003; CNDDB 2007). (USFWS, 2009) Hoover's spurge is endemic to the Central Valley of California. The known distribution is within a narrow zone of rolling topography formed by remnant alluvial fans and stream terraces on the eastern margin of the Sacramento and San Joaquin valleys (Stone et al. 1988, p. 102). Assessment of the historical range of Hoover's spurge is complicated as the earliest floristic surveys occurred after widespread conversion of potentially suitable habitat to agriculture (Stone et al. 1988, p. 106). The present distribution of Hoover's spurge is likely considerably fragmented compared to historical conditions (Stone et al. 1988, p. 106). Hoover's spurge is known from a few widely separated populations (see Table 1). Occurrences are recorded in four different vernal pool recovery regions. The main area of concentration is within the Northeastern Sacramento Valley Vernal Pool Region on the Vina Plains along the Tehama and Butte County line. Occurrences in the Solano-Colusa Vernal Pool Region are clustered on the Sacramento National Wildlife Refuge in Glenn County. In the Southern Sierra Foothills Vernal Pool Region, occurrences are adjacent to Turlock Lake State Recreation Area in Stanislaus County and on the Stone Corral State Ecological Reserve north of the City of Visalia in Tulare County. One occurrence is within the San Joaquin Valley Vernal Pool Region on the Grasslands Wildlife Management Area in western Merced County. The species' current distribution remains similar to the distribution as described in the 1997 listing rule and the 2009 status review. At the time of listing, Hoover's spurge was known from 29 populations found in Butte, Glenn, Merced, Stanislaus, Tehama, and Tulare counties, 25 of which were considered extant (Service, 1997, p. 1431). The 2009 status review notes a total of 31 occurrences of the species, including 30 occurrences recorded in the Diversity Database and an additional occurrence at the then-proposed Hamilton Ranch Conservation Bank that had not yet been included in the Diversity Database (Diversity Database 2007, entire; Service 2009, pp. 1–2). Twenty-seven occurrences were presumed to be extant in 2009 and the occurrences were distributed throughout the same counties and concentrated in the same areas as the populations described at the time of listing (Diversity Database 2007, entire; Service 2009, p. 2). There have been only minor changes to the occurrences of Hoover's spurge recorded in the Diversity Database since the 2009 status review. Currently the Diversity Database describes a total of 29 occurrences (see Table 1; Diversity Database 2023, entire). The new occurrence reported in the 2009 status review at the Hamilton Ranch Conservation Bank has been incorporated into the Diversity Database (occurrence #36). Two additional records (occurrences #34 and #35) have been added to the Diversity Database and four records (occurrences #17, #18, #20, and #31) have been combined with other existing occurrence records (see Table 1; Diversity Database 2007, entire; Diversity Database 2023, entire). The two additional records (occurrences #34 and #35) are located within the Sacramento National Wildlife Refuge in proximity to other occurrences of the species on the Refuge and were previously considered as parts of the other occurrences (Diversity Database 2023, pp. 33–34). Two previously unreported areas of occupied habitat documented by Witham (2013, pp. D-1–D-5) have also been added to the Diversity Database as part of existing records (occurrences #36 and #13) (Diversity Database 2023, pp. 13, 35). Twenty-five occurrences are currently presumed to be extant, two possibly extirpated, and two extirpated (Diversity Database 2023, entire). Since the 2009 status review, the status of occurrence #29, which is located in proximity to two other occurrences in the

northern portion of the range, has changed from “presumed extant” to “possibly extirpated” due to the intensification of agriculture. Other “presumed extant” occurrences from the last status review remain in this category currently. Witham’s 2013 status review of Hoover’s spurge and its supporting habitat found potentially suitable habitat to be present at each “presumed extant” location (Witham 2013, entire). The current status of many “presumed extant” populations has not been reassessed through on-the-ground surveys in many years, and areas that may support the species remain to be surveyed. Thus, reliable estimates of the amount and distribution of suitable habitat is unknown (USFWS, 2023).

Threats and Stressors

Stressor: Habitat loss
Exposure:
Response:
Consequence:
Narrative: Habitat loss occurs from direct destruction and modification of pools due to filling, grading, discing, leveling, paving, and other activities, as well as modification of surrounding uplands, which alters vernal pool watersheds and the supporting upland ecosystem. Fifty-five percent of presumed extant sites of C. hooveri are on private land and are not protected (CNDDB 2007). (USFWS, 2009)

Stressor: Agriculture conversion
Exposure:
Response:
Consequence:
Narrative: During the 30 years prior to listing, agricultural land conversion was known to have caused the extirpation of one population and threatened two more populations of Chamaesyce hooveri in Tulare County (Stone et al. 1988). In Stanislaus County, the area east of Waterford and Hickman was being converted into grainfields, almond orchards, and irrigated pasture. Thus agricultural land conversion in this area threatened 2 more existing populations of C. hooveri (Stone et al. 1988). It is likely that several occurrences were eliminated by habitat losses before they became known, mainly from conversion of vernal pool habitat to agricultural uses (Stone et al. 1988). We estimated a total of nearly 5,600 acres had been converted, with the greatest acreage, approximately 5,000 acres, converted within the Merced core area. Additionally, one of the occurrences of Chamaesyce hooveri within the Vina Plains core area appears to have been converted to more intensive agriculture. (USFWS, 2009)

Stressor: Habitat degradation
Exposure:
Response:
Consequence:
Narrative: Vernal pool habitats in the Central Valley now represent approximately 9 percent of their former area (State of California 2003), and remaining habitats are considerably more fragmented and isolated than historically and during the recent past. California’s human population is expected to increase by 60 percent between 2000 and 2025 (California Department of Finance 2004) and almost double the 1990 State population. In areas where habitat remains, increased urban conversion of vernal pool habitat continues to threaten this species and habitat loss is expected to continue as urban boundaries expand further especially through high and low

terrace formations on the eastern side of the valley. Even in areas where habitat is protected, the urbanization of lands surrounding conserved areas results in the fragmentation of protected habitats, preventing dispersal between occurrences, as well as increased edge effects to pool complexes. Habitat conversion is expected to continue as the human population increases (Teitz et al. 2005). (USFWS, 2009)

Stressor: Nonnative plants
Exposure:
Response:
Consequence:
Narrative: Competition from invasive native or non-native plant species threatens nine of the extant occurrences, including eight in the Vina Plains and one on the Sacramento National Wildlife Refuge in Glenn County. Native competitors of Chamaesyce hooveri include Eryngium species (coyote-thistle), Malvella leprosa (alkali mallow), a noxious weed according to Hill (1993), Phyla nodiflora (lippia), Scirpus acutus var. occidentalis (hard-stemmed tule, alkali bulrush (Scirpus maritimus), and Xanthium strumarium (cocklebur). Non-native competitors include bindweed (a noxious weed according to Dempster 1993) and Crypsis schoenoides (swamp grass) (J. Silveira in litt. 2000; CNDDB 2007). On the Vina Plains Preserve, the pools with Chamaesyce hooveri also had the highest frequency of bindweed, at least in 1995 (Alexander and Schlising 1997). Increasing dominance by these competitors may be associated with changes in hydrology and livestock grazing practices (Stone et al. 1988, Alexander and Schlising 1997; CNDDB 2007). Due to late spring rains during the last few years, an invasive plant, Crypsis vaginiflora has become dominant in many Basin-Rim vernal pools within the Sacramento NWR Complex (Sacramento, Delevan and Colusa). (USFWS, 2009)

Stressor: Drought and climate change
Exposure:
Response:
Consequence:
Narrative: Chamaesyce hooveri is an obligate wetland species found only in vernal pools, typically on alluvial fans or terraces of ancient rivers or streams, with a few on the rim of the Central Valley basin. Therefore, maintenance of the natural hydrology of the pools is necessary for the survival and recovery of this species. Drought or flood conditions will place additional strains on the vernal pool ecosystem supporting C. hooveri occurrences, some of which are already fragmented or reduced by agricultural conversion and development. Where occurrences persist on only marginal habitat, the addition of extreme drought conditions is likely to result in higher rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. (USFWS, 2009)

Stressor: Stochastic events
Exposure:
Response:
Consequence:
Narrative: Small population size poses a serious threat for at least four of the known occurrences, which total fewer than 100 individuals even in favorable years (CNDDB 2007). Such small populations are subject to extirpation from random events such as extended drought and genetic drift. Small population size makes it difficult for this species to persist while sustaining the impacts of habitat fragmentation. Such populations may be highly susceptible to extirpation

due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987). (USFWS, 2009)

Stressor: Neonicotinoid pesticides (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The Environmental Protection Agency (Agency) recently released final biological evaluations assessing the effects of labeled uses of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. All three pesticides were determined likely to adversely affect Hoover's spurge, primarily due to expected effects to its pollinators. The likely to adversely affect determination means that the Agency reasonably expects that at least one individual animal or plant, among a variety of listed species, may be exposed to the pesticide at a sufficient level to have an effect, which will be adverse. The three pesticides target insect neurotransmitters leading to their paralysis and death. The three pesticides are highly toxic to bees and available data suggest that all three pesticides are likely to affect honeybee and bumblebee colonies through brood reduction and declines in numbers of adults. The specific pollinators of Hoover's spurge are not known. Pollinators of similar species of Euphorbiaceae are usually generalists: small bees, flies, and wasps. During a field study of Hoover's spurge, Stone et al. (1998, p. 105) observed species of native bees and the western honeybee (Apis mellifera) visiting plants. Since the plant is believed to require insect pollination, a loss or severe decline in pollinators of Hoover's spurge would adversely impact the reproductive success of the species. The Agency anticipates releasing amended proposed interim decisions in 2023, which will include updates to some of the previously proposed mitigation measures to reduce neonicotinoid exposures for listed species. Mitigation measures will be finalized in the interim decisions, which the Agency expects to release in 2024 mitigation measures (USFWS, 2023).

Stressor: Livestock grazing
Exposure:
Response:
Consequence:
Narrative: Appropriate levels of grazing are a vital component of long-term management for vernal pools and vernal pool grasslands. Before their populations declined, elk (Cervus canadensis) and pronghorn (Antilocapra americana) grazed vernal pool landscapes; today, most grazing is done by domestic ungulates (Service 2005, p. I-16). The 2009 status review describes livestock grazing and trampling as an activity that may or may not adversely affect vernal pool plants, depending on how it is implemented (Service 2009, p. 16). The most recent occurrence report for Hoover's spurge from the Diversity Database lists 21 of the 25 "presumed extant" occurrences as threatened by grazing. Clarifying notes state the threat from grazing is due to trampling, winter grazing, and grazing aiding the establishment of weedy exotic plants. In one instance, threats are identified from undergrazing (Diversity Database occurrence #32). The threat grazing poses to Hoover's spurge, and other vernal pool plants, remains an active field of study. Most researchers and land managers currently agree that some level of grazing is beneficial if not necessary for maintaining the ecological health and functioning of vernal pools (Robins and Vollmar 2002, p. 402). New and collected research is presented here (USFWS, 2023).

Stressor: Climate change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Significant research into the effects of climate change throughout California has been conducted since the previous status review in 2009. The most recent comprehensive climate change assessment for the state, California's Fourth Climate Change Assessment (Fourth Assessment), was published in 2018 (Bedsworth et al. 2018, entire). Climate change will increase temperatures, sea levels, intensity of heavy precipitation events, decrease snow accumulation, increase the frequency of drought, and increase the size of wildfires (Bedsworth et al. 2018, p. 22). Present-day temperatures have increased over most of the state by at least 1°F compared to earlier in the 20th century. Annual average maximum daily temperatures are expected to further increase by 2.5°F to 8.8°F by 2100 (van Vuuren et al. 2011, p. 11). Some variability is anticipated by region, but the direction of warming trends, as well as precipitation, drought, and wildfire are expected to be similar in the Sacramento Valley (Houlton and Lund 2018, pp. 6–8) and San Joaquin Valley (Fernandez-Bou 2021, pp. 7–10) of California where Hoover's spurge occurs. Climate models predict precipitation will be more volatile; the number of drought years will increase, while the storms that occur in wet years will bring more precipitation and flood risk concentrated in a fewer number of days (Bedsworth et al. 2018, pp. 25–26). Since vernal pool vegetation varies from year to year based on climatic conditions such as precipitation amount and timing and air temperatures, climate change could drive changes in plant communities (Montrone et al. 2019, p. 1004; Javornik and Collinge 2016, p. 66). An increase in drought occurrence can also lead to invasion of vernal pool habitats by invasive upland plants during low water years and could result in the competitive exclusion of vernal pool plants such as Hoover's spurge. Hoover's spurge is most often found in large, deep pools that are characterized by prolonged inundation in the spring followed by gradual desiccation during the late spring and early summer (Stone et al. 1988, p. 102). Populations of Hoover's spurge will likely be threatened by changes to vernal pool water budgets—the total length of time a pool is inundated, and the rate of drying—under climate change. Assuming precipitation levels remain near historical levels and only temperature increases, modeled data suggest a decrease in the length of time pools are filled (Montrone et al. 2019, p. 1004). A reduction in pool inundation period will likely impact species adapted to long inundation times to a greater degree (Gosejohn et al. 2016, p. 9; Montrone et al. 2019, p. 1004). Since Hoover's spurge is associated with pools with long inundation times, it could be at greater risk of decline or extirpation if average hydrological conditions become unfavorable. Increased temperatures can also impact the rate at which vernal pools dry in the late spring and summer. Increased temperature late in the growing season may cause the pools to dry too rapidly and hinder native plant development (Javornik and Collinge 2016, p. 66). Stone et al. (1988, p. 105) observed Hoover's spurge seedlings have less time to develop if a pool dries too rapidly. Under such conditions, plants can be poorly developed and have reduced reproductive success or may even die prematurely (Stone et al. 1988, p. 105). It should be noted that both the inundation length and rate of drying are controlled by multiple factors. The timing of rain events within a year, total amount of precipitation, and period between storms can influence the aquatic phase of vernal pools in addition to air temperature (Alexander and Schlising 1997, p. 120; Javornik and Collinge 2016, pp. 64–66). Due to its requirement for vernal pools with long inundation times and preference for long pool drying periods, Hoover's spurge will likely be negatively affected under most climate change scenarios (USFWS, 2023).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8C

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Protect vernal pool habitat in the largest blocks possible from loss, fragmentation, degradation, and incompatible uses. (USFWS, 2005)
- Manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern. (USFWS, 2005)
- Conduct range-wide status surveys and status reviews for all species addressed in this recovery plan to determine species status and progress toward achieving recovery of listed species and long-term conservation of species of concern. (USFWS, 2005)
- Conduct research and use results to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts.
- Develop and implement participation programs. (USFWS, 2005)
- Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquiring conservation easements or fee title to habitat lands are some ways that conservators can help guarantee protection of the species in perpetuity. (USFWS, 2009)
- Develop standardized population trend survey protocols and implement to complete updated status surveys, especially for populations on private lands where trends have not been recently updated. (USFWS, 2009)
- Manage invasive plants on preserves. Management should include research to determine effective eradication methods of nonnative competitors, and pool conditions that favor one plant over another. (USFWS, 2009)
- Create and convene regional vernal pool working groups in regions where Chamaesyce hooveri occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas. (USFWS, 2009)
- Collect seeds from each core area following the Center for Plant Conservation Guidelines (1991). Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: In this section, we propose recommendations that will aid in the recovery and conservation of Hoover's spurge. The recommendations put forth in the Recovery Plan (Service 2005, pp. ix–xii) and the 2009 status review (Service 2009, p. 21) are still relevant. Three additional recommendations are added based on communication with species experts, a literature search, and a status review of existing records. 1. Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquiring habitat

through conservation easements or fee title are some ways that conservators can help guarantee protection of the species in perpetuity. 2. Develop and implement standardized population trend survey protocols to complete updated status surveys, especially for populations on private lands where trends have not been recently updated. 3. Manage invasive plants on preserves. Management should include research to determine effective eradication methods of nonnative competitors, and pool conditions that favor native vernal pool plants over invasive plants. 4. Create and convene regional vernal pool working groups in regions where Hoover's spurge occurs. Regional vernal pool working groups will be important for tracking the progress of recovery efforts, including the amount of suitable habitat protected for the species in core areas. 5. Collect seeds from each core area following the standard accepted practices. After genetic studies are completed, additional collections should be made from each population that contains unique genotypes. Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. Repeated small collections of seed may be necessary over several years to avoid contributing to the decline of very small populations. 6. Conduct research to confirm pollinator species of Hoover's spurge. Initiate monitoring of pollinator species to determine if there are any trends in pollinator numbers that could be inhibiting the ability of Hoover's spurge to successfully reproduce. 7. Conduct research on potential grazing regimes that target invasive native and nonnative plant species without harming Hoover's spurge or its lifecycle. Gain a better understating of how periodic disturbance from livestock grazing might aid in reducing interspecific competition with Hoover's spurge. Any resulting recommendations should be based on observable habitat conditions, such as water levels in vernal pools, since inundation periods are variable between years and are anticipated to be impacted by climate change. 8. Continue research on the demography of Hoover's spurge and its seed ecology. A better understanding of the species seed bank viability is needed to determine when local populations may be assumed to be extirpated versus simply dormant. 9. In order to reflect the most current understanding of the species' taxonomy, formally change the species name in the Code of Federal Regulations from Chamaesyce hooveri to Euphorbia hooveri (USFWS, 2023).

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SPECIES ACCOUNT: *Chionanthus pygmaeus* (Pygmy fringe-tree)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Pygmy fringe tree is a shrub or small tree that is often less than 1 m (3 feet tall), but can reach 4 m (feet). The twigs are opposite or sub-opposite and stiff, while the leaf scars and leaves are mostly opposite but sometimes alternate. The leaves are simple, mostly 3 to 10 cm (about 1 to 4 inches) long, and lacking stipules. They have short petioles, and the somewhat leathery blades are ovate to elliptic or obovate in shape, and acute to rounded at the tip. The base of the blade is attenuated to the petiole. The upper surface of the blade is dark yellow-green and smooth, but the lower surface is paler and reticulate. The inflorescence is a leafy-bracted panicle that appears with the new shoots from the axils of most leaf scars from the previous season. The axis (main stem) of the inflorescence is rather short with numerous opposite branches that are spreading, slender and dropping, terminating in clusters of three to six flowers. Bracts toward the base of the inflorescence are similar to, but smaller than, the leaves. The flowers are regular, perfect, and pleasingly fragrant. The four sepals are green, united at the base, and 1.5 to 2.0 millimeters (mm) long. The four petals are white, united at the base to a short, campanulate throat, with narrowly linear lobes, 1.0 to 1.5 cm long and somewhat spreading. The two stamens are fused (adnate) to the corolla base. The ovary is superior with a single style. The fruit is a drupe 2.0 to 2.5 cm long, oval, and green, becoming purplish-brown when ripe. (USFWS, 1999)

Taxonomy

Small (1933) named this species Chionanthus pygmaea. Since then there have been no other taxonomic treatments. There are no scientific synonyms, but the common name used in literature is pygmy fringetree and the spelling variation pygmy fringe-tree (Wood 1985, Ward and Godfrey 1979). The gender of the name has been unclear. When he named the species, Small (1933) used the Greek suffix -aea which indicates the species? status as a tree. The use of this ending has been questioned and every author since, including Hardin (1974), has used the suffix -aeus indicating its status as a shrub. (USFWS, 1999)

Historical Range

Lake, Osceola, Polk, and Highland Counties, Florida. No longer found on the Mount Dora Range (USFWS, 1999).

Current Range

Chionanthus pygmaeus is known from west of Lake Apopka in Lake County, northwestern Osceola County, and the Lake Wales Ridge in Polk and Highlands counties, Florida. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Although the reproductive biology of this species has not been thoroughly investigated, it is known to spread by root sprouts and occasionally by seed (Stout in press). The plants appear to be functionally dioecious (Gill and Pogge 1974), and the female flowers have stunted anthers that usually do not open (Goodrum and Halls 1961). The four plants in the endangered species display garden at the Historic Bok Sanctuary (2 males, 2 females) flowered and set seed in 1997 (Center for Plant Conservation 2003). After spring flowering, fruiting probably occurs in June, with seed dispersal in September (Gill and Pogge 1974, Ward and Godfrey 1979). Seeds (drupes) may remain on the plants well into winter (Stout 2001, in press). Little is known about seed dissemination of pygmy fringe tree, and seed production is variable from year to year, with mixed reports for success of germination. In nursery conditions the best results are obtained with cleaned, air-dried seed, but whole fruits have also germinated. Bok Tower Gardens has achieved 60 to 70 percent germination rates under greenhouse conditions (T. Race, Bok Tower Gardens, personal communication 1996). Germination dates for pygmy fringe tree are unknown. Leafing occurs mid-March, budding occurs in March, and anthesis is from late March to early April. Recruitment is exceedingly slow in this species. At The Nature Conservancy's Tiger Creek Preserve (Possum Creek Trail Scrub), over 100 individuals of pygmy fringe trees have been tagged and monitored (I.J. Stout, University of Central Florida, personal communication 1997). In more than 10 years of monitoring, hundreds of root sprouts were found, but only one seedling was located. Despite this extremely low seedling recruitment, the number of individuals at the site appears to be stable. Due to population stability and this species' reliable resprouting after fires, The Nature Conservancy no longer conducts detailed monitoring on this species (B. Pace-Aldana, The Nature Conservancy, in litt. 2005). This species is long-lived and persists in scrub that is burned on a frequency between 20 and 70 years. However, it is a fire-dependent species that resprouts after fire events. This species has above-ground stems growing from rootstocks or buried stems that have survived the infrequent fires that are characteristic of the habitat (Kral 1983, Ward and Godfrey 1979). It has been observed to resprout from rootstocks following a spring burn (Stout in press). Fires may have an important indirect effect on pygmy fringe tree by regulating the numbers and sizes of plants that might shade or otherwise compete with it (Kral 1983). In the spring and summer of 1997, The Nature Conservancy burned sandhill vegetation at Tiger Creek Preserve that contains pygmy fringe tree. The effects of fire on these individuals were monitored (I.J. Stout, personal communication 1997). Burning to restore the sandhill vegetation's original grassy appearance continues, and Bea Pace has monitored the results (Center for Plant Conservation 2003). Pygmy fringe tree is also present at the Carter Creek tract of Lake Wales Ridge National Wildlife Refuge, where restoration of sandhill is being studied by Archbold Biological Station (Menges et al. 2005). Their results to date "suggest that burning is beneficial for sandhill community structure and the populations of several key species. Chainsawing as a pre-treatment has mixed results depending on the species. . . . The saw & burn treatment promotes more complete and intense fires (Menges et al. unpubl. data) and more open post-treatment subcanopies, which may have a number of benefits for restoration of the sandhill ecosystem and its species. Subsequent fires may be more effective in areas impacted once with this mechanical pre-treatment to fire."

Habitat Type

Adult: Dry/Xeric Hammocks

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Pygmy fringe tree inhabits excessively drained sandy soils on central Florida's LWR (and historically on the Mount Dora Ridge, Orange County). This species is found on low- nutrient St. Lucie fine sand soil which is subject to rapid drying (Wunderlin et al. 1981), as well as other dry sand soils. Pygmy fringe tree occurs primarily in scrub as well as high pine, dry hammocks, xeric hammocks, and transitional habitats. It is abundant at a few sites, where it may form thickets along with evergreen oaks and other shrubs such as tallow wood, silk bay, and scrub hickory. In some locations, it may be the dominant plant while in others it may be codominant or subdominant (Wunderlin et al. 1981). At Carter Creek, where it is relatively abundant, it is scattered among turkey oaks.

Dispersal/Migration

Population Information and Trends

Population Narrative:

This species is protected on a substantial number of conservation lands, most of them purchased after it was listed. It has been monitored at LWR State Forest (Weekley 1996, 1999), and it is clearly a long-lived resprouting species. The Service does not have current information on threats because this shrub is considered relatively abundant and secure by managers of the conservation lands of the Lake Wales Ridge, so limited funds for monitoring have been devoted to other species. After this plant was listed, an extensive network of state conservation lands and the Lake Wales Ridge National Wildlife Refuge came into existence, providing habitat and habitat management supported by extensive ecological research and monitoring programs.

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The rapid loss of suitable scrub habitat in Central Florida to residential, recreational and related commercial development is of the utmost concern. Some of these well drained upland soils are also being converted to citrus production. The long term exclusion of fire from the scrub can lead to a dense canopy layer unfavorable to the growth of the short pygmy fringetree. (NatureServe, 2015)

Recovery

Reclassification Criteria:

1. Wen existing populations, within the historic range of C. pygmaeus, are adequately protected from further habitat loss, degradation, and fire suppression. Large areas of land are needed to support populations of this tree/shrub species. These sites must also be managed to maintain xeric oak scrub to support C. pygmaeus. Habitat destruction is occurring at an alarming rate. To ensure the survival of this species, actions must be taken to protect its remaining habitat.

Difficulty in conserving this species may be compounded by the low seed germination rates that could affect this plant's ability to rebound from a reduction of adult individuals. (USFWS, 1999)

Delisting Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of C. pygmaeus, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the serial stage of xeric oak scrub to support C. pygmaeus (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 1999)

Recovery Actions:

- Determine current distribution of C. pygmaeus. This species' distribution is somewhat questionable for taxonomic reasons and ease of overlooking individuals. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of C. pygmaeus. Develop monitoring protocol to assess population trends for C. pygmaeus. Develop a quantitative description of the population structure of C. pygmaeus. (USFWS, 1999)
- Provide public information about C. pygmaeus. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of C. pygmaeus. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of C. pygmaeus and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Work with State, Federal, and non-profit partners to ensure adequate fire and invasive species management is achieved at sites that support pygmy fringe-tree. • Determine limiting factors and preferred microsites for seedling recruitment. • Develop a standard methodology for monitoring pygmy fringe-tree on conservation lands. • Acquire or secure permanent easements on private sites with existing populations from willing sellers, and restore scrub habitat on these sites, including implementing prescribed fire and vegetation thinning by hand. • Work with private landowners to conserve extant populations. • Initiate detailed demographic monitoring (Level 3 monitoring sensu Menges and Gordon 1996) at multiple sites throughout the species' range. • Conduct a prescribed fire in one or more of the study populations at Tiger Creek Preserve to better understand the response of pygmy fringe-tree and to integrate fire management into population viability models. • Determine the overall level of threat posed by seed and fruit predators, especially the unidentified weevil. • Determine the overall level of threat to pygmy fringe-tree posed by the moth larva Palpita illibalis and white-tailed deer. • Conduct basic research on the breeding system and pollination biology of pygmy fringe-tree. • Initiate studies to determine the genetic structure of pygmy fringe-tree populations throughout the species' range. • Ensure representation of pygmy fringe-tree at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. • Strengthen ex situ conservation measures by including a wider sample (from numerous sites across the species range) of this species at Bok Tower Gardens, in both stored seed and living collections. • Conduct germination trials on stored seed to determine their long-term viability and factors that affect seed dormancy. (USFWS, 2021)

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SPECIES ACCOUNT: *Chlorogalum purpurem var. reductum* (Camatta Canyon amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; California/Nevada Region (R8) (USFWS, 2015)

Physical Description

A perennial lily with a basal cluster of bright green leaves, which are elongate, with a wavy margin, and with a thickened midrib (Service 2002, Holland 2004, Guretzky et al. 2005). The basal leaves typically range from 1 to 8 in number (Woodbury 2005b), but as many as 14 have been recorded (Guretzky et al. 2005), with a width of 2 to 5 mm. The bulb is ovoid, 2.5 to 3.0 cm long, white to brown in color, and occurs in the upper few inches of soil (Service 2002, Holland 2004). The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (USFWS 2008)

Taxonomy

Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of Chlorogalum purpureum are recognized (Hoover 1940, Jernstedt 2007): Chlorogalum purpureum var. purpureum and Chlorogalum purpureum var. reductum. However, the International Plant Names Index (2005) places the genus Chlorogalum in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

See current range/distribution.

Current Range

The Camatta Canyon amole Chlorogalum purpureum var. reductum is endemic to the La Panza Range in central San Luis Obispo County. The type locality for the Camatta Canyon amole is 18 miles east of Creston on La Panza road, San Luis Obispo County, California. The taxon is known only from a small geographic area. The main population is approximately 0.8 km (0.5 mi) east of the southern end of Camatta Canyon. (USFWS 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), Chlorogalum purpureum var. reductum (Camatta Canyon amole).

Critical Habitat Designation

The critical habitat designation for Chlorogalum purpurem var. reductum includes two units totaling approximately 1,772 ha (4,378 ac) of land. Approximately 25 percent of this total area

consists of Federal lands, private lands comprise approximately 75 percent, and State lands comprise less than 0.1 percent.

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species.

Camatta Canyon Unit: This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of Chlorogalum purpureum var. reductum and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) Chlorogalum purpureum var. reductum is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one ''population'' of plants due to the close proximity of the sites and the characteristic ''patchiness'' of plants that has been observed with both varieties of C. purpureum. The limited geographic distribution of C. p. var. reductum increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon's expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of Chlorogalum purpureum var. reductum have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of C. p. var. purpureum at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of Chlorogalum are not detectable on the surface. Because discoveries of new C. p. var. purpureum sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect ''new patches'' of C. p. var. reductum to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where Chlorogalum purpureum var. reductum is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for C. p. var. reductum growth and expansion. The Service believes it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that C. p. var. reductum occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that Chlorogalum purpureum var. reductum depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity) within the habitat are maintained such that ''edge effects'' from encroaching activities not

conducive to C. p. var. reductum persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon's expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as C. p. var. reductum. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF).

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for Chlorogalum purpureum var. reductum consist of, but are not limited to:

(i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (Quercus douglasii) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities C. p. var. reductum appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Critical habitat does not include existing features and structures, such as buildings, hard-packed roads (e.g., asphalt, pavement), aqueducts, railroads, airport runways and buildings, other paved areas, lawns, and other urban landscaped areas not containing any of the primary constituent elements.

Special management and protection that C. purpureum critical habitat may require are: (1) The soils on which Chlorogalum purpureum is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in Chlorogalum purpureum habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of Chlorogalum purpureum. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be

managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect C. purpureum growth and survival. (4) In all plant communities where Chlorogalum purpureum occurs, invasive, nonnative species such as Centuarea solstitialis (yellow starthistle), Avena spp. (wild oats), Bromus spp. (B. hordeaceus, B. diandrus, B. madritensis, B. rubens (brome)), Erodium spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that Chlorogalum purpureum needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit Chlorogalum purpureum by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of Chlorogalum purpureum) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and C. purpureum plants during the critical season of growth and reproduction. (6) In areas where Chlorogalum purpureum and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), the Service recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during C. purpureum growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during C. purpureum growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). (USFWS, 2008)

Breeding Season

Adult: April to June (USFWS, 2008)

Reproduction Narrative

Adult: Small bees are common pollinators of the Camatta Canyon amole, including sweat bees (Halictidae; Center for Plant Conservation 2007b). Flowering and fruit development occurs during May and June for the purple amole and from April to June for the Camatta Canyon amole. As the fruits mature, the leaves wither and the inflorescence dries and turns brown. The plant is then dormant as a bulb during the summer and fall. (USFWS, 2008)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 305 to 630 m (1,000 to 2,050 ft) (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: All locations for C. purpureum var. purpureum and C. purpureum var. reductum are in semiarid environments and have a Mediterranean climate with summers that are hot and dry, and winters that are cool and wet (USFWS 2008). C. purpureum var. reductum in the Los Padres National Forest grows in open areas on a ridgetop in blue oak savanna and annual grassland, and in open areas in grassland and woodland. The Service (2001, 2002) reported the Camatta Canyon amole to occur at 305 to 625 m (1,000 to 2,050 ft) elevation. However, others (e.g., Jernstedt 1993, 2007; California Department of Fish and Game 2007; California Native Plant Society 2007) reported elevations from 579 to 630 m. (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable (USFWS, 2008)

Population Growth Rate:

Slow (USFWS, 2008)

Population Size:

100,000 to 500,000 (USFWS, 2008)

Population Narrative:

One record in the California Natural Diversity Data Base (California Department of Fish and Game 2007) reports approximately 500,000 Camatta Canyon amole at the site in 1991. The Center for Plant Conservation (2007) states that as many as 100,000 Camatta Canyon amole may exist, with most of these plants on approximately 2 ha to 3 ha (5 ac to 7 ac) of land. Based upon general observations, the California Department of Fish Game has not observed the Camatta Canyon amole to be decreasing over the past ten years (Koch pers. com. 2007). The Camatta Canyon amole grows extremely slowly and requires years to mature and produce seeds (California Department of Fish and Game 2005). (USFWS, 2008)

Threats and Stressors

Stressor: Road maintenance (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The intended use of the highway right-of-way along State Highway 58 is for transportation purposes. A two-lane highway right-of-way is typically comprised of a 40-ft wide strip of land: a paved road, 24 ft wide; then a shoulder on each side, each 4 ft wide; and then another 4 ft of ground on each side. In the location with the Camatta Canyon amole, the plants are usually growing "sporadically" along the fenceline boundary with the adjacent private properties (Edell pers. com. 2007). The California Department of Transportation has designated the right-of-way with the Camatta Canyon amole as a botanical management area. Because of this designation, the California Department of Transportation conducts occasional monitoring and gives greater scrutiny when construction or maintenance occurs in the area (Edell in litt. 2007a, 2007b). (USFWS, 2008)

Stressor: Displacement by non-native annual grasses (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the Chlorogalum purpureum by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). (USFWS, 2008)

Stressor: Illegal vehicle trespass in the National Forest (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The taxon is at risk of destruction, modification, and curtailment of its habitat and known range due to illegal vehicle trespass and cattle grazing in the Camatta Canyon amole area on the Los Padres National Forest. Off-highway vehicles and cattle grazing can cause physical

damage to the Camatta Canyon amole, compact the soil, stimulate soil erosion, damage cryptogamic crusts, reduce the presence of native plants, and increase the presence of invasive plants (e.g. Fleischner 1994, Service 2000, Belnap and Eldridge 2001). (USFWS, 2008)

Stressor: Livestock grazing (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The area occupied by the Camatta Canyon amole on the Los Padres National Forest is in the Navajo Allotment where the permittee is authorized to graze cattle between February and May. Because the Camatta Canyon amole flowers and develops fruit from April to June, we believe that cattle grazing is likely adversely affecting the taxon by trampling, soil compaction, and possibly herbivory. (USFWS, 2008)

Stressor: Recreation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The Camatta Canyon amole area is in the Pozo-La Panza unit of the Los Padres National Forest. The unit "is best known for its variety of OHV [off-highway vehicle] opportunities that require advanced skill levels." The OHV routes, which include an unofficial staging area near the Camatta Canyon amole area, are heavily used (U.S. Forest Service 2005). (USFWS, 2008)

Stressor: Fires (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple amole (Niceswanger 2002) and also of the Camatta Canyon amole. The Chlorogalum purpureum are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the Chlorogalum purpureum by removing other competitive plants, both native and invasive species. The Chlorogalum purpureum may also respond favorably to fire in other ways. (USFWS, 2008)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Recovery actions are not available.

- We recommend that the U.S. Forest Service prepare and implement a management plan for the Camatta Canyon amole on the Los Padres National Forest, including surveys and a monitoring program. (USFWS, 2008)
- We recommend that the U.S. Forest Service implement measures to prevent trespass by vehicles, in particular motorcycles, into the Camatta Canyon amole area and designated critical habitat on the Los Padres National Forest. We recommend that the effectiveness of any implemented measures be monitored and then adaptive management actions taken. (USFWS, 2008)
- We recommend that the U.S. Forest Service consult with the Service regarding its activities that may affect the Camatta Canyon amole and its designated critical habitat on the Los Padres National Forest, in particular cattle grazing. (USFWS, 2008)
- We recommend that the U.S. Forest Service conduct research to determine the effects of gophers and feral pigs on the Camatta Canyon amole, and the relationship between the Camatta Canyon amole and cryptogamic crusts. (USFWS, 2008)
- We recommend that the California Department of Transportation conduct surveys to determine the distribution of the Camatta Canyon amole along State Highway 58 (and adjacent private properties if possible) and submit a report of the survey results to the Service. (USFWS, 2008)

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Final Designation of Critical Habitat for Chlorogalum purpureum, a Plant From the South Coast Ranges of California. Final rule. 67 FR 65414 - 65445 (October 24, 2002).

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SPECIES ACCOUNT: *Chlorogalum purpureum* (Purple amole)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb with a basal rosette of long, linear leaves and a widely branching stem, 1-2 dm tall, arising from an underground bulb. The flower cluster is borne on a single stem with multiple branches. The flowers are deep blue or purple with bright yellow anthers. The fruits are capsules, each with three chambers containing one or two black, ovoid seeds (Jernstedt 1993). (NatureServe, 2015)

Taxonomy

The genus Chlorogalum comprises five plant species in the lily family (Liliaceae; Jernstedt 2007) which inhabit western North America from southern Oregon to Baja California, Mexico. Chlorogalum purpureum is the only member of the genus with flowers that are blue or purple in color; the other members of the genus have flowers that are white or pink (Hoover 1940, Jernstedt 2007). Two varieties of Chlorogalum purpureum are recognized (Hoover 1940, Jernstedt 2007): Chlorogalum purpureum var. purpureum and Chlorogalum purpureum var. reductum. There have been no changes or proposed changes in nomenclature since the species was listed in 2000 (Jernstedt 2007). However, the International Plant Names Index (2005) places the genus Chlorogalum in the hyacinth family (Hyacinthaceae), while recent comparative molecular studies support the inclusion of the genus in the agave family (Agavaceae; Bolger et al. 2006). (USFWS, 2008)

Historical Range

When Chlorogalum purpureum was listed as threatened in 2000, the Chlorogalum purpureum var. purpureum taxon was known only from three localities on Fort Hunter Liggett. (USFWS, 2008)

Current Range

The purple amole Chlorogalum purpureum var. purpureum is endemic to the Santa Lucia Range of Monterey and San Luis Obispo counties, California. The taxon is known from two properties: several localities on Fort Hunter Liggett, southern Monterey County; and one locality on Camp Roberts in northern San Luis Obispo County (USFWS, 2008)

Critical Habitat Designated

Yes; 10/24/2002.

Legal Description

On October 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chlorogalum purpureum (Purple amole) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (67 FR 65414-65445).

Critical Habitat Designation

The critical habitat designation for Chlorogalum purpureum includes two CHUs in San Luis Obispo and Monterey counties, California. This species critical habitat encompasses approximately 5,910 acres (ac) (2,443 hectares (ha)) (67 FR 65414-65445).

Jolon Unit: This unit consists of 620 ha (1,532 ac) of private property near Jolon Road. This population is probably a remnant of a much larger population that historically extended beyond the immediate Fort Hunter Liggett area. The land within this unit provides those characteristics essential for the species discussed above.

Camatta Canyon Unit This unit consists of one area that encompasses the similar topographic features and vegetative communities that surround the only two known occurrences of this species. The Camatta Canyon Unit (1,772 ha (4,378 ac)) encompasses the plateau on both the north and south sides of Highway 58 near Camatta Canyon, extending south approximately 5 km (3 mi) to include two private inholding areas within the LPNF boundaries. The land within this unit provides those characteristics essential for the species discussed above. More specifically, the area surrounding the known distribution of Chlorogalum purpureum var. reductum and the plateau adjacent to the known distribution (i.e., finger-like extensions in northern portion of the unit) are essential because: (1) Chlorogalum purpureum var. reductum is found at only two sites in the La Panza Range in central San Luis Obispo County. The two sites likely make up one ''population'' of plants due to the close proximity of the sites and the characteristic ''patchiness'' of plants that has been observed with both varieties of C. purpureum. The limited geographic distribution of C. p. var. reductum increases the likelihood of its extinction. The risk of extinction elevates the need for protecting all existing plants, habitat, and soil conditions for the taxon's expansion. Additionally, ecological attributes upon which the species relies (e.g., pollinators, seed dispersal agents) should be protected. Activities that may adversely affect or destroy the plant and the habitat that is critical for its survival and expansion should be limited. These activities include, but are not limited to, off-road vehicle use, livestock grazing, herbivory, and ground disturbance by gophers. (2) Thorough surveys of the distribution of Chlorogalum purpureum var. reductum have not been conducted in the area. Surveys are needed across multiple years to determine the presence or absence of the species. Monitoring of C. p. var. purpureum at Fort Hunter Liggett has found known individual mature plants to be dormant for at least three years. During dormancy, both varieties of Chlorogalum are not detectable on the surface. Because discoveries of new C. p. var. purpureum sites are being found within the range of the taxon at Fort Hunter Liggett, one may expect ''new patches'' of C. p. var. reductum to occur in the Camatta Canyon Unit if surveys were conducted within the critical habitat boundary in those areas where the primary constituent elements occur. (3) An extension of the plateau/flattop area where Chlorogalum purpureum var. reductum is currently known to occur exists between the northern site and the southern site. This area harbors the soils and vegetation appropriate for C. p. var. reductum growth and expansion. We believe it is important to provide connectivity between the two sites. Additionally, the area encompasses what appear to be flat-top/ mesa-like extensions (which likely contain suitable habitat) that occur between the two known distributions (D. Chipping, California Polytechnic State University, in litt., 1997). A. Koch (CDFG, pers. comm., 2001) also notes that C. p. var. reductum occurs on private property which falls between the two known sites and within the critical habitat boundary line. (4) The vegetation community that Chlorogalum purpureum var. reductum depends on extends beyond the boundary of the known distribution. By encompassing plateau areas, the known distribution, and a portion of the adjacent vegetation community that the species depends on, ecological functions (e.g., cryptogamic crust formation, predator-prey relationships, pollinator activity)

within the habitat are maintained such that ‘‘edge effects’’ from encroaching activities not conducive to C. p. var. reductum persistence (e.g., off-road vehicle use, livestock grazing, etc.) do not inhibit the taxon’s expansion or survival. Additionally, adjacent grassland and oak woodland habitat that is adversely affected could result in greater rates of herbivory or regeneration/expansion of nonnative plants that can outcompete smaller, herbaceous species such as C. p. var. reductum. Lands proposed are under private, State, and Federal jurisdiction. State lands are managed by CalTrans, and Federal lands are managed by the the Forest Service (i.e., LPNF). The approximate areas of proposed critical habitat by land ownership are shown in Table 1.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chlorogalum purpureum critical habitat consists of two components (67 FR 65414-65445):

The primary constituent elements of critical habitat for Chlorogalum purpureum var. reductum consist of, but are not limited to: (i) Well-drained, red clay soils with a large component of gravel and pebbles on the upper soil surface; and,

(ii) Plant communities in functioning ecosystems that support associated plant and animal species (e.g., pollinators, predator-prey species, etc.), including grassland, blue oak woodland (Quercus douglasii) or oak savannahs, and open areas within shrubland communities. Within these vegetation communities C. p. var. reductum appears where there is little cover of other species which compete for resources available for growth and reproduction.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for Chlorogalum purpureum within the units being proposed as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of C. purpureum are maintained at those sites, and have the ability to reproduce and disperse into surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for C. purpureum. We have outlined below the most likely kinds of special management and protection that C. purpureum critical habitat may require. (1) The soils on which Chlorogalum purpureum is found should be maintained. Physical properties of the soil, such as its chemical composition, structure, and drainage capabilities, would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments; and by minimizing or avoiding activities that result in soil compaction (e.g., offroad wheeled and tracked vehicle use, trampling by people and livestock) and those that would alter the hydrology of areas immediately adjacent to or upslope of the species and its critical habitat. (2) The soil surface should be maintained to enhance cryptogamic crust formation by minimizing the intensity, frequency, duration, and acreage of soil surface disturbance. The soil surface should be protected at relict sites (i.e., sites with well-developed crusts) to provide reference areas and baseline comparisons for research. Because cryptogamic crusts are highly susceptible to hot fires (Belnap et al. 2001) and the presence of nonnative annual grasses in Chlorogalum purpureum habitat may promote fires. Annual, intense fires should be avoided. The effects of activities that can damage biotic soil crusts (e.g., excavations, offroad vehicle use, trampling) should be reduced by moving them to areas where crusts are less vulnerable, limiting the area affected, and conducting such activities in dryer

seasons. (3) The associated plant and animal communities should be maintained to ensure the habitat needs of pollinators and seed dispersal agents are maintained, and predator-prey relationships are functioning. The use of pesticides should be restricted so that viable populations of pollinators are present to facilitate reproduction of Chlorogalum purpureum. Fragmentation of habitat through road construction, development, and certain types of fencing should be limited. Additionally, predator-prey relationships should be managed and protected. For example, installation of fencing could exclude predator species (e.g., coyotes, bobcats, San Joaquin kit fox), thus causing an increase in prey species (e.g., ground squirrels, gophers, rabbits) abundance. A change such as this could result in increased herbivory, bulb predation, or burrowing that could affect C. purpureum growth and survival. (4) In all plant communities where Chlorogalum purpureum occurs, invasive, nonnative species such as Centuarea solstitialis (yellow starthistle), Avena spp. (wild oats), Bromus spp. (B. hordeaceus, B. diandrus, B. madritensis, B. rubens (brome)), Erodium spp. (storksbill or fillaree), and other species need to be actively managed and controlled to maintain the open habitat that Chlorogalum purpureum needs. Nonnative annual grasses may promote fires by providing recurring annual fuel sources. Thus, proactive management should be implemented to prevent annual fires, unless future research demonstrates that a series of annual fires can benefit Chlorogalum purpureum by reducing competition from nonnative species. (5) Certain critical habitat areas (i.e., suitable, unoccupied habitat between or adjacent to known patches of Chlorogalum purpureum) may need to be temporarily fenced or demarcated to identify exclusion areas for protection from accidental or intentional trampling by humans, livestock, or off-road vehicle use. Heavy disturbance to these critical areas may be detrimental to this species' persistence. Seasonal exclusions may work in certain areas to protect the critical habitat and C. purpureum plants during the critical season of growth and reproduction. (6) In areas where Chlorogalum purpureum and its habitat occur in conjunction with off-road vehicle traffic (e.g., military wheeled and tracked vehicles, OHVs), we recommend managing to minimize the severity of those effects. Management should include: limiting or avoiding new structures and permanent roads and trails; managing excavations, scrapings, or other ground surface disturbance; managing tracked and wheeled vehicle use during C. purpureum growing and dormant seasons; and managing foot traffic, bivouacking, and congregations of high numbers of people during C. purpureum growing and dormant seasons. These types of activities should be managed to limit loss of adults, bulbs, and seeds, loss of habitat, increased soil compaction, and increased nonnative species encroachment. (7) Monitoring programs should be developed or enhanced so that areas occupied by purple amole are studied, allowing for a full range of life-history data and a thorough analysis of the compatibility and impacts of those activities that may adversely affect the species. Representative areas should be chosen throughout the distribution of the species, including large, highdensity populations that have a higher potential for persistence. Monitoring studies should be designed to aid in the determination of population stability as well as provide basic life-history information and data on the ecological needs of the species (e.g., identification and status of pollinator species, disturbance factors, etc.).

Life History

Food/Nutrient Resources

Lifespan

Adult: 5 to 7 years (USFWS, 2008)

Breeding Season

Adult: April to May (NatureServe, 2015)

Reproduction Narrative

Adult: In one study, Chlorogalum purpureum flowered at three years following germination, and all plants had flowered at four years following germination. C. purpureum typically flower between April and May (NatureServe, 2015). Most plants died between the fifth and seventh year following germination. For seed-producing plants at Fort Hunter Liggett, the number of seeds produced per plant was highly variable, with a recorded range of 1 to 386 seeds per plant and a recorded mean of 28 seeds per plant (Niceswanger 2002). (USFWS, 2008; NatureServe, 2015))

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest/Woodland, Grassland/herbaceous, Shrubland/chaparral, Woodland - Hardwood, Woodland - Mixed (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 213 to 407 m (700 to 1,336 feet)

Spatial Arrangements of the Population

Adult: Discontinuous patches (USFWS, 2008)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. (USFWS, 2008)

Habitat Narrative

Adult: The taxon is known from the lower elevations on the eastern side of the range, at approximately 213 to 407 meters (m) (700 to 1,336 feet (ft)) elevation. On Fort Hunter Liggett, there are hundreds of discontinuous patches of purple amole in grassland, oak savanna, and oak woodland communities where they occur in association with gravelly, clay soils. The purple amole (e.g., Guretzky et al. 2005; Woodbury 2006) and the Camatta Canyon amole (E.L. Painter in litt. 1998) have been reported to grow in association with cryptogamic crusts. The purple amole occurs in patches that range from a few plants to more than 10,000 individuals per ha (4,047 individuals per ac) at the densest locations. (USFWS, 2008)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable to increasing (USFWS, 2008)

Resiliency:

In summary, for Santa Lucia purple amole, the resiliency analysis shows that three of the four populations have moderate resiliency and one is low. For Camatta Canyon amole, the resiliency analysis shows that one occurrence has moderate resiliency and two occurrences have low resiliency; there is insufficient information to calculate a resiliency score for occurrence 4 because the area of the occurrence is not known. The populations/occurrences with moderate resiliency have a moderate ability to sustain themselves in the face of environmental variation and therefore a moderate risk of extirpation in the near future. The populations/occurrences with an overall low resiliency have a low ability to sustain themselves in the face of environmental variation and therefore a high risk of extirpation in the near future. (USFWS, 2020)

Representation:

Representation describes the ability of a species to adapt to changing environmental conditions over time. It is characterized by the breadth of genetic and environmental diversity within and among populations. Measures may include the number of varied niches occupied, genetic diversity, heterozygosity, or alleles per locus. Given morphological and ecological differences between Santa Lucia purple amole and Camatta Canyon amole, representation across both varieties contributes to the species ability to adapt to changing environmental conditions over time. Both varieties have relatively small geographic ranges with mostly similar landscape features throughout. The Santa Lucia purple amole currently occupied area consists of approximately 500 hectares (1,230 acres). The known occupied area of Camatta Canyon amole in 2020 consists of greater than 36 hectares (89 acres). The niches and habitats each variety occupies have little heterogeneity. Therefore, each variety is a narrow, endemic taxon and the types of habitats or niches that it occupies are nearly uniform. Although information is lacking regarding genetics of either Santa Lucia purple amole or Camatta Canyon amole, we consider each to comprise one genetic unit due to geography. While we are not aware of any extirpated locations or occurrences, or of any contraction in the geographic range, the productivity data for Santa Lucia purple amole suggest three of the four populations may be declining. The combined data from several studies suggest that the number of Camatta Canyon amole, where monitored, has declined. Thus, declining numbers of individuals may affect genetic diversity, and the spatial extent and associated ecological representation of both Santa Lucia purple amole and Camatta Canyon amole are inherently low. (USFWS, 2020)

Redundancy:

Redundancy describes the ability of a species to withstand catastrophic events. Redundancy is characterized by having multiple, resilient populations distributed within the species' ecological settings and across the species' geographic range. It can be measured by population number, spatial extent, and degree of connectivity. Given sufficient redundancy, single or multiple catastrophic events are unlikely to cause the extinction of a species. Purple amole is composed of two varieties, both narrow, endemic taxa with relatively small geographic ranges. Santa Lucia purple amole only has four populations located within approximately 280 kilometers2 (108 square miles). Camatta Canyon amole only has four occurrences located within approximately 3

kilometers2 (1 square mile). Because all four populations of Santa Lucia purple amole and all four occurrences of Camatta Canyon amole are situated close together, they could possibly be simultaneously affected by a catastrophic event. Given that the two varieties are approximately 61 km (38 miles) apart, a prolonged, catastrophic drought could affect both varieties simultaneously. However, the two varieties are far enough apart such that a large, intense wildfire is unlikely to deleteriously affect both varieties at once. Therefore, purple amole has inherently low redundancy due to being composed of two narrow endemic varieties, but having two spatially separated varieties does provide some protection for the species as a whole from extinction due to less expansive catastrophic events. (USFWS, 2020)

Number of Populations:

4 (USFWS, 2020)

Population Narrative:

Purple amole is endemic to Monterey and San Luis Obispo Counties in central California. Santa Lucia purple amole is known from 17 occurrences in four populations in the Santa Lucia Range in southwestern Monterey County (Fort Hunter Liggett) and north central San Luis Obispo County (Camp Roberts) (CNDDB 2020, website). Camatta Canyon amole is known from four occurrences in the La Panza Range and adjacent hills in central San Luis Obispo County (Kofron et al. 2013a, entire). The Santa Lucia purple amole currently occupied area consists of less than 500 hectares (1,230 acres). The Camatta Canyon amole currently occupied area consists of greater than 36 hectares (90 acres). The species needs appropriate soil types, including welldrained with gravel components in the top and subsoil strata; suitable habitats, including openings within blue oak woodland and California buckwheat and/or chamise shrubland, blue oak savanna and valley and California prairie; sparsely vegetated areas with some open, bare ground; adequate annual precipitation; suitable temperatures; insect pollinators; and biological soil crusts. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The property comprising Fort Hunter Liggett has a long history of settlement and use by "Europeans," dating back to 1771, which has affected the current distribution of the purple amole. On Fort Hunter Liggett, the purple amole is nearly absent from areas that were previously cultivated by disking. The taxon is most abundant in areas that were not previously disked, including areas where intensive military training has been common since 1941 (U.S. Army 2004a, 2004b). (USFWS, 2008)

Stressor: Military activities (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The California Army National Guard ceased conducting military activities in the purple amole area in 2000, with exception of road use for four weeks in 2001 and 2003 and occasional use of the tank trail where the taxon does not occur. (USFWS, 2008)

Stressor: Gophers (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) reported that "gophers (or possibly other rodents) tunneled through the sites and ate the leaves and flowering stems." Woodbury's (2005a, 2005b, 2006) data suggested that gophers may forage on the leaves of purple amole, with little or no interest in the bulbs. Woodbury (2006) stated that gophers displace the soil and the bulbs. From 2003 to 2006, the amounts of quadrats with gopher activity within 1 m were 41 percent, 32 percent, 26 percent, and 23 percent, respectively. (USFWS, 2008)

Stressor: Fungus (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) observed a fungus affecting the purple amole at two transects during 2000, causing the plants to whither and rot. This is the only report of any disease affecting the purple amole. (USFWS, 2008)

Stressor: Feral pigs (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Holland (2007) observed pervasive soil disturbance by feral pigs in the purple amole habitat. Although Holland (2007) reported the effects to the purple amole to be unknown, Olson (pers. com. 2007) informed us that feral pigs eat the bulbs. (USFWS, 2008)

Stressor: Non-native annual grasses and invasive species (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses and other invasive plant species continue to be a threat to the purple amole at Fort Hunter Liggett and Camp Roberts and to the Camatta Canyon amole on the Los Padres National Forest. The invasive plant species may have the ability to displace the Chlorogalum purpureum by outcompeting and monopolizing limited resources (growing space, sunlight, soil nutrients, water; Stephenson and Calcarone 1999), with the potential effects of preventing growth and recruitment (U.S. Army 2004b). The invasive plant species may also have the ability to alter characteristics of the fire regime, such as frequency, intensity, and seasonality of fires (Brooks et al. 2004). We have no information on the site-specific presence of non-native plants in purple amole occurrences on Fort Hunter Liggett and Camp Roberts, or the effects that non-native competitors have on the frequency and seasonality of fire. (USFWS, 2008)

Stressor: Fire (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The frequency of fires in California is increasing (Syphard et al. 2007), and fires at certain times of the year have the ability to prevent annual reproductive success of the purple

amole (Niceswanger 2002) and also of the Camatta Canyon amole. The Chlorogalum purpureum are susceptible to damage by fire when the living structures, including the seeds, are above ground or near the soil surface. However, fires at certain times of the year may potentially benefit the Chlorogalum purpureum by removing other competitive plants, both native and invasive species. The Chlorogalum purpureum may also respond favorably to fire in other ways. (USFWS, 2008)

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Niceswanger (2002) believed that the population of purple amole on Fort Hunter Liggett is highly vulnerable to stochastic events, especially catastrophes affecting mature plants such as fire. She therefore recommended protection and management of the habitat by administrative regulations, including prohibitions against physical disturbances during the reproductive stage. (USFWS, 2008)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8

Delisting Criteria:
1. At least four resilient populations display evidence of recruitment of new individuals and stable or increasing population trends averaged over 10 consecutive years (USFWS, 2022);

2. Each of the four resilient populations is being managed in a way, currently and into the future, that will support continued existence of Santa Lucia purple amole and its habitat, including management of non-native, invasive species, and anthropogenic disturbance and feral wildlife (USFWS, 2022)

3. Management is effective as shown by monitoring over 10 consecutive years (USFWS, 2022)

4. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the taxon's genetic diversity (USFWS, 2022)

Recovery Actions:
- Recovery actions are not available.
- We recommend that the U.S. Army search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Fort Hunter Liggett. (USFWS, 2008)
- We recommend that the U.S. Army complete its endangered species management plan for the purple amole on Fort Hunter Liggett as soon as possible. (USFWS, 2008)
- In light of the known error by first-year surveyors in 2002 (Clark in litt. 2007a), we recommend that the U.S. Army re-analyze its data regarding fire and the purple amole on

Fort Hunter Liggett. Further, we recommend that the U.S. Army conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)

- We recommend that the U.S. Army actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the U.S. Army evaluate and consider conducting activities that may potentially benefit the purple amole on Fort Hunter Liggett, including controlled burns to remove invasive plants, the removal of feral pigs, and the use of the ball-and-chain method to remove competing plants in potential habitat. (USFWS, 2008)
- We recommend that the U.S. Army conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)
- We recommend that the California Army National Guard search for the purple amole in potentially-suitable habitat on nearby private properties and at additional localities on Camp Roberts. (USFWS, 2008)
- We recommend that the California Army National Guard complete the process of updating its draft Integrated Natural Resources Management Plan for Camp Roberts and consulting with the Service regarding it and the ongoing activities that may affect the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard statistically analyze its data regarding the effects of fire on the purple amole at Camp Roberts. Further, we recommend that the California Army National Guard conduct research regarding the effects of fire (frequency, seasonality) and invasive plants to the purple amole. (USFWS, 2008)
- We recommend that the California Army National Guard actively manage the known occupied localities for the benefit of the purple amole. In particular, we recommend that the California Army National Guard evaluate and consider conducting activities that may potentially benefit the purple amole on Camp Roberts, including controlled burns to remove invasive plants, controlled grazing by goats or sheep to remove invasive plants, and the removal of feral pigs. (USFWS, 2008)
- We recommend that the California Army National Guard conduct research to determine the effects of gophers and feral pigs on the purple amole, and the relationship between the purple amole and cryptogamic crusts. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- Recovery actions for Santa Lucia purple amole 1. Manage habitat that supports the taxon to reduce or eliminate threats (Priority 1) 2. Conduct annual census monitoring (Priority 2) 3. Collect seed and deposit accessions into the permanent conservation seedbank (Priority 3) 4. Conduct experimental research projects (Priority 3) (USFWS, 2022)

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SPECIES ACCOUNT: *Chorizanthe howellii* (Howell's spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8)

Physical Description

An herbaceous annual; the plants are 0.3—1 decimeter (1.2—3.9 inches) tall and 1—5 decimeters (3.9—20 inches) across. The basal leaves are 1—3 centimeters (0.39—1.2 inches) long and 5—15 millimeters (0.2—0.6 inch) wide. What appears to be a spiny flower is in fact mostly the involucre that surrounds the flower, tipped with 6 brown, straight spines (awns). The distinguishing morphological feature of C. howellii is its straight (not hooked) awns. The only other coastal spineflowers with this trait are C. valida (distinguished by an erect growth habit and whitish to straw-colored awns), and some northern populations of C. cuspidata (formerly distinguished as C. villosa), which has a very prominent central tooth (not minute as in C. howellii) on each perianth lobe (petal or sepal). The involucre, including its spines, is 3—4 millimeters (0.1—0.2 inch) long. Flowers are 3.5—4.5 millimeters (0.1-0.2 inch) long. Figure 1 (page 79) shows the appearance of C. howellii. (USFWS, 1998)

Taxonomy

Chorizanthe is a genus of herbs in the buckwheat family (Polygonaceae) with many species in California. Chorizanthe howellii (Howell's spineflower) was described in 1934 by George Goodman. Its name commemorates John Thomas Howell, who had collected specimens in 1929. Chromosome counts of this species (n 40) indicate that it this species originated as a stabilized polyploid hybrid (Reveal and Hardham 1989), most likely between C. cuspidata var. villosa (n = 20) and C. valida. This is a typical means by which new plant species arise. (USFWS, 1998)

Historical Range

Endemic to 7 miles of coastal dunes extending from the City of Fort Bragg north to the Ten Mile River, Mendocino County, California. (USFWS, 2019a)

Current Range

Endemic to 7 miles of coastal dunes extending from the City of Fort Bragg north to the Ten Mile River, Mendocino County, California. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2011)

Breeding Season

Adult: May to July (USFWS, 2011)

Reproduction Narrative

Adult: As an annual species, C. howellii completes its entire life cycle within a year, and therefore responds almost immediately to changes in its environment. C. howellii blooms between May and July. (USFWS, 2011)

Habitat Type

Adult: Terrestrial (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dunes (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Sea-level to 37 m, sparsely-vegetated areas, sandy substrate (USFWS, 2011; NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Dependency on Other Individuals or Species for Habitat

Adult: In coastal dunes, it is associated with sand verbena, Abronia latifolia, and Menzies' wallflower, Erysimum menziesii. In coastal prairie habitat, it is associated with two alien grasses, sweet vernalgrass, Anthoxanthum odoratum, and velvetgrass, Holcus lanatus, and two species of special concern, Mendocino coast paintbrush, Castilleja mendocinensis, and Northcoast phacelia, Phacelia insularis var. continentis (FWS, 1997). (NatureServe, 2015)

Habitat Narrative

Adult: Chorizanthe howellii prefers coastal dunes and adjacent sandy soils of coastal prairies from sea level to 37 m. The preference of this species for vegetation gaps or sparsely-vegetated areas onsandy substrate allows seedlings to establish in areasthat are relatively free from other competing native species. In coastal dunes, it is associated with sand verbena, Abronia latifolia, and Menzies' wallflower, Erysimum menziesii. In coastal prairie habitat, it is associated with two alien grasses, sweet vernalgrass, Anthoxanthum odoratum, and velvetgrass, Holcus lanatus, and two species of special concern, Mendocino coast paintbrush, Castilleja mendocinensis, and Northcoast phacelia, Phacelia insularis var. continentis (FWS, 1997). (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: High (USFWS, 2011)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Seed dispersal by C. howellii is facilitated by the floral spines, which attach to passing animals. (USFWS, 2011)

Population Information and Trends

Population Trends:
Not available

Number of Populations:
8 occurrences (USFWS, 1998)

Population Size:
~2,000,000 plants (USFWS, 2019b)

Additional Population-level Information:
In 2019, AFWO conducted a population estimate for Chorizanthe howellii. We collected density data in random 1-meter 2 plots within occupied habitat (as mapped in 2018). Density data were collected in 23 7 plots, among four different strata. Strata were identified for sampling based on land management in each strata. The four strata were sampled proportionate to their area. Results from the 2019 sampling yielded an estimated abundance of 2,025,768 plants, with a 95% confidence interval of 1,581,020- 2,525,575 plants. (USFWS, 2019b)

Population Narrative:
The mapping was updated for the current distribution of Chorizanthe howellii on MacKerricher State Park in April 2018. This updated mapping showed that the distribution had increased by 1.5 acres since the last status review. Occupied habitat as mapped in 2011 was approximately 14 acres. In 2018, occupied habitat had increased to approximately 15.5 acres. Some habitat was lost during the MacKerricher State Park Dune Rehabilitation Project (AFWO-13BO104- 13F0 189; Dune Rehabilitation Project) in 2013, due to removal of stabilized dunes when the Haul Road was removed. That loss, however, was mitigated by habitat restoration, through iceplant (Carpobrotus sp.) removal and dispersal of seeds. Monitoring data from MacKerricher State Park, collected as part o fthe mitigation and monitoring plan for the Dune Rehabilitation Project, showed an increase in cover of Chorizanthe howellii in the mitigation plots from 2013 to 2016. (USFWS, 2019b)

Threats and Stressors

Stressor: Pedestrian, equestrian, and off-road vehicle use (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Equestrian and pedestrian trails within MSP continue to affect a significant portion of the occupied habitat, mostly in the area south of the IF-TD Natural Preserve. Residential development around the park combined with completion of a pedestrian bridge between Fort Bragg and MSP likely will increase recreational pressure on the park. However, completion of a proposed coastal trail within Fort Bragg may counter some of that potential increase (R. Pasquinelli, pers. comm. 2006, 2011a). Both equestrian and recreational trails facilitate public access to the dunes, and increase the risk of trampling in the more remote populations of C. howellii. Moderate to heavy pedestrian and horse traffic preclude establishment of C. howellii within the well-used center of pathways. (USFWS, 2011)

Stressor: Invasive plant species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: C. howellii was listed, in part, due to the past introduction and invasion of its habitat by a variety of invasive, non-native plant species. These species threaten virtually the entire distribution of C. howellii, through direct competition for space, stabilization of the dunes, and in some cases, enrichment of the soils, which then stimulates invasion by other aggressive species. Within C. howellii habitat, European beachgrass, iceplant, burclover, ripgut brome and other annual grasses are principle threats (R. Pasquinelli, pers. comm. 2006). The majority of these species have not been, nor are they currently, mapped within MSP on a routine basis, so there is little documentation of encroachment rates; however, evidence suggests these taxa will continue to invade C. howellii habitat, necessitating routine and permanent management action. MSP has implemented several projects aimed at controlling European beachgrass and iceplant. Efforts to remove European beachgrass began in 1997 (CDPR 1997), and was supported by private donations, and funding under ESA section 6 grants to the states (CDPR 2002). As of 2011, European beachgrass has been treated on over 150 acres in the north portion of MSP (B. Maslach, pers. comm. 2011a). Once removed, treated habitat requires periodic retreatment to eliminate sprouting and new recruits. In summary, MSP has made substantial efforts to implement research and management aimed at controlling invasive species and restoring C. howellii habitat, and learning more about the ecology and habitat requirements of C. howellii. These efforts, particularly the monitoring, should be continued and expanded. While the threat posed by invasive species has been addressed to some extent, at least temporarily, no mechanism has been implemented which ensures continued funding and implementation of an invasive species control program, or the monitoring necessary to effectively implement such a program.

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: A new recognized threat to C. howellii is climate change and associated ocean-rise. The most recent literature on climate change includes predictions of hydrological changes, higher temperatures, and expansion of drought areas, resulting in a northward and/or upward elevation shift in range for many species (IPCC 2007). It is unknown if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. There is also little or no data indicating the sensitivity of C. howellii to changes in environmental factors such as air temperature and soil moisture. Ocean rise, coupled with the fact that in portions of MSP the waveslope is eroding inland, indicate that overwash occurrences may be more frequent and extend further inland (Wollenberg and Maslach 2004). The result will be increased potential for erosion and blowouts, resulting in loss or degradation of an unknown amount of C. howellii habitat. (USFWS, 2011)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) and the California Coastal Act are perhaps the two most important laws protecting the species. Many activities on both public and private property, such as building construction, sand mining, or road construction are subject to review under CEQA. In addition, because virtually all of the distribution of C. howellii falls within the Coastal Zone, most projects in C. howellii habitat are subject to the California Coastal Act, which is administered locally by the Mendocino Local Coastal Program (LCP). Both acts require an assessment of impacts on sensitive resources. While CEQA may allow significant impacts, subject to mitigation, the Coastal Act generally prohibits significant impacts to sensitive resources. However, a number of activities on private property that could affect C. howellii are not subject to a permit at the local, state, or federal level, or are difficult to enforce, such as small-scale vegetation removal or creation of trails through sensitive habitat. C. howellii was listed as Threatened by the State of California in January 1987. As such, it also receives limited protections under the California Native Plant Protection Act and California Endangered Species Act (Service 1992; CDFG 2011b). The primary protections under federal law are afforded by the Endangered Species Act of 1973 (Act), as amended. Overall, the most significant current threats to C. howellii are either unregulated, or of a kind not affected by land use regulations (e.g., invasive species encroachment, pedestrian impacts, climate change). Thus regulatory restrictions, even when applicable, are currently inadequate to conserve this species. (USFWS, 2011)

Recovery

Reclassification Criteria:
1. Habitat occupied by the species that is needed to allow delisting has been secured, with longterm commitments and, if possible, endowments to fund conservation of the native vegetation. (USFWS, 2019a)

2. Management measures are being implemented to address the threats of invasive species, pedestrians, and off-road vehicles at some sites. (USFWS, 2019a)

3. Monitoring reveals that management actions are successful in reducing threats of invasive nonnative species. (USFWS, 2019a)

4. Additional restored habitat has been secured, with evidence of either natural or artificial longterm establishment of additional populations, and long-term commitments (and endowments where possible) to fund conservation of the native vegetation. (USFWS, 2019a)

Recovery Priority Number: 8

Delisting Criteria:
1. General Delisting Criterion: Full recovery of these taxa will be achieved when the dune systems they inhabit are secure, with experience to demonstrate that exotic plants and other threats (recreational use, off-road vehicles, etc.) are controlled and managers have demonstrated their ability to keep the threats under control. The taxa need to be secure in their presently-occupied ranges, and opportunities should be taken to introduce these plants to restored habitat in or near historic ranges. To be counted toward recovery, (re)introduced populations should be naturally reproducing in vegetation that also appears to be persisting without excessive maintenance or “gardening.” The area occupied by the plants should increase

commensurate with improving habitat conditions. The determination that delisting is possible must be based on at least 15 years of monitoring for the endangered taxa, to include wet and drought years. For some of the species, aspects of demography and population biology must be understood to be assured that populations are likely to persist. The species can be considered for delisting when sites are secure from habitat modification (development), occupied habitat is stable or improving and free of weed invasion. (USFWS, 2019a)

2. Specific Delisting Criterion: Chorizanthe howellii may be considered for delisting when restoration of habitat at McKerricher State Park has resulted in a minimum of 42 acres of habitat occupied by C. howellii. Monitoring and mapping should demonstrate that the area occupied by C. howellii has met that minimum threshold consistently for at least 15 years and that populations are not being lost to non-native, invasive species or recreational activity. (USFWS, 2019a)

Recovery Actions:

- 1. Protect habitat of the listed species and their occurrences on private lands. The listed species addressed in this plan should be secured where they occur on private lands through conservation easements, conservation agreements, or purchase where there are willing sellers. This is necessary to prevent further declines in distribution and abundance of the listed species from loss and degradation of habitat. The development of cooperative weed control programs will greatly facilitate recovery ofthese species, so it is a high priority to develop landowner incentives and providing funds for control of invasive exotic vegetation is a high priority. This task regularly refers to “occurrences” as defined by the NDDB. Readers are reminded that “occurrences” are convenient units for storing data, and do not necessarily coincide with biological populations nor with geographic units of vegetation or geological features such asthe dune fields upon which these plants depend. (USFWS, 1998)
- 2. Minimize threats to the plants and butterfly. Invasive non-native plant species are immediate biological threatsto all ofthe listed plant species. Invasive plants are also a problem for Myrtle’s silverspot (i.e., competition with native larval and adult food plants). Infestations ofinvasive plant species need to be controlled. (USFWS, 1998)
- 3. Develop management strategies through a research program to document the listed species’ life histories and their responses to vegetation management. Habitat management for the species in this recovery plan is needed to control the threats to their existence. Data must be obtained to determine how to conduct the management. (USFWS, 1998)
- 4. Manage occurrences and habitats: Management of the listed plant species and their habitat will depend upon information gained from monitoring, threat analysis and the evaluation of protection alternatives. It will be important to involve the expertise of local landowners, land managers, and species experts to develop conservation programs. There may be different management programs for each species. The management program selected will require periodic review to ensure that it is effective in protecting the species. (USFWS, 1998)
- 5. Monitor occurrences and threats to determine effectiveness ofmanagement and to establish delisting criteria. (USFWS, 1998)
- 6. Coordinate recovery actions to protect other listed species and species of special concern. Other rare and endangered wildlife species occur within the ranges of the seven listed plant species. Management actions, such as the removal of invasive non-native plant species through herbicide application, may affect these species. Management actions should avoid

adverse impacts to these species and their habitats, and actively include them in recovery actions to facilitate their reoccupation of historic ranges and prevent range collapse or declines in their abundance. (USFWS, 1998)

- 7. Develop ecosystem restoration and multi-species reintroduction projects at degraded dune systems. Numerous dune systems within the historic range of listed species and species of concern have either reduced value or none for them because of past or ongoing degradation of habitat quality. Benefits for multiple species can be efficiently regained by establishing habitat and population restoration programs for these undermanaged or degraded dune systems. By returning independent dune systems within historic range of rare species to current ecological function, the risk of species extinction can be substantially decreased.
- 8. Develop and implement an outreach program. Increasing public awareness of the seven endangered plant species and the Myrtle's silverspot butterfly will facilitate efforts to preserve these species, associated rare species, and the coastal dune ecosystem. Prepare and distribute regionally specific informational brochures and audio-visual and sign programs on preservation and recovery. Through the cooperative interagency working groups, prepare brochures and audio-visual materials that describe the plight of the listed species and the regional efforts being undertaken for their recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities, such as park interpretive programs and school programs. Prepare interpretive educational signs for PRNS and other locations. (USFWS, 1998)
- 1. Using GPS, remap the distribution of C. howellii-occupied polygons within MSP in 2008, and again in 2012. Using that map, derive a statistically valid estimate of population during both years. In particular, the inventory should emphasize habitat restored over the past decade. (USFWS, 2011)
- 2. Continue the monitoring begun as part of the section 6 iceplant/spineflower study implemented in 2003, to better characterize the relationship between iceplant removal and recolonization by C. howellii. Plots should be monitored at no less than two year intervals, beginning spring 2008. (USFWS, 2011)
- 3. Fully implement the disturbance-related C. howellii population monitoring initiated in 2003, and monitor those plots at not less than 2 year intervals. (USFWS, 2011)
- 4. Incorporate language in the forthcoming management plan developed for the Inglenook Fen-Ten Mile Dunes Natural Preserve, which specifically commits to future conservation of C. howellii within that area. (USFWS, 2011)
- Partnerships: Successful partnership with CDPR, the agency that owns the majority of the land where C. howellii and its habitat occur, is crucial to successful implementation of the recovery plan and conserving the species. Therefore, continued collaboration between the Service and CDPR is important. (USFWS, 2011)
- Monitoring Program to Measure the Impacts of Ocean-rise and Targeted Restoration: The California Shoreline Mapping Project, implemented in 2010, will provide high resolution LIDAR photography enabling development of an accurate digital elevation model (California Ocean Protection Council 2011). Those data should become available in 2012. At that time an analysis of C. howellii occupied habitat should be conducted to help evaluate future trends in population and habitat based on habitat elevation. Because C. howellii may be vulnerable to significant impacts from ocean-rise, future habitat restoration efforts should begin to focus on areas that are at elevations sufficient to avoid the majority of impacts. (USFWS, 2011)

- Invasive Species Removal: Efforts should continue with respect to removal of iceplant and European beachgrass, and exploring ways to implement a permanent invasive species monitoring and response program. Such a program could potentially be included within the Weed Inventory Monitoring System (WIMS) program initiated by CDPR. (USFWS, 2011)
- Acquisition and/or Protection of Habitat: The CDPR and the Service should continue to pursue opportunities for acquisition or protection of important habitat adjacent to the park, which either supports C. howellii, or contributes to the integrity of the Ten Mile Dunes ecosystem. In decreasing order of priority, these important lands include: inland dune habitat immediately south of Ten Mile River; inland dune and prairie habitat northeast of Cleone Grange; dune habitat surrounding Virgin Creek and dunes habitat located east of highway 101 south of Virgin Creek; dune habitat near the inland extent of the dune sheet north of Ward Avenue; dune habitat near the inland extent of the dune sheet north of Cleone Lake. (USFWS, 2011)
- Permanent Funding: The CDPR and/or the Service should determine the amount of needed funds, and then pursue opportunities to secure permanent funding in the form of an endowment or trust fund, which ensures that periodic monitoring and habitat restoration are conducted in perpetuity. Such funding would not then be subject to future CDPR staffing and budgetary limitations. (USFWS, 2011)

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SPECIES ACCOUNT: *Chorizanthe orcuttiana* (Orcutt's spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/07/1996; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with prostrate, yellowish stems, 1-15 cm long. Yellow, densely hairy flowers (2.5-4 mm) bloom March-April and produce a single seed. (NatureServe, 2015)

Taxonomy

Not available

Historical Range

See current range/distribution.

Current Range

Known only from San Diego County, California. All of the known occurrences of this species are within 5 km of the Pacific Ocean at elevations below 100 m above mean sea level (Bauder 2000). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2007)

Breeding Season

Adult: March to April (NatureServe, 2015)

Reproduction Narrative

Adult: Chorizanthe orcuttiana (Orcutt's spineflower) is a small (1-15 cm), annual plant species known only from San Diego County, California. C. orcuttiana flowers bloom from March to April (NatureServe, 2015). (USFWS, 2007; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Maritime shrubland/chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Small patches (USFWS, 2007)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2007)

Habitat Narrative

Adult: Chorizanthe orcuttiana prefers open areas with sandy soils within low, fairly open southern maritime chaparral communities. (NatureServe, 2015). Soil samples examined were dominated by the sand fraction with moderate acidity, low organic content and nitrate nitrogen (Bauder 2000). The four extant occurrences are small patches often with constricted connectivity to adjacent patches. The habitat of C. orcuttiana is described as loose sandy soils in openings in coastal or maritime chaparral by Bauder (2000, p. 31). (USFWS, 2007; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

9 Extant, 1 possibly extant (USFWS, 2021)

Population Size:

470 to 3,000 (USFWS, 2007)

Population Narrative:

Currently we consider there to be four extant occurrences of Chorizanthe orcuttiana, one at Oak Crest Park in Encinitas and three on Point Loma. For the four occurrences considered to be currently extant, the highest recorded number of plants for any single occurrence was 2,520 plants in 1998 at Point Loma (EO 12) (Bauder 1998). Recent plant counts for all of the extant occurrences combined range from a high of about 3,000 to a low of about 470 plants. (USFWS, 2007) In summary, annual monitoring of Chorizanthe orcuttiana occurrences since 2014 has provided new information about plant abundance. We have updated our 2014 occurrence status determinations and added the additional occurrences (Appendix A). Based on those updates, there are 21 occurrences of C. orcuttiana with 9 extant, 9 extirpated, 1 possibly extirpated, and 2 research sites. While the extant distribution within the range has increased since the last review, the historical range of C. orcuttiana remains highly limited and has not changed since the previous review. Occurrences of C. orcuttiana, including the newly discovered sites, remain small and isolated throughout the range, and likely susceptible to local stochastic events. Additionally, all occurrences continue to face multiple threats including habitat degradation (trampling, recreational use, erosion), habitat loss (development, road/trail maintenance, fire), invasive species pressure, small population size, and climate change. The information received since the previous review does not appreciably alter our understanding of the species' distribution, ecology, or threats (Appendix A). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Maritime chaparral as the habitat type with which Chorizanthe orcuttiana is associated and it is estimated that there were 1,500 to 3,700 acres of southern maritime chaparral habitat remaining in San Diego County and 150 acres in Orange County. The Service stated that this represented an estimated loss of between 82 and 93 percent of southern maritime chaparral in San Diego County. (USFWS, 2007)

Stressor: Random events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: In the final listing rule (USFWS 1996 p. 52381) Chorizanthe orcuttiana was considered threatened by naturally occurring random events exacerbated by drought or fire because of the species' restricted distribution and the small size of the known population. (USFWS, 2007)

Stressor: Invasive plant species (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Invasive exotic grass and weed species as well as interruption of the natural fire cycle were also considered threats to this species. Muhlenbergia rigens (deergrass), a native grass species, was removed from some of the habitat at Oak Crest Park because of its potential to crowd out and shade the Chorizanthe orcuttiana (Bauder 2000 p. 21). The lack of a natural fire regime or managed alternative for the associated southern maritime chaparral may pose a threat to Chorizanthe orcuttiana by allowing the shrub canopy to cover over the sandy openings favored by the Orcutt's spineflower. (USFWS, 2007)

Stressor: Fire (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The natural fire cycles in the area have likely been altered. A single natural random event, such as a fire, could jeopardize the continued existence of the species at one or more of the occurrences by killing standing plants, reducing input to the seed bank, or by being intense enough to kill some of the seeds in the seed bank. Such an event could also reduce vegetation cover and result in erosion and loss of habitat. (USFWS, 2007)

Stressor: Invasive non-native plant species (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Invasive non-native plants are the greatest known threat to the occurrences of Orcutt's spineflower on Point Loma. The invasive non-native Carpobrotus edulis (Hottentot fig;

iceplant) covers many of the open sandy areas on Point Loma (Bauder 2000). Iceplant produces thick layers of prostrate, succulent stems and leaves over the soil surface, deposits organic material, and grows back readily after removal (Bauder 2000). Rhynchelytrum repens (Natal grass) is another nonnative plant that threatens Orcutt's spineflower (Rusev and Zink 2005). A potentially invasive Acacia spp. has also been identified at Point Loma (Bauder 2000). These species can prevent expression of the above ground population of Orcutt's spineflower. If this is a long-term condition, presumably the seed bank would eventually be depleted thereby diminishing the range of the species. (USFWS, 2007)

Stressor: Small populations (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Chorizanthe orcuttiana (Orcutt's spineflower) has never been known to be abundant or widespread. Local populations are still relatively to extremely small. (USFWS, 2007)

Stressor: Recreation (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The occurrence at Oak Crest Park was fenced in 2000 with money from a section 6 grant through the State to the City of Encinitas. The open rail fence affords the occurrence protection from casual walkers and other recreational activities, noted as threats in the listing rule. (USFWS, 2007)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Continue to work with the City of Encinitas and the U.S. Navy to protect and enhance habitat for Chorizanthe orcuttiana. (USFWS, 2007)
- Eliminate negative impacts from non-native and native vegetation on the known occurrence of the species in Oak Crest Park, Encinitas. (USFWS, 2007)
- Determine the presence and location of similar sites in Oak Crest Park, Encinitas and create clearings among the vegetation on suitable soils. (USFWS, 2007)
- Field-check the historical occurrence sites and suitable habitat identified by Bauder (2000) to verify the presence of suitable habitat and the presence or absence of the species. (USFWS, 2007)
- Determine the reproductive cycle of the species to include pollen and seed dispersal agents, fecundity of the species in relation to rainfall patterns, and any identifiable bottlenecks to the species survival other than those already known. (USFWS, 2007)

- Determine the most effective manner to consistently limit the impact of invasive non- native plants on this species. These may have to be site and/or species specific. (USFWS, 2007)
- Determine and implement an appropriate seed banking strategy for the species. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated or completed over the next 5 years. Successful implementation of these actions will reduce threats to Chorizanthe orcuttiana and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Conduct additional discovery surveys of potential Chorizanthe orcuttiana habitat. 2. Enhance habitat where Chorizanthe orcuttiana occur, through nonnative plant control, erosion control, removal of excessive plant litter, selective trimming or removal of encroaching vegetation, and other appropriate measures. 3. Augment small occurrences (<1,000 individuals; CBI and AECOM 2021a, table 3.6-1) where necessary into areas of suitable habitat with a genetically appropriate seed source to increase population size and support gene flow. Follow best management practices for seed reintroduction as outlined in the Rare Plant Management Plan and the Seed Collection, Banking, and Bulking Plan (CBI and AECOM 2021a, pp. 253–294; CBI and AECOM 2021b, pp. 132–145) and IUCN Guidelines for Reintroductions and Translocations (IUCN/SSC 2013, entire). 4. Identify areas for habitat enhancement and conduct reintroduction of Chorizanthe orcuttiana to establish additional populations. 5. Prioritize additional research needs outlined in the SDMMP Rare Plant Management Plan (CBI and AECOM 2021a, pp. 293–294), with higher priority towards research that can directly inform species' management. For example: a. Research effects of fire and nonnative grasses and forbs on Chorizanthe orcuttiana fitness. b. Investigate effects of grass-specific herbicide on Chorizanthe orcuttiana to assess efficacy for controlling nonnative grasses in C. orcuttiana habitat. c. Determine viability rates of wild-collected and first-generation bulked seed to assess variability. (USFWS, 2021)

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SPECIES ACCOUNT: *Chorizanthe pungens var. hartwegiana* (Ben Lomond spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/07/1994; Pacific Southwest (R8)

Physical Description

a small annual herb in the buckwheat family (Polygonaceae). The plants grow up to 2.5 decimeters (10 inches) high. Whorls of bracts (involucres) below the flowers are 1.5—2.5 millimeters (0.6—1.0 inch) long and have pink scarious (thin and dry) margins. The tepals (undifferentiated petals and sepals) are irregularly toothed at the tips. Compared to other species in thepungens-robusta complex, Ben Lomond spineflower is more erect and the flower clusters and associated structures (infloresences) are pink with small distinct heads (Ertter 1996). (USFWS, 1998)

Taxonomy

Chorizanthe pungens was first described by George Bentham in 1836 based on a specimen collected in Monterey. This taxon was recognized by George Goodman in 1934 as the type species in describing the Pungentes section ofthe genus. Chorizanthe pungens var. hartwegiana was distinguished from C. pungens var. pungens by James Reveal and Clare Hardham (1989) based on a distinction between the coastal form and an inland form “in the Ben Lomond sandhills area.” (USFWS, 1998)

Historical Range

See current range/distribution.

Current Range

Monterey and San Luis Obispo counties, CA. (USFWS, 2912)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2007)

Breeding Season

Adult: Chorizanthe pungens var. hartwegiana seeds germinate in the late fall after the first substantial winter rains. The plants remain small through the winter, then grow quickly and begin producing flowers in April. The length of the flowering season may persist for several months if the climatic conditions during the spring and early summer are favorable (USFWS, 2007).

Reproduction Narrative

Adult: Chorizanthe pungens var. hartwegiana seeds germinate in the late fall after the first substantial winter rains. The plants remain small through the winter, then grow quickly and begin producing flowers in April. The length of the flowering season may persist for several months if the climatic conditions during the spring and early summer are favorable. Flowers are pollinated by a variety of insects, including wasps, bees, flies, and butterflies (Morgan 1997 in Service 1998). Seed set varies with site conditions; in controlled experiments with plants transplanted into grass, manzanita, and pine sites, seed set varied from none to about 60 seeds per plant. Higher seed set was closely tied to the lack of shading (Kluse 1994) (USFWS, 2007). This taxon is a short-lived annual species which undergoes large variations in population numbers from year to year depending on climatic conditions and other factors (USFWS, 2007). First-year and, frequently, second-year plants consist ofa basal rosette. In subsequent years, the basal roseffe withers as the main flowering stem develops. In Erysimum species, flowering may be postponed due to unproductive habitat; therefore, some adults may be older than two years old. Successful reproduction most likely depends on habitat characteristics and climatic conditions (Berg 1986) (USFWS, 1998).

Habitat Type

Adult: Ponderosa pine woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Restricted to pockets of sandstone-derived coarse sandy soils - uplifted ancient marine terraces persisting in a mountain range of volcanic origin. These coarse sands create drier soil conditions than those in the surrounding substrates and support an unusual, open, park-like ponderosa pine woodland community. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species specific habitat requirements and low number of known populations.

Dispersal/Migration

Dispersal

Adult: Seeds dispersed by large mammals (mule deer, coyotes, rabbits) and small mammals (on their fur). Insects also disperse seed (USFWS, 2012).

Dispersal/Migration Narrative

Adult: Seeds are dispersed by mule deer (Oidocoileus hemionus), coyotes (Canis latrans), rabbits (Sylvilagus spp.), and small mammals that come into contact with the plants in late June and July (McGraw 2004b). At that time, the seeds, which are contained in spiny involucres, are easily separated from the flower stems and adhere to the coats of mammals (McGraw 2004b). Insects, including ants, carry out secondary dispersal of those seeds that fall to the soil in late summer (McGraw 2004b). Dense patches of seedlings below the parent plant, however, suggest that many seeds are not widely dispersed (McGraw 2004b). With seeds viable only up to 1 year after production, and with germination less than 0.01 percent, there is little evidence to suggest that Chorizanthe pungens var. hartwegiana has an extensive seed bank (McGraw 2004b). New information concerning the soil seed bank of the closely related Chorizanthe pungens var. pungens was published in 2006 (Fox et al. 2006). This 5-year study found that the density of Chorizanthe pungens var. pungens in a population was directly related to the previous year's seed set, and that the species germinates well under most winter conditions and does not develop an extensive persistent soil seed bank (USFWS, 2012).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2012)

Number of Populations:

21 (USFWS, 2022)

Population Narrative:

1-5 current EOs. (NatureServe, 2015). Population trends are unknown and will be difficult to monitor do to natural yearly fluctuations in populations (USFWS, 2012). Low resiliency, representation and redundancy are inferred based on the low number of known populations, specific habitat requirements and relatively small geographic area in which the species is known to occur. There are currently 21 known populations (USFWS, 2022)

Threats and Stressors

Stressor: Private development (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Private development was occurring on a limited scale within the habitat of the species at the time of listing, and is still occurring at low levels. Between 1993 and 1998, urban development has resulted in the loss of over 480 hectares (194 ha) of sandhills habitat (Service 1998). Construction of private homes, roads, and businesses has removed vegetation and modified soils through excavation, compaction, and disruption of soil horizons (Service 1998). Recent private development has had only a limited effect on the overall habitat and range of the species. One of the secondary effects of destruction and fragmentation of habitat by urban development is the introduction, either intentionally or inadvertently, of non-native plants to adjacent remaining habitat (USFWS, 2012).

Stressor: Recreational threats (USFWS, 2012)
Exposure:

Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Recreational threats identified in the Recovery Plan, including hiking, equestrian use, off-road vehicles, mountain biking, and camping, have resulted in habitat degradation and fragmentation (Service 1998; McGraw 2004b). Mountain bikes and off-highway vehicles continue to pose the greatest recreational threats to sensitive habitat, and have caused extensive damage to suitable habitat - specifically at Henry Cowell Redwoods State Park (McGraw, in litt. 2011). These activities crush and remove vegetation, compact soils, promote soil erosion, and can occasionally result in oil and gasoline spills. Equestrian use, mountain biking, motorcycles and social gatherings that can include bonfires remain ongoing impediments to recovery of the species at Olympia Wellfield and Quail Hollow Quarry (C. Mitcham, in litt. 2011; McGraw 2009b). There is also evidence of people accessing Quail Hollow Quarry for games of paintball (McGraw 2009b). These factors continue to threaten the existence of this species and remain relatively unaddressed at this time (McGraw 2004b; McGraw, in litt. 2011) (USFWS, 2012).

Stressor: Increased vegetation cover (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Increased vegetation cover resulting from fire exclusion was not identified as a major threat at the time of listing, but is one of the most serious ongoing threats to the persistence of Chorizanthe pungens var. hartwegiana (McGraw 2004b; McGraw, in litt. 2011; T. Hyland, pers. comm. 2011). Encroachment by woody species and litter buildup, in large part stemming from the disruption of natural fire cycles, encourages habitat type conversion (McGraw 2004b). The exclusion of wildfires from sandhill communities results in longer intervals between fire events, and in the sand parkland and northern maritime chaparral communities, this has resulted in increased vegetation cover and heightened competition for space with other species over time. Increased shading due to abundant vegetation cover also may reduce the quality of the habitat for this species. Chorizanthe pungens var. hartwegiana has the potential to benefit from fire, but little is known about the fire regime to which it is adapted. Ongoing modifications to the sandhills habitat, including widespread invasive species and non-native annual grasses, may impact how Chorizanthe pungens var. hartwegiana interacts and responds to fire (McGraw 2009b). Furthermore, fire suppression methods, including application of fire retardant, foam, and large amounts of water, can influence how Chorizanthe pungens var. hartwegiana will recover after a fire, and they may affect the surrounding community assemblage by fertilizing the sandy soil and perhaps providing a competitive advantage to non-native annual grasses and other invasive species (McGraw 2009b) (USFWS, 2012).

Stressor: Disease or Predation (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals (USFWS, 2012)
Narrative: Disease and predation were not identified as factors at the time of listing, and are not known to currently be factors. Limited herbivory by lepidopteran larvae (caterpillars) on Chorizanthe pungens var. hartwegiana rosettes and mammalian herbivory on seedlings were personally observed by Jodi McGraw, but do not seem to have a detrimental effect on overall seedling survivorship (McGraw 2004b) (USFWS, 2012).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Given the existing regulations, we have seen some benefit from the Federal and County regulations to Chorizanthe pungens var. hartwegiana. Several HCPs have been implemented by private landowners, who are required to mitigate the effects that their actions have on Chorizanthe pungens var. hartwegiana. The existing regulations can only prevent habitat loss if the HCP requires that landowners avoid habitat or restore degraded habitat (USFWS, 2012).

Stressor: Fire Exclusion (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although not indicated at the time of listing, fire exclusion in Santa Cruz County was leading to encroachment by native woody species and non-native annual grasses threatening habitat type conversion and loss of suitable habitat for Chorizanthe pungens var. hartwegiana. Fire exclusion allows for the accumulation of understory litter and the establishment of plants with which Chorizanthe pungens var. hartwegiana cannot compete for light. The result from fire exclusion is a reduction in sand parkland habitat for the Chorizanthe pungens var. hartwegiana (McGraw 2004b). Chorizanthe pungens var. hartwegiana experiences reductions in population size as a result of competition with exotic species for open habitat (McGraw 2004b). Research was completed by McGraw (2004b) on various habitat management strategies, including the use of prescribed fire and manual clearing. Management efforts aimed at restoring Chorizanthe pungens var. hartwegiana habitat should apply these research findings (USFWS, 2012).

Stressor: Stochastic Extinction (USFWS, 2012)
Exposure:
Response:
Consequence: Extinction
Narrative: Due to its small population and restricted habitat within a narrow geographic range, Chorizanthe pungens var. hartwegiana is vulnerable to stochastic extinction (Service 1994; McGraw and Levine 1998). Typically, annuals and other monocarpic plants (individuals that die after flowering and fruiting), such as Chorizanthe pungens var. hartwegiana, are vulnerable to random fluctuations or variation (stochasticity) in annual weather patterns and other environmental factors (Huenneke et al. 1986). A small population size may make it difficult for a species to persist while sustaining other impacts such as habitat alteration that favors non-native species (USFWS, 2012).

Stressor: Climate Change (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). Chorizanthe pungens var. hartwegiana's small and isolated range increases

its vulnerability to random fluctuations in annual weather patterns and environmental disturbances such as can be brought about by climate change. Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on climate modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" to higher elevations and northward, depending on the ability of each species to do so. In the case of the sandhills ecosystem, which is limited to specific soil types in Santa Cruz County, the opportunities to move to higher elevations or further north are limited. Chorizanthe pungens var. hartwegiana's presence at relatively high elevations (90-610 meters (295-2000 feet)) does not make it immediately vulnerable to sea level rise; however, it is susceptible to an altered hydrological regime if changes in the annual precipitation schedule or fog patterns occur. The species requires full access to the sun to survive and reproduce, and an increase in fog cover or too much precipitation can reduce the reproductive capacity of the plant to unsustainably low levels. In general, the scientific community lacks adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect species like Chorizanthe pungens var. hartwegiana. Small-ranged species, such as Chorizanthe pungens var. hartwegiana, however, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2012).

Stressor: Nitrogen Deposition (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The coarse nature of Zayante soils contributes to this sandy substrate generally having low moisture and nutrient availability. Traditionally, nitrogen can be one of the limiting nutrients in the sandhills, and increased nitrogen deposition from air pollution and urbanization can threaten the biodiversity of the ecosystem (Weiss 1999). Chorizanthe pungens var. hartwegiana could be impacted by increased nitrogen deposition, resulting primarily from the combustion of fossil fuels. Nitrogen can fertilize non-native annual grasses, such as rattlesnake grass (Briza maxima), rip-gut brome (Bromus diandrus), and rattail fescue (Vulpia myuros), which exert strong competitive effects on Chorizanthe pungens var. hartwegiana (McGraw 2004a). Competition with nonnative plants poses the greatest threat to Chorizanthe pungens var. hartwegiana (Service 1998). At the Bonny Doon Ecological Reserve, the presence of the non-native annual grass Vulpia myuros was shown to significantly inhibit the growth and reproductive success of Chorizanthe pungens var. hartwegiana where they occur together (Pollock 1995) (USFWS, 2012).

Recovery

Reclassification Criteria:
1. The 21 currently known populations have been secured through fee-title acquisition, conservation easements, or Habitat Conservation Plans. (USFWS, 1998)

2. Conservation measures for this species are included in Habitat Conservation Plans (Graniterock Quarry, Kaiser Sand and Gravel Felton Plant, and the County of Santa Cruz) that have been developed and implemented for the listed insect species. (USFWS, 1998)

3. Management plans for populations on Quail Hollow Ranch County Park and the adjacent State-owned parcel, Bonny Doon Ecological Reserve, Henry Cowell Redwoods State Park, Big Basin State Park, and Gray Whale Ranch State Park are developed and being implemented. (USFWS, 1998)

4. Population numbers are stable or increasing. (USFWS, 1998)

Recovery Priority Number: 9

Delisting Criteria:
When the downlisting criteria have been met for a species the species can be considered for delisting if: 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. (USFWS, 1998)

Recovery Actions:

- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history. ecology, and population dynamics of these species that will contribute to appropriate management strategies Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)
- 6. Evaluate progress of recovery effectiveness of management and recoverv actions and revise management plans. (USFWS, 1998)

- Recommended Action from 2012 5-Year Review: Coordination of recovery partners and consolidation of occurrence data is critical to get a better overview of the current status of Chorizanthe pungens var. hartwegiana (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Increased Service oversight as time allows, may accelerate completion of the HCP with the County of Santa Cruz and other management plans under development at Big Basin State Park, Henry Cowell Redwoods State Park, Gray Whale Ranch State Park, Quail Hollow Ranch County Park, and Bonny Doon Ecological Reserve. These plans need to be completed before implementation and effective recovery efforts may begin (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Surveys and ongoing monitoring should be undertaken to ensure that potential populations are identified and reliable demographic information is collected. These efforts should focus on sandhills habitats identified as population occurrences to clarify whether and where management actions are necessary. In addition, the CNDDB records should be updated with the most current information available. Specifically, the areas listed in McGraw (2004) as West Lompico, Weston Road, Hilton Drive, Sunset Ridge, Marion, and Landfill Heights; Gray Whale Ranch State Park; and Henry Cowell State Park (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: More detailed knowledge of population occurrences and completion of management plans should allow active management to prevent encroachment of both native and nonnative species in fire-suppressed areas which may lead to type conversion of the habitat and potential extirpation of individual populations. Prescribed burns are the most natural way to restore the vegetation thinning needed to restore open habitat, but in many areas proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion and increased germination rates in Chorizanthe pungens var. hartwegiana seeds (McGraw, 2004). This method may be used in places where fire would create unacceptable risk to local communities (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted. These parties should be provided with information necessary to facilitate management of habitats on these holdings. These private efforts could prevent habitat type conversion due to encroachment by other species in fire suppressed areas, minimize unnecessary impacts, and could aid in maximizing the conservation potential of all suitable habitat and populations (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: The second criterion for downlisting in the recovery plan should be reworded. The criterion as currently worded lists specific HCPs by name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time and even requirements may change. These changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criterion should be avoided. A blanket statement reflecting the need of the species to be included in any HCP that covers its geographic area would be more appropriate (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Conduct surveys throughout the range of Ben Lomond spineflower to create a detailed and reliable map of occupied areas and suitable but

unoccupied habitat. 2. Evaluate the presence and longevity of a seed bank at areas currently occupied, recently occupied, and historically occupied to better understand the need for supplemental seeding following habitat restoration. 3. Secure funding to support monitoring at all protected Ben Lomond spineflower locations (USFWS, 2022).

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SPECIES ACCOUNT: *Chorizanthe pungens var. pungens* (Monterey spineflower)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/04/1994; California/Nevada (R8) (USFWS, 2015)

Physical Description

An annual herb, 5-50 cm tall, somewhat prostrate or slightly ascending. The white to pink flowers (April-July) are subtended by awned bracts and distinctly or indistinctly aggregated into heads, each about 1 cm in diameter. (NatureServe, 2015)

Taxonomy

Accepted by Kartesz (1994 checklist and 1999 floristic synthesis) and Flora of North America (2005); however, not listed specifically as distinct at the varietal level by Hickman (1993). Results from a molecular study indicate that Chorizanthe pungens var. pungens and C. robusta var. robusta are more closely related to each another than to the other subspecific taxa in the C. pungens and C. robusta complex; however, more analysis is needed to determine how this would their taxonomic treatment (Brinegar 2006, Baron and Brinegar 2007, Brinegar and Baron 2008 cited by USFWS 2009). (NatureServe, 2015)

Historical Range

Based on a single collection from 1842, it may have also occurred historically in extreme northern San Luis Obispo County near San Simeon (Flora of North America Editorial Committee 2005; CNPS 2009). (NatureServe, 2015)

Current Range

California, Monterey County, Monterey Peninsula northward to extreme southern Santa Cruz County, and inland into the Salinas Valley. (NatureServe, 2015)

Critical Habitat Designated

Yes; 1/9/2008.

Legal Description

On January 9, 2008, the U.S. Fish and Wildlife Service (Service) designated revised critical habitat for Chorizanthe pungens var. pungens (Monterey spineflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in California (73 FR 1525-1554). The 2008 Rule replaced critical habitat designated on May 28, 2002 (67 FR 37498-37546).

Critical Habitat Designation

The critical habitat designation for Chorizanthe pungens var. pungens includes nine CHUs in Santa Cruz and Monterey Counties, California. In total, approximately 11,055 acres (ac) (4,475 hectares (ha)) fall within the boundaries of this revised critical habitat designation (73 FR 1525-1554).

Unit 1: Sunset (85 ac (35 ha)): This unit consists of coastal beaches, dunes, and bluffs located west of Watsonville in southern Santa Cruz County. Unit 1 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils primarily in the coastal beach, dune land, and Baywood sand series (Soil Conservation Service 1978, pp. 13– 25; 1980 (maps)) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied (CNDDB 2006, California Department of Parks and Recreation (CDPR) 2006a). This unit consists exclusively of State land (85 ac (35 ha)) and is entirely within the boundaries of Sunset State Beach. The unit includes land from Sunset Beach Road south to the gate on Shell Road, just north of the mouth of the Pajaro River, and west of Shell Road, which extends the length of Sunset State Beach. Unit 1 is essential because it supports a large population of Chorizanthe pungens var. pungens that in some years numbers in the tens of thousands (CNDDB 2006; CDPR 2006a). The features essential to the conservation of the species may require special management considerations or protection in this unit due threats from invasive, nonnative plants, particularly European beachgrass, which forms dense stands on coastal beaches and crowds out C. p. var. pungens, and from recreational activities, including camping and foot traffic, which could trample plants.

Unit 2: Moss Landing (250 ac (101 ha)): This unit consists of coastal beaches, dunes, and bluffs to the north and south of the community of Moss Landing in northern Monterey County. Unit 2 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach and dune land series (Soil Conservation Service 1978, pp. 13–25) (PCE 1). The northern portion of this unit includes lands owned and managed by the State (which includes portions of Zmudowski State Beach and Moss Landing State Beach between the mouths of the Pajaro River and Elkhorn Slough), 20 ac (8 ha) of private lands, and 6 ac (2 ha) of county lands. The southern portion of this unit includes State lands within Salinas River State Beach. This unit was occupied at the time of listing (59 FR 5499) and was included in the previous critical habitat designation. Herbarium records indicate that this site was occupied as early as 1933, and has remained occupied through time (Consortium of California Herbaria 2006 cites collections by H.S. Tates 1936; T. Craig 1933; and J. Thomas 1950). Chorizanthe pungens var. pungens was also recently observed in this unit (CDPR 2006b, unpaginated). This unit contains one of only five populations found along the coast, and it may provide connectivity between the Sunset Unit to the north and the Marina Unit to the south. The features essential to the conservation of the species may require special management considerations or protection in this unit due threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out C. p. var. pungens, and from recreational activities including foot traffic, which could trample plants.

Unit 3: Marina (881 ac (357 ha)): This unit consists of coastal beaches, dunes, and bluffs ranging from just south of the mouth of the Salinas River, south to the city of Monterey in northern Monterey County; these lands are entirely west of Highway 1. Unit 3 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, dune land, and Oceano loamy sand soil series (Soil Conservation Service 1978, pp. 13–25, 54–55) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and it is currently occupied (CNDDB 2006; CDPR 2006; Service 2002, p. 54). Unit 3 is comprised of State lands, including Marina State Beach and Monterey State Beach. This unit is essential because it supports a population of Chorizanthe pungens var. pungens that numbers in the thousands in some years (CNDDB 2006; Service 1998,

p. 67); it is the southernmost of the Monterey Bay area coastal populations; and it may provide connectivity between the populations along the coast and the more interior populations found at former Fort Ord. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out C. p. var. pungens; recreational activities such as foot traffic, which could result in the trampling of plants; and edge effects of urban development.

Unit 4: Asilomar (48 ac (19 ha)): This unit consists of coastal dunes and bluffs near the communities of Pacific Grove and Pebble Beach on the Monterey Peninsula in northern Monterey County. This unit includes a portion of Asilomar State Beach, and extends just beyond Lighthouse Avenue to the north and terminates at the boundary of the Asilomar Conference Grounds. This unit's eastern boundary extends from Highway 68 north along Asilomar Avenue, and then turns west on Arena Avenue where the boundary connects to Sunset Drive. Unit 4 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, dune land, and Baywood sand soil series (Soil Conservation Service 1978, pp. 13–25) (PCE 1). This unit is comprised of 4 ac (1 ha) of Federal lands, 40 ac (16 ha) of State lands at Asilomar State Beach, and 4 ac (2 ha) of local government ownership. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. Herbarium records that contain specimens from this area include the following (collector and year): Lemmon 1881, L.C. Wheeler 1936, R. Hoover 1941 and 1963, and L.S. Rose 1963 (Consortium of California Herbaria 2006)). This unit currently supports a population of Chorizanthe pungens var. pungens that numbers in the hundreds (Moss 2000, unpaginated). This unit is essential because it is the southernmost of only five populations of C. p. var. pungens along the coast. Preserving the genetic characteristics that have allowed individuals at this site to survive at the southern end of the species' range along the coast is essential to the long-term survival and conservation of C. p. var. pungens. Protecting peripheral or isolated populations is necessary because they may contain genetic variation not found in core populations. The genetic variation results from the effects of population isolation and adaptation to locally distinct environments (Lesica and Allendorf 1995, pp. 754–757; Fraser 2000, pp. 49– 51; Hamrick and Godt 1996, pp. 291– 295). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly ice-plant, which forms dense ground cover on coastal beaches and crowds out C. p. var. pungens; recreational activities such as foot traffic which could trample plants; and edge effects of urban development. An additional threat in this unit is the expansion of unregulated vehicle parking in the dunes associated with the high numbers of visitors this area receives each year.

Unit 5: Freedom Boulevard (24 ac (10 ha)): This unit consists of grassland, maritime chaparral, and oak woodland habitat near the western terminus of Freedom Boulevard and northeast of Highway 1 in Santa Cruz County. This unit consists entirely of private lands (24 ac (10 ha)). Unit 5 contains space for individual and population growth, including sites for seed dispersal and germination; provides for the basic requirements for growth; and includes soils in the Baywood sand and Ben Lomond sandy loam series (Soil Conservation Service 1980, pp. 64–65; maps) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied (CNDDB 2006, element occurrences (EOs) 32 and 34; Morgan 2006, unpaginated). This unit currently supports a population of Chorizanthe pungens var. pungens that numbers in the thousands in favorable years, but many fewer in unfavorable years (CNDDB 2006, EOs 32, 34). This unit is

essential because it is the northernmost known occurrence. In the absence of genetic data, protecting populations at the boundaries of a taxon's range is necessary because they may contain genetic variation not found in core populations. The genetic variation results from the effects of population isolation and adaptation to locally distinct environments (Lesica and Allendorf 1995, pp. 754–757; Fraser 2000, pp. 49–51; Hamrick and Godt 1996, pp. 291–295). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, particularly annual grasses that crowd out C. p. var. pungens, and from edge effects of urban development.

Unit 6: Manresa (94 ac (38 ha)): This unit consists of coastal bluffs along the immediate coast, south of Seacliff State Beach and north of Sunset State Beach in Santa Cruz County. Unit 6 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the coastal beach, Baywood sand, and Elder sandy loam series (Soil Conservation Service 1980, pp. 11–70, maps) (PCE 1). This unit is comprised entirely of lands owned and managed by the State at Manresa State Beach. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. This unit is essential because it is the most northerly population that is known from the immediate coast and provides connectivity to populations in the Sunset Unit to the south. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants and from recreational activities such as foot traffic, which could trample plants.

Unit 7: Prunedale (190 ac (77 ha)): This unit consists of grassland, maritime chaparral, and oak woodland in the area around Prunedale in northern Monterey County. On the west side of Highway 101, the unit includes the Manzanita County Park subunit located between Castroville Boulevard and San Miguel Canyon Road. On the east side of Highway 101, the unit consists of four additional subunits. The five subunits support similar plant communities and need similar types of special management; therefore, we discuss them as a unit. Unit 7 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the Arnold loamy sand, Santa Ynez fine sandy loam, and Arnold-Santa Ynez complex series (Soil Conservation Service 1978, pp. 9–11, 72–73) (PCE 1). This unit consists of 155 ac (63 ha) of State lands, 18 ac (7 ac) of local agency lands (Manzanita County Park), and 17 ac (7 ha) of Pacific Gas and Electric easement lands. This unit was occupied at the time of listing, was included in our listing rule in reference to the Prunedale area (59 FR 5499), and is currently occupied (Caltrans 2001; Consortium of California Herbaria 2006). This unit is essential because it is one of only four units that are known to support populations in maritime chaparral and oak woodland habitats more representative of hotter, interior sites and is the easternmost of the units in the interior hills. The features essential to the conservation of the species may require special management considerations or protections in this unit due to threats from invasive, nonnative plants, which crowd out Chorizanthe pungens var. pungens; edge effects from urban development; and recreational activities such as off road vehicles, which can crush plants and destroy seeds.

Unit 8: Fort Ord (9,432 ac (3,817 ha)): This unit consists of grassland, maritime chaparral, coastal scrub, and oak woodland on the former Department of Defense base at Fort Ord, east of the city of Seaside in northern Monterey County. This unit is entirely within the area formerly known as Fort Ord, bounded by Highway 1 on the northwest, the Salinas River to the east, and Monterey-

Salinas Road (Highway 68) on the south. Approximately 87 percent of this critical habitat unit is Federal land (8,172 ac (3,307 ha)) managed by BLM and the Army, 6 percent is State land (606 ac (245 ha)), and 7 percent is under local jurisdictions (654 ac (265 ha)). Portions of Fort Ord have been transferred to BLM; University of California, California State University at Monterey Bay; and local (city and county) jurisdictions. All of the lands included in this unit are designated as current or future habitat reserves under the Army's habitat management plan (Corps 1997, Attachment A map; Zander Associates 2002, Figures 4–6). About one-half of Unit 8 still must be cleaned of environmental contaminants by the Army before it can be transferred to BLM. Unit 8 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the Arnold-Santa Ynez complex, Baywood sand, and Oceano loamy sand series (Soil Conservation Service 1978, pp. 9– 73). Lands in this unit are intended to be managed at a landscape scale, using prescribed fire, as needed, to maintain a range of different-aged maritime chaparral stands (Corps 1997, pp. 4.24– 4.25), and by doing so preserve substantial populations of rare maritime chaparral species in the Monterey Bay area. This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. This unit is essential because it currently supports multiple large populations of Chorizanthe pungens var. pungens that number in the tens of thousands in some years (CNDDB 2006, EO 2; Jones and Stokes 1992, Figure F– 3; BLM 2006), and it is one of only five units that include maritime chaparral and oak woodland habitats more representative of hotter, interior sites. The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive species that crowd out C. p. var. pungens, munitions clean-up methods on former ranges that remove and chip all standing vegetation, and recreational activities and road and trail maintenance that could trample plants.

Unit 9: Soledad (51 ac (21 ha)): This unit consists of an interior dune in the floodplain of the Salinas River channel just south of the city of Soledad in central Monterey County on privately owned lands. Unit 9 contains space for individual and population growth, including sites for seed dispersal and germination; provides the basic requirements for growth; and includes soils in the dune land and Metz complex soil series (Soil Conservation Service 1978, pp. 24, 48–49) (PCE 1). This unit was occupied at the time of listing (59 FR 5499) and is currently occupied. Approximately 5,000 plants were observed in this unit in 1994 (CNDDB 2006, EO 28; Wesco 1994, pp. 5–8). This unit is essential because it is the southernmost interior location that supports a population and the only unit where Chorizanthe pungens var. pungens grows in interior floodplain dune habitat. This population is geographically remote from all others in this revised critical habitat designation. Protecting peripheral or isolated populations of rare species is highly desirable because they may contain genetic variation not found in core populations (Lesica and Allendorf 1995, pp. 755–757). The features essential to the conservation of the species may require special management considerations or protection in this unit due to threats from invasive, nonnative plants, which crowd out C. p. var. pungens; overspray of herbicides and pesticides from agricultural operations; and vegetation clearing activities associated with road maintenance.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The primary constituent element of critical habitat for Chorizanthe pungens var. pungens (73 FR 1525-1554) is a vegetation structure arranged in a mosaic with openings between the dominant elements (e.g., scrub, shrub, oak trees, or clumps of

herbaceous vegetation) that changes in spatial position as a result of physical processes such as windblown sands and fire and that allows sunlight to reach the surface of the following sandy soils: coastal beaches, dune land, Baywood sand, Ben Lomond sandy loam, Elder sandy loam, Oceano loamy sand, Arnold loamy sand, Santa Ynez fine sandy loam, Arnold—Santa Ynez complex, Metz complex, and Metz loamy sand.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, and roads) and the land on which such structures are located, existing within the legal boundaries on the effective date of this rule.

Life History

Food/Nutrient Resources

Breeding Season

Adult: March to June (USFWS, 2009)

Reproduction Narrative

Adult: Chorizanthe pungens var. pungens is a prostrate annual species in the buckwheat family (Polygonaceae). Flowering occurs from late March to June, depending on weather patterns, and seed is dispersed in mid-summer. Chorizanthe pungens var. pungens plants produce a maximum of one seed per flower and, depending on the vigor of the plant, produce dozens of seeds per plant (Fox et al. 2006). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest Edge, Forest/Woodland, Grassland/herbaceous, Old field, Sand/dune, Savanna, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mild maritime climate, characterized by fog and winter rains (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Found in open areas: openings between shrubs, roadsides, firebreaks, and a heavily disturbed firing range. (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2009)

Habitat Narrative

Adult: Chorizanthe pungens var. pungens is found scattered on sandy soils within coastal and near-coastal dune, coastal scrub, grassland, maritime chaparral, and oak woodland

communities. Found in open areas: openings between shrubs, roadsides, firebreaks, and a heavily disturbed firing range. This plant occurs in areas of relatively mild maritime climate, characterized by fog and winter rains. The fog helps keep summer temperatures cool and winter temperatures relatively warm, and provides moisture in addition to the normal winter rains. Other plants associated with this species include beach-bur (Ambrosia chamissonis), coastal sagewort (Artemisiapycnocephala), and mock heather (Ericameria ericoides). (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from USFWS, 2009)

Dispersal

Adult: High (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seed dispersal in C. p. var. pungens is likely facilitated by hooked spines on the structure surrounding the seed. In the Chorizanthe genus, these are believed to attach to passing animals and disperse seeds between plant colonies and populations (Reveal 2001). Wind also likely disperses seeds within colonies and populations. (USFWS, 2009)

Population Information and Trends

Population Trends:

Declining

Number of Populations:

~18 (NatureServe, 2015)

Population Size:

200,000 to 2,000,000 (USFWS, 1998)

Adaptability:

Moderate (USFWS, 2009)

Population Narrative:

Approximately 18 occurrences observed since 1989 (CNDDB 2008). Populations in the hills between Watsonville and Aptos are small, declining, and have been impacted by developments throughout the 1990s (Hayes and Taylor 2006). C. pugens var. pugens has the ability to recolonize sites when invasive plants are removed if there is a seed source (USFWS 2009). The original survey used large blocks of habitat and the calculations included closed canopy blocks of woody vegetation. The reduction in estimated occupied habitat yields a population between 200,000 and 2,000,000 individuals. (USFWS, 1998; USFWS, 2009; NatureServe, 2015)

Threats and Stressors

Stressor: Development for residential, commercial and industrial uses (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Conversion of lands for urban development continues in the Monterey Bay area. Development projects have been proposed or approved in the last 5 years that would remove or fragment habitat of Chorizanthe pungens var. pungens in the Prunedale Hills (e.g., the Prunedale Improvement Project, Pesante Canyon developments), coastal region (e.g., at Armstrong Ranch, Monterey Airport), and on the Monterey Peninsula (e.g., at Pebble Beach) (Lowe 2001, Monterey County 2005, California Department of Transportation (Caltrans) 2005, City of Marina 2007, Rana Creek Habitat Restoration 2007). Development is also planned within the boundaries of the 28,000-acre former Fort Ord military base in Monterey County. On former Fort Ord, Chorizanthe pungens var. pungens is found in maritime chaparral, coastal sage scrub, and in openings in oak woodland. It occurs on parcels designated for development and habitat reserve, as well as in the margins of areas to be redeveloped. (USFWS, 2009)

Stressor: Recreation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Chorizanthe pungens var. pungens requires open sandy habitat in which to grow, so it consequently colonizes openings along roads and trails and may colonize trail beds, if use is infrequent. In at least one State Park site, at Sunset State Beach where recreational use was previously heavy, new barriers have been introduced to funnel recreational traffic and allow C. p. var. pungens to expand into the area from nearby occurrences (State Parks 2006a). Grading of trails (e.g., at former Fort Ord) may also diminish populations. However, on Fort Ord Public Lands, BLM hopes to maintain adequate open space along the margins of trails and thereby retain trail use by people and continued occupancy by C. p. var. pungens along trail margins (BLM 2003). It appears that light recreational use, such as foot traffic, maintains more open habitat suitable for C. p. var. pungens, but excludes the taxon where traffic is frequent during the growing season. (USFWS, 2009)

Stressor: Dune stabilization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Non-native species were introduced for dune stabilization and subsequently, compete for habitat with C. pungens var. pugens. (USFWS, 2009)

Stressor: Land ownership (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The dune scrub habitat of Chorizanthe pungens var. pungens is protected from development at numerous coastal locations. In Santa Cruz County, populations occur at Sunset State Beach and Manresa State Beach. In Monterey County, coastal populations occur along the

Monterey Bay on preserved lands at Zmudowski, Moss Landing, Salinas River, Marina, Monterey, and Asilomar State Beaches, the latter of which is on the Monterey Peninsula near the southern end of this taxon's extant range (Moss 2000, State Parks 2006b, CNDDB 2007). The interior occurrences in Santa Cruz County (e.g., Freedom Boulevard and Bel Mar areas (Service 2002: 67 FR 37498)), which are not discussed in the specific recovery criteria above, are not secure from development. In northern Monterey County in the Prunedale Hills, populations occur on easements owned by Pacific Gas and Electric, on private lands, on lands owned or managed by conservation-oriented organizations such as the Elkhorn Slough Foundation, at a County Park, and on State lands managed by the California Department of Transportation (Caltrans). The eventual use of the Caltrans land has not been determined (Siepel pers. comm. 2004; Robison 2006). Chorizanthe pungens var. pungens also occurs at numerous places on former Fort Ord, a closed military base and Superfund site that is being cleaned and planned for reuse. The population in a river dune near Soledad is privately owned and represents the southernmost interior population known to be extant. (USFWS, 2009)

Stressor: Invasive non-native species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The final rule identifies competition from invasive nonnative species, such as the iceplants (sea-fig) (Carpobrotus edulis, Mesembryanthemum crystallinum), and European beach grass (Ammophila arenaria), as a threat to this taxon (59 FR 5499). These species are particularly adept at colonizing dune sands and several of them have been used in California to promote dune stabilizations (Albert 2000). Invasive nonnative species remain a threat to Chorizanthe pungens. var. pungens. In addition to the species noted in the final rule, others that have invaded maritime chaparral and coastal sage scrub where C. p. var. pungens occurs include jubata grass (Corterderia jubata), French broom (Genista monspessulana), and invasive annual grasses of European origin, such as wild oats (Avena sp.), soft chess (Bromus hordeaceus), and ripgut brome (Bromus diandrus) (BLM 2003, Parsons 2004, Fusari and McStay 2007). These latter species are typically able to colonize disturbed sites with more well-developed soils than occur on dunes. In addition to the direct effects that invasive, non-native plant species may have on Chorizanthe pungens var. pungens, Chorizanthe species may be indirectly affected by these species via diminished pollinator visitation. Many of the hymenopteran pollinators important to Chorizanthe pollination (e.g., sphecid wasps, bumblebees, and bees from the families Halictidae and Anthophoridae), require bare ground for nesting (Murphy 2003). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Beaches along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). The extent to which such events are caused by climate change and the extent to which it could affect Chorizanthe pungens var. pungens are unknown at this time. (USFWS, 2009)

Stressor: Agricultural Land Conversion

Exposure:
Response:
Consequence:
Narrative: Aerial imagery suggests that nine of 51 occurrences (18 percent) have been developed or converted to agriculture, but the amount of acres or number of individuals affected cannot be determined without survey data. Currently, there is very little land where Monterey spineflower occurs that could be converted to agriculture. We expect that the threat of agricultural land conversion will continue to decrease with time because coastal populations are not subject to agricultural conversion and the majority of inland suitable habitat occurs on the former Fort Ord where conversion to agriculture is not planned. (USFWS, 2020)

Stressor: Sand Mining
Exposure:
Response:
Consequence:
Narrative: A sand extraction operation was run on a portion of sand dunes and beach between Marina State Beach and the Salinas National Wildlife Refuge from 1986 through 2013 (CCC 2017, Exhibit 5, p. 3). The effect of this operation was the loss of approximately 243,000 cubic yards/year of sand from the Southern Monterey Bay littoral cell resulting in causing or worsening shoreline retreat and dune erosion (CCC 2017, Exhibit 5, p. 3). A settlement agreement in 2017 closed the operation and initiated reclamation of the extraction operation (CCC 2017, Appendix A, entire). Under the settlement agreement, removal of extraction equipment and facilities, and regrading and restoration will occur between 2020 and 2025 (CCC 2017, Appendix A, pp. 33-37). The closure of the sand extraction operation is likely to result in greater amounts of sand deposition on beaches within the range of the Monterey spineflower and reduce effects of shoreline retreat and coastal erosion. If the settlement agreement timeline is adhered to, sand mining will no longer be a threat to individuals or habitat of Monterey spineflower. (USFWS, 2020)

Stressor: Recreation
Exposure:
Response:
Consequence:
Narrative: Recreation from hiking, biking, equestrian, or other activities may create open space that can provide habitat for Monterey spineflower. However, sustained use of open areas is not likely to support the species because of direct damage to plants through trampling, erosion along trail systems, and introduction of invasive species that compete with Monterey spineflower. Recreation had historically been a threat at Sunset State Beach, but has been reduced through fencing that directs the impacts of recreational use to areas not occupied by Monterey spineflower (Service 2009, p. 8). It is possible that as the former Fort Ord becomes more open to the public that recreational use will increase and potentially impact Monterey spineflower. (USFWS, 2020)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:

1. The Fort Ord disposal and reuse process has led the management agencies to develop, fund, and implement permanent protection plans for the species' habitat including permanent iceplant suppression programs. (USFWS, 2009)

2. Beach-dune occurrences on State Park and private lands throughout its current range from Santa Cruz to the Monterey Peninsula are covered under a permanent protection plan. Plans at the time of writing to conserve roughly 60 percent of Fort Ord appear sufficient for recovery of the interior occurrence. A reassessment would be made should plans call for conservation of less habitat. Existing management along the coast at the State Parks units needs to be supplemented with protection and management on private lands to be determined after a thorough analysis of the beach populations. (USFWS, 2009)

3. Populations in the protected areas are stable or increasing over a 15 year period, which will include wet and drought years. (USFWS, 2019)

Recovery Actions:

- Protect habitat of the listed species and their occurrences on private lands by informing landowners and consulting with local lead agencies (USFWS, 1998)
- Minimize threats to the plants by minimizing the threats from invasive non-native plants and threats on private and public lands. (USFWS, 1998)
- Develop management strategies through a research program to document the listed species' life histories and their responses to vegetation management. (USFWS, 1998)
- Develop and implement management practices for the occurrences and habitat of Chorizanthe pungens var. pungens by establishing a working group to collaborate with private and public landowners and appropriate agencies to develop specific management guidelines. (USFWS, 1998)
- Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria including trends, effectiveness of reduce threats, and survey likely habitat for additional occurrences.
- Coordinate recovery actions to protect other listed species and species of special concern.
- Develop and implement an outreach program
- The criteria should be revised to identify the importance of having protected populations in the interior north (Santa Cruz) and central (Prunedale Hills) portions of this taxon's range.
- Encourage the State to establish a permanent protection and management mechanism for the Caltrans managed lands in the Prunedale Hills.
- Continue to support and partner with organizations, agencies, and individuals to preserve, restore, and enhance lands on which this taxon occurs.
- Develop a Memorandum of Understanding or coordinate with land managers on other mechanisms (e.g., a set of management actions within a management plan) that would meet the recovery criterion of ensuring adequate management (primarily control of nonnative species and maintaining openings in native vegetation) on lands that support Chorizanthe pungens var. pungens.
- The current recovery criteria call for 15 years of monitoring. Coordinate with land managers to determine the most efficient means to implement and document adequate monitoring to ensure that the general trend or persistence of the populations is being tracked. Focus surveys and monitoring in years of high rainfall when the extent of its distribution is most

likely to be apparent.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-year review: • A range wide monitoring program should be created in order to evaluate occurrences of Monterey spineflower that are deemed essential to the recovery of the species. • Monitoring of Monterey spineflower populations on California State Beaches and the former Fort Ord should begin with the goal of having continuous long-term monitoring that will meet the intent of the stated recovery criteria. • Restoration and reintroduction should be attempted in coastal dune systems where past disturbance or invasive species have inhibited establishment of Monterey spineflower. • The taxonomy of the varieties of Chorizanthe pungens and Chorizanthe robusta should be reevaluated to determine if revisions are necessary or warranted. • The recovery criteria should be revisited to evaluate the importance of having protected populations in the interior north (Santa Cruz) and central (Prunedale Hills) portions of this taxon's range. (USFWS, 2020)

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SPECIES ACCOUNT: *Chorizanthe robusta var. hartwegii* (Scotts Valley spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/07/1994; California/Nevada Region (Region 8)

Physical Description

An annual species in the buckwheat family. The plant grows to 3 decimeters (12 inches) high and has an erect rather than prostrate habit. The rose-pink color on the margins of the bracts below the flowers is confined to the basal portion of the teeth. The medium-sized heads (1.0—1.5 centimeters in diameter) are distinctly clustered. (USFWS, 1998)

Taxonomy

Previously known as Hartweg's spineflower. The systematics of the species comprising Chorizanthe are difficult and confusing (Reveal and Hardham 1989; Hickman 1993). The Service funded research on the phylogenetic relationships of the Chorizanthe robusta/Chorizanthe pungens complex. Using molecular techniques, Brinegar and Baron (2008) determined the following: (1) Chorizanthe robusta var. robusta is more closely related to Chorizanthe pungens var. pungens (Monterey spineflower, threatened) than to Chorizanthe robusta var. hartwegii; (2) Chorizanthe robusta var. hartwegii is more closely related to Chorizanthe pungens var. hartwegiana (Ben Lomond spineflower, endangered) than to Chorizanthe robusta var. robusta; and (3) these four taxa comprise a number of geographically-close populations in ecologically-different habitats, and although they are generally morphologically distinct (except in some cases at the extremes of their ranges), the genetic differences are small. In brief, Brinegar and Baron (2008) suggested that systematists consider recognizing Chorizanthe robusta (inclusive of Chorizanthe robusta var. robusta and Chorizanthe robusta var. hartwegii) and Chrorizanthe pungens (inclusive of Chorizanthe pungens var. pungens and Chorizanthe pungens var. hartwegiana) as a single species while retaining variety designations. (USFWS, 2009)

Historical Range

See current range/distribution.

Current Range

Scotts Valley, Santa Cruz County, California. (USFWS, 2019b)

Critical Habitat Designated

Yes; 6/28/2002.

Legal Description

On May 29, 2002, the U.S. Fish and Wildlife Service (Service), designated critical habitat (effective 6/28/2002) pursuant to the Endangered Species Act of 1973, as amended (67 FR 37336 - 37353), for Chorizanthe robusta var. hartwegii (Scotts Valley spineflower). Approximately 116 hectares (287 acres) of land fall within the boundaries of the critical habitat designation located in Santa Cruz County, California.

Critical Habitat Designation

The critical habitat designation for Chorizanthe robusta var. hartwegii includes two units totaling 297 acres in Santa Cruz County, California. The units are 1. Glenwood Unit and 2. Polo Ranch Unit. Brief descriptions are presented below. Detailed coordinates and maps depicting the CH units are available in the Final Rule (67 FR 37336 - 37353).

Unit 1: Glenwood Site. Unit 1 consists of approximately 87 ha (214 acres) to the west of Glenwood Drive and north and northwest of Casa Way, in the City of Scotts Valley, including land owned and managed by the Salvation Army, land owned and managed by the Scotts Valley High School District as a preserve, but excluding the rest of the High School, and to the east of Glenwood Drive, encompassing the parcel known as the Glenwood Development. (USFWS, 2002)

Unit 2: Polo Ranch Site. The Polo Ranch site consists of approximately 30 ha (73 ac) to the east of Carbonera Creek on the east side of Highway 17 and north and northeast of Navarra Drive, in the City of Scotts Valley, known as the Polo Ranch, in the County of Santa Cruz, California. (USFWS, 2002)

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for Chorizanthe robusta var. hartwegii are the habitat components that provide:

(i) Thin soils in the Bonnydoon series that have developed over outcrops of Santa Cruz mudstone and Purisima sandstone;

(ii) ‘‘Wildflower field’’ habitat that has developed on these thin-soiled sites;

(iii) A grassland plant community that supports the ‘‘wildflower field’’ habitat, that is stable over time and in which nonnative species are absent or are at a density that has little or no adverse effect on resources available for growth and reproduction of Chorizanthe robusta var. hartwegii;

(iv) Sufficient areas around each population to allow for recolonization to adjacent suitable microhabitat sites in the event of catastrophic events;

(v) Pollinator activity between existing colonies of Chorizanthe robusta var. hartwegii;

(vi) Seed dispersal mechanisms between existing colonies and other potentially suitable sites; and

(vii) Sufficient integrity of the watershed above habitat for Chorizanthe robusta var. hartwegii to maintain soil and hydrologic conditions that provide the seasonally wet substrate for growth and reproduction.

Special Management Considerations or Protections

Existing features and structures, such as buildings, roads, railroads, airports, other paved areas, lawns, and other urban landscaped areas, do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/or primary constituent elements in adjacent critical habitat.

The most likely kinds of special management and protection that C. r. var. hartwegii may require are: (1) The soils on which Chorizanthe robusta var. hartwegii is found should be maintained to optimize conditions for its persistence. Physical properties of the soil, such as its chemical composition, surface crust, and drainage capabilities would best be maintained by limiting or restricting the use or application of herbicides, fertilizers, or other soil amendments. (2) Overspray from irrigation or saturation of soils beyond the normal season should also be avoided, as this may alter the structure and composition of the grassland community, or render the native species more vulnerable to pathogens found in wetter soil regimes. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and seed dispersal agents are maintained. For pollinators, the use of pesticides should be limited or restricted so that healthy populations of pollinators are present to effect seed set in Chorizanthe robusta var. hartwegii. For dispersal agents, the fragmentation of habitat through construction of roads and certain types of fencing should be limited so that these agents may disperse seed of C. r. var. hartwegii throughout the unit. (4) Within the grassland community where Chorizanthe robusta var. hartwegii occurs, invasive, non-native species such as bromes and other species may need to be actively managed to maintain the patches of open habitat that C. r. var. hartwegii needs. (5) Certain areas where Chorizanthe robusta var. hartwegii occurs may need to be fenced to protect it from accidental or intentional trampling by humans and livestock. While C. r. var. hartwegii appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect C. r. var. hartwegii during its critical season of growth and reproduction.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: April to June (USFWS, 2009)

Reproduction Narrative

Adult: In general, the plants germinate during the winter, flower from April to June, dry and turn a rusty hue during the summer, and eventually break apart during the fall. Depending on vigor of individual plants, dozens to possibly hundreds of seeds are produced per plant, with seed maturation by August. The plants occur in full sun (Reveal and Morgan 1989). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Exposed bedrock (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Full sun (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 213 to 244 m elevation (700 to 800 ft) (Hinds and Morgan 1995), and approximately 11 km (7 mi inland from the coast (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: Wildflower fields (USFWS, 2009)

Habitat Narrative

Adult: The plants occur only on patches of exposed bedrock (Santa Cruz mudstone, Purisima sandstone) overlain with a thin layer of soil in fragmented islands of annual grasslands (Reveal and Morgan 1989, Service 1994) at Scotts Valley in the Santa Cruz Mountains. In the Scotts Valley area, the grasslands are generally on the middle to lower slopes within the sub-watersheds, while the higher slopes support redwood (Sequoia sempervirens) and mixed forest (Service 2003). The species occurs at 213 to 244 m elevation (700 to 800 ft) (Hinds and Morgan 1995), and approximately 11 kilometers (7 miles) inland from the coast. The plants occur in full sun (Reveal and Morgan 1989). The taxon grows in colonies in wildflower fields associated with the following native species: Arenaria californica (California sandwort), Arenaria douglasii (Douglas' stitchwort), Calochortus luteus (yellow mariposa lily), Clarkia purpurea (winecup clarkia), Corethrogyne filaginifolia (common sandaster), Gilia clivorum (purplespot gilia), Hemizonia corymbosa (coastal tarweed), Lasthenia californica (California goldfields), Lepidium nitidum (shining pepperweed), Lomatium caruifolium (alkali desertparsley), Lotus purshianus (American bird'sfoot trefoil), Lupinus nanus (sky lupine), Navarretia atractyloides (hollyleaf pincushionplant), Castilleja densiflora (denseflower Indian paintbrush), Polygonum hickmanii (Scotts Valley polygonum), Trifolium albopurpureum (rancheria clover), Trifolium barbigerum (Andrews' clover), Trifolium depauperatum (cowbag clover), and Trichostema lanceolatum (vinegarweed) (Reveal and Morgan 1989, Service 2002). (USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decreasing to stable (USFWS, 2019b)

Number of Populations:

3 (USFWS, 2019b)

Population Size:

Total estimated at approximately 35,000 individuals (USFWS, 2019b)

Population Narrative:

The geographic range comprises approximately 1.6 square kilometers (0.6 square mile), with three occurrences (mapped colonies within 0.25 mi of each other) on five properties: Salvation Army land, Scotts Valley High School Ecological Preserve, the Glenwood Open Space Preserve, Polo Ranch, and a private parcel. The total occupied area is less than 0.4 hectare (1 acre) (Service 2002). In our 2009 5-Year Review, we determined that, in light of the observed decline in numbers of individuals and the extirpation of some colonies since 1992, the abundance of Chorizanthe robusta var. hartwegii is decreasing. In 2018, the best available information indicates that three of the five sites known for the species are declining, one appears stable to increasing, and the status of one site is unknown. (USFWS, 2019b)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The threat of development has been removed at the Scotts Valley High School Ecological Preserve and the Glenwood Open Space Preserve. At the Scotts Valley High School Ecological Preserve there is an agreement to manage the land in perpetuity for the Scotts Valley spineflower and other biological resources. The Glenwood Open Space Preserve is held in a conservation easement by the Land Trust of Santa Cruz County and is managed to preserve the Scotts Valley spineflower and other biological resources and an endowment has been established that funds management actions. Development of the areas where Scotts Valley spineflower occurs at Polo Ranch is prohibited by the City of Scotts Valley's permit for the adjacent housing development, but the species cannot be considered protected from developmental disturbance and other threats until a conservation easement is finalized and a funded management plan is established. The colonies on Salvation Army land and private land are not protected and remain threatened by the possibility of development, though habitat management at the Salvation Army colonies was recently initiated through an informal agreement. All known occurrences remain threatened by stochastic extinction, invasive species, and climate change. (USFWS, 2019b)

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Stochastic extinction is a threat because Chorizanthe robusta var. hartwegii is an annual plant that is restricted to a habitat of limited distribution within a small geographic area and its populations are small and isolated. In this situation, naturally occurring events can cause extinction through mechanisms operating at the genetic level (e.g., decrease in genetic variability), the population level (e.g., lack of ability to attract pollinators because of few individuals), or the landscape level (e.g., storms, drought, fire) (Service 2003). (USFWS, 2009)

Stressor: Invasive species and competitive native species (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: Much of the previously native grassland is now occupied by invasive grasses, which are now a threat to Chorizanthe robusta var. hartwegii on all four properties. In particular, much of the habitat on the Scotts Valley High School Preserve is now occupied by non-native grasses, which must be mowed to reduce adverse effects to this species and Polygonum hickmanii. At Polo Ranch, competitive native species are also threatening Chorizanthe robusta var. hartwegii and its habitat. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). While we lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as small population size will affect Chorizanthe robusta var. hartwegii, small-ranged species are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:
1. All four parcels of private land that support the Scotts Valley spineflower have permanent conservation easements or have been acquired. (USFWS, 1998)

2. Conservation measures for the Scotts Valley spineflower are included in a Habitat Conservation Plan with the City of Scotts Valley. (USFWS, 1998)

3. Population numbers are stable or increasing. (USFWS, 1998)

Delisting Criteria:
When the downlisting criteria have been met for a species, the species can be considered for delisting if: (USFWS, 2019a) 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species; (USFWS, 2019a)

2. An ex situ seedbank is maintained in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would 4 provide assurance that a population could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019a)

3. All existing populations are stable or increasing in the wild for at least 10 years. We expect above-ground population size to fluctuate annually in response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS,

2019a)

Recovery Actions:

- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history. ecology, and population dynamics of these species that will contribute to appropriate management strategies Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)
- 6. Evaluate progress of recovery effectiveness of management and recoverv actions and revise management plans. (USFWS, 1998)
- Recommendations for Future Actions from 2019 5-Year Review: There is no opportunity to expand the range of Scotts Valley spineflower due to naturally restrictive habitat requirements and a lack of existing suitable habitat due to surrounding development. The persistence of the remaining occurrences is therefore necessary for the recovery of the species. Any additional loss of colonies will limit the ability of the species to recover. The following actions are needed to promote the recovery of the species: •Manage and monitor all occurrences by formal management plans; •Survey all occurrences annually in order to evaluate species stability and guide management; •Collect seed and place it into a conservation seed bank; • Conduct seed viability and germination tests so that experimental outplanting can be conducted; • Attempt reintroductions at colonies where Scotts Valley spineftower had occurred but has not been recently observed; • Seek conservation easements and/or agreements with landowners for all occurrences; • Periodically survey potentially suitable habitat in the vicinity of the existing occurrences for the existence of previously unrecorded populations. (USFWS, 2019b)

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SPECIES ACCOUNT: *Chorizanthe robusta var. robusta* (Robust spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/04/1994; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Chorizanthe robusta var. robusta is an annual spineflower in the Pungentes section of the genus Chorizanthe in the buckwheat family (Polygonaceae) (Figure 1). Like other spineflowers, it is branched from the base and subtended by a rosette of basal leaves. The plant has an erect to spreading or prostrate habit, usually standing not more than 20 cm (8 in high). The whorl of bracts subtending the flowers (involucres) has thin white to pinkish scarious (thin and translucent) margins along the basal portions of the teeth. Relative to other spineflower taxa in the Pungentes section, the flower heads are large (1.5 to 2.0 cm in diameter and distinctly aggregate. (USFWS, 2004)

Taxonomy

Accepted by Kartesz (1994 checklist and 1999 floristic synthesis) and Flora of North America (2005). However, Hickman (1993) does not list this taxon as distinct. Results from a molecular study indicate that Chorizanthe pungens var. pungens and C. robusta var. robusta are more closely related to each another than to the other subspecific taxa in the C. pungens and C. robusta complex; however, more analysis is needed to determine how this would their taxonomic treatment (Brinegar 2006, Baron and Brinegar 2007, Brinegar and Baron 2008 cited by USFWS 2009). (NatureServe, 2015)

Historical Range

Occurrences of Chorizanthe robusta var. robusta populations have been recorded since the late 1800s, occurring as far north as San Francisco and Alameda Counties, and south into Monterey County. Inland occurrences were documented in and around San Jose and Los Gatos in Santa Clara County. Coastal and near coastal occurrences have been documented in San Mateo County and Santa Cruz County where it is found today (CNDDB). (USFWS, 2010)

Current Range

Currently, there are 11 populations in Santa Cruz County over a range of approximately 21 miles (33.8 km). (USFWS, 2010)

Critical Habitat Designated

Yes; 5/28/2002.

Legal Description

On May 28, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Chorizanthe robusta var. robusta (Robust spineflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (67 FR 36822-36845).

Critical Habitat Designation

The critical habitat designation for Chorizanthe robusta var. robusta includes six CHUs in Santa Cruz County, California. This species critical habitat encompasses approximately 469 acres (ac) (190 hectares (ha)) (67 FR 36822-36845).

Unit A: Pogonip Unit: Unit A consists of sandy openings within mixed forest habitat within Pogonip Park in the City of Santa Cruz. Of the 64 ha (159 acre) unit, 62 ha (152 ac) are owned and managed by the City; and the remainder are privately owned. As of the year 2000, two colonies comprising approximately 800 individuals occupied this site. This unit is important to the conservation of the taxon because it supports extant colonies of Chorizanthe robusta var. robusta. This unit also includes habitat that is important for the expansion of existing colonies and connectivity between the two colonies. In addition, it is also important because, aside from the Wilder Creek location which we were not aware of at the time of the proposed rule, Pogonip Park is the most northerly and westerly location known for the species. It is also one of only three known locations where C. r. var. robusta is found more than 5 km (3 mi) away from the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions may be important for the long-term survival and conservation of C. r. var. robusta.

Unit B: Branciforte Unit: Unit B consists of an old field/ grassland unit within the city limits of Santa Cruz. The 4-ha (9-ac) unit is privately owned. As of the year 2001, this unit supported a Chorizanthe robusta var. robusta population of approximately 500 individuals. This unit also includes habitat that is important for the expansion of the existing population. This unit is important to the conservation of the species because it contains one of the only eight known locations of C. r. var. robusta. It is the only other unit in close proximity to Unit A

Unit C: Aptos Unit: Unit C consists of sandy openings within maritime chaparral. The 28 ha (70 ac) unit is comprised entirely of private lands. As of the year 2000, this unit supported a Chorizanthe robusta var. robusta population of approximately 3,000 individuals. This unit also includes habitat that is important for the expansion of the existing population. It is also one of only three locations that supports C. r. var. robusta more than 5 km (3 mi) away from the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions (i.e., more inland conditions) may be important for the long-term survival and conservation of C. r. var. robusta.

Unit D: Freedom Unit: Unit D consists of grasslands and sandy areas in openings within maritime chaparral and oak woodland. This 4 ha (9 ac) unit is comprised of private and Pajaro Unified School District lands. As of the year 2001, this unit supports a Chorizanthe robusta var. robusta colony of several hundred individuals. Additionally, other colonies of C. r. var. robusta occur within a few hundred yards of the first colony; these additional colonies are outside the critical habitat boundary. This unit is important to the conservation of the taxon because it supports one of only eight known extant locations of C. r. var. robusta. This unit also includes habitat that is important for the expansion of the existing colony and connectivity between the two colonies.

Unit E: Buena Vista Unit: Unit E consists of grasslands within maritime chaparral and oak woodland on the Buena Vista parcel. The 55 ha (135 ac) unit is comprised entirely of private lands. As of 1999, this unit supports multiple colonies of Chorizanthe robusta var. robusta comprising approximately 1,500 individuals. This unit is important to the conservation of the species because it is one of only two units that supports multiple extant colonies of C. r. var.

robusta. This unit also includes habitat that is important for the expansion of the existing colonies, and connectivity between the multiple colonies.

Unit F: Sunset Unit: Unit F consists of coastal dune habitat, and is identical to critical habitat that is being designated for the Chorizanthe pungens var. pungens. All of this 35 ha (86 ac) unit is within Sunset State Beach. As of 2001, this unit supports the largest concentration of C. r. var. robusta, including dozens of colonies of comprising tens of thousands of individuals. This unit is important to the conservation of the species because it is only one of two units that supports multiple extant colonies of C. r. var. robusta. This unit also includes habitat that is important for the expansion of these existing colonies into areas that were historically occupied, and for maintaining connectivity between the multiple colonies. The unit is also important because it is the most southerly location known for the species and the only location, aside from Manresa State Beach which was not proposed for critical habitat, where C. r. var. robusta is found so close to the beach. Preserving the genetic characteristics that have allowed individuals at this site to survive under these slightly different environmental conditions (i.e., more coastal conditions) may be important for the long-term survival and conservation of C. r. var. robusta. Lands designated as critical habitat are under private, city, and State jurisdiction. The approximate areas of designated critical habitat by land ownership are shown in Table 1.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chorizanthe robusta var. robusta critical habitat consists of four components (67 FR 36822-36845):

(i) Sandy soils associated with active coastal dunes, coastal bluffs with a deposition of windblown sand, inland sites with sandy soils, and interior floodplain dunes;

(ii) Plant communities that support associated species, including coastal dune, coastal scrub, grassland, maritime chaparral, oak woodland, and interior floodplain dune communities, and have a structure such that there are openings between the dominant elements (e.g, scrub, shrub, oak trees, clumps of herbaceous vegetation);

(iii) Plant communities that contain no or little cover by nonnative species which would complete for resources available for growth and reproduction of Chorizanthe robusta var. robusta; and

(iv) Physical processes, such as occasional soil disturbance, that support natural dune dynamics along coastal areas.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for Chorizanthe robusta var. robusta within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of C. r. var. robusta are maintained, and have the ability to reproduce and disperse into surrounding habitat at those sites. In other cases, however, active management may be needed to maintain the primary constituent elements for C. r. var. robusta. We have outlined below the most likely kinds of special management and protection that C. r. var. robusta may require. (1) In near-coastal areas, the supply and movement of sand along the coast must be maintained to create the dynamic dune habitats that are needed for

Chorizanthe robusta var. robusta. (2) In more interior locations, the sandy soils on which Chorizanthe robusta var. robusta is found should be maintained to optimize conditions for the species. Physical properties of the soil, such as its chemical composition, salinity, and drainage capabilities would best be maintained by limiting or restricting the use of herbicides, fertilizers, or other soil amendments. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and dispersal agents are maintained. The use of pesticides should be limited or restricted so that viable populations of pollinators are present to facilitate reproduction of Chorizanthe robusta var. robusta. Fragmentation of habitat through construction of roads and certain types of fencing should be limited so that seed dispersal agents may move seed of C. r. var. robusta throughout the unit. (4) In some plant communities, it may be important to maintain a mosaic of different-aged stands of coastal scrub or maritime chaparral patches so that openings that support Chorizanthe robusta var. robusta will be maintained. Depending on location, the use of prescribed fire, thinning, or other forms of vegetation management may be useful in creating and maintaining this type of mosaic. (5) In all plant communities where Chorizanthe robusta var. robusta occurs, invasive, non-native species such as harding grass (Phalaris aquaticus), veldt grass (Ehrharta spp.), European beachgrass, iceplant, and other species need to be actively managed to maintain the open habitat that C. r. var. robusta needs. (6) Certain areas where Chorizanthe robusta var. robusta occurs may need to be fenced to protect them from accidental or intentional trampling by humans and livestock. While C. r. var. robusta appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect C. r. var. robusta during its critical season of growth and reproduction.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (self-fertilization) (USFWS, 2010)

Lifespan

Adult: 1 year (annual) (USFWS, 2010)

Breeding Season

Adult: April to June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Murphy (2003) revealed that insect pollination significantly increased seed set for C. robusta var. robusta, suggesting that pollinators may enhance its overall fitness. (USFWS, 2010)

Reproduction Narrative

Adult: Chorizanthe robusta var. robusta is a short-lived annual spineflower in the Pungentes section of the genus Chorizanthe, in the buckwheat family (Polygonaceae). Chorizanthe robusta var. robusta is self-compatible and capable of self-fertilization, seed set was demonstrated to be higher in individuals that were insect pollinated. Germination of Chorizanthe robusta var. robusta occurs during winter months; flowering occurs from April through June, and in some cases throughout the summer. (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sand/dunes (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Requires open canopy; shade intolerant (USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: Moderate (inferred from USFWS, 2010)

Habitat Narrative

Adult: Specific biological and physical habitat components that are essential to the conservation of Chorizanthe robusta var. robusta include sandy soils associated with active coastal dunes and inland sites with sandy soils; plant communities that support associated species, including coastal dune, coastal scrub, grassland maritime chaparral, and oak woodland communities, and have a structure such that there are openings between the dominant elements; plant communities that contain little or no cover by nonnative species that would compete for resources available for growth and reproduction of C. robusta var. robusta; and physical processes, such as occasional soil disturbance, that support natural dune dynamics along coastal areas (Service 2004). (USFWS, 2010)

Dispersal/Migration

Motility/Mobility

Adult: High (inferred from USFWS, 2010)

Dispersal

Adult: High (inferred from USFWS, 2010)

Dispersal/Migration Narrative

Adult: Seeds disperse when the involucral spines attach to passing animals. Small mammals and birds are the most likely seed dispersers of Chorizanthe robusta var. robusta; though wind also plays a part in the dispersal of seeds (Service 2004). (USFWS, 2010)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

11 Populations. 9 populations with plants (extant) (USFWS, 2023).

Population Size:

Total counts ~199,000 total plants (9 populations) (USFWS, 2023).

Population Narrative:

Currently, there are 11 populations in Santa Cruz County over a range of approximately 21 miles (33.8 km). Three sites are on park lands that support large populations on the order of 10,000 individuals or more; the other seven sites support significantly smaller populations (USFWS 2004). Population size value left blank for this seed-banking annual because the large number of individuals suggests a sense of security that is not warranted. Approximately 12 occurrences observed since 1989 (CNDDB 2008). Known from 10 sites that support a total of 12 populations (USFWS 2004). Recent management actions performed by Baron and Eidam at the Pogonip sites may prove that slight disturbance can be beneficial for populations of C. robusta var. robusta. The disturbance can create necessary open areas that increase light, heat, and water, and may improve conditions for ground nesting pollinators (Murphy 2003). While we believe stochastic extinction is less of a threat now for C. robusta var. robusta than at the time of listing, it is still a concern for several of the smaller-sized populations. (USFWS, 2010) . 11 Populations. 9 populations with plants (extant). Total counts ~199,000 total plants (9 populations (USFWS, 2023).

Threats and Stressors

Stressor: Recreation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: In the various park units at Pogonip and Sunset and Manresa State Beaches, recreational activities can have an impact on Chorizanthe robusta var. robusta, although low to moderate levels of impacts may be beneficial. Recent management actions performed by Baron and Eidam at the Pogonip sites may prove that slight disturbance (in this case, scraping with a McLeod) can be beneficial for populations of C. robusta var. robusta. The disturbance can create necessary open areas that increase light, heat, and water, and may improve conditions for ground nesting pollinators (at Pogonip, Steniolia elegans (digger wasp) and an undescribed wasp species of the genus Tachysphex (Murphy 2003)). These populations at Pogonip showed a large increase in numbers after management actions were implemented (Baron and Eidam 2008). Conversely, without proper management, high levels of recreational impact at these park sites (i.e., horseback riding and mountain biking) may eliminate the taxon altogether (Service 2004). (USFWS, 2010)

Stressor: Invasive plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: An observation in 2009 reported that the Branciforte population appears healthy; however, the presence of a chain link fence for excluding off-highway vehicles is barring fire safety mowing that had previously helped control invasive trees from encroaching into the population. As a result, the population is now also being threatened by invasives, particularly Ailanthus altissima (tree of heaven) (Cheap, in litt. 2009a). Upon further observation at the Branciforte site, it is clear that Chorizanthe robusta var. robusta is well established there and has the potential to flourish. However, Ailanthus altissima is prolific and abundant within the C.

robusta var. robusta population and is an even more imminent threat than originally considered (Chang and Glenn, Service biologists, pers. obs. 2009b). The shade created by this non-native tree will inevitably eliminate C. robusta var. robusta from the site. In addition to Ailanthus altissima, other species that have been identified as threats to the Branciforte population are Rubis ursinus (Pacific blackberry), Rubis discolor (Himalayan blackberry), Carpobrotus edulis (iceplant), Lathyrus latifolius (sweet pea), Genista monspessulana (French broom), Lobularia maritima (sweet alyssum), and Lotus scoparius var. scoparius (deerweed) (Boursier and Hardwicke 2007). (USFWS, 2010)

Stressor: Residential development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Populations of Chorizanthe robusta var. robusta on private lands are subject to additional and sometimes more serious threats. The Branciforte site has been approved by the City of Santa Cruz for a housing development project, though it is unknown when construction activities will begin. The Service and the California Native Plant Society (CNPS) submitted comments recommending larger buffer areas for C. robusta var. robusta populations. In the early 1990s, the Freedom population at Aptos High School suffered losses of Chorizanthe robusta var. robusta individuals when land was modified in preparation for lot divisions. Additionally, in the late 1990s, the school widened a foot path running through the population in order to accommodate vehicles (Service 2004). An observation made in 2004 recorded in the CNDDB reported that a large colony east of the school baseball field remained intact, but that plants below the parking lot were eliminated by construction. Upon subsequent observation at this site, C. robusta var. robusta was visible along a foot trail southeast of the baseball field, growing on the edges of the trail, where the sandy soil is loose and there is less growth of other plants (Chang and Glenn, pers. obs. 2009a). (USFWS, 2010)

Stressor: Herbivory (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Baron and Bros (2005) investigation of insect herbivory on Chorizanthe robusta var. robusta concluded that insect herbivores reduced plant size, significantly decreasing both size and lifetime seed production of C. robusta var. robusta, subsequently compromising the plant's ability to obtain resources. In addition, rabbits browsing on C. robusta var. robusta removed mature seed heads from 11 percent of the study plants. The results of this study suggest that effects of herbivory can potentially be a threat to C. robusta var. robusta, or exacerbate other threats to C. robusta var. robusta populations (Baron and Bros 2005). (USFWS, 2010)

Stressor: Variation in annual weather patterns (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Annuals and other monocarpic plants (individuals that die after flowering and fruiting), such as Chorizanthe robusta var. robusta, are typically vulnerable to random fluctuations or variation in annual weather patterns and other environmental factors (Service 1994). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. (USFWS, 2010)

Stressor: Stochastic extinction (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A small population size may make it difficult for a species to persist while sustaining other impacts such as habitat alteration that favors non-native species. Although Chorizanthe robusta var. robusta is self-compatible and capable of self-fertilization, seed set was demonstrated to be higher in individuals that were insect pollinated. Small populations may also have a more difficult time attracting pollinators and therefore may experience lower seed viability rates. Many of the populations appear to be stable or support a larger number of individuals than we knew of at the time of listing. While we believe stochastic extinction is less of a threat now for C. robusta var. robusta than at the time of listing, it is still a concern for several of the smaller-sized populations. (USFWS, 2010)

Stressor: Competition (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Competition from nonnative species, or native shrub and tree species, can lead to declines in population abundance from shading and competition for resources (Service 2004, pp. 22-23; Service 2010, pp. 10, 12). The Freedom population, as well as the Ellicott Slough population, are believed to have declined to zero at least in part from shrub and tree shading as well as invasion by nonnative annual grasses (Service 2010, pp. 10, 12). Management actions to reduce competing vegetation and reduce canopy shading at the Branciforte and both Pogonip populations have resulted in increasing abundance of robust spineflower at those locations, suggesting that competition remains a threat to the species, but is a threat that can be successfully mitigated with management. The coastal populations at Manresa and Sunset State Beaches are likely persisting in the absence of management due to natural habitat conditions that inhibit establishment of shrub, trees, and nonnative annual species through moderate levels of disturbance. In the absence of natural disturbance processes, or management to reduce competing biomass, competition will remain a threat to robust spineflower (USFWS, 2023).

Stressor: Herbivory (USFWS, 2023)
Exposure:
Response:

Consequence:
Narrative: Moth larvae and brush rabbits have been observed to decrease plant size and reduce seed output of robust spineflower, but herbivory has not been attributed to the declines observed at the Ellicott Slough and Freedom populations (Baron and Bros 2005). Herbivory is most likely not a severe threat to robust spineflower but is a contributing factor that may be inhibiting recovery or exacerbating the effects of other threats (USFWS, 2023).

Stressor: Vandalism (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: There have been four documented instances of vandalism at three different occurrences of robust spineflower since 2019. A trailer was moved onto the Merk Road occurrence and abandoned in 2019 (Olberding 2019, pp. 20-21). This resulted in a broken fence and rutting, although the population appeared to rebound without management upon the removal of the trailer (Olberding 2021b, p. 13). In both 2019 and 2021, a homeless encampment was established at the Pogonip 1 occurrence which resulted in trampling and trash accumulation. Remediation in both years involved removing debris and the population appeared to rebound without additional management (K. Lyons pers. com. 2022). At the Branciforte population, a firebreak was established outside of the timeframe established in the Mitigation and Monitoring Plan (Olberding 2021a, pp. 20-21, 24; Olberding 2021b pp. 21, 24-25). The effect to the population is likely low since the disturbance was confined to the margin of the preserve area used as a buffer zone. Enforcement of the timing of establishing fire breaks has proven difficult because the action is being undertaken by an unknown entity. The prohibited actions are not believed to have resulted in a significant decline of individuals due to the estimated abundance observed during annual monitoring relative to the comparatively small loss of individuals. However, the repeated nature of the events shows that enforcement has been unsuccessful and future, more destructive vandalism is possible at this location. Each of these vandalism events were not purposeful actions to remove robust spineflower. The Pogonip occurrence appears to have a location that is attractive to the establishment of homeless encampments, and this may continue to occur as this societal problem persists. The Merk Road location is along a road lending itself towards vehicle or other refuse abandonment. The vandalism at the Branciforte occurrence was conducted for perceived safety reasons and not to intentionally remove robust spineflower. Fortunately, none of these actions have been observed to have resulted in sustained declines of individuals and monitoring at all locations is planned for future years (USFWS, 2023).

Recovery

Reclassification Criteria:
1. Within each recovery unit, the number of populations and acreage of occupied habitat for each population has been protected. (USFWS, 2004)

2. Habitat in each protected population has been appropriately managed and restored. (USFWS, 2004)

3. Population monitoring shows a stable or increasing trend in population size or density during favorable precipitation years over at least 10 years. (USFWS, 2004)

Recovery Priority Number: 9

Delisting Criteria:

1. Within each recovery unit, the number of populations and acreage of occupied habitat for each population has been protected. (USFWS, 2004)

2. Habitat in each protected population has been appropriately managed and restored. (USFWS, 2004)

3. Population monitoring shows a stable or increasing trend in population size or density during favorable precipitation years over at least 10 years. (USFWS, 2004)

4. The total number of populations has increased to at least 18, at least 15 of which have an average population of 1,000 individuals in favorable (nondrought) rainfall years over at least 10 years (beyond the downlisting monitoring period). (USFWS, 2004)

Recovery Actions:

- Protect habitat for Chorizanthe robusta var. robusta at all existing sites. (USFWS, 2004)
- Manage habitat for Chorizanthe robusta var. robusta at existing sites. (USFWS, 2004)
- Conduct management-oriented research. (USFWS, 2004)
- Establish populations in appropriate habitat within the historical range of the species. (USFWS, 2004)
- Review and revise recovery criteria as new information becomes available. (USFWS, 2004)
- Develop and implement an outreach program. (USFWS, 2004)
- 1. Establish and/or continue long-term management and monitoring programs for Chorizanthe robusta var. robusta populations, particularly those on park and refuge lands. (USFWS, 2010)
- 2. Continue genetic research to clarify uncertainties within the Chorizanthe robusta/Chorizanthe pungens complex. (USFWS, 2010)
- 3. Investigate opportunities for conservation of the Branciforte population, and remove Ailanthus altissima (tree of heaven) and other invasive species at the site, in accordance with the “Branciforte Creek Residential Development Robust Spineflower (Chorizanthe robusta var. robusta) Management and Monitoring Plan,” whether or not planned development goes forth. (USFWS, 2010)
- 4. Conduct surveys on suitable habitat and within the historical range to locate new populations, in conjunction with examination of genetic information to ensure the plant’s identity. Discovery of additional new populations such as the population at Merk Road will broaden our understanding of Chorizanthe robusta var. robusta’s status, its habitat, and range. (USFWS, 2010)
- 5. Initiate an outplanting program to establish new Chorizanthe robusta var. robusta populations in appropriate habitat within its historical range by: a. locating appropriate habitat for outplanting; b. conducting experimental habitat enhancement; c. applying appropriate habitat enhancement techniques; d. conducting propagation experiments to determine the best techniques for developing material to use in introductions; e. conducting experimental introductions; f. developing a protocol to guide introductions; g. conducting large-scale introductions on appropriate sites; and h. monitoring newly established populations (Service 2004). (USFWS, 2010)

- 6. Establish an outreach program to increase public awareness for populations on both public and private lands, particularly on park lands, refuges, and at Aptos High School. (USFWS, 2010)
- 7. Revise the recovery plan and recovery criteria as appropriate based on new information and/or research. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. All occurrences should be revisited to evaluate presence and suitable habitat. 2. Occurrences currently protected from development should be managed to reduce competing vegetation using the Pogonip occurrences or Branciforte as an example of successful methodologies. 3. Reintroductions within the current and historical range should be considered to evaluate techniques for population establishment and specific ecological site conditions (USFWS, 2023).

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SPECIES ACCOUNT: *Chorizanthe valida* (Sonoma spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; California/Nevada (Region 8)

Physical Description

A herbaceous annual, very similar in appearance to Chorizanthe howellii (Howell's spineflower), the primary distinguishing characteristic of C. valda being its ascending to erect growth habit and the brightly colored red and white involucres. The bright red base of the involucre's straight spines contrasts with their bright ivory tips, and the red spine bases contrast sharply with the dull-colored involucral tube. The basal leaves of C. valida are 1 to 2.5 centimeters (0.4 to 0.9 inch) long, 4 to 8 millimeters (0.2 to o.3 inch) wide, and often less hairy on the top surface than underneath. The flowers are 5 to 6 millimeters (0.2 to 0.3 inch) long. (USFWS, 1998)

Taxonomy

Closely related to C. pungens (Bittman 1998). (NatureServe, 2015) The Sonoma spineflower, Chorizanthe valida, was described by Sereno Watson in 1877 from specimens collected in 1840-41 by Ilya G. Vosnesensky, an entomologist and curator ofthe Zoological Museum in St. Petersburg, Russia, who traveled and collected in northern California. (USFWS, 1998)

Historical Range

The Point Reyes area in Marin County, California. Possible historical occurrences from the interial portion of Sonoma County. (USFWS, 2010)

Current Range

Near the eastern end of Abbott's Lagoon on the Lunny "G" Ranch, at Point Reyes National Seashore (PRNS) in Marin County, California. (USFWS, 2019)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 1998)

Breeding Season

Adult: June to August (USFWS, 1998)

Reproduction Narrative

Adult: Chorizanthe valida is an herbaceous annual in the buckwheat family (Polygonaceae). Flowers, which appear June through August, are white to lavender to rose in color, are 5 to 6 mm (0.20 to 0.24 in long (Reveal and Hardham 1989) and occur in dense, ball-shaped, pinkish clusters with green bracts below. (USFWS, 1998; USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mild maritime climate, characterized by fog and winter rains (USFWS, 1998)

Environmental Specificity

Adult: Very Narrow (USFWS, 2010)

Habitat Narrative

Adult: The Abbott's Lagoon colony is located in coastal prairie grassland and occurs on the Sidrak sand soil type, consisting of well-drained, Pleistocene dune sands with a 2-4 percent slope, bearing to the north-northwest (towards Abbott's Lagoon). This soil type has low to moderate available water capacity, and can support only a limited plant community that is drought tolerant (Davis and Sherman 1992). The species occurs in areas of relatively mild maritime climate, characterized by fog and winter rains. The fog helps keep summer temperatures cool and winter temperatures relatively warm, and provides moisture in addition to the normal winter rains. (USFWS, 1998; USFWS, 2010)

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 1998)

Dispersal

Adult: Low (USFWS, 1998)

Dispersal/Migration Narrative

Adult: After about a month, the dull brown flowerhead begins to disintegrate and the spiny seeds are dispersed on the ground nearby. (USFWS, 1998)

Population Information and Trends

Population Trends:

Variable (USFWS, 2010)

Number of Populations:

1 (USFWS, 2010)

Population Size:

Variable; estimates from 62,580 individuals in 2006 to 710,460 individuals in 2009 (USFWS, 2010)

Population Narrative:

A single extant endemic population of Chorizanthe valida exists near the eastern end of Abbott's Lagoon on the Lunny "G" Ranch, at Point Reyes National Seashore (PRNS) in Marin County, California at an elevation of approximately 15 meters (49 feet) above sea level. The population of Chorizanthe valida at Abbott's Lagoon exists as two disjunct subpopulations that are spatially separated from each other by approximately 80 meters (262 feet). The larger of the two subpopulations is referred to as the "main population" and is approximately 4 times as large as the smaller of the two subpopulations. The smaller of the two subpopulations is referred to as the "sub-population". Based on the results of mapping the spacial distribution of the population in 1999, 2000, 2005, 2006 and 2008, the area occupied by Chorizanthe valida at Abbott's Lagoon fluctuates seasonally, but does not appear to be contracting (Williams 2008). According to the recovery plan (Service 1998), the entire Abbott's Lagoon population of C. valida was estimated to cover 358 square meters (1,076 square feet) in 1983. In 1984, more than 2,000 plants covered an area of 5,130 square meters (16,829 square feet) (Fowler and Fellers 1984). According to Davis and Sherman (1992), the entire population exists within 17,000 square meters (55,773 square feet). Between 1983 and 1998, the California Native Plant Society (CNPS) conducted a census of the population and the number of individuals varied widely from 100 to 30,000 plants (Rogers 2005). In 1999, PRNS staff began developing a long-term, quantitative monitoring program for the Abbott's Lagoon population. Over the next 6 years, several monitoring methods were tested. In 1999, the number of Chorizanthe valida plants in the main population was estimated to be 18,000. In 2001, the number was calculated to be 184,311 individuals. The main population was not counted in 2000 or after 2002. From 2002 to 2004 permanent monitoring plots were used as indicators of the overall population trend in the main population. However, data collected using these permanent plots have now been rejected due to statistical invalidity. The number of plants in the sub-population has increased dramatically each year it has been censused, from 4,707 individuals in 1999 to 16,836 in 2001. Beginning in 2005, PRNS staff began sampling the main population of Chorizanthe valida using a macroplot. The macroplot is 100 x 40 meters (328 x 131 feet), encompassing 35 temporary quadrats each measuring 40 x 0.05 meters (131 x 0.16 feet). Sample results estimated there were 560,171 plants in the macroplot in 2005, with 95% confidence that the true number of plants in the macroplot is between 470,000 and 650,275. Data extrapolation to the entire population is beyond reasonable statistical inference. Since 2005, the population within the macroplot has fluctuated from an estimated 62,580 individuals in 2006 to 710,460 individuals in 2009. (USFWS, 2010)

Threats and Stressors

Stressor: Recreation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Trampling by hikers and accidental incursion still pose a minor threat to C. valida. (USFWS, 2010)

Stressor: Off-road vehicles (USFWS, 2010)
Exposure:
Response:
Consequence:

Narrative: Due to the presence of a road that bisects the Abbott's Lagoon population, which is used for ranching activities, off-road vehicle use still poses a threat. However, off-road vehicle use within PRNS is not permitted for recreational purposes and the road bisecting the Abbott's Lagoon population is scheduled for realignment in 2010; thus, this threat will be drastically reduced as a result. (USFWS, 2010)

Stressor: Cattle grazing (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The unknown effects of cattle grazing also remain a threat. However, since Chorizanthe valida is unpalatable to cattle and cattle consume many of the nonnative invasive plants that threaten the species, the removal of cattle from the system could in itself threaten the species. Due to the results of Davis and Sherman (1992), it is now believed the damaged caused by livestock trampling is outweighed by the benefits of grazing livestock in reducing competition with other plant species. (USFWS, 2010)

Stressor: Stochasticity (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Because Chorizanthe valida exists as a single endemic population and a single reintroduced population, with plant densities that fluctuate annually, it is highly susceptible to stochastic events such as prolonged drought, fire, disease, or other unforeseen causes of extinction. Stochasticity remains a major threat to the species. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Impacts to this species as a result of climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and when climate change will affect the species, the extent of average temperature increases in California/Nevada, or potential changes to the level of threat posed by drought, fire, etc. (USFWS, 2010)

Stressor: Nonnative invasive species (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The population of Chorizanthe valida at Abbott's Lagoon is surrounded by the invasive perennial grass species Holcus lanatus (common velvetgrass) on all sides. This nonnative invasive grass is of concern to the long term management of this population. As part of the Preventing Extinction Grant awarded to PRNS, H. lanatus and Lupinus arboreus will be removed from the area. Regardless, nonnative invasive species remain an ongoing threat to C. valida. (USFWS, 2010)

Stressor: Fire suppression (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The effects of fire suppression on Chorizanthe valida are not known. The natural fire return interval at PRNS is likely relatively long due to persistently moist and cool conditions coupled with relatively low incidence of lightning strikes (Keeley 2002). However, the use of fire by Native Americans in the area is not known. (USFWS, 2010)

Recovery

Reclassification Criteria:
A/1: At least six successful populations have been established. These populations will be considered self-sustaining populations after 15 years, which includes a normal precipitation cycle. (USFWS, 2019)

A/2: The area of each Sonoma spineflower population is maintained at or above approximately 2 acres in size. (USFWS, 2019)

A/3: The cover of invasive native and non-native plants, such as bush lupine, at all sites is controlled at <1% within areas containing Sonoma spineflower. (USFWS, 2019)

A/4: There are management measures implemented to address the threats of invasive species and other problems, including pedestrians and off-road vehicles at some sites. (USFWS, 2019)

A/5: Monitoring reveals that management actions are successful in reducing threats of invasive non-native species. (USFWS, 2019)

E/1: The number of individuals within each Sonoma spineflower population remains at or above 90,0004 for 15 years, which includes cycles of normal precipitation. (USFWS, 2019)

E/2: Seeds are stored in at least two Center for Plant Conservation certified facilities; seed germination, propagation, and out-planting propagation techniques are understood. (USFWS, 2019)

Delisting Criteria:
A/1: At least eight successful populations have been established on appropriate habitat [that] has been secured within the historic range. Populations will be self-sustaining after 15 years, which includes a normal precipitation cycle. (USFWS, 2019)

A/2: Further invasion or increase in non-native or native invasive plant species has been prevented, including perennial species such as bush lupine and coyotebrush, within all Sonoma spineflower populations. (USFWS, 2019)

A/3: Habitat occupied by the species that is needed to allow delisting has been voluntarily secured, with long-term commitments and, if possible, endowments to fund [the] conservation of the native vegetation. (USFWS, 2019)

E/1: Ensure that seed banking practices, including seed germination, propagation, and outplanting propagation techniques, are understood and implemented as needed. (USFWS, 2019)

E/2: Seeds at banking facilities are renewed at a rate to ensure that seed stores remain viable in perpetuity. (USFWS, 2019)

Recovery Actions:

- Protect habitat of the listed species and their occurrences on private lands. The listed species should be secured where they occur on private lands through conservation easements, conservation agreements, or purchase where there are willing sellers. This is necessary to prevent further declines in distribution and abundance of the listed species from loss and degradation of habitat. The development of cooperative weed control programs will greatly facilitate recovery of these species, so it is a high priority to develop landowner incentives and providing funds for control of invasive exotic vegetation is a high priority. This task regularly refers to "occurrences" as defined by the NDDB. Readers are reminded that "occurrences" are convenient units for storing data, and do not necessarily coincide with biological populations nor with geographic units of vegetation or geological features such as the dune fields upon which these plants depend. (USFWS, 1998)
- Minimize threats to the plants from invasive non-native species, and minimize threats on private and public lands. Invasive non-native plant species are immediate biological threats the listed plant species. Infestations of invasive plant species need to be controlled. (USFWS, 1998)
- Develop management strategies through a research program to document the listed species' life histories and their responses to vegetation management. Habitat management for the species in this recovery plan is needed to control the threats to their existence. Data must be obtained to determine how to conduct the management. (USFWS, 1998)
- Manage occurrences and habitats. Management of the listed plant species and its habitat will depend upon information gained from monitoring, threat analysis and the evaluation of protection alternatives. It will be important to involve the expertise of local landowners, land managers, and species experts to develop conservation programs. There may be different management programs for each species. The management program selected will require periodic review to ensure that it is effective in protecting the species. (USFWS, 1998)
- Monitor occurrences and threats to determine effectiveness of management and to establish delisting criteria. (USFWS, 1998)
- Coordinate recovery actions to protect other listed species and species of special concern. Other rare and endangered wildlife species occur within the ranges of the listed plant species. Management actions, such as the removal of invasive non-native plant species through herbicide application, may affect these species. Management actions should avoid adverse impacts to these species and their habitats, and actively include them in recovery actions to facilitate their reoccupation of historic ranges and prevent range collapse or declines in their abundance. (USFWS, 1998)
- Develop ecosystem restoration and multi-species reintroduction projects at degraded dune systems. Numerous dune systems within the historic range of listed species and species of concern have either reduced value or none for them because of past or ongoing degradation of habitat quality. Benefits for multiple species can be efficiently regained by establishing

habitat and population restoration programs for these undermanaged or degraded dune systems. By returning independent dune systems within historic range of rare species to current ecological function, the risk of species extinction can be substantially decreased. (USFWS, 1998)

- Develop and implement an outreach program. Increasing public awareness of the listed plant species will facilitate efforts to preserve the species,, associated rare species, and the coastal dune ecosystem. Prepare and distribute regionally specific informational brochures and audio-visual and sign programs on preservation and recovery. Through the cooperative interagency working groups, prepare brochures and audio-visual materials that describe the plight of the listed species and the regional efforts being undertaken for their recovery. Disseminate the brochures to affected landowners and other community facilities. Provide the audio-visual materials to public facilities, such as park interpretive programs and school programs. Prepare interpretive educational signs for PRNS and other locations. (USFWS, 1998)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 1. Establish or protect additional populations of Sonoma spineflower. 1.1 Introduce at least three new self-sustaining populations (Priority 1) 1.2 Research possible insect pollinator species to determine appropriate management strategies for reintroduction sites. 1.3 Continue work on seedbank dynamics with the goal of using the information to run a population viability analysis on the species (Priority 2). 1.4 Research to determine what might cause population declines within the wild population, focusing on grazing intensity and pollinators (Priority 1) (USFWS, 2019)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 2. Conduct research to better understand life history and annual establishment. 2.1 Determining the extent of Sirdrak Sand outside of the park to help inform the location of potential introduction sites (Priority 3). 2.2 Conduct an analysis of soil type and nutrients/water balance, vegetation cover, disturbance dynamics (grazing, rodents, rabbits) to identify new introduction sites outside of the PRNS to determine if appropriate habitat exists for possible reintroductions (Priority 3). 2.3 Research the potential to augment nesting habitat for main pollinators near some of the current and future introduction sites (Priority 3). (USFWS, 2019)
- Additional Site-specific Recovery Actions from 2019 Amended Recovery Plan: 3. Monitor and manage existing populations on protected lands. 3.1 Maintain shrub cover within existing sites at acceptable levels through removal, as necessary (Priority 3). 3.2 Determine where some of the main pollinators identified in the two years of study on Sonoma spineflower nest near these populations (Priority 3). 3.3 Research the potential to augment nesting habitat for main pollinators near some of the current and future introduction sites (Priority 3). (USFWS, 2019)

References

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SPECIES ACCOUNT: *Chromolaena frustrata* (Cape Sable Thoroughwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

Physical Description

Chromolaena frustrata is a perennial herbaceous plant. Mature plants are 5.9 to 9.8 inches (in) (15 to 25 centimeters (cm)) tall with erect stems. The blue to lavender flowers are borne in heads, usually in clusters of two to six. Flowers are produced mostly in the fall, though sometimes year round. (USFWS, 2014)

Taxonomy

Chromolaena frustrata (Family: Asteraceae)was first reported by Chapman, from the Florida Keys in 1886, naming it Eupatorium heteroclinium (Chapman 1889). Synonyms include Eupatorium frustratum B.L. Robinson and Osmia frustrata (B.L. Robinson) Small. (USFWS, 2014)

Historical Range

Chromolaena frustrata was historically known from Monroe County, both on the Florida mainland and the Florida Keys, and in Miami-Dade County along Florida Bay. The species was observed historically on Big Pine Key, Boca Grande Key, Fiesta Key, Key Largo, Key West, Knight's Key, Lignumvitae Key, Long Key, Upper Matecumbe Key, and Lower Matecumbe Key. (USFWS, 2013)

Current Range

In Everglades National Park, 11 Chromolaena frustrata populations supporting approximately 1,600 to 2,600 plants occur in buttonwood forests and coastal hardwood hammocks from the Coastal Prairie Trail near the southern tip of Cape Sable to Madeira Bay. In the Florida Keys, Chromolaena frustrata is now only known from Upper Matecumbe Key, Lower Matecumbe Key, Lignumvitae Key, Long Key, Big Munson Island, and Boca Grande Key (USFWS, 2013)

Critical Habitat Designated

Yes; 2/7/2014.

Legal Description

On January 8, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 7, 2014) for Chromolaena frustrata (Cape Sable Thoroughwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Florida (79 FR 1552-1590).

Critical Habitat Designation

The critical habitat designation for Chromolaena frustrata includes nine CHUs in Sabine and San Augustine Counties, Texas. This species critical habitat encompasses approximately 10,968 acres (ac) (4.439 hectares (ha)). General descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (79 FR 1552-1590).

Unit 1: Everglades National Park, Monroe County and Miami-Dade County: Unit 1 consists of a total of 6,166 acres (2,495 hectares) in Monroe and Miami-Dade Counties. This unit is composed

entirely of lands in Federal ownership, 100 percent of which are located within the Everglades National Park.

Unit 2: Key Largo, Monroe County: Unit 2 consists of a total of 3,431 acres (1,388 hectares) in Monroe County. This unit is composed of Federal lands within Crocodile Lake National Wildlife Refuge (NWR) (804 acres (325 hectares)); State lands within Dagny Johnson Botanical State Park, John Pennekamp Coral Reef State Park, and the Florida Keys Wildlife and Environmental Area (2,170 acres (878 hectares)); and parcels in private ownership (457 acres (185 hectares)).

Unit 3: Upper Matecumbe Key, Monroe County, Florida: Unit 3 consists of 69 acres (28 hectares) in Monroe County. This unit is comprised of State lands within Lignumvitae Key State Botanical Park, Indian Key Historical State Park (24 acres (10 hectares)); City of Islamorada lands within the Key Tree Cactus Preserve and Green Turtle Hammock Park and parcels in private ownership (45 acres (18 hectares)).

Unit 4: Lignumvitae Key, Monroe County: Unit 4 consists of a total of 180 acres (73 hectares) in Monroe County. This unit is composed entirely of lands in State ownership, 100 percent of which are located within the Lignumvitae Key Botanical State Park on Lignumvitae Key in the Florida Keys. This unit includes the entire upland area of Lignumvitae Key.

Unit 5: Lower Matecumbe Key, Monroe County: Unit 5 consists of a total of 44 acres (18 hectares) in Monroe County. The unit is composed of State lands within Lignumvitae Key Botanical State Park and parcels owned by the Florida Department of Transportation (22 acres (9 hectares)), and parcels in private ownership (22 acres (9 hectares)).

Unit 6: Long Key, Monroe County: Unit 6 consists of a total of 208 acres (84 hectares) in Monroe County. This unit is composed of State lands within Long Key State Park (151 acres (61 hectares)) and parcels in private ownership (57 acres (23 hectares)).

Unit 7: Big Pine Key, Monroe County: Unit 7 consists of a total of 780 acres (316 hectares) in Monroe County. This unit is composed of Federal land within the National Key Deer Refuge (686 acres (278 hectares)) and parcels in private ownership (94 acres (38 hectares)).

Unit 8: Big Munson Island, Monroe County Unit 8 consists of a total of 28 acres (11 hectares) in Monroe County. This unit is composed entirely of lands in private ownership.

Unit 9: Boca Grande Key, Monroe County: Unit 9 consists of a total of 62 acres (25 hectares) in Monroe County. This unit is composed entirely of lands in Federal ownership, 100 percent of which is located within the Key West National Wildlife Refuge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Chromolaena frustrata critical habitat consists of four components (79 FR 1552-1590):

(i) Areas of upland habitats consisting of coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse,

calcareous, storm-deposited sediment. (B) Coastal rock barren (Keys cactus barren, Keys tidal rock barren) habitat that contains: (1) Open to semi-open canopy and understory; and (2) Limestone rock substrate. (C) Coastal hardwood hammock habitat occurring in Everglades National Park that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate of marl covered with a thin layer of highly organic soil. (D) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil, marl, humus, or leaf litter on top of the underlying limestone. (E) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) Plant communities of predominately native vegetation with either no invasive, nonnative species or with low enough quantities of nonnative, invasive plant species to have minimal effect on the survival of Chromolaena frustrata.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient area to sustain viable populations in coastal berm, coastal rock barren, coastal hardwood hammock, rockland hammocks, and buttonwood forest.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Special management considerations or protection are necessary throughout the critical habitat areas to avoid further degradation or destruction of the habitat that contains those features essential for the conservation of the species. The primary threats to the physical or biological features that Chromolaena frustrata depends on include: (1) Habitat destruction and modification by development; (2) competition with nonnative, invasive plant species that changes the habitat composition and structure; (3) wildfire that destroys habitat; (4) hurricanes and storm surge, if too frequent or severe destroy or modify habitat making it unsuitable; and (5) sea-level rise that changes the habitat to a more saline environment. Some of these threats can be addressed by special management considerations or protection while others (e.g., sea-level rise, hurricanes) are beyond the control of landowners and managers. However, while landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats to the habitats. Management activities that could ameliorate these threats include the monitoring and minimizing recreational activities impacts, nonnative species control, and protection from development. Precautions are needed to avoid the inadvertent trampling of Chromolaena frustrata in the course of management activities and public use. Development of recreation facilities or programs should avoid impacting these habitats directly or indirectly. Ditching and filling should be avoided because they alter the hydrology and species composition of these habitats. Sites that have shown increasing encroachment of woody species over time may require efforts to maintain the open nature of the habitat, which favors these species. Nonnative species control programs are needed to reduce competition and prevent habitat degradation. The reduction of these threats will require

the implementation of special management actions within each of the critical habitat areas identified in this rule. All critical habitat requires active management to address the ongoing threats listed. In summary, we find that each of the areas we are designating as critical habitat contain features essential to the conservation of Chromolaena frustrata that may require special management considerations or protection to ensure conservation of the species. These special management considerations and protections are required to preserve and maintain the essential features provided to C. frustrata by the ecosystems upon which it depends. A more detailed discussion of these threats is presented in the proposed rule under ''Summary of Factors Affecting the Species'' (77 FR 61836; October 11, 2012).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2014)

Reproduction Narrative

Adult: The reproductive biology and genetics of Chromolaena frustrata have received little study. Fresh C. frustrata seeds show a germination rate of 65 percent, but germination rates decrease to 27 percent after the seeds are subjected to freezing, suggesting that long-term seed storage may present difficulties (Kennedy et al. 2012, pp. 40, 50–51). While there have been no studies on the reproductive biology of C. frustrata, the Service can draw some generalizations from other species of Chromolaena, which reproduce sexually. New plants originate from seeds. Pollinators are likely to be generalists, such as butterflies, bees, flies, and beetles (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest, dune (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moderate to full sun exposure (USFWS, 2013)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits coastal rock barrens and berms, and sunny deges of rockland hammocks. The environmental specificity is narrow, as the plants occur only along the shore zone of limestone outcrops in southern Florida (NatureServe, 2015). Grows in open canopy habitats in coastal berms and coastal rock barrens and in semi-open to closed canopy habitats, including buttonwood forests, coastal hardwood hammocks and rockland hammocks (USFWS, 2014). It prefers moderate to full sun exposure (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal is largely by wind (Lakshmi et al. 2011, p. 1) (USFWS, 2014).

Population Information and Trends

Population Trends:

Decline of 70-90% (NatureServe, 2015)

Species Trends:

30 - 50% decline (NatureServe, 2015)

Number of Populations:

8 (USFWS, 2013)

Population Size:

~5,000 (NatureServe, 2015)

Adaptability:

Moderate (inferred from USFWS, 2014)

Population Narrative:

Eupatorium frustratum's restricted ecological range, and its drastic loss of habitat suggest that the number of individuals is declining (Halupa 2002). It once ranged widely in the Florida Keys, and is now known there only from a few small sites; on the mainland, it had several historical localities, and is now known from just one site. This species has experienced a long-term decline of 70-90% and short-term decline of 30 - 50%. Thousands of plants occur densely in one area on Big Munson Island, making counting difficult; a few hundred plants altogether occur at the other sites. In total, fewer than 5,000 plants were estimated in 2003 (Bradley and Gann 2004) and the only population discovered since is not large (USFWS 2005). Only one population has good viability/integrity (NatureServe, 2015). The species appears to be able to rebound at affected sites within a few years (Bradley 2009, pers. comm.) (USFWS, 2014). The current range of Chromolaena frustrata includes eight populations spread across 209 km (130 mi) (USFWS, 2013).

Threats and Stressors

Stressor: Habitat modification and destruction (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction and modification resulting from development are considered a major threat to Chromolaena frustrata throughout the species' range. The populations on Fiesta Key, Knights Key, Key Largo, and Key West were lost due to development. Fiesta Key is completely developed as a Kampgrounds of America (KOA) campground and is devoid of native plant communities. Knights Key is almost completely developed and has no remaining suitable habitat. Key Largo has undergone extensive disturbance and development. Two Chromolaena

frustrata populations, including the largest population (Big Munson Island), are located on private lands (the population at Long Key Layton Hammock only partially so), which are vulnerable to further development. (USFWS, 2013)

Stressor: Herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: On Big Munson Island, much of the Chromolaena frustrata population was observed to suffer from severe herbivory in 2004. No insects were observed on any plants, and the endangered Key deer (Odocoileus virginianus clavium) was the suspected culprit The significance of herbivory on C. frustrata population dynamics is unknown. (USFWS, 2013)

Stressor: Nonnative plant species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Schinus terebinthifolius (Brazilian pepper), a nonnative, invasive tree, occurs in the habitat of this species. Schinus terebinthifolius forms dense thickets of tangled, woody stems that completely shade out and displace native vegetation. Schinus terebinthifolius can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for Chromolaena frustrata, which prefers moderate to full sun exposure. Colubrina asiatica (lather leaf), a nonnative shrub, has invaded large areas of coastal berm and coastal berm edges. Colubrina asiatica also forms dense thickets and mats, and is of particular concern in coastal hammocks. Casuarina equisetifolia (Australian pine) invades coastal berm and is a threat to suitable habitat at most sites that could support this species. Casuarina equisetifolia forms dense stands that exclude all other species through dense shade and a thick layer of needles that contain substances that leach out and suppress the growth of other plants. (USFWS, 2013)

Stressor: Small, isolated populations (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The current range of Chromolaena frustrata includes eight populations spread across 209 km (130 mi) between ENP and Boca Grande Key; four of eight C. frustrata populations consist of fewer than 100 individuals. These populations may not be viable in the long term due to their small number of individuals. Threats exacerbated by small population size include hurricanes, storm surges, climate change, freezing temperatures, and recreation impacts. (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Projections suggest that sea level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida (U.S. Climate Change Science Program (CCSP) 2008). This species occurs in habitats near sea level in areas of south Florida where considerable habitat is projected to be lost to sea level rise by the year 2100.

Most populations are located less than 2 m (6.6 ft.) above mean sea level, and the effects of sea level rise are expected to be a continual problem for these species and their habitats. Using Rahmstorf et al. (2007), sea level rise projections of 100 to 140 cm, 80.5 to 92.2 percent of the Florida Keys land area would be inundated by 2100. A 1.8-m (5.9-ft) rise would inundate all existing mainland Chromolaena frustrata occurrences in ENP (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Fairchild Tropical Botanic Garden (FTBG) has 44 seed collections of Chromolaena frustrata from ENP, which were provided to the National Center for Genetic Resources Preservation (NCGRP) for testing and storage, and one collection from Lignumvitae Key. Key West Botanical Garden (KWBG) has one collection of Chromolaena frustrata from Big Munson Island. Numerous C. frustrata are planted on the KWBG grounds (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support Chromolaena frustrata (USFWS, 2013).

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Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821

USFWS 2014. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Chromolaena frustrata (Cape Sable Thoroughwort)

Final Rule. 79 Federal Register 5. January 8, 2014. Pages 1551 - 1590.

USFWS. 2013. Determination of Endangered Status for Chromolaena frustrata (Cape Sable Thoroughwort), Consolea corallicola (Florida Semaphore Cactus), and Harrisia aboriginum (Aboriginal Prickly-Apple)

Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

SPECIES ACCOUNT: *Cirsium fontinale var. fontinale* (Fountain thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; California/Nevada (Region 8)

Physical Description

An herbaceous perennial of the aster family (Asteraceae) with several stout, erect reddish stems 30 to 60 centimeters (1 to 2 feet) high. The basal leaves are 10 to 20 centimeters (4 to 8 inches) long with spine-tipped lobes; the leaves on the stems are smaller. The flowers are dull white to pinkish, becoming brown with age (Munz and Keck 1959, Hickman 1993). The egg-shaped, recurved bracts beneath the flower head of Cirsium fontinale var. fontinale distinguish it from the most similar thistle in the area, brownie thistle (Cirsium quercetorum) (Niehaus 1977a). (USFWS, 1998)

Taxonomy

Cirsium fontinale var. fontinale (fountain thistle) was first described as Cnicus fontinalis (Greene 1 886a). In 1892, Greene reassigned the plant to the genus Carduus (Greene 1892). Willis Jepson, in his Flora of Westem Middle California (1901), put the taxon in the genus Cirsiurn. In 1938, John Thomas Howell described a close relative of the fountain thistle, Cirsium fontinale var. obispoense (Chorro Creek bog thistle) (Howell 1938). (USFWS, 1998)

Historical Range

May have occurred in both San Mateo and Santa Clara Counties (Niehaus 1977a) although the Santa Clara County location may be erroneous (California Natural Diversity Data Base 1996. D. Kelch, pers. comm., 1996) (USFWS, 1998)

Current Range

San Mateo County, California. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (hybridization) (USFWS, 1998)

Breeding Season

Adult: June to October (USFWS, 2010)

Key Resources Needed for Breeding

Adult: The primary pollinators for C. fontinale var. fontinale in this study were Vosnesenski's bumblebee (Bombus vosnesenskii), common honeybee (Apis mellifera), and sweat bees (Halictidae). A study showed that C. fontinale var. fontinale experienced a 90 percent reduction in seed production when pollinators were excluded. (USFWS, 2010)

Reproduction Narrative

Adult: Generally, the flower heads are grouped into clusters and are nodding when in bloom. Flowers are white to pink or lavender and appear from June to October (Keil and Turner 1993). The species may hybridize with Cirsium quercatorurn (McClintock and Danielson 1975, CaliforniaNative Plant Society 1988b, California Natural Diversity Data Base 1996). The primary pollinators for C. fontinale var. fontinale in this study were Vosnesenski's bumblebee (Bombus vosnesenskii), common honeybee (Apis mellifera), and sweat bees (Halictidae). A study showed that C. fontinale var. fontinale experienced a 90 percent reduction in seed production when pollinators were excluded. (USFWS, 1998; USFWS, 2010)

Habitat Type

Adult: Serpentine seeps (USFWS, 2019)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands or chaparral (USFWS, 2019)

Dependencies on Specific Environmental Elements

Adult: Found at elevations between 90 and 190 m (300 to 600 feet) (USFWS, 1998)

Environmental Specificity

Adult: Very narrow (USFWS, 2010)

Habitat Narrative

Adult: Cirsium fontinale var. fontinale is found in serpentine seeps in grasslands or chaparral. The largest occurrence of the species, which is a group of approximately 10 subpopulations, is located on the east side of Crystal Springs Reservoir and is approximately 400 feet in elevation. Other plant species which occur there are tufted hairgrass (Deschampsia caespitosa ssp. 8 holciformis), bugle hedgenettle (Stachys ajugoides), seep monkeyflower (Mimulus guttatus), creeping wild rye (Leymus triticoides), coyote brush (Baccharis pillularis) and the invasive species, pampas grass (Cortaderia selloana). The Stulsaft Park occurrence is found in a serpentine seep in an opening in a coast live oak-bay (Quercus agrifolia – Umbellularia californica) woodland. The elevation of this site is 150 feet and the associated plants are spike bentgrass (Agrostis exarata), twotooth sedge (Carex serratodens), blue wildrye (Elymus glaucus) and iris-leaf rush (Juncus xiphioides) (CNDDB 2010). The occurrence east of Woodside Glens is located on a serpentine seep in an open area associated with sedges (Carex sp.), willows (Salix sp.), and monkeyflower (Mimulus sp.) (CNDDB 2010). The elevation of this site is not known. (USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

3 (USFWS, 2019)

Population Size:

~25,000 (USFWS, 2019)

Population Narrative:

At the time of listing in 1995, three Cirsium fontinale var. fontinale occurrences were known to exist: 1) the occurrence located east of Crystal Springs Reservoir which contained between 1,000 and 2,800 plants, 2) the occurrence located 10 km (6 mi) to the south in the Triangle area which contained between 100 and 200 plants, and 3) the third occurrence in Edgewood Park which consisted of a single plant in 1987. The most recent data show that a newly discovered portion (Boat Ramp) of the Crystal Springs Reservoir occurrence, Element Occurrence 1, had 19,342 plants in December 2009 (S. Foree, in. litt., January 12, 2010). Survey data collected from 2007 to 2009 estimate that the entire Crystal Springs occurrence consists of approximately 7 25,000 plants (Environmental Science Associates 2010). The Triangle area occurrence declined to 7 plants by 2000 (CNDDB 2010) and is no longer considered extant as of 2009 (S. Foree, San Francisco Water District, pers. comm., August 5, 2009). The single plant in Edgewood Park disappeared in 1996 (CNDDB 2010). Two small occurrences have been found since the time of listing. An occurrence of 50 plants (Element Occurrence 7) was discovered at Stulsaft Park, in Redwood City, in 2007. Another occurrence of about 20 plants (Element Occurrence 8) was found east of Woodside Glens in 2003 (CNDDB 2010). Currently, three occurrences of Cirsium fontinale var. fontinale are known to exist. (USFWS, 2019)

Threats and Stressors

Stressor: Hydrologic changes (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A small project to widen Highway 92 east of Crystal Springs Reservoir was under review and removal of water from the increased road surface had the potential to adversely affect some of the plants. Proposed construction of multi-use trails on San Francisco Water Department land in the Triangle area west of I-280 was considered a threat to a small occurrence through modification of hydrologic regimes and direct loss of plants. C. fontinale var. fontinale is dependent on seeps and springs, therefore, any reduction in water flow would have threatened the plants. A single plant in Edgewood Park occurred in a drainage ditch beside a trail. Clearing of this ditch to improve drainage could have damaged or destroyed the plant and any seedlings it may have produced. (USFWS, 2010)

Stressor: Habitat alteration (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: Decline of populations in the Crystal Springs region of San Mateo County has been attributed to destruction of habitat from urbanization, alteration of local hydrology (California Native Plant Society 1988b), dam construction in the 19th century (D. Kelch, in litt., 1996) and

highway construction (Niehaus 1977a, K. Berg, in litt., 1991). The type locality suffered negative impacts from construction of the Interstate 280 and the Highway 92 interchange. Some seeps were incidentally created in the process of construction and may provide habitat for Cirsiurn fontinale var. fontinale (D. Kelch, in litt., 1996). The available information is insufficient to evaluate whether the seeps and drainages in question supported Cirsiurn fontinale var. fontinale before construction or were colonized as a result of the project (B. Olson, in litt., 1998). (USFWS, 1998)

Stressor: Predation by beetle larvae (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Seed predation by unspecified insect larvae continued to be observed in seed collected from the Crystal Springs Reservoir occurrence in 2009 and 2010 (M. Wall in litt., 2009, 2010); however the effects of insect predation on C. fontinale var. fontinale have not been studied. . (USFWS, 2010)

Stressor: Non-native plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Several subpopulations were known to be threatened by nonnative plant species including pampas grass (Cortaderia selloana). Dumping of garden debris from households on the ridge above the plants covered the plants and rendered the habitat unsuitable for plant establishment and growth. Seed predation had been observed and was thought to increase the vulnerability of the species to elimination by chance events. A portion of Element Occurrence 1 near the intersection of Highway 92 and Interstate 280 is impacted by jubata grass (Cortaderia jubata) (S. Foree, pers. comm., August 5, 2009). (USFWS, 2010)

Stressor: Pollinators population decline (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A threat that has become evident since the time of listing, is the species' dependence on a limited number of pollinators, one of which (the common honeybee) is in decline. The Powell et al. (2009) study on Cirsium fontinale var. fontinale found that seed production was reduced by 90 percent when pollinators were excluded. The primary pollinators were the yellow-face bumblebee (Bombus vosnesenskii) and the honeybee (Apis mellifera). Native bumblebees and honeybees are in serious decline. A decline in the abundance and distribution in North America of several native bumblebees has been noted since the mid 1990's (Evans et al. 2008). Although it is not known whether B. vosnesenskii is experiencing losses, the severe decline of several previously common bumblebees, including the recent disappearance of the western bumblebee (Bombus occidentalis) from northern and central California, is cause for concern. A similar loss of the primary pollinators for C. fontinale var. fontinale would result in greatly reduced seed production and fewer numbers of plants. (USFWS, 2010)

Stressor: Habitat fragmentation (USFWS, 2010)
Exposure:

Response:
Consequence:
Narrative: Habitat fragmentation and loss from Highway 92 widening. Construction of trails on San Francisco Public Utilities Commission land in the Triangle could result in loss of plants or modification of hydrology. (USFWS, 2010)

Stressor: Nonnative insects (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: This species is threatened by the invasion of nonnative Argentine ants (Linepithema humile) and their impact on seed dispersal. Fountain thistle seeds contain a fat- and protein-rich protrusion known as an elaiosome, which native ants are known to eat. Dispersal occurs when a native ant either drops the seed while carrying it to their nest for later consumption or by eating the elaiosome and leaving the rest of the seed buried, which can then germinate when conditions are appropriate (Pemberton and Irving 1990; Christian 2001). Conversely, Argentine ants are known to consume the elaiosomes and leave the rest of the seed exposed under the parent plant, leaving it vulnerable to predation, disease, fire, and increased competition due to being in close proximity to its parent plant (Christian 2001). Since Argentine ants are known to displace native ants in areas they have invaded (Holway et al. 2002), and Argentine ants have been documented throughout the range of the fountain thistle (Niederer and Elliott 2011), it is likely the dispersal of fountain thistle at each known location has declined. (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act is the primary Federal law that has provided protection for these species since the dates of their listing as endangered in 1985 and 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Climate is predicted to change in California during the 21st century (Field et al. 1999; Cayan et al. 2005). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Field et al. 1999; Cayan et al. 2005). The predicted impacts on California's ecosystems projected with a high certainty include higher sea level; decreased suitable habitat for many terrestrial species as climate change intensifies human impacts; and increased competition among urban, agricultural, and natural ecosystem uses (Field et al. 1999). Although the specific effects of climate change on Cirsium fontinale var. fontinale are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect these species. (USFWS, 2010)

Recovery

Reclassification Criteria:

A/1: Occupied habitats at Crystal Springs Reservoir, Stulsaft Park, and Woodside Glens, and former known habitat at the Triangle and Edgewood Park sites, are fully protected and managed with the primary intention of preserving them in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible.13 Alternatively, currently unoccupied sites may be protected as a substitute for currently occupied sites (or sites containing former known habitat) if they are of equivalent habitat quality, are managed through a Service-approved management plan (see A/2 below), and meet the occupancy criterion (see E/1 below). Populations should be secured through voluntary land acquisitions, conservation easements, or other means. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the populations located at Crystal Springs Reservoir, Stulsaft Park, and Woodside Glens and any adjacent occupied or unoccupied habitat identified as essential to continued survival. Management plans include survival of the species as an objective; provisions for standardized monitoring of populations every 3 years to determine demographic trends; and strategies to control nonnative, invasive plant species14and Argentine ants.15 Adequate funding is secured to implement the management plan(s) in perpetuity. (USFWS, 2019)

E/1: Unless research shows otherwise, populations under A/1 contain a minimum of 2,000 reproductive, self-regenerating adults to produce a mixture of reproductive stages (seedlings, juveniles, adults) sufficient to ensure self-perpetuation. The Crystal Springs Reservoir population contains a minimum of 20,000 reproductive, self-regenerating adults that are well distributed throughout each subpopulation.16 Each population and subpopulation contains reproductive, self-regenerating adults to produce a mixture of reproductive stages sufficient to ensure self-perpetuation. (USFWS, 2019)

E/2: As described in A/2, standardized population monitoring at Crystal Springs Reservoir, Stulsaft Park, Woodside Glens or any alternative site (see A/1) shows stable or increasing populations with evidence of natural recruitment over a period of 20 years that includes two normal precipitation cycles17 (or longer if suggested by the results of demographic monitoring). Because the species is a biennial to short-lived monocarpic perennial, generally flowering and dying no later than its 3rd year from seed, monitoring should include both flowering and vegetative individuals. (USFWS, 2019)

E/3 Seeds are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. (USFWS, 2019)

Delisting Criteria:

Delisting criteria have not been developed. (USFWS, 1998; USFWS, 2019)

Recovery Actions:

- Recovery actions are not available.
- Protect and manage the remaining populations by working with San Francisco Water Department, Caltrans, and San Mateo County to ensure the long-term survival of the species

on their lands. In general, the largest possible block of serpentine habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In some cases, it may be necessary to enlarge the buffer to include the entire local watershed; sites and their watersheds should be evaluated individually (R. Bittman, in litt., 1998). (USFWS, 1998)

- Other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing Cirsium fontinale var. fontinale and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized monitoring of Cirsium fontinale var. fontinale populations every 3 years to determine demographic trends. The plans should also include strategies to minimize known threats at the sites as well as to identify new threats as they may appear. In particular, threatsfrom invasive non-natives and from recreational activities must be eliminated; the former is an especially high priority for recovery. Where pampas grass (Cortaderia spp.) removal is required, cautions must be taken to avoid adverse impacts to federally listed animal species that may occur in the area (e.g. San Francisco garter snake [Tharnnophissirtalis tetrataenia]). (USFWS, 1998)
- If new threats are identified or other new information becomes available, management plans need to be reevaluated and revised. (USFWS, 1998)
- Collection and banking of seed in Center for Plant Conservation certified botanic gardens is also a high priority in recovery efforts for Cirsium fontinale var. fontinale. Collections are prudent to guard against extinction of the species from chance catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriation, andlor introductions to new sites. All known populations should be represented in seed collections. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
- Activities of lower priority include surveys of potential habitat and research. Surveys of other serpentine habitat within the species' range should be conducted to determine whether undiscovered populations may exist. If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. At least some of these surveys would require the cooperation of the San Francisco Water Department because suitable habitat occurs on their land. (USFWS, 1998)
- Research topics that need to be addressed include seed predation by the seedhead weevil (Rhinocyllus conicus), frequency of and potential threat from hybridization with brownie thistle (Cirsiurn quercetorurn), seed germination and propagation techniques, the role of disturbance in colonization, reproduction (mating system and pollination), and demography (e.g. to identify limiting life history stages). (USFWS, 1998)
- Conduct surveys at occurrences of all three species which have not been visited for five years to determine if habitat remains and whether these areas would be suitable reintroduction sites if the species is no longer present. (USFWS, 2010)
- Collect information on habitat preferences for all species in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported the species at historic locations, particularly for

Pentachaeta bellidiflora which had a far greater range historically and likely more variability between sites. (USFWS, 2010)

- Conduct research on propagation methods for the Cirsium fontinale var. fontinale and Pentachaeta bellidiflora for future outplantings and habitat restoration. (USFWS, 2010)
- Conduct research on the relationship between Cirsium fontinale var. fontinale and Deschampsia caespitosa ssp. holciformis (tufted hairgrass). Determine if D. caespitosa ssp. holciformis is critical to outplantings and restoration of C. fontinale var. fontinale occurrences. (USFWS, 2010)
- Determine identity and importance of pollinators for Acanthomintha obovata ssp. duttonii and Pentachaeta bellidiflora. (This information has already been collected for Cirsium fontinale var. fontinale). Determine habitat needs of the pollinators and ways to incorporate this information into management and restoration/outplanting plans for the species. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the fountain thistle: 1. Conduct surveys and habitat maintenance at the Stulsaft Park and Woodside Glens populations with the goal of raising population numbers to 2,000 adult plants. 2. Continue monitoring of the recently reseeded Triangle population. Manage threats if the population becomes established. 3. Attempt to establish a fifth population, possibly at the former Edgewood location. 4. Collect and store seeds at two certified facilities as recommended by the recovery plan (USFWS, 2022)

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SPECIES ACCOUNT: *Cirsium fontinale var. obispoense* (Chorro Creek bog thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/17/1995; California/Nevada (Region 8)

Physical Description

A biennial or short-lived perennial plant up to 2 meters (m) (6.6 feet (ft)) tall in the aster and sunflower family (Asteraceae). The leaves are spiny with glandular hairs on the upper and lower surfaces. The flowers are white, pink, or lavender with a drooping posture (Figure 1). Each flower head produces an average of 73 seeds up that are up to 4 millimeters (mm) (0.2 inches (in)) long (Turner and Herr 1996). Seeds are topped with a pappus (set of bristles) that aids in dispersal. (USFWS, 2014)

Taxonomy

Chorro Creek bog thistle (Cirsiumfontinale var. obispoense) is in the composite family (Asteraceae) and is one of three varieties of C. fontinale and is distinguished from the other two by a combination of morphological characteristics involving the stem, leaf, inflorescence, flower, and fruit. Cirsium fontinale var. obispoense is geographically separated from the other two varieties. The species first was described by Edward L. Greene in 1886 as Cnicus fontinalis. Six years later, he transferredthe plant to the genus Carduus, and in 1901 Jepson transferred the plant to the genus Cirsium. In 1938, J. (USFWS, 2014)

Historical Range

Local endemic on serpentine in San Luis Obispo County, California. (NatureServe, 2015)

Current Range

In San Luis Obispo County, California. The known geographic range comprises 462 square km (178 square mi), extending from San Simeon Creek (35.630897°N, 121.060711°W) to the vicinity of the city of San Luis Obispo (a distance of 56 km (35 mi)). All known occurrences of Cirsium fontinale var. obispoense are west of the outer coast ranges of the Central Coast Region in San Luis Obispo County, California. (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 2-3 years (USFWS, 2014)

Breeding Season

Adult: May to July and occasionally extends into September or October (Magney 2006). (USFWS, 2014)

Reproduction Narrative

Adult: Cirsium fontinale var. obispoense typically live 2 or 3 years. The plants usually flower during the second spring and then die after flowering. However, some plants may persist into a third year if sufficient energy reserves remain (Chipping 1994). Flowering occurs generally during May to July and occasionally extends into September or October (Magney 2006). Each flower head produces an average of 73 seeds up that are up to 4 mm (0.2 in) long (Turner and Herr 1996). (USFWS, 2014)

Habitat Type

Adult: Palustrine wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, herbaceous wetland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of 37 to 381 m (120 to 1,250 ft) (USFWS, 2014)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2014)

Environmental Specificity

Adult: Very Narrow (USFWS, 2014)

Habitat Narrative

Adult: Cirsium fontinale var. obispoense occupies perennial seeps and springs in serpentine soil and rock in western San Luis Obispo County, California (Figure 3). The plants usually occur on slopes, with existing records at 37 to 381 m (120 to 1,250 ft) elevation (CDFW 2013a). The plants often grow in colonies (spatial groups of presumably separate individuals). (USFWS, 2014)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are topped with a pappus (set of bristles) that aids in dispersal. (USFWS, 2014)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

22 (USFWS, 2022)

Population Size:

~10,000 (inferred from USFWS, 2014)

Adaptability:

Low (inferred from USFWS, 2014)

Population Narrative:

The taxon is currently known from 19 occurrences, and multiple colonies comprise most occurrences. The Service considers stochastic events, in particular drought, an ongoing threat. Because Cirsium fontinale var. obispoense is associated with seeps and springs, a severe or prolonged drought could reduce or eliminate its specialized habitat and result in the extirpation of some occurrences. Six occurrences have been reported to comprise more than 1,000 plants at particular points in time: occurrence 1 at San Simeon Creek (1,076 plants in 1993; CDFW 2013a), occurrence 2 at Laguna Lake Park (approximately 2,075 plants in 2006; M. Elvin, Service, pers. obs. 2006), occurrence 3 at Camp San Luis Obispo (1,872 plants in 2008; Holland 2009), occurrence 6 in the El Chorro Biological Reserve (2,200 plants in 1993; Chipping 1994), occurrence 10 at Miossi Creek (more than 1,000 plants in 1997; CDFW 2013a), and near Serpentine Lane (more than 4,000 plants in 2001; CDFW 2013a). The other 13 occurrences are each likely comprised of fewer than 1,000 plants in 2014, with the most recent estimates ranging from 0 to 800 plants per occurrence. (USFWS, 2014). In 2022, Chorro Creek bog thistle is known from 22 occurrences (CDFW 2021a, p. 1–2), with one of these possibly extirpated (occurrence 7). Nine occurrences are protected, but effectiveness for one of these (occurrence 12) is questionable, and 13 occurrences are not protected. To the best of our knowledge, all threats identified in USFWS (2014) and Kofron and Havlik (2016) still remain (USFWS, 2022).

Threats and Stressors

Stressor: Road maintenance (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Road maintenance (including grading, road expansion, mowing, herbicide application) and water diversions were identified as potential threats at that time (Wikler and Morey 1992). (USFWS, 2014)

Stressor: Invasive plants (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Although the serpentine substrate is not conducive for most invasive plant species (Harrison et al. 2006.), Cortaderia (pampas grass) became established in the habitat and which the City of San Luis Obispo removed in 2010. Magney (2006) reported that the invasive Sonchus asper (prickly sow thistle) was invading the habitat and that it was being eradicated. Some occurrences are threatened by dense vegetation in and near the habitat, including native (E. macrostachya, Distichlis spicata (salt grass)) and invasive species (Helminthotheca echioides (bristly oxtongue), Centaurea calcitrapa (purple star-thistle), S. asper) (J. Olson, Colorado State University, pers. comm. 2012). (USFWS, 2014)

Stressor: Cattle grazing (USFWS, 2014)
Exposure:
Response:
Consequence:

Narrative: Several properties where Cirsium fontilae var. obispoense is found is zone for grazing. Light, controlled cattle grazing is conducted in some habitats, which appears to benefit Cirsium fontinale var. obispoense by reducing invasive plants (Siepel, pers. comm. 2012). (USFWS, 2014)

Stressor: Agriculture (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: A small area (approximately 2 ha (5 ac)) of the property on the northern side of Chorro Creek is planted with row-crops, and likewise the adjacent property. This agriculture is in close proximity to Cirsium fontinale var. obispoense in Chorro Creek and is not compatible with its survival. (USFWS, 2014)

Stressor: Predation by insects (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The Eurasian flower-head weevil has been reported predating Cirsium fontinale var. obispoense at several sites (Service 1994), including San Simeon Creek (Chipping 1994; Herr 2004), Laguna Lake Park (Herr 2004), and Camp San Luis Obispo (California Army National Guard 2012). In a study on one property at San Simeon Creek, 28 percent of the flower heads of Cirsium fontinale var. obispoense were infested throughout the plant's growing season, with 27 percent of the seeds destroyed on average in the predated flower heads. (USFWS, 2014)

Stressor: Herbivory by cattle (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: There are two issues to consider regarding cattle grazing in and near the habitat of Cirsium fontinale var. obispoense: herbivory and trampling. Trampling by cattle while grazing in the habitat could severely damage established plants, especially when water becomes limited to the cattle and they congregate at the seep or spring. (USFWS, 2014)

Stressor: Stochastic events (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Species with small populations are vulnerable to extinction by stochastic events (Ricklefs 2008). This means that chance or random events can cause the population size of the species to decrease, possibly below the level of sustainability and down to extinction. We consider stochastic events, in particular drought, an ongoing threat. Because Cirsium fontinale var. obispoense is associated with seeps and springs, a severe or prolonged drought could reduce or eliminate its specialized habitat and result in the extirpation of some occurrences. (USFWS, 2014)

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:

Consequence:
Narrative: We identify climate change as a new threat. Current climate change projections for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). We lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as isolation at perennial seeps and springs will affect Cirsium fontinale var. obispoense. However, limited-ranged taxa are likely to be more vulnerable to extinction due to these changing conditions. Our major concern is the effects of extreme weather events (e.g., severe drought, severe storm, harsh winter) due to climate change on the 19 occurrences of Cirsium fontinale var. obispoense. (USFWS, 2014)

Recovery

Reclassification Criteria:
1. Populations from throughout the range, each made up of multiple colonies, and their habitat at six sites are secure from human-induced threats, including water diversions or drawdowns. (USFWS, 1998)

2. At least three of these sites are in protected areas larger than 100 acres and populations are deemed viable and stable or increasing as determined by monitoring over a precipitation cycle that includes multiple years of below average rainfall. (USFWS, 1998)

3. Protected sites are being managed in a way that will support the continued existence of Cirsium fontinale var. obispoense and its wetland habitat. (USFWS, 1998)

4. Management is effective, as shown by at least 10 years of monitoring. (USFWS, 1998)

Recovery Priority Number: 9

Delisting Criteria:
When the downlisting criteria have been met for a species, the species can be considered for delisting if:

1. Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species (USFWS, 2019)

2. An ex situ seedbank is established in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that a occurrences could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019)

3. All existing occurrences are stable or increasing in the wild for at least 10 years. We expect above-ground occurrences size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA

2018). Ten occurrences were surveyed during the 5-year period from 2012 to 2016, which will provide a baseline for the status of these occurrences; these data should provide a basis for monitoring occurrence attributes to determine trajectory over time. (USFWS, 2019)

Recovery Actions:

- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendation from 2014 5-Year Review: Additional occurrences of Cirsium fontinale var. obispoense likely exist in San Luis Obispo County, and also possibly in Monterey and Santa Barbara Counties. We recommend that searches be conducted in potentially suitable habitat with serpentine soil and rock in San Luis Obispo, Monterey and Santa Barbara Counties. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that the Service seek partnerships with the private landowners for assisting them to manage Cirsium fontinale var. obispoense on their properties. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that a range-wide census of the 19 occurrences be conducted in 2015 as a team effort including the California Army National Guard, the California Native Plant Society (San Luis Obispo Chapter), California Polytechnic State University, the City of San Luis Obispo, the private landowners, and the Service. The methods should be standardized in advance. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: We recommend that the relevant biologists, landowners, and land managers monitor for invasive plant species in and near the habitat of Cirsium fontinale var. obispoense and take the necessary actions to eliminate this threat. (USFWS, 2014)

- Recommendation from 2014 5-Year Review: We recommend that any cattle grazing in the habitat of Cirsium fontinale var. obispoense be controlled and monitored. A controlled grazing regime may benefit Cirsium fontinale var. obispoense by reducing other vegetation (invasive and native) in and near the habitat and by providing favorable sites for the germination of seeds. Herbivory of Cirsium fontinale var. obispoense would be minor because their spiny characteristics make them generally unpalatable. However, trampling could severely damage the established plants, especially when water becomes limited to the cattle and they congregate in the seep or spring. (USFWS, 2014)
- Recommendation from 2014 5-Year Review: The relevant biologists, landowners, and land managers should be aware of the introduced Eurasian flower-head weevil and the threat it poses to Cirsium fontinale var. obispoense. We recommend that they monitor for and report the presence of this introduced insect to the U.S. Fish and Wildlife Service, Ventura, California, and to the Department of Agriculture for San Luis Obispo County, California. (USFWS, 2014)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Coordinated conservation and research are needed to better understand the biology and ecology of Chorro Creek bog thistle, in particular to restore and maintain the existing occurrences. These efforts should include the following: • Conduct a more-detailed analysis of the status, threats, distribution, biology and ecology of Chorro Creek bog thistle, with a coordinated team effort including site visits by USFWS and partners. Priority should be given to visiting occurrences that have not been visited in the past 5 years. • Conduct modelling to anticipate the effects of climate change on distribution and abundance of Chorro Creek bog thistle, including changes in temperature and precipitation. • Implement management actions to benefit the individual occurrences of Chorro Creek bog thistle, including removing invasive and native plants that are threats. • Conserve and protect habitat in vicinity of and near the occurrences of Chorro Creek bog thistle. • Conduct searches for additional occurrences and locations of Chorro Creek bog thistle, with possible use of drones for searching large expanses of potential habitat and potential habitat in difficult terrain. In particular, U.S. Forest Service should search the upper reaches of Chorro Creek, Pennington Creek, San Luisito Creek and San Bernardo Creek on Los Padres National Forest (Keil 2022, p. 1). • Conduct a search to determine the precise location of occurrence 11, which is based on two herbarium specimens with imprecise location data (Kofron and Havlik 2016, p. 173). We suspect the location is near 35.275649/-120.603870. • Collect seeds for conservation seed banking. • Develop protocols for long-term restoration success. 1. Consider methods of Eckberg et al. (2017, p. 33–66). 2. In light of the threat of climate change with severe drought and increased temperatures, also consider methods for cultivating seeds for propagation and outplanting in arid lands used by Abella et al. (2012, entire), Abella et al. (2015, entire), Abella (2017, entire) and Abella et al. (2020, entire). • Introduce Chorro Creek bog thistle into living collections at several botanic gardens. (USFWS, 2022)

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SPECIES ACCOUNT: *Cirsium hydrophilum var. hydrophilum* (Suisun thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/20/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb with erect stems, usually 1-1.5 m tall, and with spiny, deeply lobed leaves. Pale lavender or pink flower heads, 2-2.5 cm long, are borne singly or in loose groups. In the pre-flowering phase, it grows as a short, broad, vegetative rosette with large leaves, approximately 0.3 to 0.9 m long. Stems are typically branched above the middle of the main stem, but up to 15 stems may occasionally branch from the base of single large plants (P. Baye unpubl. data 2000). Leaves on stems are much smaller, more deeply lobed, and spinier than juvenile leaves of the rosette. The egg-shaped flowerheads (2.5 cm) are composed of small individual florets united into a single unit. Flowerheads occur either as solitary units or in clusters. The bracts of the flowerheads have a distinct green, glutinous ridge on the back that distinguishes C. hydrophilum var. hydrophilum from other Cirsium species in the area. (USFWS, 2013)

Taxonomy

Cirsium hydrophilum var. hydrophilum was originally described as Cnicus breweri Gray var. vaseyi Gray (Gray 1888). Cnicus breweri is a taxon now placed in Cirsium douglasii DC var. breweri (A. Gray) (Keil and Turner 1993). Subsequent synonyms, now invalid, include Carduus hydrophilus Greene (Greene 1892) and Cirsium vaseyi (Gray) Jepson var. hydrophilum (Greene) Jepson (Jepson 1925). Jepson (1901) was the first to apply the combination Cirsium hydrophilum. The species Cirsium hydrophilum, as now interpreted, (Howell 1969, Keil and Turner 1993) comprises two morphologically similar varieties: C. hydrophilum var. vaseyi, (synonym: Cirsium vaseyi [A. Gray] Jepson), a related rare thistle endemic to seeps in serpentine soils on Mount Tamalpais, Marin County, and C. hydrophilum var. hydrophilum, endemic to brackish tidal marshes in Suisun Marsh, Solano County. (USFWS, 2013)

Historical Range

Not available

Current Range

Cirsium hydrophilum var. hydrophilum is only known from locations in Suisun Marsh.

Critical Habitat Designated

Yes; 4/12/2007.

Legal Description

On April 12, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cirsium hydrophilum var. hydrophilum (Suisun thistle) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (72 FR 18518-18553).

Critical Habitat Designation

The critical habitat designation forCirsium hydrophilum var. hydrophilum includes three CHUs in Solano County, California. This species critical habitat encompasses approximately 2,052 acres (ac) (830 hectares (ha)) (72 FR 18518-18553).

Unit 1: Hill Slough Marsh: Unit 1 consists of approximately 525 ac (213 ha) located north of Potrero Hills between Grizzly Island Road and Highway 12. As discussed in ‘‘Criteria Used to Identify Critical Habitat for Cirsium hydrophilum var. hydrophilum’’ above, this unit is currently unoccupied and was unoccupied at the time of listing, but it is essential to the conservation of the subspecies because it is the single best area for establishment of an additional population (see response to Comment 2). It contains all the necessary PCEs and is the subject of ongoing planning and restoration efforts within the Suisun Marsh. The unit consists of approximately 440 ac (178 ha) of Stateowned land (Hill Slough Wildlife Area), which is managed by the CDFG, and 85 ac (35 ha) of privately owned land. The unit receives tidal inundations irregularly (not daily) (NWI 2005) from Hill Slough and a flood control channel along the western unit boundary.

Unit 2: Peytonia Slough Marsh: Unit 2 consists of approximately 346 ac (140 ha) of tidal marsh (PCE 1) located adjacent to Cordelia Road to the west, Suisun Slough to the east, Peytonia Slough to the south, and Suisun City to the north. The unit consists of approximately 192 ac (78 ha) of State-owned land (Peytonia Slough Ecological Reserve), which is managed by the CDFG, and 154 ac (62 ha) of privately owned high tidal marsh. Although the unit is bisected, north to south, by an elevated railroad line, much of the track is on trestle rather than berm, allowing tidal waters to reach both sides of the unit through Peytonia Slough and several smaller unnamed sloughs (NWI 2005; Vollmar 2005a, pp. 2, 3, 5; Huffman 2006, p. 1). Because of this hydrological connection, we are treating designated habitat on both sides of the track as a single unit, rather than splitting it into two subunits as we did in the proposed designation. Cirsium hydrophilum var. hydrophilum occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. hydrophilum var. hydrophilum.

Unit 3: Rush Ranch/Grizzly Island Wildlife Area: Unit 3 consists of approximately 1,181 ac (477 ha) of tidal marsh located adjacent to Suisun Slough to the west, Cutoff and Montezuma Sloughs to the south, and Potrero Hills to the North. This unit consists of 231 ac (93 ha) of State-owned land (the Joice Island portion of Grizzly Island Wildlife Area), which is managed by the CDFG, and 950 ac (384 ha) of land owned by the Solano Land Trust (local nonprofit public land trust). Cirsium hydrophilum var. hydrophilum occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. hydrophilum var. hydrophilum. The unit receives regular tidal inundations at least once daily (NWI 2005) from the abovementioned tidal sloughs. Additional special management considerations or protection beyond the special management required for common threats, as discussed above, may be required to control the presence of Rhinocyllus conicus (a nonnative biological control weevil) or other planteating insects that could reduce the reproductive potential of C. hydrophilum var. hydrophilum.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cirsium hydrophilum var. hydrophilum critical habitat consists of three components (72 FR 18518-18553):

(i) Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);

(ii) Open channels that periodically contain moving water with oceanderived salts in excess of 0.5 percent; and

(iii) Gaps in surrounding vegetation to allow for seed germination and growth.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing and that contain the PCEs may require special management considerations or protection. Most of the PCEs and the known occurrences of Cirsium hydrophilum var. hydrophilum and Cordylanthus mollis ssp. mollis are threatened by: (1) tidal wetland conversions to diked, managed, or muted tidal marshes; (2) changes to channel water salinity and tidal regimes; (3) mosquito abatement activities; (4) marsh invasions by nonnative plants; (5) plant-eating insects; (6) urban, industrial, and agricultural encroachment; (7) impacts from livestock overgrazing; (8) feral pigs (Sus scrofa); and (9) impacts from unauthorized foot and off-road vehicle traffic. These combined threats result in the loss and fragmentation of suitable habitat for C. hydrophilum var. hydrophilum and C. mollis ssp. mollis, which could significantly affect their long-term survival. Individually, these threats may require special management considerations or protection as addressed under the critical habitat unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) (USFWS, 2013)

Lifespan

Adult: 1 year (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Bees and insects (USFWS, 2009)

Breeding Season

Adult: July to September (USFWS, 2009)

Reproduction Narrative

Adult: Cirsium hydrophilum var. hydrophilum is an annual plant, dying after one year of seed reproduction. Its vegetative period is usually one year (biennial), but if small vegetative plant size or unfavorable environmental conditions delay flowering, it may regenerate from the central root crown for more than one year. Pale lavender-rose flower heads appear between July and September. Flowering plants may produce hundreds of seed heads. Seed heads observed in July 2000 had three to five ripe seeds per head, but many of them contained aborted seeds or were found with insect larvae in active seed predation (Baye 2000). Specific flower pollinators of Cirsium hydrophilum var. hydrophilum have not been directly studied; however, field observations indicate that several bee species may be important in pollinating

the species (LCLA 2003). The most common insect species observed gathering pollen at Rush Ranch was the yellow-faced bumble bee (Bombus vosnesenskii) (LCLA 2003). (USFWS, 2009; USFWS, 2013)

Habitat Type

Adult: Tidal marsh (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to regularly flooded and permanently saturated habitats within 50 to 100 feet of the high water mark of tidal channels (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Discrete colonies or clusters of small patches (USFWS, 2013)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: The dispersion pattern of C. hydrophilum var. hydrophilum (California Department of Water Resources in litt. 1996) in discrete colonies or clusters of small patches suggests there may be limited seed dispersal. Most known Cirsium hydrophilum var. hydrophilum occurrences are found in regularly flooded and permanently saturated habitats, along the banks of canals or ditches, within 50 to 100 feet of the high water mark of natural tidal channels; and on tidal floodplains within tidal marshes (U.S. Fish and Wildlife Service 2007). (USFWS, 2009; USFWS, 2013)

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 2013)

Dispersal

Adult: Low (USFWS, 2013)

Dispersal/Migration Narrative

Adult: The dispersion pattern of C. hydrophilum var. hydrophilum (California Department of Water Resources in litt. 1996) in discrete colonies or clusters of small patches suggests there may be limited seed dispersal. (USFWS, 2013)

Population Information and Trends

Population Trends:

Long-term decline of 50 - 70% (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2009)

Population Size:

22,300 to 873,200 individuals, with a best estimate of 137,500 individuals (LCLA 2003). (USFWS, 2013)

Adaptability:

Low (USFWS, 2009)

Population Narrative:

It was once widespread in Suisun Marsh, but, due to habitat loss, in the last two decades has been found in only four localities: Grizzly Island, Peytonia Slough, Rush Ranch, and Hill Slough. These populations have been in decline in the 1990s and 2000s. The species was considered to belong to a large, single population of approximately 22,300 to 873,200 individuals, with a best estimate of 137,500 individuals (LCLA 2003) in a recent comprehensive survey in 2003. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, oil spills, genetic or demographic problems or a combination of these events. Long-term trends suggest a decline of 50-70% due to massive changes in the Suisun Marsh due to water projects and utilization. (USFWS, 2009; USFWS, 2013; NatureServe, 2015)

Threats and Stressors

Stressor: Alteration of tidal regime (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Diking and filling involved in agricultural land conversion and urbanization, ditching for mosquito abatement, changes to freshwater inflow, and habitat fragmentation are threats to Cirsium hydrophilum var. hydrophilum. Private lands continue to experience development (Grewell, pers. comm. 2007). Derelict and actively maintained levees from historic diking practices continue to result in muted (damped) tidal flows, which in turn, reduce available habitat for C. hydrophilum var. hydrophilum. Alteration of natural tidal cycles still exists in much of the potential habitat and represents both the most significant historic and current threat to Cirsium hydrophilum var. hydrophilum and its habitat. With respect to effects to C. hydrophilum var. hydrophilum, alteration of tidal cycles includes muting of tidal flows, increases in freshwater runoff and diversion of freshwater for agricultural and municipal uses. A large portion of historic tidal marshes in Suisun Bay were diked and managed for waterfowl. These historic reductions of habitat have affected the extent and composition of tidal marsh communities. The brackish tidal wetlands in Rush Ranch have been ditched extensively to drain standing water, in an effort to reduce mosquito breeding habitat. Ditching has greatly altered the hydrology of the marsh, primarily because the ditches cut across natural drainage patterns. As a result, mosquito ditches have led to the reduction of tidal inundation and the consequent infilling of first order channels, creating new mosquito breeding habitat (Collins et al. 1986, WRA et al. 1989). Originally, ditching may have reduced Cirsium hydrophilum var. hydrophilum habitat by reducing tidal influence in first order channels. However, the mosquito ditching currently provides new, artificial habitat for C. hydrophilum var. hydrophilum similar enough to first order channels to promote colonization of these ditches. (USFWS, 2009)

Stressor: Feral pigs (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: The threat from feral hogs (Sus scrofa) to Cirsium hydrophilum var. hydrophilum was not described in the listing rule, however, it is a present threat at both known locations of the species. Thirty-four percent of the C. hydrophilum var. hydrophilum subpopulations at Rush Ranch showed signs of damage due to rooting and trampling of feral pigs when surveyed in 2003 (LCLA 2003). Further, disturbances on the landscape created by feral pigs may enhance colonization opportunities for a non-native plant Lepidium latifolium (perennial pepperweed), to threaten the tidal marsh ecosystem, discussed further under Factor E (LCLA 2003). (USFWS, 2009)

Stressor: Sea-level rise (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of Cirsium hydrophilum var. hydrophilum. Conservation of high marsh zones in the face of sea level rise requires landward transgression (displacement) of the marsh profile on broad, sloping plains (Field et al. 1999, Baye 2006). If the sea level rises, conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could not support C. hydrophilum var. hydrophilum habitat (Grewell 2006). (USFWS, 2009)

Stressor: Thistle weevil (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The presence of a thistle weevil (Rhinocyllus conicus) in a portion of the Cirsium hydrophilum var. hydrophilum population was stated to be a possible threat to the species. This threat was discovered by California Department of Water Resources in June 1996 when the weevil was collected inside C. hydrophilum var. hydrophilum flower heads, many of which had no seeds (U.S. Fish and Wildlife Service 1997). The larval stage of this weevil is known to feed on seeds. Plant-eating insects can significantly limit seed production and plant demography as seen in several other Cirsium species (Louda and Potvin 1995; Palmisano and Fox 1997; Rose et al. 2005). (USFWS, 2009)

Stressor: Caterpillars (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Phyciods mylitta caterpillars were collected on a population of C. hydrophilum var. hydrophilum in September 1996. These caterpillars have caused significant damage to the rosettes of plants that will flower the following year (U.S. Fish and Wildlife Service 1997). Though documented in the listing rule to have occurred previously at Rush Ranch, Phyciods mylitta caterpillars were not located there during LCLA's 2003 study. (USFWS, 2009)

Stressor: Non-native plants (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: All known populations of Cirsium hydrophilum var. hydrophilum are negatively affected by nonnative plants. The most problematic and widespread invasive plant in Suisun Marsh is the perennial herb, Lepidium latifolium (Grewell 2005). It occurs along the high marsh edge of San Francisco Bay, especially in disturbed areas, deposits of sand or tidal litter, or levee slopes. In brackish marshes with lower salinity, it invades the middle marsh plain and channel edges. Lepidium latifolium forms large monotypic patches that displace native marsh vegetation (Renz 2000). As much as 40 percent of L. latifolium biomass is below-ground, with most of it concentrated in the upper 24 inches (Renz 2000). This concentration of biomass in surface roots enhances the weed's competitiveness for water and nutrients. Further, as well as being a prolific seed producer, its roots fragment easily and can sprout even after exposure on the soil over the winter. Root fragments also can be carried by water and establish new populations where they are deposited (Renz 2000). (USFWS, 2009)

Stressor: Hybridization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Hybridization with Cirsium vulgare, a non-native, also is a potential threat to Cirsium hydrophilum var. hydrophilum. Hybridization with C. vulgare was suggested as a possible explanation for the previously presumed extinction of C. hydrophilum var. hydrophilum (Smith and Berg 1988). Though recent studies have indicated that the two species coexist at Rush Ranch, no genetic studies have been conducted since the time of listing to determine if hybridization has indeed occurred. L.C. Lee and Associates (2003) found that 45 percent of C. hydrophilum var. hydrophilum subpopulations at Rush Ranch contained C. vulgare. It is known that C. vulgare hybridizes readily with other Cirsium species. (USFWS, 2009)

Stressor: Chronic pollution (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Oil spills and chronic pollution from point and non-point sources (heavy metal contamination from point and non-point sources) continue to occur in or near habitat for Cirsium hydrophilum var. hydrophilum (U.S. Fish and Wildlife Service 2007). On April 27, 2004, Kinder Morgan Energy Partners, L.P. spilled 123,774 gallons of diesel fuel through a ruptured pipeline in western Suisun Marsh near Roos Cut. The spill occurred within known habitat for C. hydrophilum var. hydrophilum and contaminated 225 acres of the marsh to varying degrees (Solano County 2005). It is not known whether populations of C. hydrophilum var. hydrophilum were directly affected. (USFWS, 2009)

Stressor: Fire (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: It is not known how fire affects the viability of Cirsium hydrophilum var. hydrophilum or its seed, but it is considered a minor threat nonetheless. Human-caused fires present a

continual threat of at least temporary habitat loss in Suisun Marsh. Three fires have occurred recently within existing and potential C. hydrophilum var. hydrophilum habitat in Suisun Marsh (Grewell pers comm. 2007). Arsonists set fire in 2001 to a large portion of Peytonia Slough Ecological Reserve, burning all vegetation from Suisun Slough to the Southern Pacific Railroad tracks, including the only remaining previously known population at Peytonia Slough Ecological Reserve. (USFWS, 2009)

Stressor: Random events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, oil spills, genetic or demographic problems or a combination of these events. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. The minimum area inhabited annually by the species must be 2,000 acres over a period of five years. (USFWS, 2013)

2. A minimum of 4,000 acres must be permanently preserved and under protective management. This must include existing or successfully restored tidal marsh areas with suitable habitat for the species and encompass a minimum of 80 percent of the extant occurrences of the species. (USFWS, 2013)

3. Reduction in extant Lepidium latifolium populations in tidal areas of Suisun Marsh (in and down-gradient of the high marsh-upland ecotone) to less than ten percent cover for five years. (USFWS, 2013)

4. Natural tidal range must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic tidal flooding. (USFWS, 2013)

5. At least three separate populations or one large population must occur within Suisun Marsh. Required target number of individuals is dependent on whether separate populations are easily identifiable, as described below. A population shall be any concentration of plants with closest individuals to other populations greater than 1 kilometer (0.6 mile) apart over a period of five years. (USFWS, 2013)

6. Over five years of monitoring, a mean of at least 3,000 individuals must occur annually over the entire range of the species. The third-largest separate population over the same period must have a mean of at least 300 individuals. If there are fewer than three separate populations, a mean of at least 5,000 individuals must occur annually throughout the entire range of the species over a period of five years. The entire species must not fall below 800 individuals for two consecutive years over a period of five years. (USFWS, 2013)

Delisting Criteria:

1. The minimum area inhabited annually by the species must be 3,000 acres over a period of eight years. (USFWS, 2013)

2. A minimum of 6,000 acres of suitable habitat must be permanently preserved and under protective management. This must include existing or successfully restored tidal marsh areas with suitable habitat for the species and encompass a minimum of 80 percent of the species, as well as habitat supporting adequate self-sustaining populations of pollinators. (USFWS, 2013)

3. All conditions under downlisting criterion number 3 have been met. In addition, a plan must be developed and implemented for early detection and control of Lepidium latifolium following any future increase beyond ten percent cover in tidal areas of Suisun Marsh (in and down-gradient of the high marsh-upland ecotone). Also, a funding source must be secured to fund such actions in perpetuity. (USFWS, 2013)

4. All conditions under downlisting criterion number 4 have been met. (USFWS, 2013)

5. Reliable propagation and reintroduction methods must be developed and available. (USFWS, 2013)

6. Trampling and rooting damage to Cirsium hydrophilum var. hydrophilum by feral pigs must have been eliminated at all populations for five years. (USFWS, 2013)

7. Unnaturally high seed predator pressures on C. hydrophilum var. hydrophilum from thistle weevil (Rhinocyllus conicus) must fall below a level at which it negatively affects long-term population persistence. (USFWS, 2013)

8. At least four separate populations must occur within Suisun Marsh. Over eight years of monitoring, a mean of at least 4,000 individuals must occur annually, spread across at least four populations and the fourth-largest population over the same period must have a mean of at least 500 individuals. If not divisible into separate populations, a mean of at least 7,000 individuals must occur annually throughout the entire range of the species over a period of eight years. The entire species must not fall below 1,000 individuals for two consecutive years over a period of eight years. (USFWS, 2013)

9. Seed banking of all extant populations and representative genetic diversity (per commonly accepted seed banking protocols) must be complete. (USFWS, 2013)

10. Research must be conducted to determine if hybridization is occurring between Cirsium hydrophilum var. hydrophilum and Cirsium vulgare. If research shows that hybridization is occurring, extant C. vulgare populations must be eliminated in Suisun Marsh and a monitoring plan must be in place to detect and eliminate future infestations of C. vulgare. (USFWS, 2013)

11. To minimize impacts sustained after oil spills occurring at or near populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of Cirsium hydrophilum var. hydrophilum. (USFWS, 2013)

12. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. (USFWS, 2013)

Recovery Actions:

- Short-term recovery actions should be implemented concurrently with long-term habitat restoration and should focus on protecting and managing existing populations and habitats. Recovery strategies include: suppression of invasive non-native plant species, protection and management of nearby native bee and wasp habitats, control of Cirsium vulgare, if research indicates necessity, restoration of normal tidal range and salinity, seed banking of Cirsium hydrophilum var. hydrophilum, monitoring of populations and habitat, and research aspects of life history, population ecology, and seed predation of C. hydrophilum var. hydrophilum. (USFWS, 2013)
- A recovery plan for Cirsium hydrophilum var. hydrophilum should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft recovery plan for this species and five other listed tidal marsh species is currently in development by the Service. (USFWS, 2009)
- Natural tidal cycles should be maintained (and restored at Hill Slough and the ponded area of Rush Ranch) because the middle to high marsh area, with periodic tidal flooding, is vital to Cirsium hydrophilum var. hydrophilum. (USFWS, 2009)
- Control of Lepidium latifolium should be conducted at Peytonia Slough Ecological Reserve, Rush Ranch, Hill Slough, Grizzly Island Wildlife Area, as appropriate, to reduce competition with Cirsium hydrophilum var. hydrophilum. (USFWS, 2009)
- Research should be conducted to determine whether hybridization is occurring between Cirsium hydrophilum var. hydrophilum and Cirsium vulgare at Rush Ranch. (USFWS, 2009)
- Research should be conducted to determine the extent to which seed predation by Rhinocyllus conicus is negatively affecting populations of Cirsium hydrophilum var. hydrophilum. If a substantial threat exists, research into effective means of Rhinocyllus conicus control should be researched and implemented at appropriate sites. (USFWS, 2009)
- Surveys should be conducted within potential Cirsium hydrophilum var. hydrophilum habitat as well as at known population centers to identify potential new occurrences as well as to provide an updated species status with which to make management decisions. Specifically, Peytonia Slough Ecological Reserve should be surveyed to determine if that population is extant and the Hill Slough area should be more extensively surveyed to determine the abundance of C. hydrophilum var. hydrophilum there. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Several areas of future action over the next five years are suggested, which build on the actions articulated in Service (2013) and the tidal marsh ecosystem sections of Service (2019a, 2019b). Consider developing, reviewing and implementing the following survey and monitoring plans: • A range-wide Cirsium hydrophilum var. hydrophilum survey and monitoring plan. This plan would include locations to be surveyed; the group(s) responsible for coordinating surveys; survey timing including the month(s) surveys are to be conducted; and the frequency of surveys (e.g., annually vs. every three years). These surveys should be conducted by well-trained individuals capable of reliably identifying Cirsium hydrophilum var. hydrophilum, should be reproducible, and should provide at a minimum the following information: an estimated population size with confidence interval(s); the number and locations of known

populations; an estimate of the area inhabited by Cirsium hydrophilum var. hydrophilum (acres); and an estimate of the area inhabited by Cirsium hydrophilum var. hydrophilum that occurs on preserved properties (acres). • A Lepidium latifolium survey and monitoring plan for areas occupied by Cirsium hydrophilum var. hydrophilum. This would include locations to be surveyed; the group(s) responsible for coordinating surveys; survey timing including the month(s) surveys are to be conducted; and the frequency of surveys. These surveys should be reliable and reproducible and at a minimum provide an estimate of the percent of the total distribution of Cirsium hydrophilum var. hydrophilum in which Lepidium latifolium also occurs. • A range-wide thistle weevil predation pressure monitoring plan for Cirsium hydrophilum var. hydrophilum. This plan would include information about how predation pressure will be estimated, the group(s) responsible for coordinating monitoring, and locations to be monitored including the timing and frequency of predation pressure surveys. • A feral pig and cattle damage monitoring plan to evaluate the extent of feral pig and cattle damage to Cirsium hydrophilum var. hydrophilum populations. This plan would include information about how feral pig and cattle activity and damage will be monitored, the group(s) responsible for coordinating surveys, locations to be surveyed for damage including survey timing, and the frequency of damage surveys. Consider developing and implementing the following Cirsium hydrophilum var. hydrophilum restoration actions: • A tidal marsh restoration plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. • An upland marsh restoration plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. • A propagation and reintroduction plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. • A seed banking plan for Cirsium hydrophilum var. hydrophilum, and complete the actions that are achievable within 5 years. Other future actions to consider include continued research on the habitat requirements and seed bank dynamics of Cirsium hydrophilum var. hydrophilum, which may lead to helpful information and insights in guiding long-term recovery efforts, including identifying areas for possible development of new populations of Cirsium hydrophilum var. hydrophilum within Suisun Marsh. This future work could include an analysis of how environmental variables, such as precipitation and temperature patterns, and seeding and out-planting influence population dynamics in currently occupied areas and colonization of newly restored areas. A study of the current pollinators of Cirsium hydrophilum var. hydrophilum would help add to the Service's understanding of the natural history of this plant and identify which potential pollinators, or groups of pollinators, to monitor to ensure that healthy and diverse pollinator populations continue to occur. Statistical and numerical modeling, such as with habitat suitability analysis and population dynamics modeling, can provide insights into possible locations to search for unknown populations of Cirsium hydrophilum var. hydrophilum and for identifying future locations for development of new populations, and future dynamics of these populations. Vasey et al. (2020) began developing a species distribution model for Cirsium hydrophilum var. hydrophilum. It is possible that a continuation of this line of investigation will lead to improved insights into where and how to develop additional areas that will support the recovery of Cirsium hydrophilum var. hydrophilum. It may also be useful to consider developing population viability analyses (PVA) that are specifically developed for Cirsium hydrophilum var. hydrophilum. For example, it is possible that a stage-structured matrix population model similar to the model developed by Thomson (2005; also see Gotelli 2001, Kéry and Schaub 2012) could be used to form a foundation for PVA analysis. It is also possible that building and parameterizing such a model, and then projecting this model into various possible futures, including under the influence of changing climate and hydrology conditions, could help provide useful insights. As part of efforts to improve statistical analysis and modeling, creating a well-vetted and archived dataset of all Cirsium hydrophilum var. hydrophilum surveys, and resolving any discrepancies in counts identified during this review will be critical to progressing on

this objective. The San Francisco Bay-Delta Fish and Wildlife Office has convened a recovery implementation team (RIT) to focus on the listed tidal marsh species described in Service (2013), including Cirsium hydrophilum var. hydrophilum. The primary goal of this group is to encourage Service biologists, managers and external experts to collectively consider recovery priorities for these species and tidal marsh ecosystems in northern and central California, and continue to stay abreast of emerging research related to Cirsium hydrophilum var. hydrophilum and related tidal marsh taxa, tidal marsh ecology, and other relevant topics. This group could help develop a recovery implementation strategy for Cirsium hydrophilum var. hydrophilum, which would strive to articulate relatively short-term recovery goals (e.g., on a 2-3 year time horizon) related to the long-term recovery criteria discussed in detail above and in Service (2013). (USFWS, 2021)

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SPECIES ACCOUNT: *Cirsium loncholepis* (La Graciosa thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/19/2000; California/Nevada (Region 8)

Physical Description

a biennial or short-lived perennial plant that flowers once and then dies (Lea 2002, p. 67; Teed 2003, p. iv; Baldwin et al. 2012, p. 289), with a probable life span of 2 to 6 years (Lea 2002, p. 68). It is an erect or spreading mound-like plant with spines on the leaves and flower heads. The plants have one or more stems that range usually from 10 to 100 cm/4 to 39 in tall but occasionally up to 150 cm/59 in. The lower leaves are 10 to 30 cm/4 to 12 in long with spiny petioles (leaf stalks) and usually deeply lobed with secondary lobes or teeth. The leaves have a wavy edge, with the bases of the middle and upper leaves forming short, spiny wings along the petiole. Flower heads are 2 to 4 cm/0.8 to 1.6 in wide in tight clusters and at the tips of stems. The flowers are 25 to 30 mm/1.0 to 1.2 in long, and nearly white with a purplish tube containing purple anthers (Figure 2). The fruits are achenes (dry fruit containing one seed only; Lea 2002, p. 7), 3 to 4 mm/0.1 to 0.2 in long, and topped with a pappus (umbrella of small hairs) 15 to 25 mm/0.6 to 1.0 in long (Keil and Turner 1993, p. 236) that facilitates wind dispersal. La Graciosa thistle can be confused with the clustered thistle (Cirsium brevistylum; Table 3) and cobwebby thistle (Cirsium occidentale). (USFWS, 2018)

Taxonomy

Cirsium loncholepis was described and named by Petrak (1917, p. 375) from a specimen collected “near La Graciosa” by Alice Eastwood in 1906. It is in the aster and sunflower family (Asteraceae; Baldwin et al. 2012, p. 289). The common name La Graciosa thistle is in reference to the collection site of the holotype, which apparently was near Graciosa railway station or La Graciosa village (now south Orcutt; Figure 1) in Santa Barbara County (Wilken 2009, p. 3). (USFWS, 2018)

Historical Range

See Current Range. An occurrence previously reported in Monterey County has since been determined to be the Alameda County thistle (Cirsium quercetorum). (USFWS, 2018)

Current Range

In San Luis Obispo and Santa Barbara Counties, California. (USFWS, 2018)

Critical Habitat Designated

Yes; 12/3/2009.

Legal Description

On November 3, 2009, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 3, 2009) for Cirsium loncholepis (La Graciosa thistle) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in California (74 FR 56978-57046).

Critical Habitat Designation

The critical habitat designation for Cirsium loncholepis includes six CHUs in San Luis Obispo and Santa Barbara Counties, California. This species critical habitat encompasses approximately 24,103 acres (ac) (9,754 hectares (ha)). Brief descriptions are provided below; detailed coordinates and maps are included in the Final Rule (74 FR 56978-57046; USFWS, 2009).

Unit 1: Callender-Guadalupe Dunes (9,690 ac (3,921 ha)) Unit 1 is located in the southwestern corner of San Luis Obispo County, California. It stretches along 8.5 mi (13.5 km) of coast from Arroyo Grande Creek to the Santa Maria River. This unit is south of Pismo Beach, west of Nipomo and north of Guadalupe.

Unit 2: Santa Maria River-Orcutt Creek (13,227 ac (5,353 ha)) Unit 2 is located along the lower 5 mi (8 km) of the Santa Maria River and along the length of Orcutt Creek (approximately 13 mi (21 km)) in San Luis Obispo and Santa Barbara Counties, California.

Unit 3: Canada de las Flores (740 ac (299 ha)) Unit 3 is located approximately 5 mi (8 km) northwest of the town of Los Alamos and southwest of the Solomon Hills in Santa Barbara County, California.

Unit 4: San Antonio Creek (185 ac (75 ha)) Unit 4 is located in the northwestern portion of Santa Barbara County, California. The majority of Unit 4 lands occur on VAFB.

Unit 5: San Antonio Terrace (52 ac (21 ha)) Unit 5 is located in western Santa Barbara County, California. We determined that all lands in Unit 5 (7,334 ac (2,968 ha)) on San Antonio Terrace are essential to the conservation of Cirsium loncholepis. Unit 5 stretches along 4 mi (6.5 km) of the coast north from San Antonio Creek.

Unit 6: Santa Ynez River (210 ac (85 ha)) Unit 6 is located in the western portion of Santa Barbara County, California. Unit 6 is west of Lompoc and east of Surf.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cirsium loncholepis critical habitat consists of four components (74 FR 56978-57046):

(i) Mesic areas associated with: (A) Margins of dune swales, dune lakes, marshes, and estuaries that are associated with dynamic (changing) dune systems including the Santa Maria Valley Dune Complex and Santa Ynez Valley Dune Complex; (B) Margins of dynamic riparian systems including the Santa Maria and Santa Ynez Rivers and Orcutt and San Antonio Creeks; and (C) Freshwater seeps and intermittent streams found in other habitats, including grassland, meadow, coastal scrub, and oak woodland. These areas provide space needed for individual and population growth including sites for germination, reproduction, seed dispersal, seed bank, and pollination;

(ii) Associated plant communities including: Central dune scrub, coastal dune, coastal scrub, freshwater seep, coastal and valley freshwater marsh and fen, riparian scrub (e.g., mule fat scrub, willow scrub), oak woodland, intermittent streams, and other wetland communities, generally in association with the following species: Juncus spp. (rush), Scirpus spp. (tule), Salix spp. (willow), Toxicodendron diversilobum (poison oak), Distichlis spicata (salt grass), Baccharis pilularis (coyote brush), and B. douglasii (Douglas' baccharis);

(iii) Soils with a sandy component including but not limited to dune sands, Oceano sands, Camarillo sandy loams, riverwash, and sandy alluvial soils; and

(iv) Features that allow dispersal and connectivity between populations, particularly: (A) Natural riparian drainages in Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River that are not channelized or confined by barriers or dams, such that they have soft bottoms and sides and a natural flood plain (allowing uninterrupted water flows); and (B) Natural aeolian geomorphology in the Santa Maria Dune Complex and Santa Ynez Dune Complex, and along the Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River drainages that is not confined by barriers or wind-blocks such as large manmade structures, tree rows, or windbreaks (allowing uninterrupted winds across these areas).

Special Management Considerations or Protections

Many of the known occurrences of Cirsium loncholepis are threatened by direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup); development that results in additional habitat modification or land use changes (i.e., conversion of agricultural and urban development); county zoning changes; issuance of development permits; non point source pollution such as from urban and agricultural runoff (e.g., herbicides, fertilizers); facility accidents by oil companies or VAFB; groundwater extraction throughout the range of the species; hydrological alterations; direct and indirect effects from off highway vehicle (OHV) activity (i.e., habitat disturbance, hazardous materials spills); small population size; and habitat fragmentation and loss through the invasion of aggressive nonnative weeds such as Ammophila arenaria (European beach grass), Carpobrotus spp. (iceplant), Ehrharta calycina (veldt grass), and Mesembryanthemum crystallinum (crystalline iceplant). These threats may require special management to ensure the long-term conservation of C. loncholepis.

The essential features found in Unit 1 may require special management considerations or protection resulting from: (1) direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup, facility accidents); (2) ground water extraction which lowers the water table, dries the wetlands, and can destroy surface and subsurface hydrologies; (3) stochastic (i.e., random) extirpation/extinction events that occur because the population size is small or isolated; (4) trampling and grazing from trespass of cattle; (5) competition from invasive, aggressive, nonnative weeds (e.g., Ammophila arenaria , Carpobrotus spp., Ehrharta calycina, Mesembryanthemum crystallinum); (6) direct and indirect effects from OHV activity (i.e., habitat disturbance, hazardous materials spills); (7) habitat fragmentation; and (8) nutrient inputs in the water systems that are above concentrations known to adversely affect freshwater ecosystems and cause adverse ecological effects including altering the composition of the plant community and inducing biostimulation.

The essential features found in Unit 1 may require special management considerations or protection resulting from: (1) direct and indirect effects from energy-related operations (i.e., maintenance activities, hazardous waste cleanup, facility accidents); (2) ground water extraction which lowers the water table, dries the wetlands, and can destroy surface and subsurface hydrologies; (3) stochastic (i.e., random) extirpation/extinction events that occur because the population size is small or isolated; (4) trampling and grazing from trespass of cattle; (5) competition from invasive, aggressive, nonnative weeds (e.g., Ammophila arenaria , Carpobrotus spp., Ehrharta calycina, Mesembryanthemum crystallinum); (6) direct and indirect effects from OHV activity (i.e., habitat disturbance, hazardous materials spills); (7) habitat fragmentation; and

(8) nutrient inputs in the water systems that are above concentrations known to adversely affect freshwater ecosystems and cause adverse ecological effects including altering the composition of the plant community and inducing biostimulation.

Life History

Food/Nutrient Resources

Lifespan

Adult: 2-3 years (inferred from USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Pollinators

Breeding Season

Adult: Blooms from April to September (USFWS, 2018)

Other Reproductive Information

Adult: La Graciosa thistle blooms from April to September (Baldwin et al. 2012, p. 289). Potential pollinators include ants, beetles, bees, butterflies and flies (Keil 2001, p. 1; Lea 2002, p. 80). Seed dispersal is by wind (Keil and Turner 1993, p. 236; Lea 2002, p. 7; USFWS 2016a, p. 68) and also likely by water because it is a wetland plant. The seed bank of La Graciosa thistle may be similar to that of the wetland jewelweed (Impatiens capensis) for which no persistent seed bank exists (Simpson et al. 1985, p. 307). This is supported by the data in our Table 2. Of the 13 occurrences for which zero plants were recorded and then a subsequent census conducted, 11 also had zero plants recorded in the subsequent census. In other words, only two of 13 occurrence were found to be extant after a previous census record of zero plants. This combined with the observations of Hendrickson (1990b, p. 23), Lea (2002, p. 45) and Teed (2003, p. 29) indicate that La Graciosa thistle has only a minimally persistent seed bank. (USFWS, 2018)

Reproduction Narrative

Adult: Cirsium scariosum var. loncholepis (La Graciosa thistle) is a short-lived monocarpic perennial (a plant that blooms once, then dies) (Hendrickson 1990, Keil and Turner 1993, Teed 2003). C. loncholepis flowers bloom between June to August (NatureServe, 2015). Large individuals produce more flowering heads and more seeds per head (average = 473 seeds per plant) than smaller individuals (average = 168 seeds per plant), and therefore contribute disproportionately to the future seedbank of the population (M. Lea, California Polytechnic State University, San Luis Obispo, pers. comm. 2001).

Habitat Type

Adult: Wetlands (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Mesic wetlands, coastal dunes, brackish marshes and swamps (USFWS, 2011; NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Intermediate moisture (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Requires medium moisture conditions that are neither very wet nor very dry (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: La Graciosa thistle exists as groups of individuals in wetland habitats in an arid and semi-arid landscape. The plants inhabit the margins of wetlands (swales, lakes, ponds, freshwater marshes, streams, rivers, seeps) in southwestern San Luis Obispo County and western Santa Barbara County in central coastal California. The majority of occurrences are associated with wetlands in the backdunes of two coastal sand dune complexes, the Callender Dunes and the Guadalupe Dunes (Figure 1). Many of the wetlands in the sand dune complexes occur where the groundwater table is at or near the surface (Lea 2002, p. 66; California Department of Fish and Game 2005, p. 328), and the water levels rise and fall naturally with rainfall. Low water levels can be exacerbated by drought (Holland et al. 1995, p. 23). (USFWS, 2018)

Dispersal/Migration

Motility/Mobility

Adult: High (USFWS, 2011)

Dispersal

Adult: High (USFWS, 2011)

Dispersal/Migration Narrative

Adult: The achenes (fruit) are 0.01 to 0.02 inches (3 to 4 mm) long and topped by an umbrella of long awns (0.6 to 1.0 in) that are ideal for wind dispersal (Keil and Turner 1993). Research has shown that Cirsium scariosum var. loncholepis are long-distance dispersers. (USFWS, 2011)

Population Information and Trends

Population Trends:

Declining (USFWS, 2018)

Species Trends:

Declining (USFWS, 2018)

Resiliency:

In summary, of the 21 known occurrences of La Graciosa thistle, 16 are likely extirpated, four are extant, and one has unknown status. Three of the four extant occurrences have moderate resiliency, suggesting a moderate ability of these three remaining occurrences to withstand stochastic events and natural environmental variation. One of the four extant occurrences has low resiliency, indicating a reduced ability to withstand stochastic events and natural environmental variation. Of the four extant occurrences, one is protected on a National Wildlife

Refuge, one is protected on private property by a conservation easement, one is currently protected on private property by a biological opinion, and one is on two private properties with current protection on one by a biological opinion (USFWS, 2018).

Representation:

In summary, the results indicate that the genetic diversity and the spatial extent of La Graciosa thistle have declined substantially from historical conditions. Gene flow among the four extant occurrences appears limited, and it was likely much greater historically. The four extant occurrences are in the Sand Dune Complexes population. Representation in the other three populations appears to have been lost, suggesting the species has lost potential capability for adapting to changes (natural or human caused) in its environment (USFWS, 2018).

Redundancy:

In summary, with only four extant occurrences and 16 likely extirpated occurrences (and one occurrence with unknown status), the redundancy of La Graciosa thistle is severely reduced. This reduction decreases the ability of the species to withstand catastrophic events and to survive in the face of unpredictable and highly consequential events for which adaptation is unlikely (USFWS, 2018).

Number of Populations:

8 extant occurrences; 15 likely extirpated occurrences (USFWS, 2020)

Population Narrative:

Currently, 21 extirpated and extant occurrences range coastally from Pismo State Beach (occurrence 14; 35.107367, -120.625009), San Luis Obispo County, southward to the floodplain of the Santa Ynez River near the south entrance of Vandenberg Air Force Base (occurrence 1; 34.662962, -120.556957), Santa Barbara County (32.7 km/20.3 mi distance), and from the Pacific Ocean eastward to a freshwater marsh 1.6 km/1.0 mi northeast of Los Alamos (occurrence 33; 34.748658, -120.259412), Santa Barbara County (31.7 km/19.7 mi distance). The occurrence previously reported in Monterey County has since been determined to be the Alameda County thistle (Cirsium quercetorum) (Lea 2002, p. 3). The majority (n = 17) of occurrences are within 6.3 km/3.9 mi of the coast, while four occurrences are at substantially greater distances. Most of the occurrences (n = 16) are in or proximal to two coastal sand dune complexes in San Luis Obispo County: the Callender Dunes just south of Arroyo Grande, and the contiguous Guadalupe Dunes just north of the Santa Maria River Of the 21 known occurrences, 16 are likely extirpated, four are currently extant (occurrences 6, 11, 18, 31), and one has unknown status. The four extant occurrences are on lands of various ownership: one occurrence on private property of Chevron Corporation (18), one occurrence on private properties of Chevron Corporation and another landowner (6), one occurrence on private property with a conservation easement to the Land Conservancy of San Luis Obispo County (11), and one occurrence on Guadalupe-Nipomo Dunes National Wildlife Refuge (31). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2018)
Exposure:
Response:
Consequence:

Narrative: The primary threat to La Graciosa thistle in 2018 is lack of water, with groundwater decline as the likely major source. The groundwater decline appears to be a result of extraction for urban, agricultural and industrial uses, and it is exacerbated by drought and climate change. Groundwater decline causes habitat loss and degradation for La Graciosa thistle. Past development and agriculture have also caused substantial habitat loss and fragmentation by conversion of land for other uses (Hendrickson 1990b, p. 22). From the 1850's to 1987, 90% of California's coastal wetlands disappeared (Caughman and Ginsberg 1987, p. 24). In the 21st century, the remaining wetlands in central coastal California continue to decrease in quantity and quality (USFWS 2011, p. 11). Due to its minimally persistent seed bank, any occurrence of the species that has not had flowering plants over several consecutive years is at risk of extirpation. (USFWS, 2018)

Stressor: Urbanization (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Most of the historical occurrences and their surrounding areas are urbanized and/or indirectly impacted by urbanization (Service 2009a, CNDDB 2010). As mentioned above in the Abundance and Population Trends section, Cirsium scariosum var. loncholepis has experienced considerable declines throughout its range in the number of populations, occurrences, and individuals. It is only known to be extant at 8 of the 21 known occurrences (see Table 1). This decline in range, populations, occurrences, and individuals has further limited this species' ability to colonize or recolonize adjacent and intermediate locations of suitable habitat. (USFWS, 2011)

Stressor: Development of habitat for petroleum extraction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Habitat loss has been implicated from petroleum related activities. (USFWS, 2011)

Stressor: Cattle grazing and herbivory (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Cattle have been documented crushing and breaking C. scariosum var. loncholepis plants on the Guadalupe-Nipomo National Wildlife Refuge (Elvin 2007d). Trampling and crushing impacts from cattle have been documented in and among plants at the Chevron project site in the Guadalupe Dunes (Elvin 2006). Cirsium scariosum var. loncholepis was last reported at the Cañada de Las Flores population in 1989 (Service 2009a). This population has been overgrazed according one local rancher (Elvin 2007c). This overgrazing has reduced plant cover, compacted the soil, and may have crushed plants at this population. Trampling and crushing of plants and compaction of soil may have been an exacerbating circumstance that led to the possible extirpation of this species at this population. While this plant may be able to withstand some herbivory, it may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. (USFWS, 2011)

Stressor: Loss of connectivity between populations (Long-Distance Dispersal) (USFWS, 2011)
Exposure:

Response:
Consequence:
Narrative: Recent research on species that are long-distance dispersers (such as Cirsium scariosum var. loncholepis) determined that when the distances between suitable habitat sites for a species become greater than its dispersal distance (such as due to habitat fragmentation), its long-term survival will be threatened unless the long-distance dispersal between the sites can be re-established (Trakhtenbrot et al. 2005). Alterations of hydrological regimes (e.g., flood control) have increased the lack of connectivity between populations (Service 2009a). Wilken (2009a) stated that the current hydrological regulatory process in the Santa Ynez River may not be conducive to conditions favoring establishment of C. scariosum var. loncholepis. Connectivity between populations, particularly natural riparian drainages in Santa Maria River, Orcutt Creek, San Antonio Creek, and Santa Ynez River that are not channelized or confined by barriers or dams, such that they have soft bottoms and sides and a natural flood plain (allowing uninterrupted water flows) is one of the primary constituent elements for C. scariosum var. loncholepis in the final critical habitat rule (Service 2009a) and is important to maintain connectivity between populations for see dispersal and the establishment of intermediate linkage populations that may be transitory in nature. Habitat that would provide connectivity between occurrences and populations is essential to recover C. scariosum var. loncholepis (Service 2009a). (USFWS, 2011)

Stressor: Water quality (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Threats identified since the time of listing discussed above under Factor A include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or historically supported Cirsium scariosum var. loncholepis. These nutrient levels have a direct effect on the vegetation in these watersheds, which causes excessive growth that is consistent with biostimulation and eutrophication. Excessive nutrient inputs can lead to vegetation community composition changes due to biostimulatory effects (California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et al. 1998). (USFWS, 2011)

Stressor: Genetics as affected by small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The limited gene pool of this species may depress its reproductive vigor. Human-caused or natural environmental disturbances (e.g., flood, drought, disease) could increase the risk of extinction of Cirsium scariosum var. loncholepis. Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991); this has already been observed in C. scariosum var. loncholepis (Hendrickson 1990). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). Low levels of genetic variation among and within populations could impair a species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor) (Arias et al. no date). The existence of less than 10 populations and the small number of

individuals in these populations places Cirsium scariosum var. loncholepis at extreme risk of extinction due to low levels of genetic diversity. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The extent to which climate change could affect C. scariosum var. loncholepis is unknown at this time due to the general nature of these predictions. Despite the uncertainty regarding the specific effects of climate change on this species, an increase in the rate of sea level rise has been predicted for the coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). In particular, dunes along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat estimated to be between 459 and 1,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because Cirsium scariosum var. loncholepis occurs in coastal dune habitats, erosion of these areas and corresponding loss or decreased quality of habitat could potentially adversely affect the species. (USFWS, 2011)

Recovery

Reclassification Criteria:
La Graciosa thistle may be considered for downlisting when the following criteria are met: 1) At least nine occurrences exist, with a minimum of two occurrences from each of two different population units, and they display stable or increasing trends over 10 consecutive years.1 2) Each of the nine occurrences is being consistently managed in a way that will support the continued existence of La Graciosa thistle and its habitat, including seed banking, propagation and outplanting efforts, invasive weed abatement, and assurances for adequate hydrology within associated aquatic features. 3) Annual monitoring and reporting demonstrate that management is effective over 10 consecutive years. 4) An ex situ conservation seed bank is established and maintained at one or more facilities certified by the Center for Plant Conservation. (USFWS, 2021)

Delisting Criteria:
Once the downlisting criteria have been met, La Graciosa thistle may be considered for delisting when the following criteria are met: 1) At least 13 occurrences exist, with a minimum of two occurrences from each of three different population units and they display stable or increasing trends over 10 consecutive years. 2 2) Each of the 13 occurrences is secure from known, plausible threats including from groundwater decline. 3) Each of the 13 occurrences is being consistently managed in a way that will support the continued existence of La Graciosa thistle and its habitat, including seed banking, propagation and outplanting efforts, invasive weed abatement, and assurances for adequate hydrology within associated aquatic features. 4) Annual monitoring and reporting demonstrate that management is effective over 10 consecutive years. (USFWS, 2021)

Recovery Actions:

- Recommendation for Future Actions from the 2019 5-Year Review: The results of our 2018 SSA indicate that La Graciosa thistle viability has declined sharply from historic conditions and has continued to decline since the 2011 5-year review. Both near-tenn and long-term efforts are required to achieve recovery. Several recommendations designed to halt this downward trajectory and ultimately reverse it, so that La Graciosa thistle can recover and persist into the future, are provided below. (USFWS, 2018)
- Near-term Recovery Actions: • Annual monitoring at the five extant occurrences; • Collect seed for banking and bulking, test seed viability; 10 • Conduct outplanting of La Graciosa thistle at historical occurrences and in other potentially suitable habitats; • Conduct habitat restoration and management at five extant occurrences and any newly established sites (including but not limited to- invasive species management, manual disturbance such as removal of thatch and vegetation clearing, supplemental watering, removal of overgrown hydrophytic species, re-introduction of controlled grazing regimes as a potential invasive species management tool, and installation of cages around individual plants during particular phenological stages); • Conduct education and outreach; and • Utilize the La Graciosa thistle Recovery Team and other potential recovery partners and stakeholders to facilitate ongoing collaborations. (USFWS, 2018)
- Longer-term Recovery Actions: • Establish living La Graciosa thistle collections at botanic gardens; • Pursue site access to occurrences (both historic and unknown) and potentially suitable habitats on private properties for surveys; and • Establish easements to support La Graciosa thistle recovery endeavors. (USFWS, 2018)
- Research Needs: • Habitat suitability modeling to identify potential outplanting sites throughout the species range; • Evaluation of the role of disturbance and management techniques for species recovery; • Seed viability and germination testing; • Hydrology and groundwater analyses; • Genetics work; • Pollination studies; and • Regional climate change simulations and projections. (USFWS, 2019)
- Near-Term Recovery Actions The aim of the near-term recovery actions is to prevent extirpation of the species at the eight extant occurrences, all of which are in the Sand Dunes Complex Population Unit. The actions include: 1) Habitat Restoration – invasive weed treatments with herbicides, abatement and removal to prevent re-infestations; woody debris removal to clear out downed trees and tree limbs; possibly thinning and trimming excessive arroyo willow (Salix lasiolepis), poison oak (Toxicodendron diversilobum) and blackberry (Rubus spp.); and management of dense thatch. Habitat restoration may also require dredging of aquatic features and other remedial measures to augment and renovate local hydrologic regimes. 2) Supplemental Watering – when necessary during drought or lack of water, specifically to ensure survival of particular individual plants and/or colonies. 3) Installation of Exclusionary Fencing and/or Cages – around individuals and colonies of La Graciosa thistle to prevent herbivory from mammals such as deer (Odocoileus hemionus) and rabbit (Sylvilagus audubonii), and trampling from wild pig (Sus scrofa). Fencing may also be used for disturbance studies associated with seasonal cattle grazing. 4) Propagation and Outplanting – coordinated and directed efforts to collect seed when and if it is readily available to produce seedlings from tracked maternal lines, which will be outplanted at locations that are extirpated, that have extremely low numbers of individuals and could become extirpated, or at appropriate sites located within close proximity to the extant occurrences. 5) Annual Monitoring and Reporting – these efforts are required to assess the effectiveness of the near-term actions, track and census the numbers of individuals at each occurrence and to both guide and determine future recovery actions. The property

owners/managers of each extant occurrence have agreed to complete five consecutive years of annual monitoring with reporting and to participating in the near-term La Graciosa thistle recovery program. Longer-Term Recovery Actions The longer-term recovery actions are intended to inform the strategic future development of the species recovery program, fill important knowledge gaps and to systematically move the species towards downlisting and eventual delisting. These actions can occur within any and all of the population units, include future research needs, and consist of the following: 1) Establish and Maintain a Conservation Seed Bank – seed will be collected from all extant occurrences and deposited into a permanent conservation collection at a facility that is certified by the Center for Plant Conservation. Certified affiliates are part of a national network that follow stringent guidelines for seed conservation banking set by the International Board for Plant Genetic Resources and in consultation with the National Laboratory for Genetic Resource Preservation. Once deposited, seed will be stored and curated in perpetuity to serve as emergency back-up if the species becomes extinct in the wild and for other recovery purposes. 2) Seed Viability Studies and Bulking – once the conservation seed bank is established, research will be conducted to evaluate the viability of La Graciosa thistle seed and efforts to bulk the seed will be pursued. These activities are to ensure that abundant seed is readily available for subsequent outplanting projects and recovery efforts. 3) Re-establish Several Extirpated Occurrences – facilitate outplanting efforts at numerous sites that are likely to have cooperative recovery partners based on the current land ownership status and land use practices and/or that conducive conservation easements are already established. These priority sites include and are presented in numeric order: • Occurrence 1 at Vandenberg Air Force Base; Vandenberg South Population Unit, would re-establish the species in the southwestern part of the geographic range. • Occurrence 13 at Oso Flaco Lake in Oceano Dunes State Vehicular Recreation Area; Sand Dune Complex Population Unit; owned by California Department of Parks and Recreation. • Occurrence 14 at Pismo State Beach; Sand Dune Complex Population Unit; owned by California Department of Parks and Recreation. This site also has the Oceano Dunes District Visitor Center, which could provide an opportunity to promote public education/outreach for La Graciosa thistle. • Occurrence 16 at Black Lake Ecological Area; Sand Dune Complex Population Unit; owned by Land Conservancy of San Luis Obispo County. 4) Establish cooperative relationships with other landowners – engage potential partners with the goal of surveying parcels not previously surveyed for additional occurrences or suitable habitat that could be used for additional outplanting efforts. 5) Fulfill Research Needs – work with partners to fund research and other collaborative studies to fill knowledge gaps about the species including (but not limited to) the following: best management practices and methods for the various life stages of the species; species response to disturbance from grazing, thatch removal and other vegetation management techniques; demographic studies, pollination ecology research, genetics research, habitat suitability analyses and modeling, groundwater testing and mapping and other hydrologic modeling for evaluating variable climate change scenarios. (USFWS, 2021)

Conservation Measures and Best Management Practices:

- Conservation Measures for La Graciosa Thistle: In 2018, conservation measures are being implemented on two properties: the private property of Chevron Corporation, and Oceano Dunes State Vehicular Recreation Area (1,457 ha/3,600 ac). Since 2005, Chevron Corporation has managed occurrences 6, 18 and 32 (Table 6) in the Guadalupe Oil Field under a biological opinion (USFWS 2005, entire) issued under the U.S. Endangered Species Act. Specifically, their actions have included

the following: • annual monitoring of three occurrences of La Graciosa thistle on their property (a fourth occurrence was identified in 2018); • salvaging and transplanting 1,629 individuals that would have been impacted by remediation and restoration activities, of which 1,136 individuals survived; • outplanting 2,842 individuals (2,826 grown from seed), of which 1,893 individuals flowered; • managing invasive plants in the Guadalupe Oil Field; and • removing feral pigs.

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SPECIES ACCOUNT: *Cirsium pitcheri* (Pitcher's thistle)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/17/1988; Great Lakes-Big Rivers Region (R3)

Physical Description

Pitcher's thistle is a monocarpic (flowers and sets seed only once), perennial, herbaceous plant, generally flowering after a 5-8 year juvenile stage (Loveless 1984). The stems and leaves of juveniles and adults are woolly-white, and the leaves are deeply pinnatifid with the lobes less than 1 centimeter (cm) wide and up to 4 cm long. Minute spines are concentrated along the edge of the leaf at its base, with a few spines between the lobes of the distal leaf margins. The flowering stems are up to 1 meter (m) tall and have several to a dozen widely scattered leaves. Individuals typically have a single branching flowering stem with terminal and axillary flowering heads of a cream or pinkish color. Juveniles and adults have a taproot that may reach 2 m in length (McEachern and Pavlovic pers. obs.). (USFWS, 2002)

Taxonomy

This distinctive dune plant, often referred to as the dune thistle, was first noted by Dr. Zina Pitcher about 1827 at the Grand Sable Dunes of the Upper Peninsula of Michigan. The species was first described by Eaton (1829) as Cnicus pitcheri from the type specimen which was apparently collected in 1827 on or near Mackinac Island by Dr. Edwin James (Voss 1996). (USFWS, 2002)

Historical Range

Pitcher's thistle (Cirsium pitcheri) is endemic to the beaches and grassland dunes of Lakes Michigan, Superior, and Huron. Distribution of the species extends along the Lake Michigan shoreline in Wisconsin. In the east it ranges through northern Lake Huron to the Manitoulin Island archipelago and southern Georgian Bay in Ontario. Pitcher's thistle extends as far south as Lambton County, Ontario, Canada on Lake Huron, (USFWS, 2002)

Current Range

Current distribution is Illinois (Lake County), Indiana (Porter County), and Michigan (Alcona, Alger, Allegan, Alpena, Antrim, Arenac, Benzie, Berrien, Charlevoix, Cheboygan, Chippewa, Delta, Emmet, Grand Traverse, Huron, Iosco, Leelanau, Mackinac, Manistee, Mason, Muskegon, Oceana, Ottawa, Presque Isle, Schoolcraft, Van Buren Counties), and Wisconsin (Door, Manitowoc, and Sheboygan Counties). (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual

Other Reproductive Information

Adult: Pitcher's thistle reproduces only sexually. Pollination occurs through a variety of insects but primarily through bees (Hymenoptera). Pitcher's thistle blooms from June to September and is protandrous (pollen maturing before stigmas are receptive on individual flowers), and partially self-compatible (Higman and Penskar 1999). Seed dispersal occurs from June to August (McEachern 1992), depending on latitude, and does so through individual seeds blowing from the inflorescence head or by the whole plant and heads falling to the ground at the end of the growing season. A secondary means of dispersal is by wind blowing seed and seed heads across the sand, snow or water surface (Loveless 1984). The seeds are subject to herbivory by artichoke plume moth larvae (Platyptilia carduidactyla), ground squirrels, birds, especially goldfinches (Spinus tristis), and deer. Seed dormancy is broken by cold, moist stratification (Hamzé and Jolls 2000), with seed germination occurring in May and June (Loveless 1984). After germination, seedlings emerge producing one to six leaves in the first season (Loveless 1984). Seedling densities are greater where bare ground is abundant (McEachern et al. 1989) than in stabilized sites with greater vegetation cover. Juvenile plants typically consist of one rosette and may remain dormant for one or two years as a result of drought (McEachern 1992). The chances of juvenile mortality decrease as the plants increase in size. Causes of mortality include trampling (Keddy and Keddy 1984; Gibson 1988), sand deposition and erosion, drought, and herbivory. Juveniles grow or maintain a constant size throughout the growing season, but may diminish in size over the winter (Loveless 1984; McEachern 1992). Observations indicate juvenile plants in foredunes grow by increasing leaf number, whereas in inland stabilized habitats they grow by increasing leaf size (Loveless 1984). These growth differences may be significant in determining the age when juveniles reach a critical flowering size. The probability of insect herbivory increased with juvenile size, large juvenile density, and population successional stage (Stanforth et al. 1997). However, Rowland and Maun (2001) found that plants negatively affected by herbivory were able to recover and compensate for lost tissue by the following growing season. Conversely, plants subjected to herbivory, required a longer juvenile period to reach reproductive stage, thus increasing the period of vulnerability to herbivory and environmental stresses. Pitcher's thistle typically reaches reproductive age after 5 to 8 years. Reproduction appears to be correlated with habitat as Loveless (1984) found that adults bloom sooner in more stabilized habitats than in foredunes. Specific reproductive triggers are unknown, but the length of the longest leaf (Loveless 1984) and the root crown diameter (McEachern 1992) were found to be significant predictors of timing of reproduction. However, flowering probably involves an interaction between plant size (growth rate) and age, as small plants have also been observed to flower (USFWS 2002). Pitcher's thistle plants exhibit overcompensation as a response to damage (i.e., herbivory) by producing multi-stemmed plants. Multi-stemmed plants produce more seeds per plant and exhibit higher pollination activity than single-stemmed plants (Dao 2013). (USFWS, 2018)

Reproduction Narrative

Adult: Cirsium pitcheri is closely related to C. canescens, a thistle of the sand hills of the Great Plains (Ownbey and Hsi 1963). Recent electrophoretic evidence has shown that the thistles share the same genetic loci, but differ greatly in the level of genetic diversity (Loveless and Hamrick 1988). Cirsium pitcheri possesses a much reduced level of genetic variability than does C. canescens, suggesting derivative-progenitor relationship, respectively. It is believed that Pitcher's thistle migrated to the Great Lakes region soon after the close of the Wisconsinan glaciation and that its reduced genetic diversity is a result of repeated and prolonged population bottlenecks (Loveless and Hamrick 1988).Seed germination in C. pitcheri has been observed

during June in Ontario (Keddy and Keddy 1984, Keddy 1981), Michigan and Indiana (McEachern et al. 1989). Keddy and Keddy (1984) found that the highest seedling mortality typically occurred in sand substrates, with the lowest in substrate of debris. In a season of drought, Ziemer (pers. comm.) still found seedling survivorship in the species to be fairly high (roughly 40%). Seedling survivorship in her study was found to be highest of the lakeward side of the foredune where active sand deposition and associated grasses (Ammophila and Calamovilfa) were common. Although Keddy and Keddy (1984) found that mortality did not significantly differ between seedlings growing in clusters or individually, Ziemer (pers. comm.) arrived at different conclusions. In her study, seedling survivorship was found to be highest in areas where other seedlings occurred.Once established in the rosette form, mortality is low (Keddy and Keddy 1984). This is, in part, due to the fact that immature plants can withstand burial by up to 15 cm of sand (Weller in litt.) and possess taproots that often reach down 5 to 7 feet, to where available moisture lies (Pepoon 1927). Of 193 rosettes studied in Ontario by Keddy and Keddy (1984), only seven died (due in part to caribou trampling and human intervention). Plume moth (Platyptilia carduidactyla) larvae occur within the centers of rosettes but do not appear to cause mortality (Keddy and Keddy 1984). They can, however, cause injury to the apical meristem of the plant, resulting in a multi-branched parental plant.Cirsium pitcheri is a monocarpic species which exists in a rosette for 5-8 years, flowers the following year, then dies (Crispin and Penskar 1990, McEachern et al. 1989, Dobberpuhl and Gibson 1987). Plants can remain in the rosette form until enough resources have been obtained in the root system to fuel the bolting plant and subsequent seed production (Keddy and Keddy 1984). The proportion of juvenile to adult plants is not unexpectedly skewed in favor of juvenile plants, 71.8% : 28.2% in Door County and 69.8% : 31.2% in Manitowoc County, Wisconsin (Dobberpuhl and Gibson 1987).According to Keddy and Keddy (1984) in Ontario, plants in grassland habitat dominated by beach grass and horsetail produced over twice as many branches and flower heads than plants in the debris habitat or on a crescent beach. Those on the crescent beach were nearly all vertical. This branched growth form may be attributed to the abundance of plume moth (Platyptilia carduidactyla) larvae in the grass habitat (Keddy and Keddy 1984). Attacks, by these larvae typically result in multi-branched individuals, as discussed above.Growth of C. pitcheri plants is also hindered at times by spittlebugs which lay eggs in the meristems of the plants, damaging newly-forming leaves (Crispin and Penskar 1990). This apparently causes mortality in some plants.Flowering begins in late June, peaks in late July, then declines rapidly (McEachern et al. 1989, Loveless 1983). According to Loveless (1983), many plants are dead and dying by early August, but some continue flowering until mid-September. After four to seven days of blooming, flowers begin to wither and die (Keddy 1981). As flowers brown, the involucral bracts gradually close in around them, protecting developing seeds. Flower heads per stalk vary from two to as many as 125 (Keddy 1981).Flower tubes of C. pitcheri contain several micro-liters of sweet-scented nectar secreted by a ridge at the base of the style (Keddy 1981, Knuth 1908). Apparently, a wide array of potential pollinators are attracted to this nectar. Of the 10 species of insects listed as flower visitors in Ontario (Keddy and Keddy 1984) and 23 insect visitors observed by Loveless (1983) in Michigan, only one species was the same, a bumblebee (Bombus perplexus). Insect pollen vectors include species within the genus Bombus (bumble-bees), Megachile (megachilid bees), Melissodes (anthophorid bees), Lasioglossum (small halictid bees), Agapostemon (large halictid bees), and butterflies and skippers of several genera (Loveless 1983). Other visitors to the flowers include flies, wasps, honeybees and sedentary beetles and bugs (Loveless 1983). Keddy and Keddy (1984) listed lepidopterans, dipterans and hymenopterans as flower visitors in Ontario, the most abundant of which was Bombus vagans. Prominent butterfly pollinators included Vanessa cardui and Daneus peleyippus (Crispin and Penskar 1990). Nocturnal visitors

have not been studied, but moths are believed to visit the flowers (Loveless 1983). For a species list of known pollen vectors and flower visitors, see Loveless (1983) and Keddy and Keddy (1984).Seed set is known to decline between late July and August in C. pitcheri. This decline in seed set has been attributed, in part, to pollinator availability which parallels this decline (Loveless 1983). Loveless (1983) observed that many plants died prior to maturing a single flower head, suggesting that the species allocates its resources early in the season when the likelihood of maturing fruits is highest.The artichoke plume moth (Platyptilia carduidactyla) larvae feed on the immature seeds of C. pitcheri, sometimes causing flower mortality (McEachern et al. 1989, Keddy and Keddy 1984). This insect has been observed by Loveless (1983) in Michigan, Keddy and Keddy (1984) in Ontario, and Dobberpuhl and Gibson (1987) in Wisconsin. In Ontario, Keddy and Keddy (1984) found that most plants were affected by the moth only in July, with predation highest in a grass habitat. Fewer plants were infected in a habitat of debris, while predation was non-existent in a crescent beach population. Loveless (1983), however, found that levels of seed damage in various habitats were nearly equal, suggesting that seed predation was density-dependant. In addition, Loveless observed that seed predation in Michigan did not markedly change throughout the season. For a brief description of the plume moth life cycle, see Keddy (1981). McEachern (pers. comm.) stated that she had observed a larva within the flower head in Michigan but is unsure as to its identity at this time.Mosquin et al. (1986) suggested that the presence of the plume moth in C. pitcheri populations may be mutually beneficial. Presence of larvae in the rosettes of C. pitcheri causes the plant to become multi-branched (Keddy and Keddy 1984). As a consequence, more flowers and seeds are produced. At present, there is little information to substantiate this hypothesis. In addition, the moth is also known to feed on the seeds of the thistle, so there may be a simple trade off or net loss of seed production despite the multiple-branched stemming of the plant. Keddy and Keddy (1984), in fact, suggested that up to 40% of the normal seed crop was lost in a given year in Ontario as a result of the moth predation.American goldfinches were observed to devour approximately 50% of the seeds within a given flowerhead (Loveless 1984). Other birds, primarily sparrows, forage on unburied seeds. The thirteen-lined ground squirrel (Spermophilus tridecemlineatus) is ; (NatureServe, 2015)

Habitat Type

Adult: Great Lakes sand dunes

Environmental Specificity

Adult: Broad (USFWS, 2016)

Habitat Narrative

Adult: Cirsium pitcheri occurs most prominently in Michigan, occurring in 18 counties along the shorelines of Lakes Michigan, Huron and Superior (Nepstad 1981). In Wisconsin, the species currently exists in eight sites in four counties on the Lake Superior shoreline (Alverson 1981). The species occurs at seven extant sites along Lake Michigan in Indiana (IN NHP 1989), but has been extirpated from Illinois (Sidle 1987, White 1981). It is also known from roughly 12 extant sites in Ontario, including a population on the shoreline of Lake Superior (Keddy and Keddy 1984, Keddy 1988).Pitcher's thistle is a regional endemic restricted to the dune habitats in the western Great Lakes region (USFWS 1987, Dobberpuhl and Gibson 1987, Keddy and Keddy 1984, Loveless 1983, Guire and Voss 1963). The species is a colonizer on open dune ridges, dune blowouts, and along disturbed sites in sand dunes, but is found on stabilized grassy sand terraces, sandy gravel flats and dune valleys as well (Loveless 1983). In all habitat types,

however, the species appears to establish itself only in very open, sandy soil (Loveless 1983).McEachern et al. (1989) described the habitats associated with the lakeshores as: 1) extremely exposed open communities on lake level foredunes and dune bluff edges dominated by Ammophila breviligulata, 2) transitional communities dominated by three dune grasses, A. breviligulata, Calamovilfa longifolia and Schizachyrium scoparium, and 3) stabilized inland blowouts characterized by S. scoparium/C. longifolia codominance and moderate vegetation and litter accumulation. These three habitat types mark a successional gradient, in which A. breviligulata, adapted to high rates of sand deposition occurring in the shoreline habitats, is replaced by the more competitive C. longifolia and finally, S. scoparium in progressively stable inland areas (McEachern et al. 1989). Associated with this change in dominant vegetation along a shoreline to inland transect, there is an equally significant reduction in the percentage of bare ground. This amount of bare ground is apparently significant, for it is in the most stable, S. scoparium dominated areas that C. pitcheri is the least abundant (McEachern et al. 1989).In Michigan, C. pitcheri is most common along the northern and northeastern shore of Lake Michigan, although small populations are known from the southeastern shores of Lake Michigan and northern Lake Huron (Crispin and Penskar 1990). A few populations also occur along Lake Superior. Cirsium pitcheri typically grows in association with Ammophila breviligulata, Schizachyrium scoparium, Arabis lyrata, Arctostaphylos uva-ursi, Calamovilfa longifolia and Agropyron dasystachyum (Crispin and Penskar 1990, MI NFI 1990). At disturbed sites, Asclepias syriaca may be present (Crispin and Penskar 1990).At Sleeping Bear Dunes National Lakeshore in Michigan, the species is apparently doing well, even in the intensely utilized areas around the marina (Hazlett and van de Kopple 1983). A recent survey by McEachern et al. (1989) found that C. pitcheri was occupying much of its potential habitat: foredunes, blowouts, dune ridges, valleys and slopes. Although C. pitcheri was least common from the backslopes of inland dunes, localized populations were found there as well.On the Manitou Islands portion of Sleeping Bear Lakeshore, plants have been found on perched (260 feet above Lake Michigan, on glacial moraines) and coastal dunes. McEachern et al. (1989) found that plants growing on the dunes of South Manitou Island appeared more stunted and were more dispersed than those on the mainland, possibly reflecting the harsher environment of the island. Associates on a gravel lag behind a coastal dune complex at Dimmick's Point on North Manitou Island include Agropyron dasystachyum, Schizachyrium scoparium, Anemone multifida, Artemisia caudata, Betula papyrifera, Campanula rotundifolia, Carex garberi, Thuja occidentalis and Zygadenus glaucus with an overstory of Betula papyrifera. Associates in a dune blowout on South Manitou include Schizachyrium scoparium, Anemone multifida, Arctostaphylos uva-ursi, Arenaria stricta, Aster sp., Calamovilfa longifolia, Coreopsis palmata, Equisetum hyemale, Ostrya virginiana, Polygonatum pubescens, Prunus virginiana, Trientalis borealis, Trillium grandiflorum, Viburnum acerifolium, Viola canadensis and Viola sp. (Hazlett and van de Kopple 1983). For additional habitat information pertinent to Sleeping Bear National Lakeshore, see McEachern et al. (1989), Hazlett (1986) and Loveless (1983).At Grand Sable Dunes within the Pictured Rocks National Lakeshore of Michigan, McEachern et al. (1989) found the populations occupying dune and blowout habitats ranging from the dune bluff inland to wooded areas. In contrast to Sleeping Bear, populations were scattered and were far less abundant. For habitat information concerning populations at Pictured Rocks National Lakeshore, see McEachern et al. (1989).Within the state of Indiana, plants have been observed on dunes, foredunes, blowouts and beaches along Lake Michigan (IN NHP 1989). At the Indiana Dunes National Lakeshore, Bowles et al. (1985) found Cirsium pitcheri restricted to early and mid-successional blowouts on the high dunes adjacent to Lake Michigan. It appeared to be absent from the first foredune. Sites were extremely well-drained and support sparse dry sand prairie-like communities (Bowles

et al. 1985). A recent survey of the site by McEachern et al. (1989) produced similar conclusions. In all, six small populations were found, all on the steep, lakeward-facing slopes or grassland blowouts of the secondary dunes. No plants were observed on the beach and foredune complexes still rebuilding since the high-water levels of 1986 and 1987.Dobberpuhl and Gibson (1987) stated that in Wisconsin, the plant is found in three habitats: (1) dry sand of partially-stabilized dunes along Lake Michigan, (2) dry, open areas of loose sand (sand blowouts) behind the main foredune and infrequently on (3) low, moist to wet beaches. Colonies thrive best in situations where the dunes are somewhat stabilized, in various slope aspects and degrees of steepness. Two populations in Wisconsin are at the mouths of creeks, where continual sand deposition from the creeks provides new habitat and increasing site longevity (WI NHP 1990, Dobberpuhl and Gibson 1987). Associated plants species in Wisconsin include Agropyron dasystachyum, Calamovilfa longifolia var. magna, Elymus canadensis, Ammophila breviligulata, Agropyron trachycaulon, Artemisia caudata, Lathyrus maritimus, Oenothera parviflora, Potentilla anserina and Solidago gillmani (WI NHP 1990, Alverson 1979, Johnson and Iltis 1963).In Canada, C. pitcheri is found only in Ontario on sandy beaches and dunes of the shores of Lake Huron and Georgian Bay (Moore and Frankton 1974) and Lake Superior (Keddy and Keddy 1984, Keddy 1981). At Lake Superior sites in Pukaskwa National Park, plants grow approximately 1-2 meters above the lake level on gently sloping sand beaches in three distinct habitats: 1) grass (dominated by Ammophila breviligulata and Equisetum variegatum), 2) debris (dominated by Prunus pumila and Festuca saximontana) and 3) shrub (dominated by Juniperus horizontalis and Arctostaphylos uva-ursi) (Keddy and Keddy 1984, Keddy 1981). Most plants (79%) were found in the grass habitat, with 21% growing in the debris habitat. Less than 1% were found in the shrub habitat (NatureServe, 2015). The Pitcher's thistle (Cirsium pitcheri), also known as dune thistle, is a Great Lakes endemic that is typically found on open beaches and grassland dunes and occasionally on lag gravel associated with the shoreline dunes. The Service listed Pitcher's thistle as a threatened species under the Act on July 18, 1988 (USFWS 2002). Pitcher's thistle is one of a few plant species endemic to the post-Wisconsinan Great Lakes sand dunes. It is found most frequently in the near-shore plant communities where it colonizes patches of open, windblown areas of the landscape. The species gradually declines locally as the density of vegetation and ground litter increases through plant succession and in areas heavily used by people. Pitcher's thistle density peaks in mid-successional habitats and requires 70% open sand for successful seedling establishment and survival (McEachern 1992). Healthy populations of Pitcher's thistle are an indication of the general well-being of dune ecosystems. No species is known to depend completely on Pitcher's thistle. However, the rust, Puccinia laschii, that is sometimes found on adult Pitcher's thistle leaves may be host-specific, and therefore, dependent on it (Saville 1970). In addition, Pitcher's thistle is a food (pollen, nectar, and seed) source for many organisms (Keddy and Keddy 1984; Loveless 1984). Pitcher's thistle depends on the geomorphic processes that maintain dune systems to create sparsely vegetated habitats where successful population growth can occur. Populations are prone to extirpation due to successional change, erosional loss, and catastrophic events depending on their location. A shifting mosaic of dune processes on a large dune system landscape can ensure this species' persistence as long as seed is available to disperse to existing or newly created adjacent suitable habitats. For a particular occurrence of Pitcher's thistle to survive, disturbance must be frequent enough to prevent extirpation from succession and infrequent enough to allow juveniles to reach maturity; thus, the Pitcher's thistle life history is finely tuned to a specific disturbance regime (McEachern 1992). Disturbances may eliminate local occurrences, but as long as those disturbances are not synchronous throughout the landscape and occurrence creation exceeds decline, the species will persist (Pavlovic 1994).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal occurs from June to August (McEachern 1992), depending on latitude, and does so through individual seeds blowing from the inflorescence head or by the whole plant and heads falling to the ground at the end of the growing season. A secondary means of dispersal is by wind blowing seed and seed heads across the sand, snow or water surface (Loveless 1984). The seeds are subject to herbivory by artichoke plume moth larvae (Platyptilia carduidactyla), ground squirrels, birds, especially goldfinches (Spinus tristis), and deer.

Population Information and Trends

Number of Populations:

222 (USFWS, 2023)

Population Size:

> 1,000,000 in the U.S. (USFWS, 2023)

Population Narrative:

NatureServe (2023) notes there "are an estimated 50,000 plants in Canada, 10,000 to 20,000 in Wisconsin, 500-1000 in Indiana, and possibly over 1,000,000 individuals in Michigan (Slaughter and Cuthrell 2017)" and that over "the last 10 years this species has remained stable in Michigan, stable to slightly increased in Canada, declined >50% in Indiana, and stable to declined <25% in Wisconsin." There is a total of 222 known occurrences of PITH in the United States (Figure 1). In Michigan, there are 182 extant occurrences, in Indiana there are 24 extant occurrences, in Illinois there are 5 known occurrences, and in Wisconsin there are 11 extant occurrences (personal comm. Pavlovic 2023). At the time of the previous 5-year review in 2018, several of the EOs that were found to be decreasing were located in southern Lower Michigan (Slaughter and Cuthrell 2017), and it was stated that inbreeding depression and other factors could leave EOs in southern Michigan prone to extirpation, resulting in fragmentation and isolation of remaining colony sites in other parts of the southern Great Lakes (Gauthier et al. 2010, Slaughter and Cuthrell 2017). There are 45 populations of PITH now known in Canada. Three populations at Pukaskwa National Park were surveyed annually between 1982 and 2015, and an additional 33 populations on Lake Huron were monitored annually between 2000 and 2017, with methods standardized in 2004 (Nantel et al. 2018). Monitoring at each location consisted in recording the total number of plants by life stage (i.e., seedling, rosette, or mature/flowering). Overall, habitat size increased from 2000 to 2010, stayed relatively constant until 2015, and has decreased since then (Nantel et al. 2018) (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Pitcher's thistle is threatened by habitat destruction, overuse, and repeated disturbance from trampling by beach and dune visitors and off-road vehicles. Approximately ten

percent of its population has been lost, modified or curtailed through these actions. Some populations have also been lost or negatively impacted through alteration of local dune geomorphic processes, which prevent the creation and maintenance of Pitcher's thistle habitat. In addition, shoreline stabilization projects, such as sea walls, rip rap, and planting of beach grass, northern white cedar, and some non-native species, also alter dune building processes and may decrease habitat available to Pitcher's thistle. (USFWS, 2016)

Stressor: Non-native and invasive species
Exposure:
Response:
Consequence:
Narrative: Encroachment by non-native and invasive species, such as spotted knapweed, baby's breath, and Lombardy poplar, also pose a threat to Pitcher's thistle. For example, spotted knapweed is known to negatively influence the soil in its vicinity to prevent the growth of native species (Louda et al. unpub. data 2007), as well as out-compete native species for resources. The introduction and spread of non-native insect species for biological control is an additional threat. Two species of non-native weevils used for biological control have been documented in Michigan, as well as some of the surrounding states, and these newly emerging threats place the range-wide existence of Pitcher's thistle at risk. These non-native weevils oviposit eggs near the base of developing seed heads (Louda et al. 1997, Louda et al. 2005, McEachern and Pavlovic 2013). Larvae develop inside the receptacle tissue at the base of the head, feeding on receptacle and eventually seeds within the ovary (Louda et al. 1997, Louda et al. 2005, McEachern and Pavlovic 2013). As the seed head matures, the weevils emerge as adults, often leaving visible exit holes at the base of the head (McEachern and Pavlovic 2013). The weevils' actions prevent seeds from forming or flowering. Flowerhead weevil (Rhinocyllus conicus) was introduced from Europe in 1969 to control Carduus species, especially musk thistles (Carduus nutans) and others plants (Rees 1982, Bradley 2007, Sauer and Bradley 2008). The weevil also develops on multiple native Cirsium species in the United States (Goeden and Ricker 1986a, 1986b, 1987a, 1987b; Turner et al. 1987; Louda et al. 1997). Laboratory and garden host specificity tests revealed that flowerhead weevils fed, oviposited, and developed completely on Pitcher's thistle, as well as its target species, and taller Pitcher's thistle plants with more flowerheads were significantly more vulnerable to the weevil (Louda et al. 2005). Rhinocyllus conicus has been documented in Wisconsin, where it was released in 1975, with a second release in 1978 (Sauer and Bradley 2008). It has since spread to several other counties (Sauer and Bradley 2008); however, it has not yet been documented in wild populations of Pitcher's thistle in the state. The weevil was also found on Pitcher's thistle in a common garden at Chicago Botanic Garden (CBG) in 2007 (J. Fant, CBG, pers. comm. 2007; N. Pavlovic, USGS, pers. comm., 2007) and in a Pitcher's thistle nursery at Illinois Beach State Park near a restoration site in 2011 (Bell and Hankins, unpublished, cited in McEachern and Pavlovic 2013). In 2012, R. conicus was collected from Pitcher's thistle at the Miller Dunes unit of the Indiana Dunes National Lakeshore (McEachern and Pavlovic 2013). Based on the 2012 surveys conducted in Michigan, the weevil was observed on musk thistles in Jackson and Lenawee counties (D. Landis, Michigan State University, pers. comm. 2012), which are not within range of Pitcher's thistle. A greenhouse test documented the weevil in approximately 40% of Pitcher's thistle seed heads and reduced seed set by 95% in those heads during the first year of infestation (Louda et al. 2005, Havens et al. 2012a). A demographic model suggests that R. conicus will reduce Pitcher's thistle population growth rate by 15% per year and the time to halve the population size from 66.9 years to 4.0–4.0 years (K. McEachern, USGS, pers. comm. 2011). In addition to reducing seed numbers in Pitcher's thistle, R. conicus predation is also

expected to reduce seed mass (M. Bowles, The Morton Arboretum, pers. comm. 2013). Larinus planus, a seed-eating weevil, was inadvertently introduced into the U.S. from Eurasia in the 1960s and has since been redistributed for control of Canada thistle (Cirsium arvense L.) (White 1972, Havens et al. 2012a, McEachern and Pavlovic 2013). In 2010, L. planus was first documented in Pitcher's thistle populations at Whitefish Dunes State Park, Door County, Wisconsin, in approximately one-third of examined seed heads (Havens et al. 2012). No viable seeds were found in those heads (Havens et al. 2012a). A more extensive survey of the Whitefish Dunes population in 2011 found the weevil in half the seed heads and almost no viable seeds (Havens et al. 2012a). Subsequent surveys of public and private lands throughout the Door Peninsula found L. planus in every Pitcher's thistle population (Havens et al. 2012a). In 2012, three Pitcher's thistle heads collected from research plots at Wilderness State Park, Emmet County, Michigan, had adult L. planus emerge from the flower heads in late-July 2012 (Havens et al. 2012b). Consequently, a more extensive search for the weevil was conducted at six element occurrences of Pitcher's thistle at Wilderness in mid-August 2012. Suspected weevil-damaged seed heads were collected and sent to CBG to examine for L. planus infestation. Although CBG found no adult weevils, most element occurrences had at least one damaged seed-head that was consistent with the weevil damage observed in Wisconsin, which consisted of one or more of the following characteristics: destruction of all or nearly all developing seeds, mass of digested ovules, seeds, frass remnants, and a pupal chamber visible in the receptacle tissue (Havens et al. 2012b). Currently, there is limited knowledge about the life-history of weevils, their relationships with Pitcher's thistle, and lack of knowledge of how to control the weevils along Great Lakes shoreline. (USFWS, 2016)

Stressor: Seed predation (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Pitcher's thistle seeds are subject to pre- and post- dispersal herbivory (USFWS 2002). American goldfinches (Spinus tristis) are one of the species listed in the recovery plan as being a pre-dispersal herbivore of Pitcher's thistle (USFWS 2002). The goldfinches have recently become more abundant at Indiana Dunes National Lakeshore (IDNL) and have been observed feeding on Pitcher's thistle seeds, prying open the phyllaries as seeds are developing, often consuming 90% of the seed crop of an individual thistle plant (McEachern and Pavlovic 2013). Miller High Dunes of IDNL has had up to 100% seed predation by goldfinches (Pavlovic, pers. comm. 2013). With the already small and declining populations of Pitcher's thistle at IDNL, the increase in goldfinch seed feeding has compounded the potential weevil threat (McEachern and Pavlovic 2013). (USFWS, 2016)

Stressor: Inadequate regulation (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Government units below State level generally do not provide adequate protection for rare plants. A few townships passed zoning ordinances designed to protect some natural resources, but other townships with outdated zoning ordinances remain ill-equipped to deal with current development. At the State level, MDEQ continues to permit home development in Critical Dune Areas. Although permits may include conditions to avoid immediate loss of existing plants, these permits do not address fragmentation or potential alteration of dune-sustaining

processes. The State of Michigan has no authority to require protection of plants from indirect effects and does not require State-level endangered species permits if direct impacts to the species are not expected. In Wisconsin, State agencies do not have authority to protect listed species from impacts on private lands unless the activity otherwise requires a Federal permit or funding. (USFWS, 2016)

Stressor: Climate Change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. In the Great Lakes region, the climate will likely grow warmer and probably drier overall during the 21st century (Kling et al. 2003). Although average annual precipitation may increase slightly by the end of the century, seasonal precipitation cycles are predicted to become more extreme. Winter and spring rains are likely to increase, while summer rains are expected to decrease by up to 50 percent. These potential impacts of climate change are increasingly evident in the Great Lakes region. Summer lake water temperatures are increasing, with Lake Superior's average summer surface water temperature increasing by 4.5° F since 1980 (Austin and Colman 2007). Ice forms later and melts earlier throughout the region. Earlier models had indicated that altered precipitation patterns, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000; AMEC 2006; Kling et al. 2003). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe et al. (2010) suggest that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lake levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios. If Great Lakes levels recede, more dune formation may occur, potentially increasing habitat for shoreline occurrences of Pitcher's thistle (M. Penskar, Michigan Natural Features Inventory, pers. comm. 2009). Increased water temperatures will also result in decreased ice cover that when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000; AMEC 2006), altering Pitcher's thistle habitat. A warmer climate could also bring about a northward shift and an even greater increase in invasive species that may be more problematic in the dunes and lakeshore systems, thus increasing competition with native plant species (Malcolm et al. 2002; AMEC 2006; Penskar, pers. comm.

2009). (USFWS, 2016)

Stressor: Development (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: At the time of the 2002 Recovery Plan, about 39% of the extant occurrences in the U.S. were in public ownership and an additional 20% occurred on a mix of public and private ownership. The public ownership includes populations at three National Park Service units, two National Forests, two National Wildlife Refuge units, several State Parks, and other types of protected State or local public lands. In addition, several PITH occurrences are on privately held land conservation lands (e.g., Door County Land Trust, Land Conservancy of West Michigan, Little Traverse Conservancy, Michigan Nature Association, The Nature Conservancy, etc.). In Canada, of the 30 total extant populations assessed in 2010, 4 small populations were noted in National or Provincial parks (COSEWIC 2010). As part of the Species Status Assessment, we will update and access the land ownership of the PITH occurrences as part of evaluating potential threats. Private lands supporting PITH are subject to both pressures for new development and shore protection for existing structures. Between 1992 – 2001, over 21% of all newly developed land within the Great Lakes watershed occurred within 10 km of the Great Lakes shoreline (an area which makes up 0.27% of the watershed) (Wolter et al. 2006). Much of this loss of shoreline habitat is due to urban or suburban sprawl, including second home development (Wolter et al. 2006). The strongest predictors of the distribution of second homes in the Upper Great Lakes were the presence of natural areas and the presence of water (Shellito 2006). When Great lakes water levels are high the demand for adding shoreline protection measures can increase significantly. The State of Michigan reported a nearly ten-fold increase in approved permits Great Lakes shoreline protection from Fiscal Year (FY) 2019 to FY2020's total (i.e., 2,238 shoreline protection permits approved in FY2020). Several PITH populations are also affected by sand mining (Slaughter and Cuthrell 2017). The loss and development of shoreline habitat makes it more difficult for shoreline ecosystems to shift in space with water level fluctuations as they once could (USFWS, 2023).

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 8C

Delisting Criteria:
1. The essential habitat associated with a total of 115 priority occurrences representing each biogeographic region and dune type is protected and managed under a management plan, including: a) all Federal and State owned essential habitat and occurrences, b) all publicly and privately-owned essential habitat and occurrences having a rank of A, AB, B, or BC, c) all occurrences in southern Lower Michigan, Indiana, and Wisconsin, and d) all complex perched dune systems. (USFWS, 2002)

2. Regular field surveys to verify occurrences and record new occurrences have been established. (USFWS, 2002)

3. Landowner contacts have been initiated and protection has been investigated for the remaining (rank < BC) public and private occurrences. (USFWS, 2002)

4. Monitoring of known sites shows a stable or increasing trend toward recovery and that protective plans are being implemented. (USFWS, 2002)

5. Restoration of two occurrences from among historical sites where sufficient habitat remains in Illinois, Indiana, Wisconsin, and southern Lower Michigan has been completed. (USFWS, 2002)

6. Research necessary to protect, manage and restore Pitcher's thistle has been conducted. (USFWS, 2002)

Recovery Actions:

- 1. Protect and manage known occurrences and essential habitat, giving priority to essential habitat. To ensure the long-term perpetuation of Cirsium pitcheri, planned protection for all 115 priority occurrences must occur and the remaining lower priority sites should receive some protection. Protection strategies will depend on cooperation between Federal and State agencies, private conservation organizations, regional planning councils, local jurisdictions, private developers and landowners. Principal cooperators include State and provincial resource agencies, The Nature Conservancy (TNC), The Nature Conservancy of Canada, the Center for the Great Lakes' Great Legacy program, the U. S. Forest Service (USFS), the National Park Service (NPS), and the U. S. Fish and Wildlife Service (Service). Working together should assure the highest level of protection for each site (USFWS, 2002)
- 2. Establish and conduct ongoing field surveys to verify known and record new occurrences. Pitcher's thistle is highly dependent upon the fluctuating environment of its lakeshore habitat. Therefore it is important to monitor the status of populations and habitats on a regular basis over periods of several decades to detect responses to fluctuating lake levels and habitat changes. Monitoring of sites is necessary for effective management. The monitoring should be designed to detect fluctuations in Pitcher's thistle population size and age class distribution and collect information on age at flowering. This will permit assessment of implemented management actions and determine if remedial action is required. (USFWS, 2002)
- 3. Inform the public, recreationists, public land managers, and private landowners. Knowledgeable individuals are an important part of the recovery process. Informing managers, recreational groups and landowners about Pitcher's thistle, its status as a protected species, and protection methods is an important step toward cooperative protection and management. Accurate and current information can foster interest and appreciation for the Pitcher's thistle. Groups such as the Michigan Nature Association, Michigan Natural Areas Council, The Nature Conservancy, The Nature Conservancy of Canada, Center for the Great Lakes, the International Joint Commission, Federal, State, provincial and local resource agencies, and local Audubon groups and garden clubs should be kept informed of recovery efforts. Federal land managers must be aware of the need to protect, and methods of protecting, Pitcher's thistle on Federal lands to facilitate decisions that will protect the species. Cooperators will develop, distribute, and update information and make recommendations for managers to protect Pitcher's thistle and its essential habitat. Information sent to individual managers will include the location of occurrences and

essential habitat, as well as the specific known and suspected threats to the species under the manager's care. Public utilities, with their promotion of environmental programs, may underwrite or sponsor public awareness campaigns. Resource agencies may encourage greater conservation through liaisons with public utilities. (USFWS, 2002)

- 4. Monitor occurrences for stable and increasing trends and implementation of protective plans. Protective management of Pitcher's thistle requires knowledge of its current status and threats. Inventory must incorporate population size, quality, and threats to be useful for scientific assessment and planning. (USFWS, 2002)
- 5. Restore Pitcher's thistle to an element rank of at least BC on at least one appropriate site within its historical range. C. pitcheri has been extirpated from parts of its natural range, so restoration is necessary to recover Pitcher's thistle throughout the area addressed in the recovery objective. Restoration is intended to recolonize sites where the species formerly occurred and cannot be used as justification or mitigation for destruction of an existing high quality occurrence elsewhere. Restoration planning should be integrated with ongoing interagency coordination and should be complementary and reinforcing. Restoration guidelines are needed in order to meet the objective of preserving populations throughout the species range. (USFWS, 2002)
- 6. Conduct research necessary for protection, management, and restoration. Answers to questions related to seed production, viability, dispersal distances, and predation would allow managers to assess risk to the species from different management scenarios. Improved understanding about the needs of Pitcher's thistle would focus management goals for the species and lead to better protection of Pitcher's thistle habitat(USFWS, 2002)
- Continue to plan and implement regular surveys, monitor occurrences, and document habitat conditions and population trends at all Pitcher's thistle locations. (USFWS, 2018)
- Monitor an approach of using biocontrol insects to manage non-native plant species. (USFWS, 2018)
- Seek funding opportunities to support research that addresses the following knowledge gaps: Demographic features of Pitcher's thistle populations located on Sleeping Bear Dunes National Lakeshore and other NPS properties within the Great Lakes region. Assess the threat of invasive weevils, including Larinus planus. . (USFWS, 2018)
- Work with partners to conduct a population viability analysis or similar for Pitcher's thistle . (USFWS, 2018)
- Complete Pitcher's Thistle Species Status Assessment (SSA) by 2024. Investigate whether possible extirpation of populations in southern Michigan is significant in terms of representation. (USFWS, 2018)

Conservation Measures and Best Management Practices:

- Recommendations for future actions • Continue to plan and implement regular surveys, monitor occurrences, and document habitat conditions and population trends at PITH locations. (Recovery Plan Action 2, 4 & 6)) • Monitor an approach of using biocontrol insects to manage non-native plant species. • Seek funding opportunities to support research that addresses the following knowledge gaps that assess the threat of invasive weevils, including Larinus carlinae. (Recovery Plan Action 4.41)) • Complete PITH Species Status Assessment by 2024. o Investigate whether possible extirpation of populations in southern Michigan is significant in terms of representation (USFWS, 2023).

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SPECIES ACCOUNT: *Cirsium vinaceum* (Sacramento Mountains thistle)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/16/1987; Southwest Region (R2) (USFWS, 2016)

Physical Description

A robust perennial herb with a purple stem that grows up to 2 m tall. The deeply lobed, spine-tipped leaves can be as long as 5 dm. Many nodding, white to purple flower heads appear in late summer. The plant's nectar is highly attractive to hummingbirds, bees, and butterflies (NatureServe, 2015).

Taxonomy

It was originally named Carduus vinaceus in accordance with generic concepts at that time. Wooton and Standley (1915) later combined it with the genus Cirsium where it was maintained by Petrak (1917) in his revision of the North American species of Cirsium. Although Cirsium is a common genus in the New Mexico flora, Cirsium vinaceum is a distinctive species with no close relatives within its range of occurrence. Its closest relative is the Mexican species, Cirsium conspicuum (USFWS, 1993).

Historical Range

Endemic to the Sacramento Mountains of south-central New Mexico (Otero County) (USFWS, 2010).

Current Range

The range occurs approximately 6 mi northeast to 17 mi south of Cloudcroft. Greater than 95% of the known thistle habitats occur on the Lincoln National Forest (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (USFWS, 2010); sexual (inferred from USFWS, 1993)

Key Resources Needed for Breeding

Adult: Insect and hummingbird pollinators (USFWS, 1993)

Reproduction Narrative

Adult: This species is a monocarpic, short-lived perennial initially forming robust rosettes of spiny leaves that live for one or more years as juvenile plants (Burks 1994). It is capable of root sprouting to produce multiple rosettes (clones) per genetic individual (USFWS, 2010). Pollen vectors include hummingbirds and numerous species of bees, beetles, flies, and moths (USFWS, 1993).

Habitat Type

Adult: Riparian (NatureServe, 2015); wetland (USFWS, 2010)

Habitat Vegetation or Surface Water Classification

Adult: Stream banks, wet meadows (NatureServe, 2015); conifer forest, valley (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 2,460 - 3,020 m elevation (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Dense patches (USFWS, 2010)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist banks of streams, wet meadows, and other moist areas. Remaining populations are mostly in the vicinity of springs flowing out of limestone, where steep calcium carbonate deposits have formed. These receive less grazing and trampling than the surrounding flat areas and have provided a refuge for the species. The environmental specificity is moderate; it is an obligate wetland species that is dependent on streams or springs (NatureServe, 2015). It is endemic to elevations between 2,460 and 3,020 m. It is a wetland-obligate species inhabiting saturated alkaline soils in valley bottoms. Many of the travertine deposits are covered with dense patches of C. vinaceum to the point of being nearly a monoculture of this species (Thomson 1991). Thistle habitats occur in mixed conifer forests and open valleys (USFWS, 2010).

Dispersal/Migration

Dispersal

Adult: Low to moderate (inferred from USFWS, 2010; 1993)

Dispersal/Migration Narrative

Adult: Craddock and Huenneke (1997) determined that stream flow dispersal and occasional thistle establishment in streamside habitats were sufficient to genetically link some discrete patches of thistles (USFWS, 2010). The seed is heavy, but fairly dispersible by wind. Therefore, gene flow from pollen vectors and seed dispersal is probably effective up to about 0.5 mile (USFWS, 1993).

Population Information and Trends

Population Trends:

Not available

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

~20 (NatureServe, 2015)

Population Size:

100,000 - 1,000,000 individuals (NatureServe, 2015)

Population Narrative:

Thirty-seven+ occurrences (10/96), but some may be part of a continuous population resulting in about 20 populations (11/12). Five populations were extirpated between 1995 and 2007 (10 - 30% decline). The estimated population size is 100,000 - 1,000,000 individuals (NatureServe, 2015).

Threats and Stressors

Stressor: Water diversions/altered hydrology (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Appropriation of water rights from springs for uses such as livestock water, farming, domestic use, or recreational facilities, usually uses points of diversion that curtail natural surface flows. One diversion for a residential subdivision currently is taking water from an aquifer on private property above a small thistle habitat in Fresnal Canyon and has been for several years (Sivinski, unpublished observation, 2005). Several thistle habitats have been subjected to direct and indirect impacts from land uses that damage travertine substrates and hydrological characteristics. Increasing population and associated agricultural and economic activities will require additional water from this relatively dry region (USFWS, 2010).

Stressor: Exotic weeds (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Huenneke and Thomson (1995) surmised that if a dense cover of teasel, or other exotic weeds, became established in thistle habitats, thistle germination would be inhibited by access to light, and the population might decline. Huenneke (1996) also noted that during drought, the drying soils in thistle habitats provided excellent conditions for teasel and other non-native plants, possibly lending non-natives a competitive edge in drier conditions (USFWS, 2010).

Stressor: Forestry (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Historically, negative effects of timber harvest and management on Sacramento Mountains thistle habitat have been associated with roads and other surface disturbance that directly impacted thistle habitats or made changes in hydrology and erosion. Mortality to thistles growing in moist areas along roadsides occasionally occurs from mowing, road maintenance, or herbicides (Tonne 2007; Guaderrama, pers. Comm. 2007) (USFWS, 2010).

Stressor: Recreation (USFWS, 2010)
Exposure:

Response:
Consequence:
Narrative: Recreational impacts to Sacramento Mountains thistles from human destruction have been noted to occur at the Bluff Springs habitat location (USFWS 1993, USFWS 2008, Barlow-Irick 2008, USFS 2008b, USFWS 2010). Recreationalists have also been observed driving ATVs through exclosures typically fenced to exclude livestock; cut fences and opened gates have been noted in the same exclosed areas (USFS 2008b) (USFWS, 2010).

Stressor: Livestock and wildlife (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Grazing and trampling of Sacramento Mountains thistle by livestock and wildlife can reduce photosynthetic tissue, damage seedlings, rosettes, and flowering stems, as well as inflict hoof damage to travertine and soft substrates in occupied and potential habitat (Thompson 1991; USFS 1994). Thistle habitats on travertine springs and the soft-bottom valley habitats provide the majority of watering locations for livestock and elk. These fragile habitats are subjected to trampling and hoof damage. At present, Sacramento Mountains thistle habitats continue to be exposed to livestock with consistently detrimental effects to the thistle, particularly on the Sacramento Grazing allotment (USFS 2007) (USFWS, 2010).

Stressor: Insect damage (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Burks (1994) determined that overall seed predation by insects consumed or damaged roughly 17% of the seeds produced by this thistle before dispersal. Sivinski (2007, 2008) documented insect seed predation from four native and one introduced species, which damaged flower heads or cause premature stem death of the thistle. In September 2007, these insect predators significantly damaged flowering stems. Seed production from insect attack was significantly reduced from 2007 to 2009 in the Silver Springs population, particularly as a result of the stem boring weevil (Sivinski 2007, 2008, 2009b) (USFWS, 2010).

Stressor: Pesticides (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: USFWS Standards and Guidelines allow for the use of pesticides to control forest pests and such use is likely to adversely affect the thistle by reducing pollinator populations (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: For mountain tops in New Mexico, weather patterns remain unpredictable, yet most likely will reflect regional trends of warming and drying, leading to the shrinking of cooler and moister habitats associated with higher elevations (Agency Technical Work Group State of New

Mexico 2005, Archer and Predick 2008). Drought conditions have been detected in the Sacramento Mountains based on decreased water flows at occupied springs and the contraction of the numbers and area occupied by Sacramento Mountains thistle (USFS 2007) (USFWS, 2010).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Acquire water rights specifically for the maintenance of travertine spring habitats at a minimum of 30 percent of the occupied spring localities, including at least 1 occupied spring locality in each of the 20 known canyons of occurrence (USFWS, 2010).

2. Develop habitat management plans to alleviate threats to the species and ensure permanent protection of at least 75 percent of the known occupied habitats according to steps outlined in the plans. Sites should include both core populations at springs as well as other occupied riparian habitats. Unoccupied steam habitat downstream of occupied springs should be protected for future colonization by the thistle (USFWS, 2010).

3. Establish a 10-year monitoring and research program to demonstrate the effectiveness of management implemented under the plans (USFWS, 2010).

Recovery Actions:
- Develop and implement a policy for spring development on LNF and acquire water rights to springs if in-stream flow legislation is ever passed in New Mexico (USFWS, 2010).
- Implement livestock management practices to protect plants and their associated spring and riparian habitats (USFWS, 2010).
- Implement logging practices that minimize indirect hydrologic and erosion effects on Sacramento Mountains thistle habitat (USFWS, 2010).
- Study impacts of exotic plant competitors and biological controls (USFWS, 2010).
- Conduct long-term monitoring to evaluate effectiveness of management (USFWS, 2010).
- Other (conduct genetic and hydrologic studies, locate new populations, manage recreation activities, engage in education and law enforcement) (USFWS, 2010).
- The recovery plan should be revised or amended. The criterion for acquiring water rights to maintain Sacramento Mountains thistle habitats does not reflect the legal challenges in obtaining such rights through legislation in the State of New Mexico. A revised criterion that also relies upon suitable points of diversion could have an additive effect on recovery, in conjunction with the existing criterion for water rights acquisition, should be considered. The recovery plan should also be amended to include criteria for uplisting Sacramento Mountains thistle to endangered species status (USFWS, 2010).
- The arrivals of an invasive seed-head weevil, Rhinocyllus conicus, and a stem boring weevil, Lixus pervestitus, in the immediate environment of Sacramento Mountains thistle are potential new threats to the survival of this threatened species. Additional research should be conducted to track the distribution of both weevil species in the Sacramento Mountains and the presence or absence of these weevils in Sacramento Mountains thistle seed heads and stems. Effects of R. conicus and native seed predators on seed production of the

Sacramento Mountains thistle need to be ascertained (USFWS, 2010).

- Exclosures preventing livestock access to wetland thistle habitats should be constantly maintained. Resources to construct fencing around thistle populations exposed to livestock, especially those on the Sacramento Grazing Allotment, should be obtained and additional exclosures should be constructed to prevent thistles and promote thistle recovery (USFWS, 2010).
- Erecting signage, indicating the value and conservation status of the Sacramento Mountains thistle, should be considered at the Bluff Springs site (USFWS, 2010).
- continue to monitor invasive plants in thistle habitat. Should invasive thistle and teasel in the region continue to encroach upon Sacramento Mountains thistle habitats, hand-applied use of an EPA-approved, novel herbicide, aminopyralide, commercially known as Milestone, may be warranted (Fletcher, pers, comm. 2007) (USFWS, 2010).
- Monitoring of the Sacramento Mountains thistle populations, reproductive individuals, and rosettes should be conducted biennially by experienced biologists. Demonstrated impacts of invasive wetland plants and insect predators in particular should be studied to prevent further population declines of the thistle. Interactions among thistle population trends in response to grazing, exclosures, invasive plants, and insect herbivory, along with predictions of warmer average temperatures and potentially less average precipitation potentially associated with climate change, should be monitored to direct future management for the thistle (USFWS, 2010).

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SPECIES ACCOUNT: *Cirsium wrightii* (Wright's marsh thistle)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

Wright's marsh thistle is a biennial (a plant completing development in 2 years, and producing flowers in its 2nd year) or a weak monocarpic perennial (a plant that flowers, sets seed, then dies), in the sunflower family (Asteraceae). The plant is prickly with short black spines and a 3- to 8-foot (ft) (0.9- to 2.4-meter (m)) single stalk covered with succulent leaves (Sivinski 1996, p. 1; Arizona Game and Fish Department (AGFD) 2001, p. 1). Numerous slender flowering branches emerge from the stalk, starting about one-third up the length of the plant stalk. The ends of the branches support one or a few small flowering heads, which have numerous slender phyllaries (a modified leaf associated with the flower) (Sivinski 1996, p. 1). Flowers are white to pale pink in areas of the Sacramento Mountains, but are vivid pink in all the Pecos Valley locations (Sivinski 1996, p. 1). Blooms March-August.

Taxonomy

Kingdom: Plantae; Phylum: Anthophyta; Class: Dicotyledoneae; Order: Asterales; Family: Asteraceae (Asters, sunflowers). Wright's marsh thistle is a wetland obligate that was originally collected in 1851 at San Bernardino Cienaga, Cochise County, Arizona (Gray 1853, p. 101; Smithsonian 1849, p. 1).

Historical Range

Mexico - Uncertain; U.S. - Arizona, New Mexico. Wright's marsh thistle has been extirpated from all previously known locations in Arizona (e.g., San Bernardino Cienega) (Sivinski 1996, pp. 1, 4, 9, 2006a, 2009a, p. 1, 2012, p. 2; Worthington 2002a, p. 4; Baker 2011, entire), many in New Mexico (Roswell, Lake Valley), and was misidentified and likely not ever present in Texas (Poole 1992, entire; 2010, entire; Sivinski 1996, p. 2). The status of the species in Mexico is uncertain, with few verified collections of the plant (Sivinski 2012, p. 5).

Current Range

In New Mexico, eight general confirmed locations of Wright's marsh thistle cover an area of approximately 43 ha (106 ac): Santa Rosa, in Guadalupe County; Bitter Lake National Wildlife Refuge (NWR), in Chaves County; Blue Spring, in Eddy County; La Luz Canyon, Karr/Haynes Canyon, Silver Springs, and Tularosa Creek, in Otero County; and Alamosa Creek, in Socorro County (Bridge 2001, p. 1; Sivinski and Bleakly 2004, p. 2; NMRPTC 2009, p. 1; Sivinski 1994, p. 1; Sivinski 1996, p. 2; Sivinski 2005, p. 1, 3–5; Sivinski 2009; USFWS 1998, p. 1; Worthington 2002, p. 1–3). In Otero County, the Sacramento Mountains have four unique populations of the species clustered within about 16 kilometers (km) (10 miles (mi)) of each other on the west slope of the mountains. The remaining four localities are widely disjunct, separated from the Sacramento localities by about 120 to 225 km (75 to 140 mi) and from each other by about 120 to 345 km (75 to 215 mi). In the Sacramento Mountains, two of these four localities occur on the Lincoln National Forest, one locality is on private land, and the remaining locality is on the Mescalero Apache Reservation. In the Pecos River Valley, one locality is on public lands on Bitter Lake NWR; one is on private land near Blue Springs and the Black River; and one is in the vicinity of Santa Rosa on private, municipal, and State lands. The remaining locality is on private land on

Alamosa Creek, Socorro County. Localities vary in relative population size from fewer than 20 individuals covering only about 0.02 ha (0.03 ac) at the Silver Springs locality (Sivinski 2012, p. 21), to several thousand individuals on Bitter Lake NWR, covering almost 9.3 ha (23 ac). (USFWS, 2020)

Critical Habitat Designated

Yes; 5/25/2023.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the Wright's marsh thistle (Cirsium wrightii), a thistle species from New Mexico. We also designate critical habitat. In total, approximately 156.8 acres (63.4 hectares) in Chaves, Eddy, Guadalupe, Otero, and Socorro Counties, New Mexico, fall within the boundaries of the critical habitat designation.

Critical Habitat Designation

Critical habitat units are depicted for Chavez, Eddy, Guadalupe, Otero, and Socorro Counties, New Mexico.

Unit 1: Santa Rosa, Guadalupe County, New Mexico. (i) Unit 1 consists of 26.6 hectares (ha) (65.7 acres (ac)) in Guadalupe County, New Mexico, and is composed of lands in State (12.65 ha (31.2 ac)), City of Santa Rosa (9.88 ha (24.4 ac)), and private (4.09 ha (10.16 ac)) ownership.

Unit 2: Alamosa Springs, Socorro County, New Mexico. (i) Unit 2 consists of 1.58 ha (3.9 ac) in Socorro County, New Mexico, and is composed of lands in private ownership.

Unit 3: Bitter Lake, Chaves County, New Mexico. (i) Unit 3 consists of 19.0 ha (47.0 ac) in Chaves County, New Mexico, and is composed of lands under Federal management, specifically the U.S. Fish and Wildlife Service's Bitter Lake National Wildlife Refuge.

Unit 4 has been excluded from this critical habitat designation. (10) Unit 5: La Luz Canyon, Otero County, New Mexico.

Unit 5 consists of 0.01 ha (0.03 ac) in Otero County, New Mexico, and is composed of lands under Federal management, specifically the U.S. Forest Service's Lincoln National Forest.

Unit 6: Silver Springs, Otero County, New Mexico. (i) Unit 6 consists of 0.38 ha (0.95 ac) in Otero County, New Mexico, and is composed of lands under Federal management, specifically the U.S. Forest Service's Lincoln National Forest.

Unit 7: Karr/Haynes Canyon, Otero County, New Mexico. (i) Unit 7 consists of 1.79 ha (4.42 ac) in Otero County, New Mexico, and is composed of lands in private ownership.

Unit 8: Blue Springs, Eddy County, New Mexico. (i) Unit 8 consists of 14.04 ha (34.7 ac) in Eddy County, New Mexico, and is composed of lands in private ownership.

Primary Constituent Elements/Physical or Biological Features

The physical or biological features essential to the conservation of Wright's marsh thistle consist of the following components:

(i) Water-saturated soils with surface or subsurface water flow that allows permanent root saturation and seed germination

(ii) Alkaline soils

(iii) Full sunlight

(iv) Diverse floral communities to attract pollinators

Special Management Considerations or Protections

Management activities that could ameliorate these threats include, but are not limited to:

(1) Conservation efforts to ensure sufficient water availability

2) managing livestock grazing via the use of exclosures

(3) control of native and nonnative plants via controlled burning or mechanical treatments

(4) spill prevention and groundwater protection during oil and gas development and mining

(5) watershed/wetland restoration efforts

(6) efforts to restore a diverse floral community sufficient to attract pollinators. These management activities would protect the physical or biological features for Wright's marsh thistle by providing for surface or subsurface water flow for permanent root saturation, soil alkalinity necessary for all life stages, the availability of direct sunlight for plant development, and habitat for pollinators to complete cross pollination of the thistle. Additionally, management of critical habitat lands would help limit the impacts of current risks to population viability.

Life History

Food/Nutrient Resources

Lifespan

Adult: Cirsium wrightii can display life history traits of a biennial (a plant completing development in 2 years, flowering in its second year) or a weak monocarpic perennial (USFWS, 2017).

Breeding Season

Adult: Flowering occurs August to October

Reproduction Narrative

Adult: Flowering occurs August to October (USFWS, 2017). Pollination—Species of Cirsium may be pollinated by a wide variety of insects, including social bees, solitary bees, flies, and beetles (Powell et al. 2010, pp. 910–911; Sivinski 2017b, pers. comm.). Bees are the primary pollinators

of C. wrightii, especially bumble bees (Bombus spp.), with butterflies also being common pollinators (Sivinski 2017b, pers. comm.). Bumble bees are large, strong fliers and some species frequently travel 1 mile (mi) (1.5 kilometer (m)) or more to patches of desirable forage plants (Osborne et al. 2008, p. 406). Sivinski (2017b, pers. comm.) observed bumble bees, black swallowtails (Papilio polyxenes), green June beetles (Cotinis nitida), and oblique syrphid flies (Allograpta obliqua), among other insect pollinators, visiting C. wrightii. Hummingbirds have been observed visiting C. wrightii flower heads as well, but it is unknown if hummingbirds affect much pollination of the plant (Keil 2006, p. 131). The presence of other species of native flowering plants may help to attract abundant pollinators, and thus also benefit Cirsium wrightii. This may be more important for western populations of C. wrightii, where there are fewer thistles. In the larger eastern populations, there are likely enough individual C. wrightii to attract pollinators (USFWS, 2017).

Habitat Type

Adult: In New Mexico, the species occurs in wet, alkaline soils in spring seeps and marshy edges of streams and ponds between 3,450 and 7,850 ft (1,152 and 2,393 m) in elevation (Sivinski 1996, p. 1; 2005a, pp. 3-4; Worthington 2002a, entire). C. wrightii appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009). Plants commonly found in areas inhabited by this species include Scirpus spp. (bulrush), Salix spp. (willow), Baccharis glutinosa (seepwillow), Helianthus paradoxus (Pecos sunflower), Juncus spp. (rush), and Typha spp. (cattail) (Sivinski 1996, pp. 2-5; Sivinski and Bleakly 2004, p. 2; Worthington 2002a, pp. 1-2).

Habitat Vegetation or Surface Water Classification

Adult: Palustrine habitat: Herbacious wetland; Terrestrial habitat: Desert; marshy wetlands (cienegas) near springs in otherwise semi-arid to arid areas. (NatureServe)

Dependencies on Specific Environmental Elements

Adult: Wright's marsh thistle appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009).

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 2014)

Habitat Narrative

Adult: Wright's marsh thistle is a wetland obligate (occurs only in water-saturated soils) that was originally collected in 1851 at San Bernardino Cienaga, Cochise County, Arizona (Gray 1853, p. 101; Smithsonian 1849, p. 1). In the New Mexico portion of the species range, C. wrightii appears to be an obligate of seeps, springs, and wetlands that have saturated soils with surface or subsurface water flow (Sivinski 1996, 2012, entire; Service 1998, pp. 1-2; Worthington 2002a, p. 2; NMRPTC 2009). Plants commonly found in areas inhabited by this species include Scirpus spp. (bulrush), Salix spp. (willow), Baccharis glutinosa (seepwillow), Helianthus paradoxus (Pecos sunflower), Juncus spp. (rush), and Typha spp. (cattail) (Sivinski 1996, pp. 2-5; Sivinski and Bleakly 2004, p. 2; Worthington 2002a, pp. 1-2).

Dispersal/Migration

Dispersal

Adult: Water/Wind

Dispersal/Migration Narrative

Adult: In addition, seed banks of C. wrightii may be reduced annually due to predation from insects and birds, by seed moving to non-habitat via wind or water dispersal, or by the germination of many seeds which grow into the sometimes thousands of rosettes that have been reported from sites (USFWS, 2017).

Population Information and Trends

Population Trends:

Unknown

Species Trends:

Unknown

Number of Populations:

8 populations in 5 counties (Otero, Chavez, Guadalupe, Eddy, and Socorro)

Population Size:

populations of 2 to ~18,000

Population Narrative:

There are eight general localities of Wright's marsh thistle extant within New Mexico. Additional historical populations have been extirpated, including at least two larger and two smaller populations in New Mexico, and the population at the type locality in Arizona. The population at BLNWR is likely the most robust, with between 14,000 to 18,000 individuals (Sivinski 2012, p. 30). Santa Rosa contains scattered localities throughout four sections of land, and some of these have been extirpated recently. However, the population in 2012 was estimated between 12,000 to 14,000 individuals (Sivinski 2012, p. 52). The population along Tularosa Creek has undergone a significant reduction since 1995 and now contains only four individuals (Sivinski 2012, p. 21). The remaining populations in the Sacramento Mountains are mostly small, containing from two to perhaps several hundred individuals (Sivinski 2012, p. 9-24). The populations at Blue Spring and Alamosa Springs were recently discovered. There have been no subsequent surveys at Blue Spring to determine whether this population is stable or declining. Alternatively, in 2012, the population at Alamosa Springs was estimated at 900 flowering individuals (Sivinski 2012, p. 9), indicating a relatively stable status since its discovery in 2005). An experimental planting of 61 rosettes occurred at Burro Cienega in 2011, but was not monitored during 2012 to determine success or failure. The collections from Texas were misidentified, and we conclude C. wrightii never occurred in the state. Finally, there is only one verified historic collection from Mexico, and no recent information on the status of the species from this population. For these reasons, the status of this species remains tenuous.

Threats and Stressors

Stressor: Agricultural and urban development

Exposure: Water withdrawal
Response:
Consequence:
Narrative: Past and present alteration of rare desert springs, seeps, and wetland habitats that support Wright's marsh thistle is a significant threat. The four largest localities of C. wrightii at Blue Spring, BLNWR, Santa Rosa, and Alamosa Creek have the potential to be further modified by ongoing and future water withdrawal. Changes in water tables throughout the range of C. wrightii have also resulted in diminished discharge from springs or complete loss of surface water. Therefore, there has been a trend of diminishing habitat quantity and excessive degradation of habitat quality for the species throughout its range, as a result of agriculture and urban development, diversion of springs, and drought.

Stressor: Introduced plants
Exposure: Increased fire risk, competition and changes in hydrology
Response:
Consequence:
Narrative: The presence of and effects from Phragmites australis (common reed) threatens C. wrightii localities through increased fire risk, competition, and changes in hydrology.

Stressor: Inadequate regulatory protection
Exposure:
Response:
Consequence:
Narrative: Wright's marsh thistle receives inadequate protection from the Clean Water Act. Similarly, the species lacks adequate regulatory protection from its various designationsa Forest Service sensitive species, or endangered status by the State of New Mexico because these designations only serve to notify the public of the species' status and do not require conservation or management actions. We are not aware of any other existing regulatory mechanisms. Wright's marsh thistle is currently threatened by the inadequacy of existing regulatory mechanisms. This will continue into the foreseeable future.

Stressor: Livestock Grazing (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: In the semi-arid southwestern United States, wet marshes and other habitat of Wright’s marsh thistle attract ungulates (e.g., livestock, elk, and deer) because of the availability of water and highquality forage (Hendrickson and Minckley 1984, p. 134). Livestock grazing is present at localities in the Sacramento Mountains, Santa Rosa, Blue Springs, and Alamosa Springs. At the Santa Rosa locality, photographs indicate that the growth of Wright’s marsh thistle and the integrity of its habitat have been negatively affected by livestock herbivory and trampling (Sivinski 2012 pp. 33–53). Dry periods likely increase the effects of livestock trampling and herbivory on Wright’s marsh thistle when other water and forage plants are not available (75 FR 67925). Grazing may be more concentrated within habitats similar to those occupied by Wright’s marsh thistle during drought years, when livestock are prone to congregate in wetland habitats or where forage production is greater than in adjacent dry uplands (USFS 2003, entire). Livestock may trample individual plants and eat the thistle when other green forage is scarce, and when the seedlings or rosettes are developing and abundant. Further, livestock may eat

mature plant inflorescences (the complete flower head), which could reduce seed production. For example, the threatened Sacramento Mountains thistle (C. vinaceum) (52 FR 22933), which is also found in New Mexico and associated with habitats similar to those occupied by Wright's marsh thistle, is eaten by livestock and appears to be the preferred forage at some times of the year. It may provide some of the only green forage during droughts (NMRPTC 2009, p. 2). Also, it is possible that livestock grazing within and adjacent to spring ecosystems could alter or remove habitat or limit the distribution of the thistle (USFWS 2017). (USFWS, 2020)

Stressor: Native and Nonnative Plants (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Some native and nonnative plants pose a threat to Wright's marsh thistle and its habitat through habitat encroachment and competition for resources at most localities. The native plants include cattails (Typha spp.); nonnative species include the common reed (Phragmites australis), purple loosestrife (Lythrum salicaria), Russian olive (Elaeagnus angustifolia), saltcedar (Tamarix spp.), and Russian thistle (Salsola spp.) (Sivinski 1996, p. 6). These particular native and nonnative species all have the same effect on Wright's marsh thistle by functioning as invasive species with respect to the thistle's habitat. Though cattails and Wright's marsh thistle may have evolved in the same area, decreased water availability has altered habitat conditions such that cattails have a competitive advantage in Wright's marsh thistle habitat. These plants present unique challenges and potential threats to the habitat, including shade effects on Wright's marsh thistle seedlings and rosettes. For example, the common reed, a nonnative invasive plant introduced from Europe and Asia, increases the potential for wildfire and is increasing in density at some locations in New Mexico. The dense plant growth blocks sunlight to other plants growing in the immediate area and occupies all available habitat (PCA 2005, p. 1). The increase of the common reed in Wright's marsh thistle habitat is a current threat to the species through increased wildfire risk, competition, and changes in hydrology (impacts on degree of soil saturation), especially when habitat is disturbed through burning or drying. The impacts vary based on location, with the greatest impacts occurring at Santa Rosa, Bitter Lake NWR, Blue Spring, and Tularosa Creek. We expect that the threats caused by native and nonnative plant competition and habitat loss will likely continue and possibly intensify, due to lack of vegetation management practices at several locations (Santa Rosa, Blue Spring, Tularosa Creek) and the pervasiveness of native and nonnative plants despite ongoing efforts for habitat restoration at other locations (Bitter Lake NWR). As this species is comprised of small, isolated populations, the impacts of native and nonnative plants could pose a significant stressor to the thistle. Attempts to manage native and nonnative plants through herbicide use and mowing may also exacerbate effects to Wright's marsh thistle as these techniques are difficult to preferentially apply to only the native and nonnative plant species when habitat is shared. In addition, we expect increases in drought periods to exacerbate the effects of this stressor. (USFWS, 2020)

Stressor: Oil and Gas Development and Mining (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Oil and gas development occurs within and adjacent (i.e., within 10 miles) of some areas occupied by Wright's marsh thistle including Santa Rosa, Bitter Lake NWR, and Blue Spring

(New Mexico State Lands Office, 2017; NMDGF 2007, pp. 18–19; NMDGF 2005, p. 35). There are also mining activities adjacent (i.e., within 5 miles) to other areas such as a potential beryllium mine at Alamosa Springs, and subsurface drilling and exploration of the mineral bertrandite on Sullivan Ranch near Alamosa Springs (New Mexico Mining and Minerals Division 2010; New Mexico State Lands Office, 2017; Sivinski 2012, p. 9). As of February 2020, the Service has no information on any new actions towards developing the potential beryllium mine at Alamosa Springs. The main impacts from oil and gas development and mining include the potential for contamination. Contamination from oil and gas development has been observed within close proximity (i.e., within 16 km (10 mi) of some Wright's marsh thistle localities (New Mexico State Lands Office, 2017). While laws and regulations related to water quality have reduced the risk of contamination in and near occupied locations from oil and gas production, the likelihood that a spill could impact these habitats is still present based on the high volume of oil and gas leases near these areas. Potential contamination from both oil and gas development and mining could have several impacts on plants (such as Wright's marsh thistle), including the following: increased available nutrients, which may favor competitive or nonnative plant growth; altered soil pH (either higher or lower), which can kill plants; absorption of chemicals, which can poison plants or cause poor growth or dead spots on leaves; and plant mortality. In addition, oil and other contaminants from development and drilling activities throughout these areas could enter the aquifer supplying the springs and seeps inhabited by Wright's marsh thistle when the limestone layers are pierced by drilling activities. An accidental oil spill or groundwater contamination has the potential to pollute water sources that support Wright's marsh thistle, and mining activities could alter or destroy habitat. The largest occupied habitat area is less than 16 ha (40 ac), and more than half the known populations are less than 2 ha (5 ac) in size. Even a small, localized spill has the potential to contaminate and destroy a population. The loss of even one of the eight populations would result in loss of representation and redundancy to the species as a whole. Because this species is comprised of small, isolated populations, these stressors could potentially negatively affect the thistle, but it is unclear whether these impacts would be localized or widespread stressors as the interaction between contaminant spills and groundwater and surface water hydrology is poorly understood. Therefore, we have determined that oil and gas development and mining functions as a stressor to the future viability of the species via impacts to water sources that provide habitat for Wright's marsh thistle. (USFWS, 2020)

Recovery

Recovery Actions:

- Establish additional grazing exclosures in riparian areas on Forest Service lands, on the Lincoln National Forest to support expansion of extant populations of Wright's marsh thistle.
- Investigate the possibility of reintroductions to historically occupied habitat where natural recolonization is unlikely. Transplants of rosettes within existing localities may also assist in the expansion of occupied habitat.
- Conduct additional surveys for Wright's marsh thistle particularly springs and cienegas in southeastern New Mexico and Mexico.
- Coordinate closely with BLNWR on management of the species. For example, investigate how Wright's marsh thistle responds to changing water levels on the refuge, when soils are not continuously saturated throughout the growing season.
- Develop a conservation strategy for the species, to guide coordinated conservation efforts by multiple partners. This strategy would also include an educational component to inform private and State landowners of wetland permitting requirements when they fill or drain

their lands.

- Monitor and evaluate whether insect predators are a threat to Wright's marsh thistle, particularly in Sacramento Mountains.
- Control populations of Pyhragmites Australis where they threatened Wright's marsh thistle.

References

USFWS. 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Cirsium wrightii (Wright's Marsh Thistle)

Southwest Region

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Threatened Species Status for the Wright’s Marsh Thistle (Cirsium wrightii) With a 4(d) Rule and Designation of Critical Habitat. FR Vol. 85, No. 189. Pages 61460-61498.

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USFWS 2014. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form for Cirsium wrightii (Wright's Marsh Thistle)

29 p. USFWS. 2017. Species status assessment report for Cirsium wrightii (Wright’s Marsh Thistle), Version 1.0. October 2017. Albuquerque, NM.

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SPECIES ACCOUNT: *Clarkia franciscana* (Presidio clarkia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; California/Nevada Region (R8)

Physical Description

A slender, erect, herbaceous annual of the evening-primrose family (Onagraceae), 40 centimeters (16 inches) tall with few, very small, and narrow leaves. The lavender-pink petals have a lighter basal portion and a reddish-purple basal spot. The slender capsule is 2 to 4 centimeters (1 to 2 inches) long. Clarkia franciscana can be distinguished from Clarkia rubicunda (ruby chalice clarkia), a related species that may occur in the same area, by its petals that have irregular teeth on the apical margin (the edge near the tip). Clarkia rubicunda has petals that are rounded at the apex (Lewis and Raven 1958a) and usually twice the length of Clarkia franciscana (Lewis and Raven 1958a, Lewis 1977). (USFWS, 1998)

Taxonomy

The type specimen of Clarkia franciscana (Presidio clarkia) was collected by Peter Raven in 1956. Clarkia franciscana was described by Harlan Lewis and Peter Raven (1958a). (USFWS, 1998)

Historical Range

In California, in San Francisco County, and later found in Alameda County. (USFWS 1998).

Current Range

In California, in San Francisco County and Alameda County. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominantly self-pollinated with possibility cross-pollination (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Possibly small halictid bees (USFWS, 2010)

Breeding Season

Adult: May to July (USFWS, 2010)

Reproduction Narrative

Adult: Presidio clarkia flowers from May to July. Flowers develop from erect buds and set seed in late summer or early fall. It is thought to be predominantly self-pollinated; however, there is some evidence to suggest that small halictid bees (sweat bees) could potentially be pollinators for the species. Due to its mechanism of self-pollination, there is restricted genetic variability in the populations. (USFWS, 2010)

Habitat Type

Adult: Grassland and coastal scrub communities (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: restricted to serpentine soil

Spatial Arrangements of the Population

Adult: Clumped

Environmental Specificity

Adult: special habitat requirements

Site Fidelity

Adult: high

Habitat Narrative

Adult: C. franciscana is known from only two locations within highly urbanized areas of the San Francisco Bay Area, California (the Presidio within the City of San Francisco [SF Presidio] and the Oakland Hills within the City of Oakland, Alameda County [Oakland Hills]), where the plant is restricted to serpentine soils in grassland and coastal scrub communities (Skinner and Pavlik 1994). Serpentine soils are formed from weathered volcanic (ultramafic rocks) such as serpentinite, dunite, and peridotite. The C. franciscana has adapted to the harsh environments of serpentine soils that limit plant growth: low calcium : magnesium ratios; lack of essential nutrients such as nitrogen, potassium, and phosphorus; and high concentrations of heavy metals (mineral toxicity).

Dispersal/Migration

Motility/Mobility

Adult: not mobile

Dispersal

Adult: limited

Dispersal/Migration Narrative

Adult: Not much information is available regarding the dispersal of this species (USFWS, 2010)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Species Trends:

Unknown (USFWS, 2019)

Population Growth Rate:

unknown

Number of Populations:

9 extant populations (USFWS, 2010)

Population Size:

~ 100,000 or more individuals estimated in all populations (USFWS, 2019)

Population Narrative:

This species is known to occur in only two locales, the Presidio in San Francisco County and Oakland Hills in Alameda County, California. Since the approval of the 1998 recovery plan, new locations for Presidio clarkia within these two locales have been either introduced or discovered. The 2010 5-year review for Presidio clarkia (Service 2010b) summarizes the introduction along the Pacific coast at the Presidio ("Coastal Bluffs" site) and the discovery of four additional sites in Oakland Hills (for seven total Oakland Hills sites). Since the 2010 5-year review, Presidio clarkia was also reintroduced at the historical "West Crissy Bluffs" site (also referred to as "McDowell Avenue," CNDDB occurrence #3) at the Presidio (Chassé and Forrestel 2014). The CNDDB (2018) reflects all known Presidio clarkia sites in Oakland Hills (CNDDB occurrence #4), but has not been updated for the Coastal and West Crissy bluffs introductions at the Presidio. - Ongoing habitat restoration and enhancement at the Presidio and Redwood Regional Park have increased local distributions and abundances of Presidio clarkia at these managed sites. Inspiration Point (Presidio; CNDDB occurrence #2) and Redwood Regional Park (Oakland Hills) continue to be the largest and most productive Presidio clarkia sites. The average population estimates for a 1.0-hectare (2.5-acre) plot at Inspiration Point is 58,904 individuals (2006-2018) and for a 3.0-hectare (7.4-acre) plot at Redwood Regional Park is 59,758 individuals (2008-2011, 2014-2015, and 2017). Since monitoring began, abundances at the other Presidio clarkia sites did not exceed 2,000 individuals3 until 2018. The 2018 censuses recorded 2,924 and 3,223 individuals at the Presidio's West Crissy Bluffs and WWII Memorial sites, respectively. Despite the recent increase in numbers, the likelihood that the West Crissy Bluffs site (or the Coastal Bluffs site) will continue to support Presidio clarkia is in question. - All of the seven Oakland Hills sites are likely the remaining portions of a single population that was fragmented by residential development. Six of the Oakland Hills sites contain only small patches of serpentine that are surrounded by residences, roads, and a tennis club. These sites, held by the City of Oakland or private landowners, are rarely monitored. Thus, the status of Presidio clarkia in these patches is currently unknown. Prior to 2010, these six Oakland Hills sites had abundances that ranged from 20 to over 1000 plants (summarized in Service 2010b). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat disturbance (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The six small Oakland Hills sites remain unprotected and are especially vulnerable to erosion, roadside maintenance for fire management, competing plant species, and residential development. Presidio clarkia has likely persisted in some of these habitat fragments because the steep terrain is unconducive for development and landscaping. Thus, the terrain is also erosive and Presidio clarkia plants and seeds are subject to being washed into roads and disposed of. The

habitat fragments that are not too steep and erosive are frequently mowed prior to seed set (R. Kanz, conservationist and Oakland resident, pers. comm. 2018; Service 2010b). Unlike the protected sites, the Oakland Hills fragments are not managed to reduce nonnative plant competition and trees are typically favored in residential areas. Plans for a residential development on the Crestmont Drive site are in process, though it is uncertain when the development will be constructed. The City of Oakland has not yet approved the lot divisions for the development because the requirements for a rare plant conservation easement have not all been fulfilled (M. Grefsrud, CDFW, pers. comm. 2018). At the Presidio in San Francisco County, Presidio clarkia at the West Crissy Bluffs site are threatened by the site's small size, high disturbance rate, and position just below a road. Declining numbers of Presidio clarkia at the Coastal Bluffs introduction site could be due to inadequate seed input (only one year of seeding), or because the coastal climate and habitat are not suitable for Presidio clarkia (M. Chassé, pers. comm. 2018). (USFWS, 2019)

Stressor: Erosion and altered hydrology (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: In 1978, the Ecology Trail was routed through a then unknown subpopulation of Clarkia franciscana at Inspiration Point. Since then, the trail has been fenced off but the Inspiration Point subpopulation of C. franciscana at the SF Presidio continues to be threatened by trail erosion, storm drain runoff, and other hydrologic issues. A storm drain flows directly into the Inspiration Point site. This is thought to potentially threaten the C. franciscana because, as observed at the War Memorial site, the species does not do well under wetter conditions. - In the Oakland Hills, most of the subpopulations of Clarkia franciscana occur on very steep, highly erosive serpentine roadcuts, and, therefore, are vulnerable to altered hydrology and accelerated erosion resulting from human disturbance. The C. franciscana has become restricted to areas with steeper slopes and thinner soils in the Oakland Hills due to the invasion of nonnative annual grasses onto the deeper serpentine soils. The lower Tennis Club site within the Tennis Club/Sunrise subpopulation is highly vulnerable to altered hydrology and erosion due to its location in a steep gully between the Sunrise Assisted Living Facility and the Oakland Hills Tennis Club. Only the Chadbourne Way subpopulation and some patches of the Redwood Regional Park subpopulation are not currently threatened by erosion and altered hydrology do to their locations on more gentle slopes. - Until recently, concerns about landslides slowed residential development on some of the steeper serpentine slopes in the Oakland Hills where Clarkia franciscana occurs. However, since the Federal listing of the species, many residential developments have been constructed on steep serpentine soils that may or may not have had C. franciscana. In some cases, these residential developments proceeded without environmental review. - The Crestmont Drive subpopulation of Clarkia franciscana may be threatened by altered hydrology and erosional gullying due to the construction of seven single family homes immediately upslope on Colgett Drive between 1998 – 2003. A local resident and member of Friends of Oakland's Endangered Species reports "observations of the site [Crestmont Drive] indicate the impacts of water from uphill properties [on Colgett Drive] may be causing rilling and erosion". (USFWS, 2010)

Stressor: Small populations (USFWS, 2010)
Exposure:
Response:

Consequence:
Narrative: The Recovery Plan (Service 1998) recommends securing populations containing a minimum of 2,000 plants each (but preferably more). The probability of population persistence over the long-term is expected to be higher for larger populations because large size decreases the likelihood of reduced viability or population extirpations due to random demographic or genetic events (Barrett and Kohn 1991, Ellstrand and Elam 1993). Currently, only two of the nine subpopulations of Clarkia franciscana (Inspiration Point and Redwood Regional Park) exceed the criteria for containing a minimum of 2,000 plants. Thus, the C. franciscana continues to be threatened by habitat fragmentation, a small number of populations, and the small size of most of the subpopulations. (USFWS, 2010

Stressor: Loss of pollinators (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The Clarkia franciscana is thought to reproduce primarily through self-pollination. However, small halictid bees (sweat bees) have been observed visiting the flowers and could potentially be pollinators for the species (Lewis and Raven 1958). Thus, the use of pollinators by the C. franciscana could be important for increasing gene flow among populations and maintaining the genetic variability of the species. A study by Gottlieb and Edwards (1992) verified the low intrapopulation genetic variability within the SF Presidio population and the Oakland Hills population (Redwood Regional Park) as is expected for a species that is predominately self-pollinated (Stebbins 1978). Species with small populations and low genetic variability, such as the C. franciscana, are at greater risk of extirpation from natural catastrophic events (disease, fire, and drought) (Menges 1991). The reproduction and genetic variability of the Clarkia franciscana could be threatened by the recent worldwide decrease in pollinators. Pollinators are threatened by the use of both regulated (e.g., malathion) and unregulated pesticides (e.g., pyrethroids) (Department of Pesticide Regulation 2006, Keith 2006, Service 2000). More recently, the decline in pollinators observed across North America has been attributed to introduced parasites, in particular the varroa mite (Varroa jacobsoni), which affects the honey bee (Apis millifera) (Nielsen 2006, National Research Council 2006). The potential effects of introduced parasites on C. franciscana pollinators are not known. Hafernik (2009), however, reported a rich diversity of bees at the SF Presidio, including 56 species representing 23 genera. The diversity and abundance of bees and other pollinators in the Oakland Hills is not known at this time. (USFWS, 2010)

Stressor: Loss of genetic diversity (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The SF Presidio and Oakland Hills populations of the Clarkia franciscana are separated by 17 miles and the San Francisco Bay resulting in two genetically distinct populations (Gottlieb and Edwards 1992). However, the genetic distinctiveness of the Oakland Hills population of C. franciscana could potentially be threatened by genetic swamping from C. franciscana plants of SF Presidio genetic stock (which had been cultivated for 40 years at Tilden Botanical Garden) planted by residents within the Oakland Hills. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:

Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. The Clarkia franciscana has evolved to adapt to the highly specific soil, environmental, and microclimatic conditions that are unique to the two locations where it occurs in the San Francisco Bay Area: the SF Presidio and the Oakland Hills. Observations at the War Memorial site demonstrate that the C. franciscana is not very tolerant of certain microclimatic conditions associated with this coastal location (cooler, wetter, and greater exposure to wind and fog) (Chassé et al. 2009). Thus, due to the highly restrictive soil, environmental, and microclimatic conditions under which the C. franciscana can grow, the species may be vulnerable to even small changes in climate. (USFWS, 2010)

Stressor: Competition from plant species (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Presidio clarkia, throughout its limited range, is threatened with competition from nonnative invasive grasses, native shrubs, nonnative trees, and native trees planted outside of their natural range. Invasive grasses compete by depleting shallow soil moisture and creating dense thatch that smothers and suppresses seedling recruitment in native plants. Elevated atmospheric nitrogen deposition from increased air pollution exacerbates the invasive grass problem because additions of nitrogen to nutrient-deficient soils, like serpentine, facilitate the invasion of weedy species (Weiss 2006). Nitrogen deposition in nitrogen-limited ecosystems may also affect mycorrhizal communities and increase plant susceptibility to other environmental stressors (summarized in Service 2010b). Shrubs and trees compete by shading annual grassland plants. Trees also bury the nutrient-poor serpentine soil with a thick layer of organic material, which encourages further invasion of non-serpentine species. (USFWS, 2019)

Stressor: Atmospheric nitrogen deposition from air pollution (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Elevated atmospheric nitrogen deposition from air pollution is particularly harmful to the nutrient-poor serpentine grasslands where the Clarkia franciscana occurs because nitrogen is the primary limiting nutrient for plant growth on serpentine soils (Weiss 1999). The use of catalytic converters on vehicles has increased the availability of nitrogen in a form that is directly absorbed by plants (EBRPD 2009a). The excess nitrogen deposited leads to increases in nonnative annual grasses which outcompete the native flora (Fenn et al. 2003, Weiss 1999). Other potential effects of elevated atmospheric nitrogen deposition on plants in nitrogen-limited ecosystems (Wolkowski et al. 2008), such as that in which the Clarkia franciscana grows, include decreased diversity of mycorrhizal communities. Increased nitrogen deposition can also

predispose plants to other environmental stresses such as elevated concentrations of ozone, drought, frost, or insect attacks. It is not known at this time if elevated atmospheric nitrogen deposition from air pollution impact C. franciscana mycorrhiza. (USFWS, 2010)

Recovery

Reclassification Criteria:
A/1: A minimum of five populations of Presidio clarkia, which shall include Inspiration Point at the Presidio and Redwood Regional Park in Oakland Hills, are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat and known former habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the populations described in A/1 and any occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized annual monitoring of populations. (USFWS, 2019)

E/1: Each population described in A/1 contains a minimum of 2,000 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

E/2: Each population described in A/1 has numbers of individuals that exhibit a stable or increasing trend over a period of 20 years that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

E/3: Impacts from competing plant species are managed so they do not pose a threat to the persistence of any of the Presidio clarkia populations described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 10 years in order to ensure seed viability. (USFWS, 2019)

Delisting Criteria:
A/1: A minimum of ten self-sustaining populations of Presidio clarkia are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. Additional populations are protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the populations described in A/1 are protected from incompatible uses. (USFWS, 2019)

A/3: Each of at least six of the populations described in A/1 are contained in a protected area comprised of at least 12 hectares (30 acres) of rehabilitated serpentine grassland. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years79 that include two normal precipitation cycles, each population described in A/1 exhibits a stable or increasing population trend with a minimum of 2,000 individuals81 each year. (USFWS, 2019)

E/2: For a minimum of 20 consecutive years82 that include two normal precipitation cycles, each of the six populations described in A/3 contains a minimum of 28,000 individuals84 each year with a rolling 20-year average of at least 140,000 individuals. (USFWS, 2019)

E/3: The populations described in A/1 adequately represent the genetic diversity present in the range of the species. At least two of the six populations described in A/3 represent the genetic diversity of Presidio clarkia at the Presidio and another two of six populations represent the genetic diversity in Oakland Hills. (USFWS, 2019)

E/5: The populations described in A/1 occupy serpentine grasslands with negligible nonnative plant cover and with species-appropriate disturbance regimes such as grazing and/or burrowing mammal populations. Impacts from competing plant species are managed so they do not pose a threat to the persistence of Presidio clarkia in any of the populations described in A/1. (USFWS, 2019)

E/6: Long-term management of Presidio clarkia habitat is both practically and financially sustainable. Active management is not required more frequently than once every 5 years. Financial resources for long-term habitat management are secured. (USFWS, 2019)

Recovery Actions:

- 1. Protect Presidio clarkia sites and establish additional populations. 1.1. Identify and protect potential introduction sites. (Priority 1). 1.2. Develop and implement a seed increase or collection program that represents the breadth of genetic diversity in the species. (Priority 1). 1.3. Establish, by seeding, new populations within or near the species' known historical range. Seeding should take place in suitable habitats that also exhibit a range of natural environmental conditions. Numerous introductions may be necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 1). 1.4. Secure populations through land acquisitions, conservation easements, or other means. (Priority 1). 1.5. Work with the City of Oakland and private landowners to maintain Presidio clarkia sites for the long-term survival of the species on their lands. Collaboratively determine the best management practices to accomplish both landowner objectives and conservation goals. Educate local roadside maintenance crews and landscapers. (Priority 1). (USFWS, 2019)
- 2. Research Presidio clarkia life history and conservation strategies. 2.1. Conduct genetic research on existing populations to determine the species' genetic structure and diversity. (Priority 2). 2.2. Research optimal habitat characteristics, mechanisms of dispersal, pollination biology, seed viability of populations from both the Presidio and Oakland Hills, and potential impacts from climate change. (Priority 2). 2.3. Study the demography and reproductive biology of populations. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage Presidio clarkia populations. 3.1. Implement site-specific management plans for Presidio clarkia and other native serpentine species. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent areas). . Best habitat management practices may include complete eradication of nonnative species and restoration of native

serpentine plant communities. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

- 1. Implement and evaluate the effectiveness of the habitat enhancement recommendations suggested by Weiss and Neiderer (2009) and EBRPD (Appendix B in EBRPD 2010) (e.g., tree removal, reseeding, scraping, fall tarping, fall flaming (post-germination), spring mowing, and installation of protective fencing), for increasing the survivorship of Clarkia franciscana, controlling nonnative annual grasses, and expanding C. franciscana populations into adjacent areas . (USFWS, 2010)
- 1a. The effectiveness of various habitat enhancement measures may vary dependent on sitespecific conditions as observed in the different results obtained in studies of the SF Presidio (Weiss and Neiderer 2009) and Oakland Hills (EBRPD 2010) populations. Monitor the results, determine the best treatment intervals, and adaptively manage. (USFWS, 2010)
- 1b. Expand Clarkia franciscana plants into adjacent areas of suitable habitat by collecting clarkia seeds from nearby plants and actively seeding in areas of bare ground and low cover of nonnative annual grasses. Collect seeds at different times in the season from C. franciscana plants throughout the adjacent areas, from large and small individuals, to capture a range of genetic diversity (Appendix B in EBRPD 2010). To avoid overcollecting, seed collection should be limited to less than 1 percent of the seedset in the first year while efficacy is being tested (EBRPD 2010). (USFWS, 2010)
- 1c. Persuade private landowners in the Oakland Hills (e.g., Oakland Hills Tennis Club, Sunrise Assisted Living Facility, and the proposed Crestmont development) to monitor the Clarkia franciscana subpopulations on their lands and control invasive species as required under their management plans that were developed during the CEQA process (e.g., Center for Biological Diversity 2007; Kanz in litt. 2009; EBRPD 2009b; City of Oakland 2006b). (USFWS, 2010)
- 1d. Persuade the City of Oakland and private landowners in the Oakland Hills (e.g., Colgett Drive, Kimberlin Heights Drive, and Crestmont Drive) to remove trees where they have been planted in suitable Clarkia franciscana habitat as is being done at Redwood Regional Park and the SF Presidio. (USFWS, 2010)
- 2. Reintroduce Clarkia franciscana to suitable habitat at the SF Presidio (restored site at the West Crissy serpentine grassland near McDowell Avenue; historic location for the species) (Chassé et al. 2009). (USFWS, 2010)
- 3. Address storm drain runoff and erosion issues at Inspiration Point in the SF Presidio and at Crestmont Drive in the Oakland Hills. (USFWS, 2010)
- 4. Increase education of City of Oakland road maintenance and vegetation and fire management teams in how to avoid and minimize impacts to the Clarkia franciscana including delaying their activities (e.g., mowing and weed-whacking) in areas with C. franciscana (Chadbourne Way, Old Redwood Road, and Redwood Regional Park subpopulations) until after the clarkia have set seed (late summer, early fall). (USFWS, 2010)

- 5. Analyze the genetic diversity among the seven subpopulations of Clarkia franciscana within the Oakland Hills. Store seeds representing the genetic diversity within the Oakland Hills population at the University of California Botanical Garden, Berkeley, California, and the Rancho Santa Ana Botanic Gardens, Claremont, California. Also collect seeds from the SF Presidio population of C. franciscana for storage at the Rancho Santa Ana Botanic Gardens, Claremont, California. (USFWS, 2010)

References

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SPECIES ACCOUNT: *Clarkia imbricata* (Vine Hill clarkia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; California/Nevada (Region 8)

Physical Description

An erect annual herb in the Onagraceae (Evening primrose) family, growing up to 60 centimeters (2.5 feet) tall, with unbranched or numerous short branches in the upper parts. This plant is densely leafy, with entire (smooth leaf margins), lanceolate leaves (tapering to a point at the apex and sometimes at the base) 2.0 to 2.5 cm (0.8 to 1.0 in long and 4 to 7 mm (0.2 to 0.3 in broad that are ascending and overlapping. Showy inflorescences appear from late June through July. Flowers are grouped closely together and each flower has a conspicuous funnel shaped tube at its base and four fan-shaped, lavender petals 2.0 to 2.5 cm (0.8-1.0 in) long with a V-shaped purple spot extending from the middle to the upper margin of the petal. Clarkia imbricata is distinguished from other morphologically similar Clarkia species by the broad, overlapping, ascending leaves. (USFWS, 2015)

Taxonomy

In 1953, Frank H. Lewis and Margaret Lewis described Clarkia imbricata from specimens collected on July 10, 1951, along Vine Hill Road, near Pitkin Ranch in Sonoma County, California. Clarkia imbricata is distinguished from other morphologically similar Clarkia species by the broad, overlapping, ascending leaves. (USFWS, 2015)

Historical Range

Same as current range. (USFWS, 2015)

Current Range

Vine Hill Area, Sonoma County, California. in the area of Vine Hill Road between the cities of Forestville and Santa Rosa. (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (self-fertilization) (USFWS, 2015)

Lifespan

Adult: 1 year (USFWS, 2015)

Breeding Season

Adult: June to August (USFWS, 2015)

Reproduction Narrative

Adult: Clarkia imbricata is self-compatible (capable of self-fertilization). Plants begin to flower in June, and often bloom through August. Seeds generally set in early September. It is not known when seeds germinate or how flowers are pollinated. As with many annual plants, numbers can vary substantially from year to year, depending on seasonal weather variations. (USFWS, 2015)

Habitat Type

Adult: Palustrine wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to open grassland near freshwater marsh at elevations between 60 to 75 m (California Native Plant Society, 2001) (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: All known populations of Clarkia imbricata have been found between 60 to 75 meters (197 to 246 feet) elevation, on what has been mapped as Goldridge acidic sandy loams, in an area sometimes referred to as the Sonoma Barrens. Clarkia imbricata is restricted to Vine Hill region on Goldridge acidic sandy loam soil series. Historically the vegetation growing in the Vine Hill region was “chaparral or Sonoma barren”, a mixture of chaparral and Douglas-fir/oak woodland, mixed evergreen forest in the canyons and freshwater marsh and riparian habitat along Pitkin, Green Valley and Atascadero Creeks in Sonoma County. C. imbricata inhabited open grassy portions of this area. (USFWS, 2011)

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 2015)

Dispersal

Adult: Low (inferred from USFWS, 2015)

Dispersal/Migration Narrative

Adult: Clarkia imbricata plants would likely be unable to shift their range naturally because of their dependence on specific soil characters, climate, the presumably low dispersal-potential of the species, and natural and anthropogenic barriers to dispersal (agriculture and housing developments).

Population Information and Trends

Population Trends:

Previous reports have described the population trend to be increasing and stable (USFWS 2011, 2016). However, recent data suggest the population has declined in the past decade. (USFWS, 2019)

Number of Populations:

1 (USFWS, 2019)

Population Size:

Variable; past surveys have noted from 60 to 8,700 plants (USFWS, 2019)

Additional Population-level Information:

The only known, extant population of Vine Hill clarkia exists at the Vine Hill Preserve (preserve) in Sonoma County, California. The preserve is owned and managed by CNPS volunteers (USFWS 2016; K. Symonds, in litt. 2018). Historically, there were as many as three locations where the plant existed in central Sonoma County. All known populations existed on Goldridge acidic sandy loam soils, in an area known as the Sonoma Barrens. Past surveys have documented as many as 8,700 plants and as few as 60 plants at the reserve, suggesting a high degree of population variation at the site, typical of annual plant species (USFWS 2016; S. Gordon, in litt. 2018). Previous reports have described the population trend to be increasing and stable (USFWS 2011, 2016). However, recent data suggest the population has declined in the past decade. Vine Hill clarkia continues to be located only within the 0.6 hectare (1.5 acre) Vine Hill Preserve (K. Symonds, pers. comm. 2018; S. Gordon, pers. comm. 2018). (USFWS, 2019)

Population Narrative:

Narrowly endemic to a small area in Sonoma County, California. Historically, four populations were known; currently, there is one natural population, with a total of about 5000 plants, and one planted population with < 400 plants (NatureServe, 2015). Based on monitoring by The Nature Conservancy and CNPS, in 1978, 60 plants were observed; from 1988 to 1993, the population fluctuated from about 200 to 300 plants; and, from 2007 to 2012, the population fluctuated from approximately 500 to 8,781 plants. In 2013, the population of C. imbricata at Vine Hill Preserve was estimated at 908 individuals (S. Gordon, personal communication 2013) and in 2015 was estimated at 270 plants (S. Gordon, personal communication 2015). The number of C. imbricata plants on the property to the east of the Vine Hill Preserve fluctuates from zero to 100 plants, depending on property maintenance activities. In 2010, the area occupied by C. imbricata on the Vine Hill Preserve was measured at 1,540 square meters (16,576 square feet), up from 1,467 square meters (15,791 square feet) in 2009. (USFWS, 2011; USFWS, 2015; NatureServe, 2015)

Threats and Stressors

Stressor: Land use conversion (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing in 1997, the most significant threat to the two remaining populations of Clarkia imbricata was extirpation through land use conversion to housing, vineyards and orchards. Land use conversion is now lesser threat given that of the two populations that existed at the time of listing, only one is known to remain and it is on the Vine Hill Preserve which is protected by the California Native Plant Society (CNPS). The second population (Sequoia Circle) was on private land with restricted access and plants have not been surveyed since 1997. The extant Vine Hill Preserve population is protected, monitored and

managed by CNPS, but the plants growing on the adjacent property are not protected. Thus habitat destruction, modification or curtailment due to land use conversion remains a threat, but a lesser one than at the time of listing. In 2011 land use changes on the adjacent parcel reduced the available habitat for C. imbricata. (USFWS, 2011)

Stressor: Shading and nonnative species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Another mechanism for habitat destruction, modification or curtailment that is probably a greater threat than at the time of listing is succession of the grassland habitat that Clarkia imbricata requires. This threat has increased because there is now only a single known population that is restricted to the open, grassy area of the Vine Hill Preserve. The open area will decrease if the grassland is allowed to progress through successional stages into chaparral and forest. This will shade C. imbricata and enrich the soil with leaf litter which may encourage competing non-native species such as Holcus lanatus, a perennial plant that reseeds readily and can tolerate fire. Invasive species such as Holcus lanatus threaten C. imbricata through competition for space and resources. In areas where H. lanatus grows, C. imbricata is shaded and grows at a lower density. H. lanatus has increased in numbers over the last few years in an area of the Vine Hill Preserve that lies under trees growing on a neighboring property (S. Gordon, personal communication 2010). (USFWS, 2011)

Stressor: Over-collection (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the Vine Hill Preserve population of Clarkia imbricata was threatened by over-collection and damage associated with trespassing by recreational plant enthusiasts seeking not only the C. imbricata plants and seeds, but also Arctostaphylos densiflora and Ceanothus foliosus var. vineatus, ostensibly for the nursery trade. However at this time overcollecting is not thought to be a major threat, as no incidents have occurred within the last 10 years (P. Van Soelen, personal communication 2010). Therefore over collection remains a threat, but less so since 1997. (USFWS, 2011)

Stressor: Risk of extirpation due to small population sizes (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Risk of extinction through random events was listed as a threat in the 1997 listing rule. The small number of individuals in the single Clarkia imbricata population increases the threat of extinction of the species as a whole through stochastic demographic and environmental events. C. imbricata has been reduced to a single protected population with fluctuating numbers of individuals. Even with as many as 5,000-10,000 plants in an annual plant population, risk of extirpation due to small populations is a major threat because we do not know enough about population dynamics, and annual plant numbers can vary greatly between years. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:

Response:
Consequence:
Narrative: Global climate change was not included in the 1997 listing rule, but is a potential threat to Clarkia imbricata. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). C. imbricata may be at risk with global climate change if it cannot disperse to favorable climate and conditions. (USFWS, 2011)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of the listing, regulatory mechanisms thought to provide protection to Clarkia imbricata included: 1) listing under the Endangered Species Act; 2) the National Environmental Policy Act (NEPA); 3) listing under the California Endangered Species Act (CESA); 4) the California Environmental Quality Act (CEQA); and 5) the California Native Plant Protection Act (NPPA). In summary, the Act is the primary Federal law that provides protection for Clarkia imbricata since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Federal Endangered Species Act. (USFWS, 2011)

Recovery

Reclassification Criteria:
E/1. There are three separate locations with C. imbricata, each consisting of 2 acres or more, and each with a 10-year average of 4,000 plants or more. Due to the longterm persistence of the species at the Vine Hill Preserve (smaller than 2 acres) and the successful management of the site by CNPS, the Vine Hill Preserve may be counted as one of the three locations if it meets all other aspects of the downlisting criteria. For the purpose of meeting this criterion, a separate location is defined as a group of C. imbricata plants sufficiently separated from any other group of C. imbricata as to minimize the potential that a typical single stochastic event (e.g., fire or storm damage) would affect more than one location with C. imbricata. (USFWS, 2015)

E/2. Develop a management plan to control competing native and non-native vegetation. Competing native and non-native vegetation should be controlled at a level whereby years with less than 4,000 C. imbricata plants at each location counted towards recovery (as defined in delisting criterion E/1) cannot be attributable to competition with native and non-native vegetation. Also, there is a monetary commitment in place to continue control in perpetuity for all locations counted toward recovery (as defined in downlisting criterion E/1). (USFWS, 2015)

A/1. All populations of C. imbricata counted toward recovery, as defined in E/1, are protected from incompatible uses with a binding legal commitment from the landowner, and funding has been secured for the perpetual implementation of the management plans defined in E/2. (USFWS, 2015)

Delisting Criteria:

A/1. All populations of C. imbricata counted toward recovery are protected from incompatible uses with a binding legal commitment from the landowner, and funding has been secured for the perpetual implementation of the management plans. (USFWS, 2015)

E/1. There are five separate locations with C. imbricata, each consisting of 2 acres or more, and each with a ten year average of 4,000 plants or more . Due to the longterm persistence of the species at the Vine Hill Preserve and the successful management of the site by CNPS, the Vine Hill Preserve (smaller than 2 acres) may be counted as one of the five locations if it meets all other aspects of the delisting criteria. For the purpose of meeting this criterion, a separate location is defined as a group of C. imbricata plants sufficiently separated from any other group of C. imbricata as to minimize the potential that a single stochastic event (e.g., fire or storm damage) would affect more than one location with C. imbricata. (USFWS, 2015)

E/2. Competing native and non-native vegetation are controlled to a level whereby years with less than 4,000 C. imbricata plants at each location counted towards recovery (as defined in delisting criterion E/1) cannot be attributable to competition with native and non-native vegetation. Also, there is a monetary commitment in place to continue control in perpetuity for all locations counted toward recovery (as defined in delisting criterion E/1). (USFWS, 2015)

Recovery Actions:

- Establish additional populations of Clarkia imbricata. (USFWS, 2015)
- Monitor and manage competing native and non-native vegetation affecting Clarkia imbricata. (USFWS, 2015)
- Conduct research for the development of a population viability analysis, determine levels of genetic diversity and interbreeding coefficients, and model the rate at which genetic diversity can be expected to be lost to genetic drift. (USFWS, 2015)
- Protect, manage, and increase the population where possible within its native range. If appropriate areas that are not within the native range are found, reintroduce C. imbricata. (USFWS, 2011)
- Establish at least two additional separate populations on protected land. (USFWS, 2011)
- Control of succession and nonnative plants where possible through hand removal of vegetation. (USFWS, 2011)
- Explore the use of a burn box to determine how fire affects C. imbricata seed bank and germination, in addition to nonnative species such as Holcus lanatus seed bank and germination. (USFWS, 2011)
- Gather information about life history and the ecosystem requirements of Clarkia imbricata. More specifically, gather information about how long the seed bank remains viable and how it responds to fire, germination requirements, and genetic diversity. (UFSWS, 2011)
- Create and implement a monitoring plan for Clarkia imbricata. Yearly plant counts are already conducted. Add estimation of percent cover of nonnative species and percent cover by shrubs and trees.
- Monitor land-use conversion in parcels adjacent to Vine Hill Preserve. If development occurs, attempt to rescue plants or seeds if possible. (USFWS, 2011)
- Control and monitor access to the Vine Hill Preserve to prevent and monitor trespassing. (USFWS, 2011)

- Pruning and managing the extent of Vine Hill Manzanita. Reports suggest the Vine Hill clarkia and Vine Hill manzanita coexisted naturally in the Sonoma Barrens prior to European settlement (USFWS 2016). Today, both plants only exist at the Vine Hill Preserve. In previous years, Vine Hill clarkia existed in the margins between individual Vine Hill manzanitas. Currently, the Vine Hill manzanita have grown to a point that they are shading and excluding the Vine Hill clarkia from these areas, limiting the number of individual clarkia which can grow at the site. We suggest pruning the Vine Hill manzanita to increase the amount of available habitat for the Vine Hill clarkia. This will require coordination with the California Department of Fish and Wildlife, as the Vine Hill manzanita is a state listed species. (USFWS, 2019)
- Continued seeding upslope. Vine Hill clarkia populations could be dispersal limited (S. Gordon, pers. comm. 2018). Upslope areas at the Vine Hill Preserve previously contained plants (S. Gordon, pers. comm. 2018); however, today the population has shifted spatially within the preserve to areas where its survival is threatened by competition with the Vine Hill manzanita (USFWS 2016). This threat would decrease if individual Vine Hill clarkia seeds were collected and distributed upslope habitat every few years. (USFWS, 2019)

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SPECIES ACCOUNT: *Clarkia speciosa ssp. immaculata* (Pismo clarkia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/17/1995; California/Nevada (Region 8)

Physical Description

An annual herb, with branched stems, in the four o'clock family (Onagraceae). It is up to 50 cm (20 in) tall and has flowers 1.5 to 2.5 cm (0.5 to 1.0 in) wide that are white or cream colored at the base, streaking into pinkish or reddish-lavender at the tips. (USFWS, 2009)

Taxonomy

A member of the four o'clock family (Onagraceac), was first collected in Carpenter Canyon by Frank Harlan Lewis and Margaret Ensign Lewis in 1947. Their monograph on the genus Clarkia (Lewis and Lewis 1955) described the plant for the first time (USFWS, 1998). Clarkia speciosa ssp. immaculata differs from the more abundant ssp. speciosa in having somewhat larger flowers with a different petal-color pattern (lacking a red spot); genetic studies (Lewis and Lewis, Univ. Calif. Publ. Bot., 1955) showed "considerable" genetic differentiation between these two subspecies. (NatureServe, 2015)

Historical Range

See Current Range.

Current Range

Western San Luis Obispo County, California, ranging from San Luis Obispo south to the Nipomo Mesa area, an area approximately 20 kilometers (km) (13 miles (mi)) long by 10 km (7 mi) wide. (USFWS, 2009). Pismo clarkia's range increased to an area approximately 35 km by 13 km or 22 mi by eight mi from what we estimated it to be in 2009 (22 km by 10 km or 14 mi by seven mi; Service 2009, pg. 5). When we simply trace the circumference around the outermost datapoints on Figure 1, the taxon's range occupies approximately 40,359 hectares or 99,730 acres (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 1998)

Breeding Season

Adult: May through July, occasionally extending into September (USFW, 1998)

Reproduction Narrative

Adult: Pismo clarkia is an annual herb that typically flowers from May through July, occasionally extending into September. (USFWS, 1998). The reproductive biology of Pismo clarkia is not well

studied. All C. speciosa have relatively large, showy flowers with eight stamens arranged in two series of four and a stigma that is distinctively four-lobed. The mature style is longer than the stamens and situated above them. It reaches maturity after the stamens (called protandry), and this is believed to have evolved to encourage outcrossing and help ensure that self-fertilization does not occur. However, all species in the genus are self-compatible (Lewis and Lewis 1955, pg. 246, 249, 289). Selfing evolved independently from other outcrossing species within Clarkia at least 10 times but is likely not utilized for reproduction in C. speciosa because of its persistent protandrous floral morphology (Moeller and Geber 2005, pg. 787). While selfing may occasionally occur in C. speciosa, most successful reproductive events occur via outcrossing with insect pollinators. Based on studies from other Clarkia species, potential pollinators of C. speciosa may include both specialist and generalist bees, flies, butterflies and moths, beetles, and hummingbirds (Lewis and Lewis 1955, pg. 249; Moeller 2005, pg. 30–31; Miller et al 2014, pg. 320–321). However, evaluations of floral visitors and pollinators for taxa within C. speciosa have not occurred. We do not know how long Pismo clarkia seeds remain viable. Seeds likely persist in the soil as a seedbank based on observations by researchers that Pismo clarkia plants did not appear in the same locations in consecutive years (Service 1998, pg. 33). Other research showed that C. williamsonii seeds remained viable and ungerminated as a seed bank in any given year of monitoring (Price et al 1985, pgs. 154–155). C. springvillensis seeds stored at room temperature were not viable after eight years. However, they remained viable for at least two consecutive years of study (McCue and Holtsford 1998, pg. 33). Therefore, we presume Pismo clarkia is similar to many other California native annual plants that produce seeds with multiyear dormancy and make large, and potentially long-lasting soil seed banks (USFWS, 2023).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest Edge, Forest/Woodland, Old field, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations below 600 feet (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 2009)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Pismo clarkia typically occurs in fine, dry, sandysoils, derived from ancient marine terraces, in grasslands or openings in chaparral and oak woodlands at elevations below 600 feet. Due to the patchy distribution of these openings, C. speciosa subsp. immaculata populations (and polygons within each population) are fragmented by nature. (USFWS, 1998; USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

26 populations. Of these, two are extirpated, six are likely extirpated, four are at least partially extant, four are extant, and 14 are presumed extant. We also know of two other occurrences where development projects are proposed, and these are presumed extant (USFWS, 2023)

Population Narrative:

Currently, there are 14 populations listed within CNDDB that are extant or presumed to be extant. While more populations have been found in recent years, the overall status of this species is not improving. Development has adversely affected or threatens to adversely affect nine of the remaining 14 known populations and fragmentation due to development is a serious concern for the survival of the species as a whole. (USFWS, 2009). Pismo clarkia currently consists of 26 known CNDDB occurrences. Of these, two are extirpated, six are likely extirpated, four are at least partially extant, four are extant, and 14 are presumed extant. We also know of two other occurrences where development projects are proposed, and these are presumed extant. Lastly, we know of 17 georeferenced Pismo clarkia herbarium specimens, although we do not know the status of the taxon at these locations. We have little current information about Pismo clarkia abundance throughout the range and are unable to assess any trends about the status of the taxon, even at the scale of individual occurrences. At this time, we have met none of the downlisting criteria established for the taxon and therefore delisting criteria are not considered (USFWS, 2023).

Threats and Stressors

Stressor: Development and secondary impacts from development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Residential development and other secondary impacts associated with urban development continue to be the greatest threat to the continued existence of Clarkia speciosa subsp. immaculata. Development has caused the loss of all or part of five known populations of this species since listing. Development has affected or continues to threaten nine additional populations in part or in whole (Roalman 2000, CNPS 2006, CNDDB 2009). In addition to direct loss of plants and occupied sites, development eliminates adjacent suitable habitat that otherwise would allow for natural population expansion and movement as suitable microhabitats shift in the landscape. Furthermore, it may eliminate habitat that supports populations of pollinators and seed dispersal vectors and habitat that contains a seedbank, in cases where there is no germination in a given year when surveys are conducted. (USFWS, 2009)

Stressor: Urban sprawl and development (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: Urban sprawl and development leads to habitat loss and increased fragmentation and is the number one cause of imperilment to listed species, including Clarkia speciosa subsp. immaculata, in California (Doyle et al. 2001). Likewise, urban sprawl and development are directly linked to introduction of and competition from non-native species and outdoor recreation, the second and third leading cause in the decline of listed species, including C. speciosa subsp. immaculata (Alberts et al. 1993, Doyle et al. 2001). The fragmentation of habitat and populations due to development projects may pose the greatest threat to the recovery of the species. Commercial and residential development is rapidly increasing within areas in close proximity to existing and potential C. speciosa subsp. immaculata habitat (Draeger 2002), leading to a substantial increase in fragmentation of populations since listing. A large increase in the amount of development (e.g., residential, recreational, infrastructure) within this area has occurred between populations, which may have increased their isolation from each other (CNDDB 2005; AirPhotoUSA Inc. 2000, 2003; USDA National Agricultural Image Program 2005; M. Elvin, Service Biologist, pers. obs. 2006). Additionally, numerous development projects have further fragmented individual populations by extirpating portions of them (CNDDB 2005; AirPhotoUSA Inc. 2000, 2003; USDA National Agricultural Image Program 2005; L. Althouse, pers. comm. 2006). (USFWS, 2009)

Stressor: Habitat fragmentation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Habitat fragmentation affects persistence of populations or species within habitat fragments (Wilcove et al. 1986, Noss et al. 1997). Fragmentation also may lead to a decrease in pollination and reduced reproductive success, due to decreased visitation from pollinators to small and/or isolated populations (Kearns and Inouye 1997). While fragmentation does not necessarily lead to extinction of a species within a habitat patch, small populations in small habitat patches have an increased likelihood of extinction and are increasingly affected by their surroundings (i.e., edge effects such as physical effects differing at the boundaries of a patch and the interior of a patch) (Noss and Cooperrider 1994). At what point in the fragmentation process biological integrity of this species declines dramatically is not known. (USFWS, 2009)

Stressor: Habitat degradation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The CNDDB indicates that many of the properties containing Clarkia speciosa subsp. immaculata populations have been proposed for development since listing (CNDDB 2005), although many of these projects either have not occurred yet or have fallen through (L. Althouse pers. comm. 2009; Google Earth 2009). We know of two instances where the translocation of C. speciosa subsp. immaculata populations (soil and seedbank) was attempted in an effort to mitigate for impacts to portions of the original populations due to development (EO 16 and 17). Plants survived during the monitoring and management phases of these projects, but after the monitoring and management ended, the sites became so degraded and the vegetation/habitat was altered to the point that suitable habitat for C. speciosa subsp. immaculata no longer exists at any of the sites. Plants have not been seen at these locations since 1998 and all of these sites (original donor populations and the recipient translocated populations) are now presumed to be

extirpated (J. Dart, pers. comm. 2006; L. Althouse, pers. comm. 2006; M. Elvin, pers. obs. 2006; CNDDB 2009). Therefore, all of the known translocation efforts for C. speciosa subsp. immaculata have failed and the translocation of populations of this species may not be a sufficient mitigation or conservation strategy. (USFWS, 2009)

Stressor: Non-native plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Cortaderia jubata (pampas grass) and Ehrharta calycina (veldt grass) are nonnative plants adversely affecting many populations (CNDDB 2005, 2009; L. Althouse pers. comm. 2009), and their invasions are most likely an indirect effect from nearby development and plants that escaped from landscaping. (USFWS, 2009)

Stressor: Roadside threats (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Threats and adverse effects from road grading, roadside traffic, and roadside maintenance (including mowing and herbicide spraying) have not caused the extirpation of any entire occurrence, but they continue to threaten the species as a whole. At least three occurrences are threatened by road maintenance activities (CNDDB 2005, CNPS 2006, CNDDB 2009). (USFWS, 2009)

Stressor: Cattle grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: We noted that two of the four known extant occurrences (at that time) had been subject to grazing by livestock (Service 1994), but that C. speciosa subsp. immaculata might be able to sustain a certain amount of grazing by livestock (Dunn 1987). Although cattle grazing may adversely affect Clarkia speciosa subsp. immaculata, it may not necessarily be a threat to its survival under all conditions. If controlled and timed correctly, cattle grazing may provide some benefits to C. speciosa subsp. immaculata by reducing competition from other vegetation. Over-grazing, on the other hand, can be extremely detrimental to the species, particularly through trampling and alterations to the hydrology (Service 1997, 1998). While this plant may be able to withstand a small amount of grazing, grazing still appears to adversely affect it through the reduction of reproductive success due to loss of flowers and a correlated reduction in the production of seeds (Service 1998). Grazing has been reported as a potential threat at four occurrences (CNDDB 2009). (USFWS, 2009)

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Clarkia speciosa subsp. immaculata may be threatened with stochastic extinction due to the small number of individuals within populations and isolation of the remaining populations (Airphoto USA Inc. 2000, 2003; CNDDB 2009). It is generally accepted that small populations

have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Soulé 1987, Shaffer 1981, 1987; Meffe and Carroll 1997, Primack 1998). (USFWS, 2009)

Stressor: Isolation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Another factor commonly understood to make populations vulnerable to stochastic events is isolation. Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (i.e., colonization is less likely as isolation increases) (Wilcox and Murphy 1985, Meffe and Carroll 1997). (USFWS, 2009)

Stressor: Isolation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In addition, wide fluctuations in numbers from year to year in annual plants, such as Clarkia speciosa subsp. immaculata, may reduce population viability if there is a series of poor seed production years (Menges 1991). The limited gene pool may depress reproductive vigor or a single human-caused or natural environmental disturbance (e.g., wildfire) could extirpate one or more populations of this species. Additionally, small populations are threatened by inbreeding depression and can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since the time of listing, we have identified climate change as a potential threat to the species. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. Clarkia speciosa subsp. immaculata may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap with regions that would be climatically suitable in the future (Levine et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Eight populations are on lands secured from human-induced threats with adequate surrounding habitat to permit natural population expansion and movement as suitable microhabitats shift in the landscape. (USFWS, 1998)

2. The eight protected populations represent the plant's entire range. (USFWS, 1998)

3. These populations must be large, stable or increasing (a minimum of 10 years of monitoring is needed because the population sizes fluctuate due to precipitation). (USFWS, 1998)

4. Management of these populations and associated lands in the future must be reasonably assured for the long term, and must be effective, as demonstrated by stable or increasing populations. (USFWS, 1998)

Recovery Priority Number: 6C

Delisting Criteria:
When the downlisting criteria have been met for a species, the species can be considered for delisting if:

(1) Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species; (USFWS, 2019)

(2) An ex situ seedbank is established in a Center for Plant Conservation-affiliated botanic garden. While sufficient seedbank in the soil would typically provide a strategy for the taxon to persist through several years of short- or medium-term drought, it may not be sufficient to persist through long-term drought. Therefore, an ex situ seedbank would provide assurance that an occurrences could be reseeded, should long-term drought – or other stochastic events – make it necessary; (USFWS, 2019)

(3) All existing occurrences are stable or increasing in the wild for at least 10 years. We expect above-ground occurrence size to fluctuate annually, based on response to amount and timing of rainfall. Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region. Monitoring of occurrences should be undertaken and access to private properties that support the species should be pursued, which will provide a baseline for the status of these occurrences; these data should provide a basis for monitoring occurrence attributes and trends to determine the species trajectory over time. (USFWS, 2019)

Recovery Actions:
- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts ofeasement orfee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are

adjacent to high density residential and urban development. (USFWS, 1998)

- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)
- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity ofthe recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion ofmaintaining sufficient numbers ofpopulations or conservation areas should be assessed, and the success or failure of management actionsshould be evaluated. (USFWS, 1998)
- Recommendations for Actions from 2009 5-Year Revview: Work with local partners to secure occupied sites that meet recovery criteria. Work with local partners (including the County of San Luis Obispo) to help development projects avoid impacts to Clarkia speciosa subsp. immaculata, considering the two attempted translocation projects for this species have failed, resulting in the presumed extirpation of both populations. Work with the County of San Luis Obispo to develop an improved system to track projects that might adversely affect listed and other sensitive species. Amend the recovery objectives and tasks to account for the increase in fragmentation and how it affects our ability to accomplish the recovery criteria. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access (if possible) to all mapped Pismo clarkia occurrences to conduct comprehensive surveys of abundance, assess the status of the taxon, and evaluate threats at these locations. Include estimates of numbers of individuals present, global positioning system (GPS) mapping of occupied spatial area, ecological setting, co-occurring and codominant vegetation, presence of natives versus nonnative species, timing of phenology, and observations of potential insect pollinators. Update information in resource agency databases (CNDDB) to ensure that these data remain accurate and current. 2. Pursue grants and other funding to purchase properties that support the taxon and other plausible mechanisms to secure occurrences from development threats. Acquisitions should also include endowments to manage Pismo clarkia and its habitat in perpetuity. 3. Conduct experimental research on strategic, applied grazing as a management tool for Pismo clarkia recovery and nonnative, invasive weed controls. 4. Conduct experimental research across the species' range to improve and refine our understanding of techniques for population reintroduction, augmentation, and establishment. 5. Continue making accessions for conservation seed banking throughout the species; range so that all populations are represented in the collections. Conduct seed bulking of accessions that may serve as a source for recovery efforts and a backup in the event of stochastic loss and local extirpation (USFWS, 2023).

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SPECIES ACCOUNT: *Clarkia springvillensis* (Springville clarkia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

An erect annual herb, up to about 1 m tall. Flowers (May-July) have lavender petals with a long narrow base and an expanded, diamond-shaped tip that has a darker, purplish basal spot. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the foothills of the Sierra Nevada in a small area of Tulare County, California along the Tule River drainage. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: May to July (NatureServe, 2015)

Reproduction Narrative

Adult: Clarkia springvillensis is a narrowly distributed annual in the evening primrose family (Onagraeae) and blooms from May to July. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest Edge, Forest/Woodland, Woodland - Hardwood (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers sunny open sites (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 330 and 1,220 m (1,080 to 4,000 feet) (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Habitat Narrative

Adult: Clarkia springvillensis grows mostly on the uphill slope of roadbanks, on small decomposing granitic domes, and in sunny openings from elevations between 330 and 1,220 meters (1,080 to 4,000 feet) within the blue oak woodland community. Clarkia springvillensis is found on granitic soils at sunny sites. Population surveys revealed 18 colonies in 2002 and 23 colonies in 2003. (USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining (USFWS, 2009)

Number of Populations:

27 Presumed Extant (USFWS, 2022)

Population Size:

1,016 (USFWS, 2022)

Population Narrative:

The California Department of Fish and Game (2001) characterized the species as a whole as declining in 1999. There are about 10 populations known extant (NatureServe, 2015). The population size of Clarkia springvillensis can vary enormously from one year to the next due to interactions between the soil seed bank and seasonal weather conditions. (USFWS, 2009). At the time of listing, there were 15 occurrences of Springville clarkia occupying 61 hectares (150 acres), which are now considered historical occurrences (Service 1998, p. 49023; Forest Service 2012, p. 10). At the time of our 2009 5-year review, there were 17 presumed extant occurrences (Service 2009, p. 3). New occurrences of Springville clarkia have been added to the Diversity Database since the previous status review (Diversity Database 2021). These occurrences are likely due to increased survey efforts and do not change the overall distribution of the species. According to the Diversity Database (2021), there are currently 28 occurrences. The type locality is possibly extirpated, while the other 27 occurrences are presumed extant (Diversity Database 2021). Of the extant occurrences, nine occurrences have not been surveyed since before 2000 (Diversity Database 2021). Collected specimen from Diversity Database occurrences #29 and #30 are thought to be an atypical outcrossing form of Kern River clarkia (Clarkia exilis) (U.S. Army Corps of Engineers 2021, p. 45). However, further field work is needed to confirm (Diversity Database 2021). See Appendix Table 1 for further details on Diversity Database occurrences (note: table includes all occurrences recorded as Springville clarkia in the Diversity Database, including occurrences that need further expert verification on species identity) USFWS, 2011).

Abundance: Abundance of Springville clarkia varies across colonies and across years (Diversity Database 2021). Recorded abundance data includes extremes of single plants to hundreds of thousands of plants (Diversity Database 2021). As is common in annual plants, the aboveground population size of Springville clarkia drastically fluctuates from year to year (Service 2009, p. 5). The number of plants depends on interactions between the soil seed bank and weather (Forest Service 2012, p. 12). Rainfall patterns may be the most important factor for determining abundance in the following year (Forest Service 2012, p. 12). For example, as discussed in the previous status review, a comprehensive multiyear study of Springville clarkia as part of Southern California Edison's Lower Tule River Hydroelectric Project documented this drastic change in abundance in the project area (Service 2005, p. 4). The project area overlaps with the Siphon Canyon–Coffee Canyon area in the Middle Fork of the Tule River watershed. Survey data from 2002 to 2005 revealed that the area's abundance fluctuated between 2,500, 4,880, 1,800, and 10,000 individuals, with high and low numbers corresponding to wetter and drier years, respectively (Service 2005, pp. 8–9). Surveys estimate 3,055–3,315 individuals within the area in 2016 (Cardno, Inc. & Stebbins 2016, p. 3-2–3-3. The most recently available survey data estimates 1,016 individuals within the area in 2021, representing the low in the 2017–2021 reporting period (Cardno, Inc. & Colgate 2021, p. 3-4). The highest abundance surveyed during this period was 7,590 individuals in 2019 (Cardno, Inc. & Colgate 2021, p. 3-4). While abundance continues to fluctuate in this area, the changes do not as closely correspond with annual precipitation as previously reported (Cardno, Inc. & Colgate 2021, pp. 3-4–4-1). Botanists hypothesized that the Pier Fire in 2017 created unsuitable microhabitat conditions and/or precipitation patterns were unfavorable for the species (Cardno, Inc. & Colgate 2021, p. 3-4) (USFWS, 2022).

Threats and Stressors

Stressor: Residential development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Prior to listing, residential development affected Clarkia springvillensis at two sites. Element Occurrence 5 was damaged, but not destroyed, when an access road, building pad, and well were constructed in the midst of the C. springvillensis population (Ashford 1989) for a home that was never built. Mobile home development contributed to the extirpation of Element Occurrence 1. No mobile homes are currently located at that site, but road construction, maintenance and improvement associated with the former residences are believed to be responsible for its disappearance (J. Stebbins, pers. comm. 2001, J. Stebbins in litt. 2002; CNDDB 2009). (USFWS, 2009)

Stressor: Road maintenance (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Road maintenance and improvements have affected Clarkia springvillensis on steep banks near roadways to some extent (Stebbins 1991, J. Stebbins, in litt. 2002; CNDDB 2009). Road maintenance is still a threat at five occurrences in Clarkia springvillensis habitat. The dirt along which it grows are maintained either by Tulare County, Pacific Gas and Electric, or Souther California Edison. Road maintenance includes activities such as mowing, grading, spraying

herbicide, mechanically removing brush, and clearing culverts (USFS 1996), whereas road improvements are activities such as widening or straightening roads, or installing culverts (USFWS, 2009)

Stressor: Livestock grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The apparent decline of Clarkia springvillensis is likely due to a complex combination of inappropriate livestock (J. Shevock, USFS, in litt. 1985; Stebbins 1991; Hansen 1992; USFS; 1996), competition from nonnative plants (McCue et al. 1996), and altered fire regimes (McCue et al. 1996; S. Carter, pers. comm. 2001, J. Stebbins, in litt. 2002). Inappropriate grazing practices that apparently contributed to the decline of C. springvillensis included (1) repeated consumption of the same plants in a single growing season; (2) grazing late in the season (May or later) so C. springvillensis plants did not have time to send up new shoots or set seed before dying back (McCue 1997; J. Stebbins, pers. comm. 2001); and (3) livestock spending long periods in one area, which caused direct trampling of plants, soil compaction, and surface disturbance (Hansen 1992). Concern over grazing peaked in the 1980s, and several occurrences were then fenced to exclude livestock (Stebbins 1991). (USFWS, 2009)

Stressor: Random demographic, environmental or genetic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The combination of small range and restricted habitat still renders Clarkia springvillensis susceptible to extirpation due to random events such as flood, drought, disease, or other factors (Shaffer 1981, 1987; Groom et al. 2006). Demographic events that may put small populations at risk involve random fluctuations in survival and reproduction of individuals (Shaffer 1981, 1987; Lande 1998; Groom et al. 2006). Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991, Ellstrand and Elam 1993). Populations that are continually small in size are particulary susceptible to genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes. Increased homozygosity resulting from genetic drift and inbreeding in small populations may lead to a loss of fitness. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993). Clarkia springvillensis has small population size for at least five occurrences, therefore, it also is susceptible to extirpation due to demographic events, genetic drift, and inbreeding. (USFWS, 2009)

Stressor: Competition with nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Nonnative plants, especially Bromus grass species (brome), may have contributed to the decline of Clarkia springvillensis by competing directly for moisture and nutrients (J. Stebbins in litt. 2002). Dead stems of nonnative grasses create a build-up thatch that may have prevented C. springvillensis from becoming established in openings, thereby isolating populations (McCure et al. 1996; J. Stebbins, pers. comm. 2001). Prolonged grazing may have exacerbated these

problems because soil disturbance favors some nonnative plants over native species (Hansen 1992). A related problem is that the stems and thatch of nonnative plants contribute to an increased fire frequency. Conversely, fire suppression activities may have inadvertently contributed to the decline of Clarkia springvillensis by allowing encroachment of shrubs and trees into the openings where it grows (McCue et al. 1996; S. Carter, pers. comm. 2001, J. Stebbins in litt. 2002). (USFWS, 2009)

Stressor: Global climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Impacts to Clarkia springvillensis under predicted future climate change are unclear. A trend of warming in the mountains of western North America is expected to decrease the snowpack, hasten spring runoff, and reduce summer stream flows, and increased summer heat may increase the frequency and intensity of wildfires (IPCC 2007). While it appears reasonable to assume that the species may be affected, we lack sufficient certainty on knowing how and how soon climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by drought and fire. (USFWS, 2009)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 8

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Recovery actions are not available.
- Complete and published the draft recovery plan, and approve a final recovery plan (USFWS, 2009)
- Establish reliable baseline data for monitoring plant occurrences. Monitor the status and trend of Clarkia springvillensis in order to estimate current population sizes, the number and distribution of populations, the threats to each occurrence, and whether the species is stable, increasing, or declining. (USFWS, 2009)
- Work with the Forest Service, Bureau of Land Management, and California Department of Fish and Game to conduct research on a) the value of prescribed burning and mechanical brush removal; and b) study the effects of livestock grazing on Clarkia springvillensis. (USFWS, 2009)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Springville clarkia. Some of these recommendations have already been discussed in the previous status review (Service 2009, pp. 13–14) and remain valid. 1. Verify Springville clarkia occurrences recorded in the California Natural Diversity Database, especially occurrences with a currently unknown status

and/or that have not been surveyed in the previous ten years. 2. Conduct further research on Springville clarkia's reproduction parameters (e.g., seed production rate, germination rate) and their relationship to environmental conditions to better understand population dynamics and effective population size. 3. Establish reliable baseline data for monitoring Springville clarkia occurrences, including both aboveground presence and soil seed bank. Work with the U.S. Forest Service and other landowners/managers to monitor the status and trend of occurrences to (a) track any threats, (b) estimate current colony/population sizes and the number and distribution of colonies/populations, and (c) determine whether the species is stable, increasing, or declining. Annual precipitation and monitoring data should be compared to assess the impact of drought on population changes, as this may be the most significant threat to the species. 4. Conduct genetic and ecological studies to gain a better understanding of the potential for hybridization between Springville clarkia and other clarkia species, such as elegant clarkia (Clarkia unguiculata). Create a species identification key based on genetic and morphological relationships. This information can then be used to help determine the status of California Natural Diversity Database occurrences with an uncertain identification. 5. Conduct further research on the effect of disturbance on Springville clarkia. Work with the U.S. Forest Service, Bureau of Land Management, and California Department of Fish and Wildlife to conduct research on (a) the value of prescribed burning and mechanical brush removal and (b) the effects of livestock grazing on Springville clarkia. 6. Provide support to the Tule River Indian Tribe of California to implement conservation actions for Springville clarkia on the Tule River Reservation. The Tribe plans to implement several conservation measures to protect occurrences on the Reservation and intends to survey for new colonies should any activities occur in suitable habitat. 7. Complete a recovery plan for Springville clarkia. The plan would establish a framework for agencies and landowners to coordinate conservation efforts. The plan would set recovery priorities and estimate costs of various tasks necessary to accomplish them. It also would describe site-specific management actions necessary to achieve conservation and survival of the Springville clarkia (USFWS, 2022).

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SPECIES ACCOUNT: *Clematis morefieldii* (Morefield's leather flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/19/1992; Southeast Region (R4)

Physical Description

A perennial vine in the buttercup family (Ranunculaceae). This species is a member of the Viornae subsection of Clematis, distinguished by urnshaped flowers which occur singly, or in few-flowered groups, in leaf axils. Their primary flower stalks (peduncles) are subtended by leafy bracts. Clematis morefleidii is closely related to C. viorna, a more variable species. However, C. morefleidii is distinguished from this species by the dense white hairs on the shoot, the velvety lower leaf surfaces, and stouter, usually shorter (15 to 25 millimeters (mm) or 0.6 to 1.0 inch long) peduncles with sessile to nearly sessile bracts at the base (Kral 1987). Clematis morefleidii attains heights up to 5 meters (16 feet) and has compound leaves reaching lengths of 2 decimeters (8 inches). Leaves have 9 to 11 leaflets and the terminal 1 to 3 leaflets form tendrils. The flowers, which are present from May to July, are pinkish in color and 20 to 25 mm (0.8 to 1.0 inch) long. Fruits are clusters of hairy achenes. (USFWS, 1994)

Taxonomy

It was first collected by Morefield in the early 1980's from Round Top Mountain in Madison County, Alabama and later described by Kral (1987). This species is a member of the Viornae subsection of Clematis, which is noted for its narrow endemics (Kral 1987). Clematis morefieldii is closely related to C. viorna, a more variable species (USFWS, 1994).

Historical Range

Endemic to the southeastern United States, known from three states (Alabama, Georgia, and Tennessee). (USFWS, 2019)

Current Range

Endemic to the southeastern United States, known from three states (Alabama, Georgia, and Tennessee). (USFWS, 2019). In five counties in three states (Jackson and Madison counties, Alabama; Walker County, Georgia; and Franklin and Grundy counties, Tennessee). The species' known range spans fewer than 70 miles east to west and under 50 miles north to south. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2018)

Breeding Season

Adult: May - July (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2018)

Other Reproductive Information

Adult: Crabtree (2011) observed bumblebees (Bombus sp.) visiting flowers of Morefield's leather flower. Preliminary data indicate that pollinated flowers are capable of producing abundant (15 or more per flower) achenes (a type of simple, dry fruit containing only one seed) (Crabtree 2014a). Preliminary data also indicate a moderately positive correlation with precipitation and fruiting in the field (Crabtree 2014a). Likewise, Paris et al. (2015, 2016) also noted increased flowering and fruiting in the rainiest year of their multiyear studies. However, lack of rainfall has also been associated with poor flower production (Emanuel 2000, Boyd and Paris 2013). (USFWS, 2018)

Reproduction Narrative

Adult: Crabtree (2011) noted reproductive activity at 11 of 18 Morefield's leather flower sites in Tennessee during 2009–2010 and further noted the presence of seedlings at most sites. However, follow-up surveys in 2013 failed to relocate mature plants resulting from these seedlings (Crabtree 2014a), but small plants were found where seedlings were previously located during follow-up monitoring surveys in 2018 at two sites (Crabtree pers. comm. 2018c). Crabtree (pers. comm. 2018c) suggested that surveying earlier in the year than previous surveys may have contributed to these discoveries and further suggested that seedlings and small plants may go dormant as precipitation decreases during summer's progression. Boyd and Paris (2013) likewise noted seedling recruitment in most of the populations in Alabama and Tennessee visited as part of their study. Interestingly, Crabtree (2011) noted repeatedly observing Morefield's leather flower seedlings along deer trails, suggesting that deer (Odocoileus virginianus) may be potential dispersal agents of the species' seeds, but recommended additional research to further understand this putative relationship. Additionally, the species' pollen has been imaged and

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone bluffs, montane hardwood forests, riparian (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: ~800 - 1700 ft. elevation (USFWS, 2018)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in the Cumberland Plateau physiographic region in Madison County (Figure 1). It occurs in patches near seeps and springs in rocky limestone woods, typically at elevations of 800 to 1100 feet, on the south and southwest facing slopes of mountains (Weber 1991). Currently, it is known from a total of five sites with populations on Huntsville, Keel, and Monte Sano Mountains. Populations tend to occur on limestone of the Monteagle formation with a

sandstone cap (Weber 1991). Plants are rooted in basic clay-loam soils and are often found sprawling over shrubs and boulders or climbing understory shrubs and trees (Kral 1987). Clematis morefleidji occurs locally within a open to dense juniper-hardwoods community. (USFWS, 1994) Morefield's leather flower is found within an elevation gradient of approximately 700 to 1,700 feet above sea level (Cook 2018), but most sites are found between roughly 1,000 and 1,400 feet elevation. The species has remarkably high fidelity with the Plateau Escarpment Level IV ecoregion - which is found within the Southwestern Appalachians Level III ecoregion - with all known populations occurring within this ecoregion. A small portion of one population slightly crosses into the Eastern Highland Rim Level IV ecoregion (part of the Interior Highlands Level III ecoregion); however, this apparent ecoregional association may simply be an artifact of how the population and/or ecoregion were mapped rather than a true association. (USFWS, 2018)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown

Dispersal/Migration Narrative

Adult: Crabtree (2011) noted repeatedly observing Morefield's leather flower seedlings along deer trails, suggesting that deer (Odocoileus virginianus) may be potential dispersal agents of the species' seeds, but recommended additional research to further understand this putative relationship. (USFWS, 2018)

Population Information and Trends

Population Trends:

Uncertain (USFWS, 2018)

Species Trends:

Uncertain (USFWS, 2018)

Number of Populations:

36 extant (USFWS, 2024)

Population Size:

Insufficient data available (USFWS, 2018)

Additional Population-level Information:

For this 5-year review, a provisional population definition of 1 kilometer (0.6 mile) is used to delimit individual populations, which is in line with both the Tennessee Natural Heritage Program's (TNHP 2018) and the Alabama Natural Heritage Program's (ANHP 2018) element occurrences. As such, individuals or groups of Morefield's leather flower that are separated by at least 1 kilometer from their nearest known neighbors are considered to be a distinct population. Under the 1-kilometer provisional population definition, there are 34 known populations of Morefield's leather flower across three states (Alabama, Florida, and Georgia), with 32 populations considered extant and 2 considered extirpated. With 20 extant populations in two counties (Franklin – 18; Grundy – 2), Tennessee is home to nearly two-thirds of known

populations (TNHP 2018). Six of Tennessee's populations (Franklin – 5; Grundy – 1) have been discovered since 2010 (TNHP 2018). Alabama has 11 extant populations in 2 counties (Jackson – 2; Madison – 9; ANHP 2018). A previously unknown population was discovered in Walker County, Georgia in 2015 (GDNR 2018a), which represents an extension of the species' known range into Georgia. No other occurrences from Georgia are known. (USFWS, 2018)

Population Narrative:

Current population size data are limited and no systematic population monitoring and survey protocols are known for Morefield's leather flower. The only known monitoring program for the species occurs in Tennessee, which is funded by the Service's U.S. Endangered Species Act (ESA) Section 6 cooperative grant program and is conducted by TNHP (cf. Bailey 2005, Crabtree 2011, 2014a). While population size data are available for 31 of the 32 extant populations (no population size data are available for Georgia's only known population), only 20 populations have data available that were collected since the last 5-year review (i.e., 2010), 11 of which have data that are 5 or less years old. Available population data for the remaining 11 populations were collected between 1990 and 2009. Together, these data, ranging from 1 to 28 years old, indicate that the total population size of Morefield's leather flower may be potentially as large as 16,000 individuals (Boyd and Paris 2013, Paris 2013, ANHP 2018, Cook pers. comm. 2018, TNHP 2018). Based on these latest available observations, individual population sizes range from 1 to over 7,000 individuals, but only 2 populations are greater than 1,000, whereas, 17 populations (over half of all extant populations) have fewer than 100 individuals and 11 have 20 or less. The lack of recent (i.e., less than 5 years old), systematic survey and monitoring data for many populations increases the uncertainty of our assessment of individual population sizes, the species' total population size, and population trends. (USFWS, 2018). Additional Morefield's leather flower sites were recently discovered in Georgia and Tennessee, expanding the extent of three previously known populations (one in Georgia and two in Tennessee) and adding four more populations (one in Georgia and three in Tennessee) (Crabtree 2023, pers. comm.; Steppe 2023a, 2023b, pers. comms.). Georgia's newly discovered population was found in 2023 on state conservation lands in Walker County, Georgia, while three new populations were found in 2018 on privately owned lands in Franklin, Tennessee. Currently, there are 36 extant populations, 1 extirpated population (in Alabama), and 1 population (in Tennessee) that has not been observed since 2006 and may be extirpated. Thirty-four extant populations have been observed at least once in the past 20 years, 20 have been observed in the past 10 years, and 9 have been observed since completion of the last 5-year review (i.e., 2018). Available monitoring data indicates that most populations of Morefield's leather flower are small, with as many as 25 populations (over 69% of extant populations) consisting of fewer than 100 plants (Alabama Natural Heritage Program data; Tennessee Natural Heritage Program data; Georgia Natural Heritage Program data; Paris 2013; Cook 2018, pers. comm.; Crabtree 2018; Cook 2020). Furthermore, most populations (61.1% or 22 of 36) are ranked by state natural heritage programs as being in fair to poor condition, while the remaining populations (28.9% or 14 of 36) are considered to be in good to excellent condition (Alabama Natural Heritage Program data, Tennessee Natural Heritage Program data, Georgia Natural Heritage Program data). Seventeen populations occur at least in part on conservation lands. Together, these sites support about half of all Morefield's leather flower plants, including 8 populations with 100 or more individuals; however, state natural heritage programs only consider 7 of these populations on conservation lands to be in good or excellent condition (Alabama Natural Heritage Program data, Tennessee Natural Heritage Program data, Georgia Natural Heritage Program data). Countylevel summaries of populations are presented in Table 1 (USFWS, 2024).

Threats and Stressors

Stressor: Development (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Since its discovery, two populations of this species were destroyed or damaged by residential development in Alabama (Weber 1994, ANHP 2018). Clematis morefieldii continues to be threatened by habitat destruction from development, particularly for those sites located in the Huntsville area (Schotz 2007, Paris 2013). One of the largest populations in this area consists of pockets of plants on lots slated for development within the city limits. Long-term protection of these populations in the Huntsville vicinity population is precarious. Overall, development, particularly for residential purposes, has been identified as a significant threat to species associated with privately owned forested lands (Stein et al. 2010), such as Morefield's leather flower. Development and associated land use changes on unprotected sites could negatively impact or destroy populations if precautions are not taken. Such development activities can also fragment populations (see Factor E). Within the southeastern United States, the urban footprint has been projected to more han double by 2060 compared with 2009 for the region and may more than triple within the Southwestern Appalachians ecoregion during the same period (Terando et al. 2014), thus putting further development pressure on Morefield's leather flower and its habitats. However, the overall proportion of the landscape within the Southwestern Appalachians ecoregion projected to be urbanized during this time is expected to remain small (less than 10%) (Terando et al. 2014). Likewise, Morefield's leather flower typically inhabits locations that are less suitable for urban development (sensu Baldwin et al. 2018), which likely ameliorates some of the threats posed by continued urban development. (USFWS, 2018)

Stressor: Small populations (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Over half (53%) of known extant populations (17 of 32) remain vulnerable due to their small numbers of plants, having fewer than 100 individuals, including 11 populations (34%) with no more than 20 individuals (Boyd and Paris 2013, Paris 2013, ANHP 2018, Cook pers. comm. 2018, TNHP 2018). Maintenance of genetic diversity within populations is the best protection against future environmental changes (Boyd et al. 2008). Those populations with small numbers of plants likely have limited genetic diversity, which makes their persistence into the future precarious (Ellstrand and Elam 1993, Matthies et al. 2004). The negative consequences of small populations are further exacerbated by habitat fragmentation. For example, habitat fragmentation from development and other activities can disrupt pollinators and consequent gene flow between populations, which may ultimately reduce viability of individual populations (Honnay and Jacquemyn 2007). Potential deleterious consequences (e.g., inbreeding, loss of genetic diversity, genetic drift) of fragmented populations increase as population sizes decrease and with increasing length of time that fragmented conditions remain in place (Young et al. 1996, Aguilar et al. 2008). (USFWS, 2018)

Stressor: Herbivory (USFWS, 2018)
Exposure:

Response:
Consequence:
Narrative: Herbivory of Morefield's leather flower plants is common (Paris et al. 2015, 2016) and continues to be of some concern. Insect infestation was thought to cause the decline of one population in Alabama (Weber 1994). Bailey (2005) observed mealybug infestation on numerous individuals at several locations in Tennessee and suggested that damage from these insects may inhibit reproductive capacity of plants. However, during surveys in following years mealy bugs were only observed at one population (Crabtree 2011), indicating the need for further investigation of this potential threat to the species throughout its range. Crabtree (2011) also noted extensive deer browsing at one site in Tennessee and suggested that large deer populations could potentially threaten the species at some sites. Similar deer browsing has also been noted more recently in Tennessee (Crabtree pers. comm. 2018b). Paris et al. (2015) found decreased flower bud damage and increased fruit production on Morefield's leather flower plants treated with insecticide, and further noted that both insect and vertebrate browsing damage was reduced on treated plants. Such observations indicate that insecticide application could successfully reduce herbivory in particularly vulnerable populations. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Alabama has no state laws affording specific protections to Morefield's leather flower or its habitat; however, Alabama Department of Conservation and Natural Resources (ADCNR) has recently designated the species as a Plant of Conservation Concern in the State Wildlife Action Plan (SWAP; ADCNR 2016). However, this designation does not carry any legal protections. Clematis morefieldii is state listed as endangered by the Tennessee Department of Environment and Conservation (TDEC). The Tennessee Rare Plant Protection and Conservation Act of 1985 (T.C.A. 11-26-201) forbids persons from knowingly uprooting, digging, taking, removing, damaging, destroying, possessing, or otherwise disturbing for any purpose, any endangered species from private or public lands without the written permission of the landowner. Written permission from a landowner or manager before knowingly removing or destroying a state listed species (T.C.A. §§70-8-301–314). In addition, a state-issued scientific collecting permit is required before removing any state-listed species from TDEC lands (TDEC Rule 0400-02-02-.23) and a state-issued license is required to sell state-listed species in Tennessee (TDEC Rule 0400-06-02-.06). Clematis morefieldii is also identified as a species of Greatest Conservation Need in Tennessee's SWAP (Tennessee State Wildlife Action Plan Team 2015). As with Alabama's SWAP, such designation does not confer additional legal protection to the species, but may serve to help focus conservation efforts on this species and its habitats. In Georgia, the species is state protected as endangered (GDNR 2018b) under the Wildflower Preservation Act of 1973 (O.C.G.A. 12-6-170). This law authorizes rules for permitted collection, transport, sale, and listing of protected plants within the state. In addition, no protected plants may be collected without landowner approval and no transport within the state is allowed without a state-issued permit (Patrick et al. 1995). Furthermore, the Georgia Environmental Policy Act (GEPA) of 1991 (O.C.G.A. 12-16-1) requires that impacts to protected species be addressed for all projects on state-owned lands and for all projects undertaken by a municipality or county if funded half or more by state funds or by a state grant of more than $250,000. The provisions of GEPA do not apply to actions of non-governmental entities. On private lands, the landowner has ultimate authority on what protection efforts, if any, occur with regard to protected plants (Patrick et al. 1995). Otherwise,

protection is also afforded to the species under Sections 7 and 9 of the ESA throughout its range. (USFWS, 2018)

Stressor: Encroachment of exotic plants (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Encroachment of exotics, most notably Japanese honeysuckle (Lonicera japonica) and fragrant honeysuckle (L. fragrantissima) may pose problems for some populations, particularly those within the Huntsville city limits (Schotz 2007). Recently, the Alabama Plant Conservation Alliance and Georgia Plant Conservation Alliance—non-governmental plant conservation organizations—have begun to focus attention on Morefield's leather flower by including them as an organizational project or priority species, which will help provide additional attention to the conservation needs of this species, such as habitat management in the wild and ex situ (off-site) conservation in botanical gardens and arboretums (Thompson 2018, Ceska pers. comm. 2018). (USFWS, 2018)

Stressor: Rock mining (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Rock mining occurs on property adjacent to one population in Grundy County, Tennessee and is considered a potential threat to this population (Crabtree pers. comm. 2018b). Mining activities have also been noted as potential threats to suitable habitat elsewhere in Tennessee (Bailey 2005). More recently, expansion of quarrying activities in Grundy and Franklin Counties, Tennessee has been proposed (Crabtree 2011), which may increase threats posed by these activities to the species and its habitat. In Franklin County, Tennessee State acquisition—via donation and purchase in 2016—of land formerly owned by a mining company has alleviated threats posed to Morefield's leather flower by continued mining activities on this land by incorporating this area in the State's conservation lands estate. (USFWS, 2018)

Stressor: Forestry practices (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Incompatible forestry practices and logging have also been noted to pose threats to a number of the Alabama sites (Schotz 2007, ANHP 2018) and at least one Tennessee site (Crabtree 2011). Schotz (2007) noted three sites in Alabama that were threatened by timber harvesting activities. Crabtree (2011) noted that tops from harvested trees were left on favorable habitat for Morefield's leather flower at one of the smallest Tennessee populations. Disturbance from logging activities may also promote the encroachment of exotic invasive species. (USFWS, 2018)

Stressor: Road construction (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: A Franklin County, Tennessee population located near a road is thought to have been extirpated when the road was widened (Crabtree pers. comm. 2010, TNHP 2018). However,

shifting right-of-way maintenance from herbicide spraying to vegetation cutting has apparently benefitted Morefield's leather flower plants that were recently discovered along a highway in Franklin County, Tennessee (TNHP 2018). Roadside maintenance involving herbicide spraying or mowing at inappropriate times may threaten populations in Alabama and Tennessee that are located near roads. (USFWS, 2018)

Recovery

Reclassification Criteria:
1. At least ten (10) geographically distinct populations of sufficient size within the Plateau Escarpment ecoregion exhibit stable or increasing population trends over an appropriate time span, as evidenced by natural recruitment and multiple size classes. (USFWS, 2019)

2. These ten (10) populations are protected by a conservation mechanism. (USFWS, 2019)

3. Protected populations are managed to promote open canopies, integrity of native plant communities, and growth of Morefield's leather flower plants. (USFWS, 2019)

Recovery Priority Number: 8

Delisting Criteria:
In addition to meeting downlisting criteria, Morefield's leather flower will be considered for delisting when the following criteria are met: (USFWS, 2019)

4. At least 10 additional geographically distinct populations of sufficient size within the Plateau Escarpment ecoregion exhibit stable or increasing population trends over an appropriate time span, as evidenced by natural recruitment and multiple size classes. (USFWS, 2019)

5. At least one population (as described in Criterion 1) protected by a conservation mechanism occurs in each of the five counties where the species is known to occur (Madison and Jackson Counties, Alabama; Walker County, Georgia; and Franklin and Grundy Counties, Tennessee). (USFWS, 2019)

Recovery Actions:
- Protect populations and habitat. Ensure protection of publicly-owned sites. Secure plants on private lands. (USFWS, 1994)
- Survey for new populations. Limited surveys have been conducted by Kral (1987), Weber (1991), and the author; however, a thorough systematic survey for new populations is needed. Suitable habitat should be identified through an analysis of habitat supporting extant populations. Current sites occur near seeps and springs at elevations of 800 to 1100 feet in Monteagle Limestone with overlying shales and sandstones. Particular attention should be focused on sites with Cotinus obovatus, which appeats to be a principal indicator species for Clematis morefleidji habitat. Surveys should continue in north Alabama (Limestone, Madison, Morgan, Jackson Counties) and extend into Franklin and Marion Counties in Tennessee (Kral 1987). Possible sites which have good potential include the south\southwest faces of the plateau region between Huntsville (AL) and Carter Mountain (TN) in Monteagle limestone and Brindley Mountain in Morgan County, AL (Weber in liii. 1994). The location and protection of additional sites is essential for reclassification to

threatened and future recovery. The location of other populations will perhaps yield important information on this species' habitat requirements. In addition, documentation of apparently suitable habitat, which lacks the plants, will be important to any future plans to establish additional populations. (USFWS, 1994)

- Gather baseline data on populations and habitat and conduct long-term monitoring. An understanding of this species' distribution within populations and its habitat needs is essential to determining limiting factors. (USFWS, 1994)
- Investigate potential management techniques. Weber (1991) reported reduced vigor for plants under extremely shaded conditions. Populations appear to have been enhanced at sites where the canopy was more open from a limited amount of selective logging. Test plots to evaluate this species' response to different light levels and competition will assist in determining appropriate management for this species. Information gathered from Task 3 will aid indeterminingif management will be needed. (USFWS, 1994)
- Study species' biology and conduct life history studies. No research on this particular species' life history has been conducted. An understanding of this species' biology and life history is essential to identifying limiting factors and understanding the dynamics of the populations. Information gained will ensure that populations are appropriately protected and managed. (USFWS, 1994)
- Preserve genetic stock. This species is extremely vulnerable due to such few populations. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation. This will provide material for research, propagation, and horticultural interests. Such activities should be conducted under the guidance of the Center for Plant Conservation. Roles which could be played by local botanical gardens (Huntsville-Madison County Botanical Garden) in this task should also be explored. (USFWS, 1994)
- Establish additional populations, if found to be necessary. Establishment of additional populations should be considered only after extensive searches for new populations have been conducted and there has been ample time to assess the progress of management actions on existing populations. Establishment of new populations should be considered as a means of decreasing the vulnerability of this species, which is restricted to only a few sites. Established populations and their habitat will likely require active management and long-term monitoring to assess success of efforts. The number of populations to be established will be determined at the time the necessity of this task is assessed. (USFWS, 1994)
- Develop public awareness program. Public support is an important part of recovering listed species. General information on this species and its conservation needs should be provided to landowners, governmental agencies, local parks, and nature centers, as well as the media. The recovery of this species will depend largely on the voluntary protection from private landowners and local governments. Education efforts will lead to a public more informed of the conservation needs of endangered species and possibly to the location of additional populations. (USFWS, 1994)
- Recommendations for Future Actions from 2010 5-Year Review: Gather base-line data on all populations and initiate long-term monitoring on sites, particularly on the secure, protected sites. - Continue surveys in Alabama and adjacent Tennessee (survey reports in "V. References" below identify target areas for surveys). - Work to obtain protection for sites on privately-owned lands. - Investigate habitat parameters. - Develop protection and management plans for all sites as indicated by information acquired from habitat studies. - Evaluate significance of insect predation on populations. - Conduct species biology studies (i.e. reproductive biology etc.). - Implement all other tasks identified in the recovery plan,

with exception of #7,(Establish additional populations) which is not likely needed in light of the discovery of new populations. - Revise recovery plan. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Current recovery criteria are presented in the Recovery Plan Amendment (Service 2019) while the Recovery Plan (Service 1994) provides a detailed discussion of necessary recovery actions. During this status review, new and/or targeted potential recovery activities were identified and are included below. These actions are recommended to support and promote recovery of Morefield's leather flower. Use of a numbered list for these recommendations is for convenient reference only and does not necessarily imply prioritization of any activity over others. Recovery Activities 1. Pursue protection of populations not currently located on conservation lands. 2. Conduct habitat management to control competing and invasive vegetation and promote population growth. 3. Continue surveys to locate additional populations. 4. Expand ex situ conservation collections. Monitoring and Research Activities 1. Implement consistent monitoring of all extant populations (USFWS, 2024).

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SPECIES ACCOUNT: *Clematis socialis* (Alabama leather flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

A member of the family Ranunculaceae. The most distinctive features are its rhizomatous habit and formation of dense clones with erect stems reaching 0.2-0.3 meters(in) or 7-12 inches (in.) in height. The leaves are variable from the base to the apex of the stem. The lowermost leaves are scalelike, oblong or triangular in shape and mostly under 1 centimeter (cm) (0.39 in.) long; median leaves are simple, mostly elliptic-linear in shape, 4-12 cm (1.6-4.7 in.) long, and 0.5-1.0 cm (0.20-0.39 in.) wide; upper leaves are 3 to 5 foliolate and shaped as in median leaves. The flowers are solitary at the tips of slender stems, urn to bell-shaped, 2-3 cm (0.79-1.18 in.) long, and blue-violet in color. The fruits are aggregates of achenes which are densely pubescent and 2.5-3.0 cm (0.98-1.18 in.) in length (Figure 1). Clematis socialis, a member of the Viorna section of Clematis, superficially resembles the more widespread C. crisna but is distinguished by its erect stems, rhizomatous nature, solitary flowers and lack of tendrils (Kral 1982, 1983). (USFWS, 1989)

Taxonomy

Described as a new species in 1982 by Dr. Robert Kral. (USFWS, 1989)

Historical Range

The Alabama leather flower was known from only two sites, one each in St. Clair and Cherokee counties, Alabama, at the time of listing in 1986. (USFWS, 2010)

Current Range

St. Clair County (3 populations) , Cherokee County (two populations), and Etowah County (1 population), Alabama. Floyd County, Georgia (two populations). (USFWS, 2017)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Clonal, sexual (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Bombus pennsylvanicus and Anthophora ursina (USFWS, 2010)

Breeding Season

Adult: March - June (USFWS, 2010)

Other Reproductive Information

Adult: Genetic sampling of populations in Alabama by Goertzen et al. (2011) revealed that individual genets (genetically distinct individuals) of Alabama leather flower can be quite large, spreading to at least 36 feet (ft.) (11 meters [m]) via underground rhizomes. The authors note that these genets may span greater distances than their sampling scheme detected. These data, coupled with earlier estimates that Alabama leather flower's rhizomes grow approximately 4 inches (10 centimeters [cm]) per year (Goertzen and Boyd 2007), indicate that the species is relatively long-lived and capable of living for at least 55 years. (USFWS, 2017)

Reproduction Narrative

Adult: Flowering occurs March to June. Fruit development begins in June; seeds mature by late July through early August and seeds have senesced by late August. Pollinators include queen bumblebee (Bombus pennsylvanicus), bee (Anthophora ursina); pollination not required for production of seeds, but seed production increases with pollination. Anthophora is a more productive pollinator than Bombus (EPA, 2016). Plants are believed to reproduce primarily by forking and spreading rhizomes which form dense clones (Kral 1982, Garrett 2004). Timmerman-Erskine and Boyd (1999) suggested that sexual reproduction in this species was limited by a combination of pollinator frequency, herbivory, low light levels, and post-maturation achene predation by mice. The level of genetic diversity in the Alabama leather flower is higher than average for rare species and surprising given that it is a narrow endemic with a clonal nature, thus suggesting that considerable sexual reproduction has likely occurred in these populations despite low observed seedling recruitment (Boyd et al. 1998, Goertzen and Boyd 2007) (USFWS, 2010).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, riparian, forest, grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fires (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped, scattered (USFWS, 2010)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Silt and clay of alluvial, grass-sedge openings along a highway right-of-way, extending into the adjacent hardwood edge. Associated members of the grass-sedge community prior to logging included: Scarpus lineatus, S. atrovireus, Fimbristylis puberula, and Rhynchospora caduca; several andropogons, such as A. gerardi and A. scoparius; patches of Allium and Sysyrinchium were noted, in addition to violets and composites. The woodland overstory prior to logging (Kral, 1982) was composed of lowland oaks, hickories, white and green ash, sweet gum, black gum, persimmon, and red maple. The understory included flowering dogwood, swamp cornel, sassafras, buckthorn, elderberry, viburnums, honeysuckle, and blackberry. Many of these species have been documented as components of the climax vegetation usually

associated with southeastern loblolly pine forests. These forests experience natural fires approximately every ten years (Wright and Bailey, 1982). It has a moderate environmental specificity (NatureServe, 2015). Open grass-seed-rush prairie areas and adjoining hardwood swamp forests. Soil types are Conawauga and Firestone formations (developed from weather shale, are acidic, low fertility, and poor in organic material); Tupelo series with Dowellton series inclusions (calcareous flatwood communities growing on circum-neutral soils) (EPA, 2016). The Alabama leather flower is found occurring in tight patches or sparsely scattered (Goertzen and Boyd 2007). Though plants are found in sunny and shaded conditions, they are more vigorous in full or partial sunlight where plant competition is low (Emanuel 2000, 2002; Garrett 2004, 2005; Garrett and Schotz 2005; Sherbundy and Martin 2007) (USFWS, 2010).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown.

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2017)

Number of Populations:

6 extant natural pops in Alabama. 2 populations in Georgia, 1 Natural with transplants augmented and 1 transplanted (USFWS, 2022)

Population Size:

Approximately 13,000 - 18,000 stems across extant populations (USFWS, 2017)

Additional Population-level Information:

Because of the clonal nature of Alabama leather flower, individual populations can be thought of in terms of both genetically distinct individuals (genets) and clones (ramets). Genets are often composed of numerous ramets (clonal stems). As such, population assessments using numbers of stems alone can easily overestimate the actual population in terms of genets (Tepedino 2012). With respect to Alabama leather flower clonality, as noted above, genets have been documented to be at least 36 ft. (11 m) long (Goertzen et al. 2011). It is unknown how large individual Alabama leather flower genets can grow or how many ramets a given genet may produce. Similarly, no known study has attempted to characterize the number of genets found in an entire population of Alabama leather flower, let alone all populations of the species. In addition, ramets from individual genets grow intermixed with each other (Service 1989), further complicating population estimates using aboveground stem counts. Given these challenges, stem counts/estimates can be considered to represent maximum ramet population sizes, but are likely to overestimate the actual genet population size. (USFWS, 2017)

Population Narrative:

Alabama leather flower's known range has expanded from two Alabama counties (St. Clair and Etowah) at the time of listing (see Service 1986) and completion of the recovery plan (see Service 1989). Currently, the species is known from eight natural populations—six extant, one extirpated, and one uncertain (likely extirpated)—in northeastern Alabama's Cherokee, Etowah, and St. Clair Counties and northwestern Georgia's Floyd County . The species' entire known range spans less than 90 miles (145 kilometers [km]), with individual populations typically separated by 30 or more miles (48 km) from their nearest neighbors. All known populations occur within the Valley and Ridge physiographic province. (USFWS, 2017). Limited new information on Alabama leather flower populations is available. Of note, two of Alabama's populations, both in Cherokee County, are extirpated (Service 2017, Byrd 2020) and three of the species' six extant populations are considered large (≥1,000 plants). No new information is available for either of Georgia's populations (including one natural population and one transplanted population) (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Habitat for this species has been reduced through development and conversion to agriculture and pine plantations. Logging operations have degraded the habitat at two sites in Alabama (ANHP data, Byrd 2016c). The use of heavy equipment has adversely impacted these sites by creating ruts and promoting erosion, and has destroyed several plants. In addition, soil disturbance has fostered invasion by exotic and weedy species, further reducing habitat integrity and species viability. One population, in Cherokee County, Alabama, has been repeatedly impacted by disking for row-crop agriculture and has recently been extirpated by conversion to a soybean field (Schotz pers. comm. 2014, Byrd 2016c). One subpopulation in St. Clair County, Alabama was damaged by silt fencing installation for road improvement work (Byrd 2016c). Road improvements (e.g., widening, repaving) could jeopardize the continued viability of plants in adjacent rights-of-way if such activities are not conducted in an appropriate manner and coordinated with the Service. Rutting by ATVs and mowing equipment also pose threats to plants in rights-of-way (Emanuel 2000, Byrd 2016c). Development, particularly for residential purposes, has been identified as a significant threat to at-risk species associated with privately owned forested lands (Stein et al. 2010), such as Alabama leather flower. Within the southeastern United States, the urban footprint has been projected to more than double by 2060 compared with 2009 (Terando et al. 2014), thus putting further development pressure on Alabama leather flower and its habitats. Development and associated land use changes on unprotected sites could negatively impact or destroy populations if precautions are not taken. (USFWS, 2017)

Stressor: Small, isolated populations (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A number of the populations remain vulnerable due to the small number of plants and the limited area they occupy. Three of the populations occupy no more than an acre in area and

one of these consists of only 2 plants occupying a 15 m2 area (Martin 2008, 2009).

Stressor: Disease or predation (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Disease and predation are not known to threaten Alabama leather flower. Herbivore browsing damage has been observed in Georgia and fencing has been erected to deter herbivores around some plants (von Schmeling pers. comm. 2016). Accounts of such herbivore damage to Alabama leather flower are rare, indicating that this may be a localized rather than widespread phenomenon. One study identified a species of carpenter bee, Xylocopa virginiana, exhibiting nectar-robbing behavior on Alabama leather flower (Boyd and Wall 1998, Wall et al. 2003); however, the authors noted that given the apparently low visitation rates of this nectar-robbing bee, its effects on Alabama leather flower reproduction is likely small. It has also been suggested that deer mice (Peromyscus sp.) may be seed predators of Alabama leather flower (Timmerman-Erskine and Boyd 1999), which may potentially limit seedling recruitment. However, given the species' clonal nature (i.e., its ability to spread locally without seedling recruitment), it is unlikely that seed predation by deer mice alone presents a substantial threat to Alabama leather flower. Furthermore, as noted by Goertzen et al. (2011), Alabama leather flower's relatively high genetic diversity indicates that sufficient sexual reproduction is occurring within the species, despite low apparent seedling recruitment. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: No State laws in Alabama protect Alabama leather flower and its habitat. In Georgia, the species is State protected as endangered under the Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. This law authorizes rules for the collection, transport, sale, and listing of protected plants within the State. In addition, no protected plants may be collected without landowner approval and no transport within the state is allowed without a State-issued permit (Patrick et al. 1995). Otherwise, protections are afforded to this species under sections 7 and 9 of the ESA. Two populations are considered protected from outright habitat destruction or adverse habitat modification due to their protection on a TNC preserve (in Alabama) and on lands set aside as a state Natural Area by the State of Georgia (in Georgia). In Georgia, state-designated Natural Areas are managed by GDNR to conserve natural communities and rare species (GDNR 2017). In addition, part of one population has received some habitat protection and management by the City of Gadsden, Alabama.(USFWS, 2017)

Stressor: Inadequate/Incompatible Habitat Management (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Inadequate management—e.g., lack of mowing, prescribed fire, and/or hand clearing—remains a persistent concern for Alabama leather flower populations. At least one subpopulation in St. Clair County, Alabama has not been relocated, in part, due to growth of encroaching plants (Byrd 2016c), which has obscured plants and/or suppressed their growth. Plants at this site have not been observed since 2009 and it is unknown if they still exist. Three

other subpopulations in St. Clair and Cherokee Counties are in need of management activities to reduce competing understory and woody vegetation (Wiggers 2014, Byrd 2016c). (USFWS, 2017)

Stressor: Competition from Encroaching Species (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Alabama leather flower is an apparently poor competitor, as it is most vigorous in open areas with little competing vegetation and open canopies. Indeed, low light levels have been associated with increased flower abortion (Timmerman-Erskine and Boyd 1999). The species also benefits from occasional, limited disturbance (such as periodic mowing or prescribed fire) which reduces encroachment of competing vegetation. However, Alabama leather flower can apparently remain dormant for some time as evidenced by its appearance in openings created in woods that were selectively logged (Service 1989). Even though the increased light initially benefited Alabama leather flower, it also stimulated more aggressive competing vegetation including the exotic Japanese honeysuckle (Lonicera japonica). All populations of Alabama leather flower need active management (e.g., thinning overstory trees, mowing, prescribed fire) due to shading and competition from more aggressive vegetation. (USFWS, 2017)

Stressor: Small Population Size and Small Number of Populations (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Attempts to locate additional Alabama leather flower populations since completion of the species' original Recovery Plan in 1989 (e.g., Boyd 1991, Boyd and Hilton 1992, Govus 1999, Ware 1999, Garrett and Schotz 2005) have had some success thus far, with eight natural populations now known for the species. Of these populations six are extant (ANHP data, GNHP data, Byrd 2016c, Byrd pers. comm. 2016a, b, Thompson 2016), one may have been extirpated (Schotz pers. comm. 2014, Byrd 2016c), and one has been extirpated (Schotz pers. comm. 2014). Only three populations are considered to be large (1,000+ stems), while two are of moderate size (400–500 stems) (GNHP data, Wiggers 2014, Byrd 2016c). Alabama leather flower's limited number of extant populations and relatively small local population sizes increase the species' vulnerability to anthropogenic and environmental perturbations. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). However, the unexpectedly high level of genetic diversity maintained within Alabama leather flower populations studied thus far (Boyd et al. 1998, Goertzen and Boyd 2007, Goertzen et al. 2011), may limit some of the genetic threats posed by the species small number of populations and overall small population size. Attempts to augment existing and establish new populations have been made in Georgia, but these efforts have had limited success (GNHP data, CNC 2010, Hodges pers. comm. 2013, 2014, von Schmeling pers. comm. 2016). As such, the one known established population is not yet considered a viable population for recovery. (USFWS, 2017)

Stressor: Climate Change (USFWS, 2017)
Exposure:
Response:
Consequence:

Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) and reduced average annual precipitation by the end of the century (Joyce et al. 2011, Ingram et al. 2013). Specific effects of climate change on populations of Alabama leather flower are poorly understood; however, a variety of effects are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Alabama leather flower may be negatively impacted by climate change within Alabama if available habitat becomes constricted under drier conditions. In addition, climate change may disrupt plantpollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Alabama leather flower. Given that only two primary pollinators have been identified for Alabama leather flower, Wall et al. (2003) suggested that such asynchrony between flowering and pollinator activity may be particularly severe for this species. Given the variety and complexity of climate change's potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Alabama leather flower populations and habitats. (USFWS, 2017)

Recovery

Reclassification Criteria:
When 10 geographically distinct, self-sustaining populations, occupying a minimum of one acre of habitat each, are known and protected from any foreseeable threats. (USFWS, 1989)

Recovery Priority Number: 5

Delisting Criteria:
When 20 geographically distinct, self-sustaining populations, occupying a minimum of one acre of habitat each, are known and protected from any foreseeable threats. (USFWS, 1989)

Recovery Actions:

- 1. Protect and manage populations and habitat. The first step in the recovery process is to protect the populations and their habitat. Protection efforts, excluding Section 7 obligations, may include land donations, conservation easements, long-term conservation agreements, land acquisition or other methods. (USFWS, 1989)
- 2. Establish a monitoring program for protected sites. A monitoring program should be established on protected sites in order to track population trends and evaluate effectiveness of recovery efforts. (USFWS, 1989)
- 3. Study ecology and species' biology. An understanding of the ecology and species' biology of the Alabama leather flower is necessary in order to appropriately manage and protect this species. (USFWS, 1989)
- 4. Determine effective management for maintaining or increasing populations. Management needs of the Alabama leather flower are largely unknown; however, this species appears more vigorous in areas of partial or full sunlight with little competition. In order to maintain or expand populations, active management of its habitat, targeted at controlling competing vegetation, will probably be necessary. Management is further necessitated due to the disturbed nature of the present sites. (USFWS, 1989)

- 5. Preserve genetic stock. This species is extremely vulnerable due to such few populations. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation. Additionally, this will provide material for research, propagation, and horticultural interests to reduce pressure on wild populations and other recovery activities. Such activities should be conducted under the guidance of the Center for Plant Conservation which sponsors the establishment of garden populations of endangered plants at member botanical gardens. (USFWS, 1989)
- 6. Establish experimental population(s) within historic range. if deemed necessary. Clematis socialis is only known from two sites and only one is protected. If after extensive surveys, no new populations are located and secured, it may be necessary to establish additional ones in the wild to decrease this species vulnerability. (USFWS, 1989)
- Recommendations for Future Actions from 2017 5-Year Review: - Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations,including the development and implementation of management plans. - Conduct surveys to locate additional populations. - Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. - Conduct studies into the species' life history, biology, habitat, and ecology to inform future population searches, management, and potential population augmentation and (re)establishment efforts. - Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. - Develop and implement long-term demographic monitoring to track population trends and evaluate management efforts. - Expand ex situ conservation efforts to include plants from all known extant populations. - Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The following actions are recommended to support and promote recovery of Alabama leather flower. Use of a numbered list for these recommendations is for convenient reference and does not necessarily imply prioritization of any activity over others. 1. Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans. 2. Conduct surveys to locate additional populations. 3. Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. 4. Conduct studies into the species' life history, biology, habitat, and ecology to inform future population searches, management, and potential population augmentation and (re)establishment efforts. 5. Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. 6. Expand ex situ (off-site) conservation efforts to include plants from all known extant populations. 7. Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management) (USFWS, 2022).

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SPECIES ACCOUNT: *Clermontia drepanomorpha* (`Oha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia drepanomorpha, of the bellflower family (Campanulaceae), is a terrestrial orepiphytic (not rooted in the soil), branching tree 2.5 to 7 m (8.2 to 23 ft) tall. The stalked leaves are 10 to 27 cm (4 to 11 in) long and 1.5 to 4.5 cm (0.6 to 1.8 in) wide. Two to four flowers, each with a stalk 2 to 3.5 cm (0.8 to 1.4 in) long, are positioned at the end of a main flower stalk 5 to 12 cm (2 to 5 in) long. The calyx (fused sepals) and corolla (fused petals) are similar in size and appearance, and each forms a slightly curved, five-lobed tube 4 to 5.5 cm (1.6 to 2.2 in) long and 1.5 to 2 cm (0.6 to 0.8 in) wide which is blackish purple. The berries are orange and 2 to 3 cm (0.8 to 1.2 in) in diameter. (USFWS, 1998)

Taxonomy

Clermontia drepanomorpha, a member of the bellflower family (Campanulaceae), was described by Joseph Rock (1913) from collections made in the Kohala Mountains in the early 1900s (USFWS 1996, 1998). The species has no known synonyms (Wagner et al. 1999; Lammers 1991), although hybrids between it and another species have been named (see below) (Lammers 1991). Lammers (1991) revised the genus Clermontia and treated Clermontia drepanomorpha, much as he (the author of the treatment) had in Wagner et al. (1999). Lammers (1995) studied the taxonomy and speciation patterns in Clermontia and included Clermontia drepanomorpha in Section Clermontia, Series Kakeanae. Based on cladistic studies, C. drepanomorpha was stated to be most closely related to C. montis-loa and C. kohalae (Lammers 1995). (USFWS, 2012)

Historical Range

Historically, Clermontia drepanomorpha was known only from the Kohala Mountains (Hawaii Heritage Program (HHP) 1993a1-1993a4; Rock 1913; Skottsberg 1944; Stemmermannand Jacobson 1987). (USFWS, 1998)

Current Range

Endemic to Kohala Mountains on the island of Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Clermontia drepanomorpha on the island of Hawaii.

Critical Habitat Designation

The critical habitat designation for Clermontia drepanomorpha includes one unit totaling 4,709 acres in Hawaii county, Hawaii. The unit is Hawaii 8—Clermontia drepanomorpha—a.

Hawaii 8—Clermontia drepanomorpha—a [1,906 ha (4,709 ac)]: This unit contains part of the Kohala Mountains, Opaeloa summit, Puu O Umi, and Puu Pohoulaula. The western portion of the unit is in the Honokane Nui watershed, the eastern portion is in the Wailoa/ Waipio watershed, and the southern portion in the Waikoloa/Waiulaula watershed. The northern portion contains the upper reaches of the Honopue, Nakooko, Ohiahuea, Waikaloa, and Waimanu watersheds. The unit lies completely within the Kohala Forest Reserve. This unit provides habitat for 6 populations of 300 mature, reproducing individuals of C. drepanomorpha; and is currently occupied by about 200 individuals. This unit is essential to the conservation of C. drepanomorpha because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. Although we do not believe enough habitat currently exists to reach the recovery goal of 8 to 10 populations for this island-endemic species, this unit is of an appropriate size such that each of the 6 potential recovery populations within the unit is geographically separated to a sufficient extent to be likely to avoid destruction of all of the populations by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, montane wet forests dominated by Metrosideros polymorpha, Cheirodendron trigynum, and Cibotium glaucum.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for theis species. However, both the Act and the relevant court orders require the Service to to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, bogs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 915 and 1,676 meters (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2012)

Habitat Narrative

Adult: Clermontia drepanomorpha grows in montane bogs in montane wet forests (Lammers 1991) between approximately 915 and 1,640 meters (3,002 and 5,381 feet) elevation. However, elevational estimates vary by source (e.g., Wagner et al. 1999 and Lammers 1991; USFWS 2002, 2003). At the time critical habitat was designated (USFWS 2003), the given range was between 1,106 and 1,676 meters [3,627 and 5,495 feet] elevation, which was based on the only known extant population at the time. Native plant species associated with Clermontia drepanomorpha include Carex alligata (no common name), Melicope clusiifolia (alani), Leptecophylla tameiameiae (pukiawe), Astelia menziesiana (painiu), Rubus hawaiensis (akala), Cyanea pilosa (haha), Sphagnum moss (unidentified to species), and species of Coprosma (pilo) (USFWS 1996, 2003; National Tropical Botanical Garden 2011). (USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2012)

Population Size:

~200 (USFWS, 2012). <300 (USFWS, 2020)

Population Narrative:

When critical habitat was proposed, C. drepanomorpha was known from a single population comprising approximately 200 individuals (USFWS 2002, USFWS 2003). (USFWS, 2012). Currently there are fewer than 300 wild individuals of Clermontia drepanomorpha in the Kohala mountains on the island of Hawai‘i. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that C. drepanomorpha is highly vulnerable to the effects of climate change. Propagation is ongoing with 161 plants reintroduced to the Kohala area. Reintroductions are provided protection from feral ungulates by fencing. (USFWS, 2020)

Threats and Stressors

Stressor: Ditch road improvements and herbicide application (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Threats to Hamakua Ditch Population include proposed ditch road improvements and herbicide application along ditch. Road or ditch modification may have eliminated some individuals along the Alakahi and Kawainui Streams headwaters several years ago (C. Corn, DOFAW, in lift. 1994). (USFWS, 1998; NatureServe, 2015)

Stressor: Rodent predation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Rodent and slug predation or herbivory – Girdling of stems by rats (Rattus sp.) (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010) remains a threat. (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Small population size (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Low numbers – increased likelihood of stochastic extinction due to changes in demography, the environment, genetics, or other factors (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010). (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 1998; USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Established invasive plant species competition (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010) including Axonopus fissifolius (common carpetgrass), Juncus spp. (no common name), Polygonum punctatum (dotted smartweed), Setaria palmifolia (palmgrass), and Rubus rosifolius (thimbleberry. (USFWS, 1998; USFWS, 2012)

Stressor: Over-collection (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Over-collection by collectors and researchers (N. Agorastos, pers. comm. 2011) is a possible threat. (USFWS, 2012)

Stressor: Habitat degradation by ungulates (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Ungulate degradation of habitat: disturbance by feral pigs (Sus scrofa) (USFWS 1996, 2003; Hawaii Biodiversity and Mapping Program 2010; National Tropical Botanical Garden 2011) and habitat degradation by cattle (Bos taurus) (N. Agorastos, pers. comm. 2011) are a continual threat. (USFWS, 2012)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:
- Construct fenced exclosures on State lands in the Kohala Mountains around the known populations, and initiate removal of feral ungulates and weeds from its habitat. (USFWS, 1998)
- Steps should be taken to control rats within and surrounding the exclosures. This should include the use of the currently approved Diphacinone bait blocks and ultimately amore broad-scale method such as aerial dispersal of rodenticide. (USFWS, 1998)

- Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records. (USFWS, 2012)
- While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2012)
- Construct ungulate-proof fenced exclosures around each population and monitor the fences for any signs of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Implement effective control methods for rodents. (USFWS, 2012)
- Develop and implement control methods for slugs. (USFWS, 2012)
- Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of collecting, drought, and hiking and trail maintenance. (USFWS, 2012)
- The historical range of the species should be resurveyed intensively, preferably in July, which coincides with the greatest number of historical records of the species being in flower. Determine if previously unknown populations exist and whether the species has reappeared at localities where it formerly was believed to have been extirpated. (USFWS, 2012)
- Study the reproductive biology of the species in the field to determine which (presumably) bird species pollinate the plant, and what species likely are involved with fruit dispersal. (USFWS, 2012)
- Tag and sample at least 50 individuals in the single extant population and carry out genetic studies using microsatellites or other appropriate genetic markers to determine the genetic variation within the population. Based on the results of microsatellite (or other appropriate genetic markers), consult with a population geneticist to devise a crossing plan that will maximize the amount of genetic variation in the progeny. (USFWS, 2012)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or other significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Surveys and inventories— o The historical range of Clermontia drepanomorpha should be surveyed intensively, preferably in July, which coincides with the greatest number of historical records of the flowering time. o Determine if historical populations are extirpated. o Determine sites that have the highest likelihood of maintaining reintroductions. • Ungulate monitoring and control—Fence all

known populations and continue to monitor and maintain fenced exclosures to protect individuals from the negative impacts of ungulates. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species, and those that compete with C. drepanomorpha. • Site and habitat protection—Develop and implement effective control measures to reduce the impact of collecting and drought. • Climate change adaptation strategy—Assess the modeled effects of climate change on these species and use to determine future landscape needed for their recovery. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents and slugs. o Monitor populations for evidence of insect predation and disease and determine if control methods are necessary and are available. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts keeping track of the maternal source used. o Collect and store seeds at three separate facilities. • Reintroduction and translocation— o Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats. o Maximize genetic variation among individuals at reintroduction sites. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Carry out genetic studies to determine the genetic variation within the population and devise an effective breeding program. • Alliance and partnership development—Work with the Hawaii Division of Forestry and Wildlife and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- New Management Actions: • Captive propagation for genetic storage and reintroduction—The Volcano Rare Plant Facility (VRPF) is propagating plants for reintroduction at Kohala: in 2014, VRPF reported nine plants in inventory representing one founder from Kohala. In 2015, VRPF reported propagation and reintroduction of eight plants (representing the same founder) to Kohala. In 2017, VRPF reported propagation of 63 plants representing two different founders from Kohala, with 32 plants from one of those founders reintroduced back to Kohala. In 2019, there were nine plants in inventory and 121 plants prepared for reintroduction representing a fourth founder from Kohala (VRPF 2014, 2015, 2017, 2019). (USFWS, 2020)

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SPECIES ACCOUNT: *Clermontia pyrularia* (`Oha wai)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Clermontia pyrularia Hillebr. is a tree that grows to about 13 ft (3-4 m) tall (Lammers 1990). Narrowly elliptic leaf blades are 5.9-11 in (15-28 cm) long and 1-2 in (2.5-5 cm) wide, finely-toothed, alternate, dark green on the upper surface, and light green beneath. The leaf blades are attached to winged stalks 0.8-1.4 in (1.5-3.5 cm) long. Two, three, or sometimes five flowers are attached to a flower cluster stalk (inflorescence) 1.1-2.4 in (2.8-6 cm) long. Each flower is subtended (supported) by a flower stalk 0.3-0.8 in (0.8-2cm) long. The calyx and petals are fused at the flower's base into a tube 0.4-0.7 in (1-1.8 cm) long and 0.7-4.7 in (0.8-12 cm) wide. The calyx is small and its lobes are triangular, 0.10.2 in (0.3-0.5 mm) long and 0.4-0.8 in (1-2 cm) wide. Petals, 1.6-1.8 in (4-4.5 cm) long, are fused into a tube 0.2-0.3 in (5-8 mm) wide, which is 2-lipped and curved. Five white or green-white petals are finely hairy, lobed and spreading. Berries, 0.7-1.1 in (1.8-2.8 mm) long and 0.6-0.9in (1.5-2.4 cm) wide, are oboval or ob-pear-shaped and orange. (USFWS, 1996)

Historical Range

Clermontia pyrutaria is known only from the Big Island, where it occurred on the western and northeastern slope of Mauna Kea, the western slope of Mauna Loa and the saddle between the two (59 FR 10305, HHP 1991d1-d6). (USFWS, 1996)

Current Range

Its current range includes Hawaii. (NatureServe, 2015)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Clermontia pyrularia on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

Critical habitat for Clermontia pyrularia is designated in two units totaling 6,823 acres in Hawaii County, Hawaii. The two units provide habitat for combined total of six populations, each with 300 mature, reproducing individuals. The units are geographically separated. The units are Hawaii 1—Clermontia pyrularia—a and Hawaii 2—Clermontia pyrularia—b.

Hawaii 1—Clermontia pyrularia—a [1,378 ha (3,405 ac)]: This unit contains Kaloaloa summit and portions of Hakalau, Honolii, and Kapue streams. It is bordered in the north by Kolekole watershed and in the south by Wailuku watershed, and it contains portions of the Kapue and Honolii watersheds. The unit lies completely within Hakalau Forest NWR; provides habitat for 3 populations of 300 individuals; and is currently unoccupied. This unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of

additional populations in order to reach recovery goals.

Hawaii 2—Clermontia pyrularia—b [1,383 ha (3,418 ac)]: This unit contains a portion of Nauhi Gulch and is bordered in the north by Kaawalii watershed; and in the south by Umauma watershed. It also contains portions of Haakoa, Kaiwilahilahi, and Waikaumalo watersheds. The unit lies partly in the Hilo Forest Reserve in the north and south-central portion of the unit and in Hakalau Forest NWR in the south and north-central portion of the unit. This unit provides habitat for 3 populations of 300 individuals of C. pyrularia and is currently occupied by 4 individuals. This unit is essential to the conservation of C. pyrularia because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, wet and mesic montane forest dominated by Acacia koa or Metrosideros polymorpha, and subalpine dry forest dominated by Metrosideros polymorpha; and montane wet Metrosideros-Cibotium forest.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for theis species. However, both the Act and the relevant court orders require the Service to to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in fruit and flower during December 1978 (HHP 1991b3) and November 1957 (HHP 1991b4). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 3,000 to 7,000 feet (USFWS, 1996)

Environmental Specificity

Adult: Narrow, with key requirements (USFWS, 1996; NatureServe, 2015)

Habitat Narrative

Adult: Moist and wet forests on old lava flows and old cinder cones. The habitat for Clermontia pyrularia is wet montane forest dominated by Acacia koa and/or Metrosideros polymorpha, and subalpine dry forest dominated by M. polymorpha, at elevations between 3,000 to 7,000 ft (910and 2,130 m) (HHP 1991d1-d2, 59 FR 10305). Associated taxa are Lythrum maritimum Kunth (pukamole), Rubus hawaiensis A. Gray (kala), and Hedyotis (HHP 1991d1-d2). (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2007)

Population Size:

3 (USFWS, 2020)

Population Narrative:

Currently, C. pyrularia is known from 1 natural population of 15 individuals in the Upper Piha GMA, and several outplanted populations at Hakalau National Wildlife Refuge (Hakalau NWR). Since 1992, 569 individuals of C. pyrularia have been outplanted in the Hakalau NWR, with 136 surviving as of 2003. (USFWS, 2007). Currently there are three wild individuals of Clermontia pyrularia on the island of Hawai‘i. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that C. pyrularia is highly vulnerable to the effects of climate change. Wild and reintroduced individuals are provided protection from ungulate destruction of habitat and herbivory by fencing; however, the exclosures must be monitored for animal ingress. Some nonnative plant control is ongoing at one reintroduced population. Seed collection, propagation, and reintroduction are ongoing, with several hundred individuals planted. Air-layering is also being tested. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat damage by feral ungulates (USFWS, 2007)
Exposure:

Response:
Consequence:
Narrative: Clermontia pyrularia is threatened by feral ungulates which damage habitat by rooting and trampling vegetation, and feed on its fruit (Jeffrey and Horiuchi 2005). As early as 1778, European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawaii, especially to wet and mesic forests, and dry areas at high elevations. Feral pigs are currently present on the island of Hawaii, and inhabit both rain forests and grasslands. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Pigs are a primary vector causing the spread of many introduced plant species (Smith 1985; Scott et at. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et at. 1999). Cattle (Bos taurus), the wild progenitor of which was native to Europe, northern Africa, and southwestern Asia, were introduced to the Hawaiian Islands in 1793. Large feral herds developed as a result of restrictions on killing cattle decreed by King Kamehameha I. While small cattle ranches were developed on Kauai, Oahu, and west Maui, very large ranches of tens of thousands of acres were created on east Maui and Hawaii. Much of the land used in these private enterprises was leased from the State or was privately owned and classified as Forest Reserve and/or Conservation District land. Cattle eat native vegetation, trample roots and seedlings, cause erosion, create disturbed areas into which alien plants invade, and spread seeds of alien plants in their feces and on their bodies. The forest in areas grazed by cattle becomes degraded to grassland pasture, and plant cover is reduced for many years following removal of cattle from an area. Several alien grasses and legumes purposely introduced for cattle forage have become noxious weeds (Tomich 1986; Cuddihy and Stone 1990). Cattle have been eliminated from the Upper Piha GMA, but feral pigs remain a threat to C. pyrularia (L. Perry, Division of Forestry and Wildlife, pers. comm. 2006). All domestic cattle grazing was discontinued in the Hakalau Forest NWR between 1989 and 2001, and over 250 feral cattle and 1,000 feral pigs were removed from refuge lands. Eight feral ungulate management units have been completely fenced. The process of removing feral ungulates will continue in all currently fenced management units until eradication has been completed. Fencing and eradication will continue in other areas of the refuge as funding allows (Jeffrey and Horiuchi 2005). In June of2005, Hakalau NWR received Congressional funding for fencing and feral ungulate removal (Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Non-native plant species (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Nonnative plant species degrade habitat of and compete with Clermontia pyrularia. At the time of listing the primary nonnative species impacting C. pyrularia was Passifloramollissima (banana poka) (59 FR 10307). Passiflora mollissima, a vine native to the Andes of South America and first collected in Hawaii in 1926, is a serious pest in mesic forest on the islands of Hawaii, where it overgrows native trees (Wagner et al. 1999). It is distributed by feral pigs and other animals that feed on its fruit (Service 1996). Currently, the nonnative plant species Rubus argutus (prickly Florida blackberry), Passiflora mollissima, Ehrharta stipoides (meadow rice grass), and Pennisetum clandestinum (kikuyu grass), compete with C. pyrularia for space, light, water, and

nutrients (Jeffrey and Horiuchi 2005). Weed control is ongoing at fenced areas of Hakalau NWR (Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Predation (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Predation on fruits and seeds by black rats (Rattus rattus) may limit the successful establishment of new plants (Service 1996) (Factor C). The black rat occurs on all the main Hawaiian Islands around human habitations, in cultivated fields, and in dry to wet forests. Rats are known to eat the fruit and strip the bark of some native plants, particularly fruits of plants in the African violet (Gesneriaceae) family with fleshy stems and fruits (Wagner et al. 1985; Tomich 1986; Cuddihy and Stone 1990; Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: In addition to the above threats, species like Clermontia pyrularia that are endemic to single islands are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. In the past, C. pyrularia was pollinated by nectar feeding birds, and its seeds were disseminated by fruit eating birds. Some of these bird species are now extinct, and others have been decimated by mosquito borne diseases, predation by introduced rats, cats and mongooses, competition from introduced birds, and habitat destruction by feral ungulates. As a result, little or no cross pollination takes place and seeds are no longer dispersed. A possible solution to this dilemma is to plant the bird pollinated and seed dispersed C. pyrularia in small areas at relatively high densities intermixed with common native food plants that fruit and flower synchronously with C. pyrularia (Jeffrey and Horiuchi 2005). Propagation and seed storage of C. pyrularia is conducted at Lyon Arboretum Seed Storage Facility, the Volcano Rare Plant Facility, Hakalau NWR, and at Lyon Arboretum's Micropropagation Facility (Service 2005). Since 1992, 569 individuals of C. pyrularia have been outplanted in the Hakalau NWR, with 136 surviving as of 2003. The outplanted individuals were propagated from seeds collected from the wild plants of C. pyrularia as well as from seeds collected from outplanted individuals that had matured and fruited (Jeffrey and Horiuchi 2005). (USFWS, 2007)

Stressor: Climate change loss or degradation of habitat (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Clermontia pyrularia is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.617 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional

management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2020)

Recovery

Reclassification Criteria:

1. A total of five to seven populations of Clermontia pyrularia should be documented on the Big Island where it now occurs or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:

1. A total of 8 to 10 populations of Clermontia pyrularia should be documented on the Big Island where it now occurs or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable, or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before delisting is considered. (USFWS, 1996)

Recovery Actions:

- The known remaining individuals should be protected from ungulates and encroachment of alien plants. (USFWS, 1996)
- In order to prevent possible extinction of this taxon, maintenance of ex situ genetic stock is necessary. (USFWS, 1996)
- Propagation and outplanting of ex situ stock will be needed in order to establish a sufficient number of populations and plants for recovery. (USFWS, 1996)
- Research into the taxons pollination vectors may be necessary. (USFWS, 1996)
- Search for Clermontia pyrularia throughout its historical range, particularly in leeward Mauna Loa, where no wild plants are known to be extant. (USFWS, 2007)
- Study Clermontia pyrularia with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2007)
- Formulate a plan to maintain or increase genetic variability of Clermontia pyrularia. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2007. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Surveys and inventories—Continue to search for Clermontia pyrularia throughout its historical

range, particularly in leeward Mauna Loa. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with C. pyrularia. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Rodent predation and herbivory—Implement effective control measures for rats at all populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy to reduce impacts of low numbers and hurricanes. • Reduced viability—Continue to study C. pyrularia with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. Test reintroduction of C. pyrularia into small areas at high densities intermixed with common native food plants for birds, as suggested in the annual permit reports for endangered plant propagation and outplanting activities (Jeffrey and Horiuchi 2005; Kendall and Horiuchi 2013). • Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—In 2014, an individual of Clermontia pyrularia was discovered at Kanakaleonui (PEPP 2014). After Hurricane Iselle, only one wild plant remained at both Pihā and Kālepa (PEPP 2015). • Ungulate monitoring and control—Fencing is monitored and maintained at all reintroduction areas (PEPP 2014, 2017). • Invasive plant monitoring and control—Invasive plant monitoring and control is conducted at fenced reintroduction areas (PEPP 2016, 2017). • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum reports seven explants in storage representing one individual at Pihā (Lyon Arboretum 2019). The Lyon Seed Conservation Laboratory reports more than 13,000 seeds collected, with 1,900 tested and over 11,000 remaining in storage representing one founder from Kālepa and one to two founders at Puakala, Hakalau Forest National Wildlife Refuge (NWR) (Lyon Arboretum 2019). o The National Tropical Botanical Garden (NTBG) reports more than 300 seeds collected in 1991 in storage representing the Pihā population (NTBG 2019). The viability of these seeds is unknown. o The Volcano Rare Plant Facility (VRPF) reports one plant in storage representing one individual from Pihā, and 315 plants in storage representing two individuals at Humu‘ula (Laupāhoehoe). In addition, two of these plants were reintroduced at Hakalau (VRPF 2019). o Hakalau Forest NWR reports propagation and reintroduction of 325 individuals representing 11 founders, all at Hakalau Nui (HFNWR 2018). o PEPP reports 11 surviving reintroduced individuals at Pihā, 101 reintroduced plants at Hakalau, and 318 reintroduced individuals at two sites at Laupāhoehoe (PEPP 2014, 2015, 2017). PEPP is also attempting air-layering of plants as a means of propagation to ensure that clones could be preserved in storage (PEPP 2015). (USFWS, 2020)

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SPECIES ACCOUNT: *Clitoria fragrans* (Pigeon wings)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/27/1993; Southeast Region (R4)

Physical Description

Pigeon wings is a 15 to 100 cm tall herbaceous plant. Plants have a thick horizontal root, which may grow to more than 2 m long, and bear one to several erect, purplish, wiry, very straight stems. The somewhat leathery leaves consist of three leaflets. Leaflets of the upper leaves are obtuse at the tip and narrower than those of lower leaves. (Fantz 1977).Pigeon wings produce flowers aboveground (chasmogamous flowers) and underground (cleistogamous flowers). Aboveground flowers usually occur in pairs, each corolla consisting of one 3.5 to 5 cm-long standard petal and a small white keel. The common name of this species refers to the petals of the aboveground flowers, which resemble wings. The seed pod (legume) is 5 to 8 cm long and extends from the calyx (Fantz 1979). (USFWS, 1999)

Taxonomy

Clitoria fragrans was described and named from a Highlands County specimen in 1926 (Small 1926). The name C. pinetorum was recognized but never published (Fantz 1977). The North American Clitoria species were moved to the genus Martiusia by Small (1933), but were later transferred back to the genus Clitoria by Fantz (1977). This herb?s common name, pigeon wings, was derived because of its flowers? bird-like appearance (Fantz 1979). It is one of three species of the genus occurring in the southeastern United States. The others are the native butterfly pea (C. mariana) and a butterfly pea escaped from cultivation (C. ternata). (USFWS, 1999)

Historical Range

In Florida, along the Lake Wales Ridge, primarily in Highlands, Orange, and Polk counties; in central Osceola County; near Leesburg IN Lake County. (USFWS, 1999)

Current Range

In Florida, along the Lake Wales Ridge, primarily in Highlands, Orange, and Polk counties (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated

Lifespan

Adult: > 5 years

Breeding Season

Adult: Chasmogamous flowers bloom from May to June.

Reproduction Narrative

Adult: Pigeon wings are long-lived (> 5 years) perennials. Flowers are pollinated by insects, while cleistogamous flowers are self-pollinating. Cross-fertilization of cleistogamous flowers is prevented, since the flowers do not open. Chasmogamous flowers bloom from May to June. Cleistogamous flowers occur later in the summer through late September. No information is available on the pollination vector, fertilization rate, seed production, or germination rates for this species.

Habitat Type

Adult: Xeric upland/sandhill and oak hickory scrub

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: SUMMARY: Widely scattered in undisturbed clearings of xeric sandhill and scrub communities on well-drained upland soils. END SUMMARY. Suzanne Cooper of the Florida Natural Areas Inventory (unpublished FNAI data) reports that C. fragrans is more commonly found in the sandhill or sandhill/scrub ecotones than in the scrub proper, which is contrary to published reports. Sandhill typically occurs on rolling hills of yellowish sand with a longleaf pine/turkey oak overstory (bluejack and/or sand live oak may also be dominant) and a ground cover of numerous herbs dominated by wiregrass. The white sand scrub is generally found with an overstory of scattered pines (sand, slash or longleaf), a middle layer of scrub oaks, several ericaceous shrub species and saw palmetto, and a thin layer of many herbaceous or dwarf shrub species (Duever 1983). Clitoria is typically found in undisturbed clearings in the scrub but also occurs in very open scrub as well (Kral 1983). (NatureServe, 2015). Pigeon wings occurs in a range of xeric upland habitats on the Lake Wales, Winter Haven, and Bombing Range Ridges and on xeric upland sites west of Bombing Range Ridge within APAFR. On the southern third of the LWR (i.e., the part within Highlands County), it occurs primarily in sandhill and oak-hickory scrub (Menges et al. 2007b). On APAFR, it occurs primarily in sandhill and oak scrub (S. Orzell, APAFR, pers. comm. 2008). Pigeon wings is a soil generalist, occurring on a yellow, white, and gray sands (Menges et al. 2007b; S. Orzell, pers. comm. 2008).

Dispersal/Migration

Population Information and Trends

Number of Populations:

21 - 80 (NatureServe, 2015); 77 (USFWS, 2016)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Requires undisturbed soils and fire. Doesn't seem to return quickly to abandoned farmland or neglected orange groves. Never abundant at a given site Fifty nine Element Occurrences

recorded by FNAI as per July 1995 (Gary Knight, pers. comm., July 17, 1995) (NatureServe, 2015). Data on population trends are not available for pigeon wings because monitoring programs at most sites do not involve repeated censuses of populations within well defined areas. However, the evidence that is available, usually based on short-term surveys of relatively few individuals, suggests substantial year to year fluctuations in aboveground population sizes. For example, annual monitoring of a small pigeon wings population (< 70 plants in all years surveyed) at ABS from 1992 to 2000 found annual survival rates ranging from 72 to 98 percent (C. Weekley, pers. comm. 2008). Over the nine years of the study, sexual reproduction was negligible and few seedlings were found (C. Weekley, pers. comm. 2008). The study also documented the presence of belowground dormancy in pigeon wings, with 14 percent of tagged plants re-appearing aboveground following a year or more in which they were absent. Stout et al. (2003) recorded an annual survival rate of 68% (28 of 43 plants) in one APAFR population tagged in 2002 and re-surveyed one year later. Weekley and Menges (2003) characterized pigeon wings as a moderate resprouter based on the percentage of tagged aboveground individuals present two years after a prescribed burn (48.4 percent). However, aboveground pigeon wings populations may fluctuate annually due to belowground dormancy (C. Weekley, pers. comm. 2008). Anecdotal evidence also indicates that dramatic increases in post-burn aboveground population sizes may be short lived (C. Weekley, pers. obs. 2008). Thus, population densities may increase post-fire and decline with time-since-fire. High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (C. Weekley, pers. obs. 2008). The FNAI identifies 77 occurrences of pigeon wings. Fifty-four (70.1 percent) of the occurrences are on protected sites on the Lake Wales (45) or Winter Haven Ridges (1), or on the APAFR (8). Of the 24 occurrences outside protected areas, all but two are on the LWR (one each on the Winter Haven and Mount Dora Ridges). Since most of these occurrence records are more than 20 years old, it is not known how many of the unprotected sites remain. Pigeon wings is currently known from 18 managed areas on the LWR: A. D. Broussard Catfish Creek Preserve State Park, ABS, Crooked Lake Sandhill, Jack Creek, LWRSF (Arbuckle, Hesperides, and Walk-in-Water Tracts), Lake Wales Ridge National Wildlife Refuge (Carter Creek South, Flamingo Villas), LWRWEA (Carter Creek North, Holmes Avenue, Lake Placid Scrub, Mountain Lake Cutoff, Royce Ranch, Silver Lake, and Sunray/Hickory Lake Tracts), Seminole State Forest (Warea Tract), and Tiger Creek Preserve. It is also protected at Lake Griffin State Park on the Sumter Upland, LWRWEA (Lake Blue) on the Winter Haven Ridge, and at APAFR. EORs compiled by FNAI often have abundance estimates, although these are not standardized. Among the reports with pigeon wings abundance estimates, populations are rarely estimated as having 100–999 plants (4 EORs), while smaller populations of 10–99 plants (23) and less than 10 plants (18) are more typical (FNAI 2019). Abundance data based on counts or estimates are also available for three of the largest protected sites. At APAFR, Stout (pers. comm. 2008b) reported 2,951 plants, based on complete surveys of 59 soil polygons conducted between 2002 and 2006. Plants there were individually tagged and mapped with a GPS (Stout pers. comm. 2008c). At LWRSF, Malatesta (pers. comm. 2008) reported >1,800 plants in total throughout the Arbuckle, Walk-in-Water, and Hesperides tracts; however, the surveys were conducted over a period of three years and some populations may have been counted twice, thereby potentially inflating the final estimate. Finally, at the Tiger Creek Preserve, Pace-Aldana (pers. comm. 2008) estimated the pigeon wings population at >1,000 plants. These numbers, collected over large areas, generally provide estimates of the lower limits of population sizes at each of these three sites. Minimum abundance estimates are also available for several of the smaller sites, including Crooked Lake Sandhill ($n \geq 49$; Pace-Aldana, pers. comm. 2008), the Warea Tract of Seminole State Forest ($n = 43$; Cox 2006), and the Carter Creek North ($n = 15$), Silver Lake ($n = 58$), and Lake Blue ($n = 19$)

tracts of the Lake Wales Ridge Wildlife and Environmental Area (LWRWEA) (Menges et al. 2007a; Weekley, pers. comm. 2008). Population trends - In a study of the postfire responses of 12 Florida scrub endemics, Weekley and Menges (2003) characterized pigeon wings as a moderate resprouter based on the percentage of tagged aboveground individuals present two years postburn (48.4 percent). However, aboveground pigeon wings populations may fluctuate annually due to belowground dormancy (Weekley, pers. comm. 2008). Populations tend to increase markedly and flower profusely following fire, but then decline with timesince-fire (Lewis 2007; Weekley, pers. obs. 2008; H. Rosner-Katz, Florida Department of Agriculture and Consumer Services [FDACS], pers. comm. 2019). High percent flowering by postburn plants also suggests that they are more likely resprouts than seedling recruits (Weekley, pers. obs. 2008). (USFWS, 2020)

Threats and Stressors

Stressor: Predation
Exposure:
Response:
Consequence:
Narrative: Heavy vertebrate and invertebrate predation, including the destruction of entire seed crops or the complete removal of aboveground individuals, have been documented for pigeon wings (e.g., Stout and Lewis 2004; Lewis 2007; A. Faivre, pers. comm. 2008). Other likely invertebrate predators on pigeon wings include orthopterans and possibly seed predating coleopterans. Vertebrate herbivores probably include white-tailed deer (Odocoileus virginianus) and eastern cottontail rabbits (Sylvilagus floridanus). Herbivory may threaten the persistence of local populations. The impact on pigeon wings plants of partial or complete defoliation is unknown.

Stressor: Inadequate fire frequency/management
Exposure:
Response:
Consequence:
Narrative: Human development has disrupted the natural disturbance regime for pigeon wings. Because pigeon wings occurs in pyrogenic communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Some data (Weekley and Menges 2003, Lewis 2007) and anecdotal evidence (C. Weekley, pers. obs. 2008) suggest that aboveground populations decline with time-since-fire. Thus, inadequacies in existing prescribed fire programs or the use of mechanical methods such as mowing or gyro-tracking as a substitute or pre-treatment for fire may be adversely affecting the persistence of populations.

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: Pigeon wings is protected in 18 managed areas on LWR and in three managed areas off LWR. However, almost one-third (24 of 77) of the FNAI EORs are on unprotected sites. It is not known how many of these sites remain. Although unprotected populations at Avon Park Lakes were targeted for acquisition (Turner et al. 2006), the site is quickly being converted to

residential development and the population will almost certainly be lost. Surveys of other unprotected FNAI EORs will be required to determine it they are still extant. (USFWS, 2008)

Stressor: Human development
Exposure:
Response:
Consequence:
Narrative: Human development has disrupted the natural disturbance regime for pigeon wings. Because pigeon wings occurs in fire dependent communities with a range of natural fire return intervals, we can infer that it can tolerate a range of fire frequencies and intensities. Some data (Weekley and Menges 2003, Lewis 2007) and anecdotal evidence (C. Weekley, pers. obs. 2008) suggest that aboveground populations decline as the time-since-fire interval increases. Thus, inadequacies in existing prescribed fire programs or the use of mechanical methods such as mowing or gyro-tracking as a substitute or pretreatment for fire may be adversely affecting the persistence of populations. Observations by B. Blihovde at Lake Wales Ridge NWR suggest pigeon wings thrive in and around mechanically treated fire breaks. Data being generated by ABS's PDEP project aims to provide answers to some of these questions. In the meantime, development of science-based guidelines for the management of pigeon wings is precluded for lack of data.

Recovery

Reclassification Criteria:
Not relevant. (USFWS, 1999)

Delisting Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of C. fragrans, are adequately protected from habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the ecotone between xeric oak scrub and high pine that supports C. fragrans (USFWS, 1999)

4. When monitoring programs demonstrate that populations of C. fragrans on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Actions:
- Determine current distribution of C. fragrans. Some portions of C. fragrans?s range have been well surveyed, yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)

- Conduct research on life history characteristics of C. fragrans. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor populations of C. fragrans. Develop monitoring protocol to assess population trends for C. fragrans. Develop a quantitative description of the population structure of C. fragrans. (USFWS, 1999)
- Provide public information about C. fragrans. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where C. fragrans is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of C. fragrans and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions. Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Quantitative surveys (e.g., Weekley et al. 2001; Stout and Lewis 2006; Malatesta, pers. comm. 2008) of pigeon wings populations at several sites to establish the basis for level 2 monitoring (sensu Menges and Gordon 1996) to track changes in population size over time and in response to management treatments. These surveys should be repeated at defined intervals (e.g., annually, bi-annually, every five years; both before and after imposition of management treatments) and take place within well-defined areas (e.g., within plots small enough to be searched thoroughly and thereby reduce inconsistencies in sampling intensity). • Where monitoring is being conducted, data should be collected on fire and other management activities to aid in the interpretation of trends and to identify the most favorable treatments. • Conduct surveys to assess the status of the 19 FNAI EORs that occur on unprotected sites and to evaluate the feasibility of protecting additional pigeon wings populations. Any new populations discovered should be added to the FNAI database. • Demographic data need to be collected across the full geographic range of pigeon wings, from both scrub and high pine habitats, and from populations responding to contrasting management treatments (e.g., fire alone vs. various mechanical treatments being used as a substitute or pre-treatment to fire). Demography needs to be related to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness. • As we learn more about the fire requirements of pigeon wings, prescriptions should be adjusted to a frequency and intensity appropriate to avoid habitat degradation. • Study the seed production, seedling establishment, and seedling survival at various populations. • Study the floral biology, pollination ecology, and demography in detail throughout the species' range, including comparison of pollinator numbers to chasmogamous flowers at different populations. • Careful data collection is needed to further investigate plant dormancy, which may be an important trait allowing persistence at a site through unfavorable times. • The extent of invertebrate and vertebrate predation on pigeon wings needs to be quantified. • Genetic studies should be conducted to understand the genetic diversity of the species; this may aid in the identification of new acquisition needs. (USFWS, 2020)

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SPECIES ACCOUNT: *Conradina brevifolia* (Short-leaved rosemary)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4)

Physical Description

The short-leaved rosemary (Conradina brevifolia) is a shortlived, erect, woody, perennial shrub that reaches about 1 m in height (Kral 1983). It is very similar to the relatively widespread, and quite variable C. canescens of the Florida panhandle, Alabama, and Mississippi, and it is similar to the endangered C. glabra of the Apalachicola bluffs (Gray 1965, FWS 1994). As its name implies, C. brevifolia's alternate leaves are shorter than C. canescens. The larger leaves on well-developed flowering branches are 6.0 to 8.2 mm long, and mostly shorter than the internodes, whereas C. canescens'leaves are 7 to 20 mm long and are mostly longer than the internodes. C. brevifolia also tends to have more flowers per axil than C. canescens: one to six per axil versus one to three in C. canescens. (USFWS, 1999)

Taxonomy

The short-leaved rosemary is one of five shrubby mints in the interior central Florida scrub. The others are Calamintha ashei, Dicerandra frutescens, D. christmanii, and a Dicerandra population whose taxonomic status is unresolved. C. brevifolia was described as a new species by Shinners (1962). Taxonomic reviews of Conradina have upheld C. brevifolia's treatment as a distinct species (Gray 1965, Wunderlin et al. 1980, Kral 1983, Kral and McCartney 1991). However, Wunderlin (1982) and DeLaney and Wunderlin (1989) included C. brevifolia in C. canescens, without noting C. brevifolia as a synonym. Gray (1965) showed that C. brevifolia, like C. glabra, is morphologically not strongly differentiated from, and is less variable than, C. canescens. (USFWS, 1999)

Historical Range

Not Available

Current Range

Lake Wales Ridge in Polk and Highlands counties, Florida (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual

Reproduction Narrative

Adult: We have no species-specific data on the reproductive biology of C. brevifolia. In fire-dependent scrub habitat, most plants respond to fire by sprouting while a few recruit from seed that is stored in the sand (Johnson and Abrahamson 1990). Anecdotal information suggests that

C. brevifolia does not persist when burned, clipped, or defoliated (FWS 1996). If this is true, sprouting and other forms of asexual reproduction are unlikely. (USFWS, 2019)

Habitat Type

Adult: white sands/scrub

Environmental Specificity

Adult: Very narrow to narrow. (Natureserve, 2015)

Habitat Narrative

Adult: Conradina brevifolia inhabits white sand scrub with a scattered overstory of sand pine (Pinus clausa), interspersed with evergreen scrub oaks (Quercus spp.). C. brevifolia is usually found interspersed in clearings with other small shrubs and herbs (FWS 1992). Like all other xeric scrub communities, oak scrub is a fire-dependent vegetative complex that persists when burned at intervals of 10 to 20 years. In the slower-growing oak scrub of Florida's ridges, including Highlands and Polk counties, fire frequencies of 15 to 20 years are sufficient to maintain the vegetative diversity of the scrub habitats. (USFWS, 1999)

Dispersal/Migration

Population Information and Trends

Number of Populations:

21 (USFWS, 2021)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

The FNAI 2015 Element Tracking Summary (FNAI 2015), identifies 28 occurrences, 15 of which are on 7 different managed areas that are presumed or known to be extant. The other 13 occurrences were located on private lands. This represents roughly a 20 percent decline from the last 5-year status review, which reported 35 known occurrences (Service 2008c). The current status of occurrences and trends of short-leaved rosemary on private lands is unknown. (USFWS, 2019) . Short-leaved rosemary is a perennial herb occurring in rosemary scrub and related scrub ecosystems in Highlands and Polk Counties on the central portion of the LWR. It is restricted to a small portion of this range and does not occupy all available habitat, possibly due to fire suppression and inherit limitation to dispersal (Weekley et al. 2008). FNAI data (2021) show that there are only 21 populations and that one-third are unprotected. Short-leaved rosemary usually responds favorably to fire, often with strong population growth, but the duration of that population growth may be limited. Lack of frequent fire in both managed and unmanaged sites is the main threat to this pyrogenic species, although invasive species could also be an important threat at some locations. There has been little intensive monitoring of short-leaved rosemary, and therefore, not enough data exist to evaluate species viability in a substantive manner or determine long-term population trends. In addition, compared to many LWR endemic plants, relatively little is known about the basic biology of short-leaved rosemary, making it difficult to target for land management and other conservation measures. Threats from habitat loss due to development and climate change factors are expected to continue. For

these reasons, shortleaved rosemary continues to meet the definition of endangered under the ESA. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have

become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of C. brevifolia, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain sand pine scrub (USFWS, 1999)

4. When monitoring demonstrates that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary and yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:
- Determine current distribution of C. brevifolia. Some portions of C. brevifolia's range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection. (USFWS, 1999)

- Conduct research on life history characteristics of C. brevifolia. Little is known of the basic biology and ecology of this species. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor populations of C. brevifolia. Develop monitoring protocol to assess population trends for C. brevifolia. Develop a quantitative description of the population structure of C. brevifolia. (USFWS, 1999)
- Conduct research on life history characteristics of C. brevifolia. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit, since the recovery of C. brevifolia and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Acquire private sites with existing populations and/or implement conservation actions on private sites with existing populations. • Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support short-leaved rosemary. Monitoring/Research Activities • Conduct field surveys of occurrences, including Level 2 (population sizes) (as recommended by Menges et al. 2019) and Level 3 monitoring, throughout short-leaved rosemary's geographic range, including sites across a spectrum of time-since-fire and management regimes • Monitor this species' responses to management actions on conservation lands. • Conduct basic and applied research on the biology and ecology of short-leaved rosemary, including responses to management, propagation techniques, and germplasm storage. • Strengthen ex situ conservation measures, including ensuring representation of shortleaved rosemary at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. (USFWS, 2021)

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SPECIES ACCOUNT: *Conradina etonia* (Etonia rosemary)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4)

Physical Description

A perennial, aromatic shrub, reaching 1.5 m tall, with slender, arching branches. Leaves are 1.5-3 centimeters long with rolled margins. Both sides of the leaves are hairy; mid-rib and veins are strongly raised on the lower surface. Flowers appear in clusters of 3-7 bent flowers, lavender in color, the lip marked with streaks and dots. (NatureServe, 2015)

Taxonomy

Conradina etonia could be the best marked species in a genus whose species differ mostly in very fine characters (Kral and McCartney, 1991). (NatureServe, 2015)

Historical Range

It is known from only two sites near Etonia Creek, northeast of Florahome, Putnam County, Florida (USFWS, 1994).

Current Range

Occurs at six sites near Etonia Creek, northeast of Florahome, Putnam County, northeastern Florida. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Spring - fall (USFWS, 1994)

Reproduction Narrative

Adult: Flowering occurs from early spring to late fall (USFWS, 1994).

Habitat Type

Adult: Terrestrial (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Forest, savanna, shrubland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Excessive shade (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: It occurs in Florida scrub vegetation with sand pine and shrubby evergreen oaks. Scrub in this area is the northeastern range limit for several plant species of Florida scrub, including silk bay [Persea humilis), sand holly [Ilex cumulicola), Garberia heterophylla, and the scrub palmetto [Sabal etonia), which is named for this area but does not occur in the immediate vicinity of Conradina etonia (Krai and McCartney 1991; S. Christman, Florida Dept, of Natural Resources, pers. comm., 1991). (USFWS, 1993)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are unknown (EPA, 2016).

Population Information and Trends

Population Trends:

Increasing (USFWS, 2019)

Number of Populations:

3 (USFWS, 2024)

Population Size:

>3,000 (USFWS, 2024)

Population Narrative:

All presently known individuals occur within 6 km of each other with a contiguous landscape of xeric uplands (Figure 1). The known populations are approximately 1,500 m away from each other, meeting the definition of separate populations by NatureServe (2004), where occurrences greater than 1 km from each other are considered different populations. It is likely that increased survey efforts have led to the discovery a new population (i.e., the Florida Trail population) and additional plants. Increased management has also likely increased the number of plants within populations. These efforts have increased the number of plants from 1,475 in 2018 and peaked in 2021 at 3,232. Most of the increase in population is from the Big Scrub population, which has increased in population three-fold since 2018. The entire plant count has remained above 3,000 over the past three years (Figure 2). Management actions within Etoniah State Forest, such as prescribed fire, site preparation for planting trees, and herbicide treatments, have been effective in increasing the number of plants by recruiting seedlings. Additional details about each known population are described below (USFWS, 2024).

Threats and Stressors

Stressor: Habitat loss and degradation (Factor A)
Exposure:
Response:

Consequence:
Narrative: Development has and continues to be the primary threat to C. etonia. In 1991, there were only two known populations; both on what were then private lands (USFWS 1994). These private lands were platted and planned for development. In 1993, the State of Florida purchased much of these lands as the Etoniah Creek State Forest (ECSF), and surveys found additional populations of C. etonia in areas that are now protected. Within ECSF, there is still a large population located mostly on privately owned lots (Garden Drive/Blossom Street population). ECSF has purchased several of these lots and plans to continue to acquire additional property as funds become available. (USFWS, 2019)

Stressor: Hurricanes (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: In 2004, hurricanes impacted populations at ECSF and DCSP by blowing over sand pines and crushing plants in areas occupied by C. etonia. At DCSP, four of the historic sites of C. etonia could not be located since the area was covered with downed sand pines (Herring 2004). ECSF also had areas where the presence of downed sand pines made it difficult to access known sites of C. etonia. During the 2004 surveys at ECSF, it was determined that the number of plants did decrease after the hurricanes. However, since then surveys at ECSF and DCSP have shown an increase in the number of plants. The increase in plants is most likely due to more intensive surveys of additional areas at ECSF and DCSP. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When five (5) wild populations are under protection and management (USFWS, 1994).

Recovery Priority Number: 8C

Delisting Criteria:
1. In addition to the five (5) populations identified in the downlisting criteria, at least five (5) additional populations are established or discovered that exhibit stable or increasing trends as evidenced by natural recruitment, and multiple age classes. (USFWS, 2019)

2. All ten (10) populations are located on lands protected via a conservation mechanism. (addresses Factors A and D). (USFWS, 2019)

3. Threats (e.g. inadequate management, invasive species) have been reduced and/or managed to a degree that Etonia rosemary will remain viable for the foreseeable future (addresses Factors A and D) (USFWS, 2019)

Recovery Actions:
- Protect and monitor natural populations (USFWS, 1994).
- Survey for additional populations along Etonia Creek, in Putnam County, and potential areas of scrub habitat (USFWS, 1994).
- Continue propagation at several locations to prevent extinction of the species due to disease or other disaster at any one propagation site (USFWS, 1994).

- Determine habitat requirements, life history characteristics, and requirements for reproduction (USFWS, 1994).
- Locate potential (re)introduction sites on protected lands, including public land, highway rights-of-way, and conservation easements on private land (USFWS, 1994).
- (Re)introduce plants to protected sites using plants under cultivation and/or plants from natural sites (USFWS, 1994).
- Revise the current recovery plan to include updated objective and measurable recovery criteria, as well as updated information on the species distribution and biology. (USFWS, 2019)
- Provide funding and technical support for further research on: (a) The effects of prescribed burning and other management tools (e.g., thinning sand pines or mechanical clearing to reduce the understory) on C. etonia. Continue working with public land managers to increase the management on their sites. (b) The role pollinators play in the life history of C. etonia. Additional life history information may also be needed. (c) The genetics of the different populations to determine how different they are based on geographic distribution. Genetics could also tell us if inbreeding depression is occurring in some of the smaller populations. This information will help us determine what constitutes a stable population. (USFWS, 2019)
- Acquire additional private lands within ECSF that currently contain C. etonia (USFWS, 2019).
- Work with the Service's partners for Fish and Wildlife program staff to encourage private landowners to protect this species on their lands (USFWS, 2019).
- Conduct additional surveys on public lands adjacent to ECSF and DCSP (such as along the Crescent City Ridge) to look for suitable habitat and new populations of C. etonia. Continue annual surveys of populations at ECSF and DCSP (USFWS, 2019).
- Consider reintroduction and monitoring on adjacent publicly owned lands with suitable habitat. Conduct research into whether C. etonia will hybridize with other more common Conradina species, which could equate to loss of genetic variability of C. etonia. Reintroduction of C. etonia could help to increase the number of geographically distinct, self-sustaining populations on protected sites and augment populations where needed (USFWS, 2019).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1994). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities - Manage habitat with mowing, chopping, or burning as necessary to create the open habitats that are needed for this species to thrive. - Plant the species on managed conservation lands with adequate habitat to create new populations and meet downlisting and delisting population targets. - Conserve lands with suitable habitat adjacent to the Etoniah Creek State Forest. Monitoring and Research Activities - Annually monitor current populations. - Develop methods for propagation and outplanting to increase success. - Germination trials to determine what factors promote germination and how seeds can be successfully stored (USFWS, 2024).

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SPECIES ACCOUNT: *Conradina glabra* (Apalachicola rosemary)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4)

Physical Description

Conradina glabra is a much-branched shrub up to 2 meters tall. The branches of C. glabra are spreading or upright. The leaves are evergreen, opposite, with additional leaves in short shoots in the axils giving the appearance of fascicles. The leaves are needle-like, “very similar to the needles of fir” (Kral 1983, p. 949). The leaves are hairless on the upper surface—the only species of Conradina for which this is the case. Conradina glabra flowers from March to June and then intermittently until frost (Kral 1983). The flowers are usually in groups of two or three. The calyx and corolla are two-lipped. The corolla is 1.5 to 2.0 centimeters (0.5 to 0.75 inches) long from its base to the tip of its longest lobe, with a slender corolla tube that is straight for about 5 millimeters (mm) long, then bends sharply downward to form a funnel-shaped throat 5 mm long, then widens out into upper and lower lips. The outside of the tube and throat are white, with the lobes and lips lavender blue at the tips. The lower lip of the corolla is three-lobed, with a band of purple dots extending along its inner side. The four stamens are paired. Many flowers are male sterile. (USFWS, 1994)

Taxonomy

Conradina glabra was named as a distinct species by Shinners (1962), a treatment that was upheld by Gray (1965) and Kral and McCartney (1991). The plant had first been collected in 1931, and Small (1933, p. 1167) mentioned the specimen without assigning a name. (USFWS, 1994)

Historical Range

Historical extent and abundance of this species is unknown because the silviculture industry destroyed large areas of this species' sandhill habitat during the 1950’s, and the species was not described until 1962. We can assume that the species was once more widespread within the sandhill habitat in Liberty County, Florida. (USFWS, 2017)

Current Range

Conradina glabra is restricted to approximately 1000 to 1470 ha in northern Liberty County, Florida, west of Tallahassee near the Apalachicola River. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (NatureServe, 2015)

Breeding Season

Adult: March - first frost (NatureServe, 2015)

Reproduction Narrative

Adult: Reproduction for C. glabra occurs both rhizomatously/clonally and sexually via seed set, but in-situ attempts at seed germination have failed; seed viability is low. Currently, we cannot distinguish whether or not nearby stems are from the same genetic individual, so it is difficult to determine what constitutes a "plant." For now, we will use 'clumps', which was also used by Pruner and Schmidt (2017) for C. glabra (USFWS, 2019).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine forest, field, steephead (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: 15 - 40 year fire intervals (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Heavy shade (USFWS, 1994))

Environmental Specificity

Adult: Very narrow to narrow (NatureServe, 2015)

Habitat Narrative

Adult: Florida rosemary (Ceratiola ericoides) requires longer fire cycles (15–40 year intervals) to maximize soil seed bank (Quintana-Ascencio et al. 2003) (USFWS, 2009). Conradina glabra occurs in an area of several square miles northeast of Bristol, Liberty County (Figure 2). The area is a gently undulating upland, originally with longleaf pinewiregrass vegetation, dissected by ravines of the Sweetwater Creek system, which drain westward to the Apalachicola River. Parts of the Apalachicola ravines are incorporated in public and private nature preserves that protect rich hardwood forests with the narrowly endemic Florida torreya (Torreya taxifolia, also federally listed as endangered) and Florida yew (Taxus floridana). Heads of ravines, called steepheads, have slopes that are undermined by groundwater seeping into the ravine bottom, causing the slopes to gradually slump, carrying the vegetation with it. At least one steephead shrub, Florida yew, appears to be adapted to slowly moving down the slopes (Redmond 1984, cited in Platt and Schwarz 1990), and C. glabra may sometimes be carried into ravines. "Many older Conradina shrubs occur at the edge of the ravine and even extend a short distance down into open areas of the ravine; younger Conradina plants have become established in the barren, exposed soil adjacent to the pines and often extend into the pine stand. This suggests that C. glabra is able to compete effectively in open, newly exposed areas but is unable to compete in closed stands of mixed hardwoods or pines. This species probably features significantly in secondary plant succession in the area, much of which is frequently subjected to burning" (Gray 1965). Wilson Baker (pers. comm. cited in Schultz 1987) suggested that Conradina spread from the ravine edges into newly planted pine plantations on the uplands during the 1950's. Kral (1983) considered C. glabra to have inhabited the grassy understory of the upland longleaf pine-wiregrass vegetation before pine plantations were developed, as well as steephead edges. Kral thought that C. glabra was increasing in slash pine plantations, along with another woody mint,

Calamintha dentata. However, Kral thought it “premature to state that this will be a stable system” because the planted slash pine had not thrived, the plantations were probably more open than had been intended, and that if the slash pines matured, they might provide “more shade and more competition than is good for the Conradina”. Most of the slash pine was cut in 1987 and replanted to sand pine (S. Gatewood, TNC, in litt., 1987). Conradina glabra currently “is found on road edges, in planted pine plantations and along their cleared edges, and along the edges of the ravines” (Baker, pers. comm., in Schultz 1987). A recent (1993) survey along the Florida Gas Transmission pipeline found an estimated 10,000 plants, artificially divided into six populations. The plants appeared to be thriving in the exposed soil along the pipeline (Biological Assessments, Florida Gas Transmission Company, Phase III Natural Gas Pipeline Expansion Project, 1993). Additionally, a new population was discovered east of State Highway 12 (R. Hilsenbeck, pers. comm.) (USFWS, 1994).

Dispersal/Migration

Population Information and Trends

Population Trends:

30 - 50% decline (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2017)

Number of Populations:

1 (USFWS, 2022)

Population Size:

>100,000 (USFWS, 2022)

Additional Population-level Information:

The only population on public land is found at the SCT, Torreya State Park. This area was prepared by a bulldozer scraping topsoil and remaining vegetation into linear berms called windrows, planted in slash pine (with 500-700 stems per acre of sand pine), and then logged in the late 1980s (Spector and Bente 2009). Despite this severe alteration of habitat, SCT contains the majority of C. glabra. The estimated number of plants (or ramets, see recovery action 2.1) in 2009 for 102 ha was about 89,815 (Spector 2009); current and projected counts are underway (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). At present, about 15-20% of the core known habitat within the park remains to be surveyed (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). Data are collected on an ongoing basis, allowing for trend analysis as well as assessing the effects of restoration, particularly the effects of aggressive fire. (USFWS, 2017)

Population Narrative:

The species is currently known from only one natural population on public land, from three introduced sites in 1991, rights-of-way, and private silvicultural lands. The population on public land, which contains most of the plants, is found at the SCT, Torreya State Park (TSP; Fig. 1). At SCT, C. glabra covers an area between 1,000 ha (2,471 acres, Spector and Bente 2014; Fig. 1) to 1,470 ha (3,632 acres, Pruner and Schmidt 2017). This area was prepared by a bulldozer scraping topsoil and remaining vegetation into linear berms called windrows, planted in slash pine (Pinus

elliottii), with 500-700 stems per acre of sand pine (Pinus clausa), and then logged in the late 1980s (Spector and Bente 2009). Despite this severe alteration of habitat, SCT contains the majority of C. glabra. The estimated number of plants (or ramets) in 2009 for 102 ha was about 89,815 (Spector 2009); whereas the estimated number of plant clumps in 2017 was > 100,000. According to Pruner and Schmidt (2017), about 15-20% of the core known habitat within the park remains to be surveyed. They also provided preliminary trend analysis as well as some assessment of the effects of restoration, particularly the effects of aggressive fire (Appendix A). But current estimated counts are presently unknown due to the impact of Hurricane Michael on SCT habitat and C. glabra plants and subsequent site prepped (A. Schmidt, Wildland Resources LLC, pers. comm., 2021). (USFWS, 2022)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Habitat modification remains the main threat to date for this species as a result of silviculture practices. The entire range was altered by site preparation (e.g. bulldozing of topsoil into linear berms called windrows, and possible herbicide application) and conversion to pine plantations in the 1950s (Spector and Bente 2009). A large extent of Liberty County was logged mainly for longleaf pine, and many acres were converted to slash pine. The uplands on the SCT were managed for timber for several decades. The St. Joe Timberland Company harvested planted slash pine in1987, followed by sand pine plantation. Although C. glabra has been seen growing at the edges and sporadically within pine plantation, plant density is low compared to more open areas. Therefore, shading, due to increases in canopy cover from natural longleaf pine forests to managed pine plantations, is a threat to this species and should be evaluated. (USFWS, 2017)

Stressor: Inappropriate fire management (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Longleaf pine has not been introduced to the ongoing Florida Park Service forest management restoration treatments (restoration zone 2), at SCT. Introduction of longleaf pine may result in hotter fires due to needle accumulation. Also, ongoing conversations are considering a planting density of 400+ longleaf pine trees per acre to control woody species such as oak, potentially allowing for hotter fires (R. Pruner, Florida State Parks, 8/4/2017, pers. comm.). This should be closely monitored because C. glabra is also a woody species. Therefore, the use of a too frequent fire return interval and intensity could be a threat to the species. (USFWS, 2017)

Stressor: Herbicides (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The Recovery Plan mentioned that the use of the herbicide (hexazinone, Velpar) is a threat when it is used in timber regeneration areas. According to M. Ludlow (Department of

Environmental Protection; 2009, pers. comm. to Negrón-Ortiz), spot application of Garlon 4 (a less toxic herbicide) is used to treat exotic shrubs or trees at TSP. In addition, there are almost no woody exotics in the area where C. glabra occurs. Therefore, herbicide use is currently considered a minor threat. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on nonfederal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. Conradina glabra is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (http://www.virtualherbarium.org/EPAC). Several sites containing C. glabra occur on private timberland and highway and utility right of way (ROWs). While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for non-federal landowners. Neither section of the Act provides protection for plants on non-federal lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. At present, we have not been able to comment on state park management practices, and the Service doesn't have a legal mechanism to regulate management on state lands. The next revision of the park management plan will likely start around 2020 and finalized in 2022, and the Service should be able to attend public meetings and request a copy of the draft plan for commenting (R. Pruner, Florida State Parks, 9/25/2017, pers. comm.). Right of way maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting federally listed species on state highway ROWs, then the Service can recommend consultation to the Florida Department of Transportation (FDOT) under the Act because FDOT recently assumed NEPA authority and is considered a federal agency for consultation purposes. The FDOT routinely consults with the Service on all major road construction activities. Currently, these protections are inadequate for this plant and its habitat. (USFWS, 2017)

Stressor: Climate change (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: According to the Intergovernmental Panel on Climate Change Report (IPCC 2013), warming of the earth's climate is "unequivocal," as is evident from observations of increases in average global air and ocean temperatures, widespread melting of snow and ice, and rising sea level. Scientific evidence indicates a rapid and abrupt climate change, rather than the gradual changes that were previously forecasted (IPCC Report 2007), posing a significant challenge for

fish, wildlife, and plant conservation. Highly specialized or endemic species, such as C. glabra, are likely to be most susceptible to the stresses of changing climate. Species that are already rare may become rarer. This may be even more pronounced for those species with restricted ranges, with poor dispersal ability, requiring long generation times, possessing susceptibility to extreme conditions (such as flood or drought), exhibiting extreme habitat/niche specialization, or requiring symbiotic relationships (Hawkins et al. 2008). Using the NOAA Sea Level Rise (SLR) and Coastal Flooding Impacts Viewer (https://coast.noaa.gov/slr/), the projections indicated no potential impact to C. glabra population in Liberty County by intrusion of saltwater. Heatwave intensities and drought events, however, have strengthened in parts of the United States including the southeast (Mazdiyasni and AghaKouchak 2014) and Florida (Gao et al. 2012), and are becoming more likely to overlap. Heatwaves can make xeric areas such as sandhills even drier, and if these concurrently occur with drought events, represent a growing threat to C. glabra survival. Thus, it is recommended to avoid or postpone prescribed-fire during extreme drought and heatwave conditions. (USFWS, 2017)

Stressor: Forestry and Development (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Most of the remaining population of C. glabra is now protected under ownership by the State of Florida and managed by the Florida Park Service. The private land east of SCT where C. glabra likely occurred has been recently cut. In addition, herbicide was applied to the entire tract, limiting the likelihood of C. glabra persistence in the treated area (M. Maples, Florida State Parks, 9/12/2017, pers. comm.). There are other properties adjacent to SCT that have not been surveyed, but likely contain this species. Given the ownership of these surrounding properties, it is probable that they will continue to be utilized as pine plantations or converted to residential and/or commercial development in the near future. Therefore, conversion to pine plantations and residential or commercial developments are threats. (USFWS, 2017)

Recovery

Reclassification Criteria:
1. The Sweetwater Creek Tract population is assessed as resilient (addresses Factor A). Resilient: naturally reproducing, stable or increasing in number, and actively and appropriately managed. (USFWS, 2019)

2. Five additional populations are: 1) discovered or reintroduced within the historic range of the species, and 2) under long-term protection. These populations must be resilient (addresses Factors A and D). (USFWS, 2019)

Delisting Criteria:
1. Threat reduction and management activities (e.g., compatible silviculture practices, fire return interval and intensity, and restoration) have been implemented to a degree that the long-term resiliency of all six C. glabra populations and habitat is demonstrated over multiple prescribed burn cycles (addresses Factors A and D). (USFWS, 2019)

Recovery Actions:

- 1. Protect existing populations. Encourage conservation of existing populations on private lands. Conduct annual mapping and monitoring of all known populations of C glabra. Manage rights-of-way. Acquire habitat. (USFWS, 1994).
- 2. Conduct population biology studies. Study the effects of prescribed fire and forest management practices. Conduct life history studies. Survey for Conradina glabra outside its current range (USFWS, 1994).
- 3. Conduct genetic studies. Research is needed to determine genetic variability within reintroduced populations. This research will ensure that reintroduced populations have genetic variability similar to natural populations to withstand drought, diseases, etc. (USFWS, 1994)
- 4. Propagate Conradina glabra and reintroduce and/or augment populations within its historic range. Establishment of the artificial population on ABRP shows that C. glabra can be propagated and introduced rather easily. If necessary, additional reintroductions could take place on protected sites within the historic range of the plant. (USFWS, 1994)
- An in-depth C. glabra inventory across the species' historic sites and on new locations is conducted where appropriate habitat exists (addresses Factor A and redundancy). (USFWS, 2019)
- The effects of prescribed fire and forest management practices on long-term persistence of C. glabra (survival, growth and reproduction) in the sandhill community is assessed and a standardized monitoring technique is in place (addresses Factor D and resiliency). (USFWS, 2019)
- The contribution of sexual reproduction and clonal propagation to population maintenance is assessed via research related to (1) in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth), and (2) genetic composition and clonality (addresses Factors A, D, and E, and resiliency; it will inform representation). (USFWS, 2019)
- A living collection of viable germplasm3is maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach (addresses Factor E, and representation). (USFWS, 2019)
- 1. Conduct population surveys using a consistent, statistically valid, repeatable survey method. Once population numbers are known and an inventory has been conducted to find new populations throughout appropriate sandhill habitat, consistent surveys would allow for the analysis of long-term trends for this species. This information would help to determine when the species is stable and may be considered for reclassification. This information would also help to inform conservation managers of appropriate management techniques, and whether restoration of the pine plantation back to sandhill is assisting in the recovery of the species. - Continue and complete ongoing surveys throughout the present distribution. - Continue regular monitoring of marked individuals (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring). (USFWS, 2017)
- 2. Conduct an inventory of sites where appropriate habitat exists. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. (USFWS, 2017)
- 3. Identify appropriate soil types and other environmental conditions within the C. glabra range and adjacent areas as well as other sandhill areas within the Florida panhandle. This

action can include the use of aerials and species distribution modeling methods to initially determine potential habitat associations. (USFWS, 2017)

- 4. An ex-situ plant collection should be actively pursued and implemented. Studies on the viability of seeds, germination, and seedling establishment, in addition to whether the C. glabra spread by rhizomes and a persistent seed bank is present should be addressed. (USFWS, 2017)
- 5. Continue the restoration of and subsequent management of C. glabra's habitat. This is crucial for the long-term population stability (Park Service staff, 2017, pers. comm.) given that the global population of C. glabra is only found at the TSP. - Determine the fire regime (intensity) and monitor the effect of this event on C. glabra density, fecundity, and size structure. (USFWS, 2017)
- 6. Avoid or postpone prescribed-fire during extreme drought and heatwave conditions. (USFWS, 2017)
- 7. Evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change. (USFWS, 2017)
- 8. Assess the occurrence of vegetative reproduction (i.e., clonality) using genetic markers and determine the conservation implications. (USFWS, 2017)
- 9. Develop a stand-alone plan for managing listed plants at the TSP and integrate it to the restoration protocol and the Torreya State Park Unit Management Plan. - Evaluate the reference (remnant) site and determine the relevance and utility in informing restoration. (USFWS, 2017)
- 10. Seek partnership with private landowners to help better understand the present distribution of C. glabra. (USFWS, 2017)
- 11. Acquire the following properties adjacent to SCT: Candence Bank (3 parcels), Holland Ware, and R Dell Phillips. (USFWS, 2017)
- 12. The recovery plan should be updated to define objective measurable recovery criteria. A few key points to consider when addressing this action are: current population resiliency, effects of management and restoration efforts (particularly the effects of aggressive fire), and seedling recruitment. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Continue and complete ongoing surveys throughout the present distribution. This will assess the effect of 2018 Hurricane Michael (HM) and subsequent site prepped post HM on C. glabra at SCT. Conduct population surveys using a consistent, statistically valid, repeatable survey method (Service 2013). Once population numbers are known and an inventory has been conducted to find new populations throughout appropriate sandhill habitat, consistent surveys would allow for the analysis of long-term trends for this species. This information would help to determine when the species is stable and may be considered for reclassification. This information would also help to inform conservation managers of appropriate management techniques, and whether restoration of the pine plantation back to sandhill is assisting in the recovery of the species 2. Continue regular monitoring of marked individuals (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring). 3. In-situ seed germination and seedling recruitment studies o Many plants in fire-prone environments produce seeds that need fire, directly or indirectly, to germinate. To address whether seeds of C. glabra germinate postfire, a seed burial and retrieval experiment is recommended. 4. Investigate the longevity of seeds (soil seed bank), viability, seed germination and

seedling recruitment. Ongoing by the Atlanta Botanical Garden, 2019-2021: Grant No. F18AC00195: Studies to assess resiliency and status of endangered Apalachicola rosemary (Conradina glabra). ABG proposed to 1) collect seeds from wild SCT populations, 2) test for seed viability via staining and microscopy, and 3) perform seed germination trials. 5. Conduct an inventory of sites where appropriate habitat exists. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. 6. Private land conservation Seek partnership with private landowners to assess adjacent properties to SCT [e.g., Candence Bank (3 parcels), Holland Ware, and R Dell Phillips] for the presence of C. glabra. Objectives are to: • conduct surveys and document previously unknown locations. • better understand the present distribution of C. glabra. • develop conservation goals and best management practices • secure populations via land acquisition, conservation easement, or by implementing permanent conservation measures. 7. Identify appropriate soil types and other environmental conditions within the C. glabra range and adjacent areas as well as other sandhill areas within the Florida panhandle. This action can include the use of aerials and species distribution modeling methods to initially determine potential habitat associations. 8. An ex-situ plant collection should be actively pursued and implemented. This action can be guided by the genetic study currently being carried out by the ABG (2021). 9. According to A. Stiles (DRP, pers. comm., 11/09/2021), observations suggest a decrease in the abundance C. glabra in high-density sand pine plantations, supporting restoring SCT to a Sandhill natural community. Therefore, restoration of and subsequent management of C. glabra's habitat should continue. This is crucial for the long-term population stability given that the global population of C. glabra is only found at the TSP. 10. Determine the fire regime (intensity) and monitor the effect of this event on C. glabra density, fecundity, and size structure. Ongoing. 11. Avoid or postpone prescribed fire during extreme drought and heatwave conditions. 12. Assess the occurrence of vegetative reproduction (i.e., clonality) using genetic markers and determine the conservation implications. Ongoing 13. Evaluate the benefits and risks of translocation, augmentation, and reintroduction strategies under the combined pressures of habitat fragmentation and climate change. Partially done (Bladow et al. 2017). 14. Evaluate the reference (remnant) site and determine the relevance and utility in informing restoration. Partially done. 15. Develop a stand-alone plan for managing listed plants at the TSP and integrate it to the main management plan and the restoration protocol. (USFWS, 2022)

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SPECIES ACCOUNT: *Conradina verticillata* (Cumberland rosemary)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/30/1991; Southeast Region (R4)

Physical Description

Cumberland rosemary, an evergreen perennial shrub in the mint family, is most noted for its aromatic leaves, which smell like the culinary herb rosemary, and for its abundant pink to purple flowers. A full technical description can be found in Gray (1965), but a few characteristics from Kral (1983), Patrick and Wofford (1981), and Roulston (1994) are presented and will aid in field identification. Inflorescence: Flowers on short-stalked, linear-bracted, axillary cymes from most or all upper nodes; the cyme stalks hispidulous; the bracts covered with long-spreading gland-tipped hairs. Flowers: They are 1 to 2 centimeters (cm) long; lavender, purple, or rarely white, usually with dark spots leading down the throat; two-lipped, the upper lip with two lobes, the lower with three; floral tube strongly bent, giving the flower an s-shape in profile; borne in small clusters in the axils of the present year's leaves from early May until early June. Calyx: Bilabiate, five-toothed, persistent, 7 to 9 millimeters (mm) long, glandular-pubescent and/or sparsely puberulent to appressed pubescent. Stems: Four-sided; woody but lax, often decumbent; seldom growing more than 1 foot tall before falling over, rooting at the nodes, and putting up more stems. Leaves: Entire, needlelike, opposite with additional pairs clustered in the axils appearing whorled, somewhat fleshy, with strongly revolute margins, 1 to 3 cm long, resin dotted, aromatic. Seeds: Up to four per calyx, dry, dark brown, spherical, 1 mm in diameter; loose in calyx but usually not falling out before calyx falls off plant. No other plants are likely to be mistaken for it when it is in flower. Without flowers, however, it resembles Aster linari~folius, Hypericum densforum, and Pycnanthemum tenuforum, which also have needlelike leaves and grow in the same habitat but do not have the distinctive rosemary aroma. (USFWS, 1996)

Taxonomy

Conradina is a genus of six allopatric species confined to the Southeastern United States (Shiners 1962, Gray 1965, Kral and McCartney 1991) (USFWS, 1996).

Historical Range

This species is known from five counties in north-central Tennessee and one county in southeastern Kentucky (USFWS, 1996).

Current Range

Tennessee: Cumberland, Fentress, Morgan, Scott, and White Counties; Kentucky: McCreary County. These occurrence are along nine major streams of the Cumberland Plateau--Big South Fork River, New River, Clear Fork River, White Oak Creek, Caney Fork River, Obed River, Daddys Creek, Clear Creek, and Emory River. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual, sexual (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Bumblebees and honeybees (USFWS, 1996)

Breeding Season

Adult: May - June (USFWS, 1996)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2018)

Reproduction Narrative

Adult: Flowering occurs from May to June, with fruiting in mid June. Pollination is primarily by bees, especially bumblebees and honeybees, although it attracts many different types of insects (USFWS, 1996). Less than 10 percent of the seeds are fully developed and fertile. Germination takes about 2 weeks (USFWS, 1996). C. verticillata reproduces sexually and asexually. Due to low seed viability, a majority of reproduction is the result of asexual reproduction via fragmentation (NatureServe, 2015).

Habitat Type

Adult: Wetland (USFWS, 1996)

Habitat Vegetation or Surface Water Classification

Adult: Riparian, flood plain, sand bar (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal flooding (NatureServe, 2015); full to moderate sunlight (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: Excessive vegetation/shading ; saturated soil (USFWS, 1996)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1996); colonial (NatureServe, 2015)

Environmental Specificity

Adult: Very Narrow (USFWS, 2018)

Habitat Narrative

Adult: Cumberland rosemary is found on rocky river bars composed of unsorted boulders, cobbles, gravel and sand, with the largest populations occurring in open, 8 washed-out areas near the centers of these bars. The essential habitat requirements of this species are: open to barely shaded sites; moderately deep, sandy, well-drained soils with no visible organic matter; periodic forceful flooding to maintain openness; topographic features to enhance sand deposition; and, perhaps, periods of inundation of at least two weeks to induce rooting at the lower nodes (Patrick and Wofford 1981). (USFWS, 2018)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal seems to be mainly through fragmentation during winter storms (USFWS, 1996).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Unknown (USFWS, 2011)

Number of Populations:

3 (USFWS, 2023)

Population Size:

Unknown (USFWS, 2018); < 4,000 (NatureServe, 2015)

Population Narrative:

There currently are 66 extant occurrences; though, it is likely many others also are extant but lack current observation data to verify their persistence. While most extant sites are located on conservation lands, few are actively managed to improve habitat conditions and promote population growth of Cumberland rosemary occurrences. Data are lacking from most sites for generating reliable estimates of the species abundance, either in terms of individual clumps or genetically distinct plants. However, viability ranks assigned by Kentucky and Tennessee NHPs indicate that fewer than 100 clumps are present at 90 percent of extant occurrences. Available monitoring data suggest general trends in each of the major watersheds where the species occurs, at least among monitored sites, including declines at a majority of occurrences in the Big South Fork and Caney Fork watersheds and increases or stability at a majority of sites monitored in the Obed-Emory. (USFWS, 2018). Cumberland rosemary is represented by three populations in Tennessee and Kentucky in the Big South Fork, Emory, and Caney Fork watersheds. The species is monitored at 25 sites at varying frequency by the National Park Service's Appalachian Highlands Inventory and Monitoring Network (NPS-APHIN), Tennessee Department of Environment and Conservation (TDEC), and the Office of Kentucky Nature Preserves (OKNP) (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The potential exists that small ponds and reservoirs constructed in upper reaches of watersheds have altered hydrologic and geomorphologic processes necessary to maintain suitable conditions for the species on the cobble bars where it occurs. White (pers. comm. 2010)

reported that encroachment of woody species, both native and exotic, onto cobble bar habitats led to the decline of at least three Cumberland rosemary occurrences in Kentucky, and suggested that either drought or altered hydrology could be factors contributing to these declines. Impacts associated with hiking and equestrian trails at Big Island in BSFNRRA and impacts from vehicular and camping activity at the Lilly Bridge site in ONWSR may be a threat (USFWS, 2011).

Stressor: Recreational activities (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Recreational activities have been identified as a potential threat to Cumberland rosemary due to trampling in areas near trails used for horseback riding and hiking, camping, off-road vehicle traffic, and whitewater boating. There is no updated information on this threat, but riparian recreation on Big South Fork NRRA, Obed WSR, and Catoosa Wildlife Management Area is still popular, and trampling remains a potential threat (USFWS, 2023).

Stressor: small, fragmented range (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The best available information continues to indicate that the small, fragmented range that Cumberland rosemary occupies increases the species vulnerability to localized extinction due to random events, such as natural disasters and loss of genetic diversity and adaptive potential through genetic drift (Service 2018). Low seed viability and low recruitment also reduce the species' ability to recover from habitat-related threats. These factors persist, but we are not aware of any additional studies addressing them. Research into the need for and requirements of a captive propagation program would lay the groundwork for future efforts to increase numbers of individuals and boost population size at wild sites (USFWS, 2023).

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
There are 25 protected and managed colonies with 50 genetically distinct individuals per colony on the five major rivers (five colonies on each river) where it occurs (USFWS, 1996).

Recovery Actions:

- Protect existing colonies and habitat. Only three populations with 91 colonies are known to exist, with the majority in north-central Tennessee and a few in adjacent Kentucky. The largest colonies in each population need immediate protection. A total of76 colonies are located on land managed by the National Park Service, and 15 sites are located on privately owned land. Only five colonies are known to have more than 100 clumps of plants. Protection of five colonies in each of the five major rivers in which Cumberland rosemary occurs is considered to be essential to the recovery of the species and to prevent its irreversible decline. (USFWS, 1996)

- Search for new populations within the known range and in other watersheds. The search for new populations is necessary within both the known range and other watersheds. This information will be useful in making management decisions and for determining the genetic variability of the species. The most intensive searches for Cumberland rosemary in Tennessee were conducted in 1979 and 1980 (Patrick and Wofford 1981, Patrick 1979, Schmalzer and DeSelm 1982). These searches were restricted to the five major rivers within the known range of the species. Only a few new colonies have been found since 1980 (see Appendix). Suitable habitat north of and between the known Kentucky population has been thoroughly searched; no new colonies were located (White 1994). Searches should be conducted in other watersheds in Tennessee's northern Cumberland Plateau. Because of the restricted riparian habitat, access by canoe is the most efficient method of surveying for new colonies. Searches in the BSFNRRA and the 16 ONWSR should continue in order to ensure that all federally owned colonies are adequately managed and protected. (USFWS, 1996)
- Conduct studies of the species' biology. Additional information on the biology of C. verticillata is important and necessary for developing and implementing management guidelines. (USFWS, 1996).
- Maintain and expand cultivated sources for the species. Vegetative material should be preserved for the purpose of establishing new populations if natural populations were to be eliminated. (USFWS, 1996).
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation o fCumberland rosemary could play an important part in encouraging conservation efforts. In order to ensure that the taking threat is not increased, information materials should not identify specific plant locations. (USFWS, 1996).
- Annually assess the success of recovery efforts for the species. The review of new information, evaluation of ongoing actions, and redirection of recovery efforts, if necessary, are essential for assuring that full recovery is achieved as quickly and efficiently as possible. (USFWS, 1996)
- Work with NPS, TDEC, and KSNPC to reconcile data concerning extant and historic locations, abundance at extant locations, and threats (USFWS, 2011).
- Continue efforts to control invasive, exotic plants at occurrences on NPS lands at BSFNRRA and expand these efforts, as needed, to ONWSR (USFWS, 2011).
- Continue long-term monitoring begun by TDEC. Expand monitoring effort to occurrences in Kentucky. Review monitoring protocols and revise, if warranted, to provide a more repeatable system for tracking changes in distribution and abundance. Incorporate threats assessment into monitoring program (USFWS, 2011).
- Use data from NPS Cobble Bar Monitoring program to track threats to Cumberland rosemary at BSFNRRA and ONWSR (USFWS, 2011).
- Continue implementation of Recovery Plan for Cumberland rosemary (USFWS, 2011).
- · Conduct a population genetics study to assess the level of genetic variation found in the species and how that variation is distributed among watersheds and sites within watersheds; assess inbreeding risk for watersheds and occurrences; and evaluate the relationship between number of clumps/plants (ramets) 30 observed at sites and the number of genetically distinct individuals (genets) they represent. This information should be used to evaluate abundance at site and watershed levels and determine whether population augmentation should occur in some watersheds/sites to facilitate gene flow and

increase the number of compatible mates. (USFWS, 2018)

- · Coordinate monitoring efforts between KSNPC, TDEC, and NPS-APHN to avoid duplication and ensure monitoring is conducted at standardized times of year, using consistent methodology. Monitoring programs should also be designed to document threats observed at Cumberland rosemary sites, including assessing impacts of recreational activities in sites with known threats, and should attempt to document seedling recruitment into populations. (USFWS, 2018)
- · The Service's (2016) programmatic BO for streams crossings on trails at BISO included a nondiscretionary requirement that NPS coordinate with the Service to devise a monitoring plan for Cumberland rosemary that includes formally designated trail crossings and other significant sites where this plant occurs in proximity to trails in BISO. While NPS conducts monitoring at 18 sites in BISO and OBRI, there has been little coordination with the Service on the monitoring program. Some NPS monitoring sites for Cumberland rosemary are located along trails, but we do not currently know which sites, nor do we know if data are collected regarding evidence of impacts related to recreational use of trails or nearby areas. The NPS staff at BISO, OBRI, and APHN, should coordinate with the Service to evaluate whether the current NPS monitoring program includes a representative set of sites for assessing effects of recreational uses on and near trails and to establish routine coordination and reporting procedures. (USFWS, 2018)
- · Evaluate data and reports from the NPS-APHN (Murdock et al. 2013) long-term cobble bar monitoring program, to increase understanding of cobble bar geomorphology and dynamics in relation to vegetation structure and composition, as well as responses of Cumberland rosemary to changes in these habitats over time. We are not currently aware of any publicly available data or reports that have been produced from this monitoring program. (USFWS, 2018)
- · There is a need to reconcile NPS data on observations of Cumberland rosemary at OBRI and BISO with data in NHP databases. Nearly one-third (~30 percent) of all known EOs are considered historical, because there are no observations recorded for them in NHP databases since prior to 1998. The greatest number of these historical occurrences are located in the Big South Fork watershed, where NPS-APHN conduct cobble bar monitoring and other biological surveys and potentially have collected data on Cumberland rosemary occurrences (both previously known and not yet documented). While some data have been provided to Tennessee's NHP program, there is a need to ensure that NPS observation data for Cumberland rosemary and other listed species are routinely shared with NHP programs. (USFWS, 2018)
- · Once NPS and NHP data are reconciled, data should be reviewed and sites prioritized for surveys where recent observation data are lacking. Current data are needed to verify persistence of many EOs and to estimate abundance for evaluating the species' status with respect to recovery criteria. (USFWS, 2018)
- · Surveys for new occurrences should be conducted and negative data stored in a collective database. (USFWS, 2018)
- · Prioritize and increase efforts to control invasive species and assess whether additional management is needed on highest priority sites. Document areas where invasive species control and other habitat management occurs. (USFWS, 2018)
- · Additional seed banking and testing of seed viability are needed to provide adequate ex situ resources for conservation of the species. (USFWS, 2018)

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SPECIES ACCOUNT: *Consolea corallicola* (Florida semaphore Cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

Physical Description

Consolea corallicola is a tree-like cactus; mature plants grow 2 meters (m) (6 feet (ft)) tall with an erect main trunk, which is elliptical or oval in cross section and armed with spines. The flowers are bright red and 1.3 to 1.9 cm (0.50 to 0.75 in) wide, and the fruits are yellow, egg-shaped, and 2.5 to 5.1 cm (1 to 2 in) long (USFWS, 2013)

Taxonomy

John Kunkel Small discovered and described Consolea corallicola (Family: Cactaceae) in 1930. While some authors still place this species in the genus Opuntia , genetic studies by Gordon and Kubisiak (1998) confirmed that the Florida plants are a genetically distinct species. Recent taxonomic treatments accept the genus Consolea and apply the name C. corallicola to the Florida species. Synonyms include Opuntia corallicola (Small) Werdermann. (USFWS, 2013)

Historical Range

Consolea corallicola was known historically from three islands of the Florida Keys in Monroe County: Key Largo, Big Pine Key, and Little Torch Key, and from Swan Key, a small island in Biscayne Bay in Miami-Dade County. (USFWS, 2013)

Current Range

The current range of Consolea corallicola includes two naturally occurring populations, one on Swan Key in Biscayne National Park (BNP), Miami-Dade County, and one at the Nature Conservancy's (TNC) Torchwood Hammock Preserve on Little Torch Key, a small island in the Florida Keys, Monroe County (Bradley and Gann 1999, p. 77; Bradley and Woodmansee 2002, p. 810) (USFWS, 2013).

Critical Habitat Designated

Yes; 2/22/2016.

Legal Description

On January 22, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 22, 2016) for Consolea corallicola (Florida semaphore Cactus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Florida (81 FR 3866-3925).

Critical Habitat Designation

The critical habitat designation for Consolea corallicola includes four CHUs in Miami-Dade and Monroe Counties, Florida, , all of which was occupied by the species at the time of listing. The critical habitat includes lands under Federal (28 percent), State (58 percent), county (1 percent), and private or other (13 percent) ownership. This species critical habitat encompasses approximately 4,411 acres (ac) (1,785 hectares (ha)). General descriptions are presented below. Maps depicting the CH units are available in the Final Rule (81 FR 3866-3925).

Unit FSC1: Swan Key—Biscayne National Park, Miami-Dade County, Florida: Unit FSC1 consists of 37 ac (15 ha) in Miami-Dade County. This unit is composed entirely of lands in Federal ownership, 100 percent of which are located on Swan Key within Biscayne National Park. The unit includes all upland rockland hammock habitat on Swan Key, most of which is located on the eastern side of Swan Key, surrounded by the island's mangrove fringe. A second, smaller area is located on the island's elongate western half and is also surrounded by mangroves.

Unit FSC2: Key Largo, Monroe County, Florida: Unit FSC2 consists of 3,434 ac (1,389 ha) in Monroe County. This unit is composed of Federal lands within Crocodile Lake National Wildlife Refuge (NWR) (702 ac (284 ha)); State lands within Dagny Johnson Botanical State Park, John Pennekamp Coral Reef State Park, and the Florida Keys Wildlife and Environmental Area (2,331 ac (943 ha)); lands owned by Monroe County (17 ac (7 ha)); and parcels in private or other ownership (384 ac (155 ha)). This unit extends from near the northern tip of Key Largo, along the length of Key Largo, beginning at the south shore of Ocean Reef Harbor near South Marina Drive and the intersection of County Road (CR) 905 and Clubhouse Road on the west side of CR 905, and between CR 905 and Old State Road 905, then extending to the shoreline south of South Harbor Drive. The unit then continues on both sides of CR 905 through the Crocodile Lake NWR, Dagny Start Printed Page 3889Johnson Key Largo Hammock Botanical State Park, and John Pennekamp Coral Reef State Park. The unit then terminates near the junction of U.S. 1 and CR 905 and Garden Cove Drive. The unit resumes on the east side of U.S. 1 from South Andros Road to Key Largo Elementary; then from the intersection of Taylor Drive and Pamela Street to Avenue A, then from Sound Drive to the intersection of Old Road and Valencia Road, then resumes on the east side of U.S. 1 from Hibiscus Lane and Ocean Drive. The unit continues south near the Port Largo Airport from Poisonwood Road to Bo Peep Boulevard. The unit resumes on the west side of U.S. 1 from the intersection of South Drive and Meridian Avenue to Casa Court Drive. The unit then continues on the west side of U.S. 1 from the point on the coast directly west of Peace Avenue south to Caribbean Avenue. The unit also includes a portion of the barrier island (El Radabob Key) in Largo Sound located directly east of Avenue A, extending south to a point directly east of Mahogany Drive.

Unit FSC3: Big Pine Key, Monroe County, Florida: Unit FSC3 consists of 772 ac (313 ha) in Monroe County. This unit is composed of Federal land within the National Key Deer Refuge (NKDR) (508 ac (205 ha)), State land managed as part of the NKDR (172 ac (70 ha)), lands owned by Monroe County (11 ac (5 ha)), and parcels in private or other ownership (81 ac (33 ha)). This unit extends from near the northern tip of Big Pine Key along the eastern shore to the vicinity of Hellenga Drive and Watson Road; from Gulf Boulevard south to West Shore Drive; Big Pine Avenue and Elma Avenues on the east, Coral and Yacht Club Road, and U.S. 1 on the north, and Industrial Avenue on the east from the southeastern tip of Big Pine Key to Avenue A.

Unit FSC4: Little Torch Key, Monroe County, Florida: Unit FSC4 consists of 168 ac (68 ha) in Monroe County. This unit is composed of State lands (47 ac (19 ha)), lands owned by Monroe County (10 ac (4 ha)), and parcels in private and other ownership (111 ac (45 ha)). This unit extends along State Highway 4A, from Coral Shores Road, south to County Road, resuming at Linda Street and extending south to the Overseas Highway. South of the Overseas Highway, the unit includes areas west of Kings Cove Road, and an area comprising the southern tip of Little Torch Key that includes portions of the John J. Pescatello Torchwood Hammock Preserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Consolea corallicola critical habitat consists of the following components (81 FR 3866-3925):

(i) Areas of upland habitats consisting of coastal berm, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse, calcareous, and storm-deposited sediment. (B) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil covering limestone or organic matter that accumulates on top of the limestone. (C) Buttonwood forest habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) A plant community of predominately native vegetation with no invasive, nonnative animal or plant species or such species in quantities low enough to have minimal effect on survival of Consolea corallicola.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient size to sustain viable populations in coastal berm, rockland hammocks, and buttonwood forest.

(v) Habitats that provide populations of the generalist pollinators that visit the flowers of Consolea corallicola.

Special Management Considerations or Protections

Special management considerations or protection are necessary throughout the critical habitat units to avoid further degradation or destruction of the habitat that provides those features essential to the species' conservation. The primary threats to the physical or biological features that Consolea corallicola depends on include: (1) Habitat destruction and modification by development and sea level rise; (2) Competition with nonnative, invasive plant and animal species; (3) Wildfire; and (4) Hurricanes and storm surge. Some of these threats can be addressed by special management considerations or protection, while others (e.g., sea level rise, hurricanes, storm surge) are beyond the control of landowners and managers. However, even when landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (NatureServe, 2015)

Reproduction Narrative

Adult: The breeding system is complex, with one population being effectively male-only, while the other is reproducing. Sexual reproduction has not been observed. The Little Torch Key population consists of eight individual plants none of which seem to have produced viable fruit (Williams, pers. comm., 1989). The flowers tend to drop off shortly after peak bloom is reached and these blooms occasionally take root beneath the parent plant (Avery, 1963; Williams, pers. comm., 1989). This type of vegetative reproduction is also mentioned by Small (1930) who suggests that the lack of proper ovary development is a result of not having been pollinated. In this same report, however, Small does mention that fruits have been observed and he describes the seeds from them. It is possible that the pollinators of the plant were present when the plant was better represented in the wild, but when the plants were extirpated the pollinators may have been effectively eliminated from the area. Species specific pollinators are not common in the Cactaceae, but they do occur (Grant and Hurd, 1979). It is also possible that the presence of a diversity of pollinators in past years was affecting more frequent pollination than now occurs. Research in this area is critical if anything more than clones are to be preserved (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Hardwood hammocks, mangrove hammock (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Moderate sunlight (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: High elevations (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Small (1930) reported that in Florida the plants occur on bare rocks with only a slight covering of humus in hardwood hammocks near sea level. Substrate material in this area of the Keys is almost entirely Key Largo limestone with some sand. The single remaining Florida population occurs in a transitional zone between mangrove and hardwood hammock habitats (Williams, pers. comm., 1989), and the most common associate species include: Sporobolus virginicus (L.) Kunth., Conocarpus erectus L., Maytenus phyllanthoides Benth., Manilkara bahamensis (Baker) Lam. & Meeuse, Hippomane mancinella L., Opuntia stricta var. dillenii (Ker-Gawl.) L. Bens. Both mature extant populations of this species occur at or near mean sea level. The environmental specificity is narrow, as it currently occurs in a narrow ecotone near sea level between salt tolerant communities (salt marsh/mangrove) and hammock (fire-intolerant) communities (NatureServe, 2015). It seems to prefer areas where canopy cover and sun exposure are moderate (Grahl and Bradley 2005, p. 4) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:
50 - 70% decline (NatureServe, 2015)

Species Trends:
Relatively stable (NatureServe, 2015)

Number of Populations:
6 (USFWS, 2013)

Population Size:
< 1,000 (USFWS, 2013)

Adaptability:
Low (inferred from NatureServe, 2015)

Population Narrative:
This species is unlikely to ever have been very common, but there is evidence (herbaria) that it was once more common than it currently is (extinct populations on Big Pine Key, Key Largo), with one natural, one apparently non-natural, and one recently planted population remaining. Both mature extant populations of this species occur at or near mean sea level. Intrinsic vulnerability is the most likely dominant long-term threat. This species has experienced a log-term decline of 50-70%. This plant is clonal and several small 'pups' are associated with larger, older 'trunked' individuals. Population size depends on what is considered an individual. Genetic studies suggest that there are few genetic individuals in one population (<5). The other population has 570 plants with trunks, up to 200 more without trunks, with a genetic analysis funded as of 15 Mar 03. The population now extant on Little Torch Key, in all probability, originated from wild stock of the Keys population and thus is of the same gene pool. Currently, the trend is most likely stable to a slight decline (NatureServe, 2015). Of six extant populations, one wild population and three reintroduced populations are small. The naturally occurring populations account for fewer than 1,000 plants (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Destruction and modification of habitat from development throughout the species' range continue to be a threat to Consolea corallicola. Unoccupied suitable habitat throughout the species' former range is under intense development pressure. At one State-owned site where a reintroduction was attempted, all of the plants were accidentally destroyed by the expansion of a trail (USFWS, 2013).

Stressor: Fungal pathogen (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: A fungal pathogen, Fusarium oxysporum, can infect Consolea corallicola, causing crown rot, a disease in which plants rot near their base (Slapcinsky et al. 2006, p. 2; Stiling 2010, p. 191). Cacti in the Florida Keys populations that are affected by this disease have also tested positive for a fungus, Phomopsis sp. (Slapcinsky et al. 2006, p. 3). This disease was largely responsible for the high mortality rates in some reintroduced populations in the Florida Keys (Stiling 2010, p. 193). At present, crown rot does not appear to be affecting the population at BNP (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation by the moth Cactoblastis cactorum (Lepidoptera: Pyralidae) is considered a significant threat to Consolea corallicola (Stiling et al. 2000, pp. 2, 6; Gann et al. 2002, p. 481; Wright and Maschinski 2004, p. 4; Grahl and Bradley 2005, pp. 2, 7; Slapcinsky et al. 2006, pp. 2–4). Native to South America, Cactoblastis cactorum was introduced to Australia in 1925, as a biological control agent for nonnative species of Opuntia. Adult moths deposit eggs on the branches of host species. When these eggs hatch, larvae then burrow into the cacti and feed on the inner tissue of the plant's stems. The larvae then pupate, and the cycle repeats. To date, C. cactorum has not been observed in BNP (McDonough 2010a, pers. comm.). Even if the moth has not yet reached the BNP, it likely will, based on its rapid spread in the Caribbean and Florida. This threat has the potential to cause steep declines in populations of Consolea corallicola if they become infested. No satisfactory method of large-scale control is known at this time (Habeck et al. 2009, p. 2). Potential impacts to C. corallicola at the population level as a result of predation by C. cactorum are severe. Predation by the Cuban garden snail (Zachrysia provisoria) has been observed at one Consolea corallicola reintroduction site (Duquesnel 2008, pers. comm.). The population-level impact of the Cuban garden snail is not known (USFWS, 2013).

Stressor: Fire (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Wildfire, whether naturally ignited or caused by unauthorized burning, such as bonfires, is a threat to Consolea corallicola. In general, these plants do not survive fires, making this a severe threat to remaining populations and occupied sites (USFWS, 2013).

Stressor: Nonnative plant species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Schinus terebinthifolius can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for Consolea corallicola, which prefers moderate to full sun exposure. Colubrina asiatica is also present in BNP in areas supporting Consolea corallicola (McDonough 2010b, pers. comm.). Other invasive plant species that are a threat to Consolea corallicola include Scaevola taccada (beach naupaka), Neyraudia

reynaudiana (Burma reed), Cupaniopsis anacardioides (carrotwood), Thespesia populnea (Portia tree), Manilkara zapota (sapodilla), Hibiscus tiliaceus (hau), and Hylocereus undated (night blooming cactus) (FNAI 2010f, p. 4; Bradley et al. 2004, p. 13; McDonough 2010b, pers. comm.) (USFWS, 2013).

Stressor: Vandalism (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: For Consolea corallicola, vandalism has been documented twice. In 1990, branches were cut off plants at one site, but instead of being taken (as would be the case for poaching), the cut stems were left at the base of plants. In 2003, vegetative recruits and pads were damaged by unauthorized removal of protective cages from plants (Slapcinsky et al. 2006, p. 3). Due to their historic significance and possible presence of artifacts, shell mounds are susceptible to vandalism by artifact hunters. Despite regulations that protect these sites on State lands (Florida Statute 267.13), there is a long history of artifact hunters conducting unauthorized excavation of shell mounds in Florida (USFWS, 2013).

Stressor: Sea level rise (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Suitable habitat such as coastal rock barrens on Key Largo have been inundated with saltwater during spring and fall high tides over the past 5 to 10 years; these extreme events killed planted Consolea corallicola at one location (Duquesnel 2011a, pers. comm.). In the future, sea level rise could cause increases in flooding frequency or duration, prolonged or complete inundation of plants, and loss of suitable habitat. A 1.8-m (5.9-ft) sea level rise would completely inundate Little Torch Key and severely reduce the area of habitat remaining on Swan Key, including all areas currently supporting C. corallicola. In 2100, the nearest upland habitats from Little Torch Key may be as far as 100 miles north in peninsular Florida, or 100 miles south in Cuba. On Swan Key, the species may be able to disperse to the remaining higher ground, and the location could continue to support a population given a 1.8-m (5.9-ft) sea level rise.

Stressor: Small population size (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The two natural populations of Consolea corallicola are spread across 193 km (120 mi) between Biscayne Bay and Big Pine Key. One of the two remaining natural populations of C. corallicola consists of fewer than 20 adult plants (see table 2). Threats exacerbated by small population size include hurricanes, storm surges, and poaching. Populations can also be impacted by demographic stochasticity, where populations are skewed toward either male or female individuals by chance. This may be the case with C. corallicola, in which the two remaining populations do not contain any female plants. While the species may continue to reproduce indefinitely by clonal means, populations may not be viable over the long term due to a lack of genetic mixing and thus the potential to adapt to environmental changes (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- The Nature Conservancy purchased Torchwood Hammock Preserve on Little Torch Key in 1988, to protect what was at the time the only known remaining population of Consolea corallicola (USFWS, 2013).
- The comprehensive conservation plan (CCP) for the Lower Florida Keys National Wildlife Refuges (National Key Deer Refuge, Key West National Wildlife Refuge, and Great White Heron National Wildlife Refuge) and Crocodile Lake National Wildlife Refuge promote the enhancement of wildlife populations by maintaining and enhancing a diversity and abundance of habitats for native plants and animals, especially imperiled species that are only found in the Florida Keys. This CCP provides specifically for maintaining and expanding populations of candidate plant species including Consolea corallicola (USFWS, 2013).
- Cactoblastis moth (Cactoblastis cactorum) monitoring and hand removal efforts are underway at BNP and Torchwood Hammock Preserve in an effort to protect Consolea corallicola. No satisfactory method of large-scale control for the Cactoblastis moth is known at this time. The USDA Agricultural Research Service's Center for Medical, Agricultural, and Veterinary Entomology in Tallahassee, Florida, is developing containment methods including the use of female sex pheromone wing traps and irradiation techniques to control the spread of the Cactoblastis moth. These techniques have not yet been approved for widespread use (USDA 2006, p. 9) (USFWS, 2013).
- Reintroductions of Consolea corallicola have been implemented at several locations on State lands in the Florida Keys, but these have been largely unsuccessful due to Cactoblastis moth predation, crown rot, and burial of small plants by leaf litter (USFWS, 2013).
- Fairchild Tropical Botanic Garden (FTBG) has 11 collections of Consolea corallicola, representing both wild populations, each of which is represented by at least one living specimen of at FTBG, for a total of 17 living specimens. Key West Botanical Garden (KWBG) has one collection of Consolea corallicola represented by several living specimens (Maschinski 2013b, pers. comm.) (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support Consolea corallicola (USFWS, 2013).

References

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Determination of Endangered Status for Chromolaena frustrata (Cape Sable Thoroughwort), Consolea corallicola (Florida Semaphore Cactus), and Harrisia aboriginum (Aboriginal Prickly-Apple)

Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821.

USFWS. 2013. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Cordia bellonis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/10/1997; Southeast Region (R4) (USFWS, 2015)

Physical Description

An arching to erect shrub of about 1 to 2 meters (3.3 to 6.6 feet) high with very slender twigs with short hairs. The leaves are alternate, oblong to oblong lanceolate, 2 to 6 centimeters (0.8 to 2.4 inches) long, usually 2.5 to 3 times longer than wide. The corolla is white with 4 subcylindric lobes. The fruit is a pointed drupe, 5 millimeters (0.2 inches) in length (Proctor 1991). The white axillary flowers are unisexual and the plants are either male or female (dioecious) (Breckon and Kolterman 1993). The flowers have a thin, reduced corolla that is adnate at its apex to the apical rim of the calyx. Breckon and Kolterman (1993) specified that all other species of the genus apparently have bisexual flowers. The plants remain dense and shrubby in open, exposed habitats, but in closed vegetation the branches become divaricating and form obtuse angles that hook the plant into the surrounding trees, forming a clambering, rigidly branched liana (Breckon and Kolterman 1993). (USFWS, 1999)

Taxonomy

Cordia L. is a genus of about 250 or more species octrees and shrubs of tropical and subtropical regions (Breckon and Kolterman 1993). Cordia bellonis was described by Urban (1899). Britton and Wilson (1925) described this species as a member of Varronia (USFWS, 1999).

Historical Range

See current range/distribution.

Current Range

It is known from only three public forests: Maricao, Susua, and Rio Abajo in Puerto Rico (USFWS, 1999). The scrambling growth form and plants that have reached the canopy make the species difficult to detect. (USFWS, 2017).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 1999)

Breeding Season

Adult: October - January (USFWS, 1999). In general, the flowering period of C. bellonis occurs during the rainy season. The fructification period was recorded from the end of the rainy season and continues until the dry season (September-February). Immature fruits were synchronic from October to December and mature fruits from November to January. Observations made on female individuals indicate that fruits in C. bellonis plants mature

unequally. Female plants were seen with mature and immature fruits at the same time, and all fruits were single seeded. No evidence of fructification was observed in any male individuals (Sánchez-Cuervo 2006). (USFWS, 2017).

Other Reproductive Information

Adult: According to Sánchez-Cuervo (2006), recruitment does not occur every year. She noted that no recruitment occurred in February 2004 in known localities compared to 2005. The recruitment period occurred during the short dry season and the beginning of the rainy season. According to her observations, recruitment occurs in one or two months around the fructification period (February) suggesting a short latency period. (USFWS, 2017). Sánchez-Cuervo (2006) also conducted diurnal and nocturnal observations during the flowering period from August to November 2004 in 3 females and 6 males to document the presence of floral visitors or pollinators. She documented 4 species of insects visiting the flowers. The most frequent visitor was a moth from the Noctuidae family (Lepidoptera), and the second most abundant species of visitor was the honey bee (Apis mellifera L. (Hymenoptera:Apidae). Other two species from the Syrphidae (fly) and Pompilidae (wasp) families were also recorded. Sánchez-Cuervo (2006) also collected some specimens of the visitors to determine the presence of pollen in their bodies. Since no pollen from C. bellonis was detected on any insect part, it was not possible to determine the presence of a "true" pollinator for the species. These visitors caused no harm to the floral parts and there was no preference to visit either male or female plants. (USFWS, 2017). Sánchez-Cuervo (2006) conducted diurnal and nocturnal observations in Maricao during the fructification period of November 2005 to determine the potential seed dispersal agents for C. bellonis. Her observations indicated that the majority of the fruits matured in the plant until the pericarpus (wall of the ripened fruit) was colonized or invaded by fungus and fell directly on the floor. The majority of seedlings observed were found under the canopy of female plants. According to Sánchez-Cuervo (2006), seed dispersal could be carried out by birds because of the pericarpus morphology and color of the fruit. (USFWS, 2017). Data to obtain information on average monthly growth was collected by Sánchez-Cuervo (2006) from 40 seedlings which germinated approximately in February and March 2005 after the previous fructification season (September 2004-February 2005). Seedlings grew an average of 0.46 cm from April to May and presented an average height of 3.23 cm at the beginning of the observation period (April 2005). The highest growth rate (0.83) and an average height (5.44 cm) were recorded in October, during the rainy season. Data from material germinated at the tree nursery of the Cabo Rojo National Wildlife Refuge indicated that individuals may develop into reproductive plants in less than 2 years if maintained under nursery conditions (O. Monsegur, Service, 2012, pers. obs.). (USFWS, 2017). Observations made indicate that this species do not form seed banks possibly due to soil depth (low profile). Soil type may also influence the establishment of seed banks under C. bellonis plants. Seed producers were found in serpentine soils and Nipe and Rosario soil series. These soils are characterized by their clay-like and sticky texture, which can make the seed emergence to the soil surface difficult. However, seedbank formation may not be discarded as it has been documented for other related species such as V. rupicola, and this may represent a strategy to colonize areas or colonize gaps when conditions are favorable. (USFWS, 2017).

Reproduction Narrative

Adult: Produces flowers and fruit at least from October through January. Honeybees and other insects have been observed visiting flowers USFWS, 1999). The species of Cordia typically have perfect (bisexual) flowers, and some species exhibit heterostyly; meaning that some plants

produce flowers with short styles and long stamens, while other plants produce flowers with long styles and short stamens (Breckon and Kolterman 1993). These authors established that this condition favors outcrossing. Breckon and Kolterman (1993) reported asexual reproduction in the wild, some stems creep along the ground or under the leaf litter, and some of these were observed producing roots. Breckon and Kolterman (1996) grew 26 plants from seeds collected in Maricao; the sex ratio estimated for the cultivated plants was 7 females to 4 males (USFWS, 1999).

Habitat Vegetation or Surface Water Classification

Adult: Subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: ~752 - 2681 ft. elevation (USFWS, 1999)

Environmental Specificity

Adult: Moderate (inferred from EPA, 2016)

Habitat Narrative

Adult: It is found at road edges, river margins, and steep slopes in Maricao and Susua. In Rio Abajo, it is found along sunny banks along dirt roads, growing in thickets of vegetation, and in open saddles between limestone hills. Life zones include: subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest. Topography is The area has serpentine outcrops interspersed with Nipe and Rosario clay soils (derived from serpentine). Occurs between 752 to 817 ft. (Susa); 1442 to 2681 ft. (Maricao) (USFWS, 1999).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

3 Localities (USFWS, 2023)

Population Size:

516 total (USFWS, 2023)

Additional Population-level Information:

Approximately 226 individuals of C. bellonis were reported by Sánchez-Cuervo (2006) from the Maricao (192), Río Abajo (34) and Susúa (0) Commonwealth Forest. However, initial surveys under an ongoing project between the Service, PRDNER and the Royal Botanical Garden (KEW) to determine the population status of C. bellonis (Coop. Agreement F15AC01225) shows that as of the day of this review there are at least 275 detected individuals within the Maricao (255) and Río Abajo Commonwealth Forest (20), with further surveys planed along the northern karst and the Susúa Commonwealth Forest (Hamilton 2017). Some individuals are at sites of reintroduction. (USFWS, 2017). According to Sanchez-Cuervo (2006), the species may be

extirpated from the Susua Commonwealth Forest, and some historical locations in the Rio Abajo and Maricao Commonwealth forests were not located during the research. In addition, the distribution of the species in Puerto Rico has expanded to privately owned lands within the municipality ofMaricao, and in the municipalities of Ciales and Utuado (Hamilton 2017). (USFWS, 2019).

Population Narrative:

Only 81 individuals of Cordia bellonis are known to occur in the wild (USFWS, 1999). In summary, based on recent research on the species' status, the cumulative observation records of C. bellonis includes 516 individuals divided across three size classes (adults = 339, saplings = 87, seedlings = 90; Table 1) (Hamilton 2022b), and individuals found to be extant at all the known historical collecting locations and at several new localities in the municipalities of Arecibo, Ciales, Lares, Maricao, Sabana Grande, San German, and Utuado (Hamilton 2020a; Hamilton 2018c). However, the species is not uniformly distributed across the suitable habitat (O. Monsegur-Rivera, 2008-present, pers. obs.). Although the 2017 5-year review discussed that the species likely occurred across un-surveyed areas supporting suitable habitat, recent extensive habitat surveys indicate that the species was not as abundant and widespread as expected. Although there is localized evidence of natural recruitment across the species' range, C. bellonis remains rare within its habitat and there is evidence of ongoing threats affecting the species (e.g., urban development, road maintenance, utilities right of ways, agriculture, and invasive species) as well as other interrelated effects (e.g., species dioicous reproductive biology; see discussion below under the Threats Summary below) that can affect the species' abundance and its long-term viability (Hamilton et al 2021). Therefore, we believe the slight increment in the number of recorded individuals could be attributed to a wider habitat sampling compared to previous research and that may not necessarily imply the number of individuals is naturally augmenting or that populations are expanding (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 1999).
Exposure:
Response:
Consequence:
Narrative: Destruction and modification of the habitat are considered to be the most significant factors affecting the numbers and distribution of Cordia bellonis. In Maricao, the species is found at 17 localities in three areas, with a total of87 individuals. Thirty-four of these individuals were eliminated due to clearing along the roadside and the reconstruction of Road 362. Half of the localities consist of isolated individuals. Because the majority of these individuals occur along both sides of two public roads, maintenance of road sides, as well as fires and vandalism, may result in the loss of these individuals. In Susua, a small population of only 5 individuals was found in 1992. The species was previously unknown from this area. This small population may be affected by certain forest management practices. Ninety-five individuals were located along the construction route for a highway (which is now completed) and were removed for possible future transplantation. Of the remaining 23 individuals, 13 have been found in an area designated for compensation (mitigation) for the highway and 10 are found in highway rights-of-way. The species is also known from a private landholding where extraction of fill material for the construction of the road will likely result in the loss of these plants (USFWS, 1999). Activities along Road PR-120 in Maricao Commonwealth Forest continue to be a threat to the species.

(USFWS, 2019).

Stressor: Other natural and manmade factors (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Human-induced fires, river flooding, landslides, hurricanes. (USFWS, 2019).

Stressor: disease or predation (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: In the 2017 status review, impacts due to disease or predation were not considered a threat to C. bellonis. However, researchers have documented Petrusa epilepsis (an insect pest) and an unknown insect that promotes the formation of galls on C. bellonis in wild populations (Hamilton 2016, Hamilton 2017a, Hamilton 2018e). However, these pests do not currently appear to be detrimental to the species (e.g., reducing the reproductive output), and the galls has been recorded in historical specimens, suggesting it may be a native insect (Monsegur-Rivera 2010-present, pers. obs.). Additionally, material of C. bellonis under nursery conditions have been affected by scale insects, requiring direct treatment and application of pesticides for the control of this pest (Hamilton and Dani-Sanchez 2021, Hamilton et al. 2021). This suggests that insect pests may be a threat the species and cautions must be taken when moving C. bellonis material from the nursery to the wild. Most of the evidence of animal foraging on the fruits of C. bellonis corresponds to the exotic Ratus ratus (black rat), which may be a limiting factor affecting the species dispersal patterns and likely its populations genetics (USFWS, 2023).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Maricao, Susua and Rio Abajo Commonwealth Forests (USFWS, 1999).

2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas. One of these populations should be established using the 111 individuals already located at the Cambalache greenhouse (USFWS, 1999).

Amended criteria in 2019: 1) Existing three (3) main populations at Rio Abajo, Maricao and Susua Commonwealth forests show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Amended criteria in 2019: 2) Existing three (3) populations on privately-owned lands in Maricao, Ciales and Utuado arc protected via a conservation mechanisms, and show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A

and E). (USFWS, 2019).

Amended criteria in 2019: 3) Threat reduction and management ·activities have been implemented to a degree the species will remain viable into the foreseeable future (addresses Factor E). (USFWS, 2019).

Recovery Actions:

- Educate the public on conservation values and regulations (USFWS, 1999).
- Search for additional populations and potential habitat suitable for reintroduction efforts (USFWS, 1999).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1999).
- Conduct propagation and enhance existing populations and establish new ones on protected lands (USFWS, 1999).
- Annually assess the overall success of the recovery program and recommend actions (USFWS, 1999).
- Protect the existing populations and its habitat through the development and implementation of a management plan for the Maricao, Susua and Rio Abajo Commonwealth Forests (USFWS, 1999).
- Monitor known populations (USFWS, 1999).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1999).
- Reintroduce transplanted individuals (USFWS, 1999).
- 2017 Recommended actions: a. The PRDNER and the Service should develop a comprehensive survey program to inventory areas with potential habitat for C. bellonis in Río Abajo, Susúa and Maricao Commonwealth Forests. (USFWS, 2017).
- 2017 - b. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability. (USFWS, 2017).
- 2017 - c. Development of a habitat suitability model for the species (USFWS, 2017).
- 2017 - d. Development of management plans or establishment of management practices in areas where the species occur to avoid and/or minimize impacts by road or trails maintenance activities. (USFWS, 2017).
- Conservation measures provided to federally listed species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private groups and individuals. The Endangered Species Act provides for possible land acquisition in cooperation with the States and requires that recovery actions be carried out for all listed species. Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is listed as federally endangered or threatened. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Fish and Wildlife Service (USFWS, 1999).
- Studies of the distribution, abundance, population size and structure, and reproductive biology of Cordia bellonis have been ongoing since 1993. These studies have provided information on the threats to the species. Preliminary results from these studies have been incorporated into this recovery plan (USFWS, 1999).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. The PRDNER and the Service should develop a comprehensive survey program to inventory further areas with potential suitable habitat for C. bellonis within the northern karst (FACF) and moist serpentine soils (SCF and MCF). a. The above surveys should be prioritized based on the development of a habitat suitability model for the species. 2. Provide training to forest managers and development of management plans or best management practices in areas where the species occur to avoid and/or minimize impacts by road or trails maintenance activities. This may include signage along trails and roads. 3. Develop a long-term monitoring program of C. bellonis populations to establish population trends (including recording survival of seedlings and evidence of natural recruitment). 4. Develop and implement a seed collection and propagation protocol, which considers the populations along the northern karst and serpentine soils are genetically distinct to secure the availability of plant material for enhancing existing populations. a. Based on the species populations genetics, material from limestone and serpentine soils must not be planted together. 5. A critical step for the long-term conservation of the species is the accession of seed (seed banking) and live material from all known localities across the species range to be secured in ex situ locations for conservation (USFWS, 2023).

References

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SPECIES ACCOUNT: *Cordylanthus maritimus ssp. maritimus* (Salt marsh bird's-beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1978; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A hemiparsitic annual herb, 1-3 dm tall, with grayish-green, herbage, often tinged with purple. Specimens are branched and may be up to 16 inches (40 centimeters) tall with numerous flowers arranged on flower stalks termed spikes. The flowers of some C. maritimum taxa have showy pale pink pouches with darker purple lips on purplish-green plants. The hairiness of the foliage and stems is variable, and most plants have visible salt-encrusted glandular hairs. Chloropyron maritimum ssp. maritimum may occur as short, erect, scarcely branched plants, or as plants with a profusion of spreading or ascending branches. (USFWS, 2013; NatureServe, 2015)

Taxonomy

At the time Chloropyron maritimum ssp. maritimum was listed (as Cordylanthus maritimus ssp. maritimus), the genus Cordylanthus was placed in the Scrophulariaceae (figwort family). However, based on molecular systematic studies using DNA sequences of three plastid genes, Olmstead et al. (2001) transferred the hemiparasitic group Castillejiinae, including Cordylanthus, to the Orobanchaceae. Though the taxon continues to be called Cordylanthus maritimus ssp. maritimus on the Federal List of Threatened and Endangered Wildlife and Plants (List) pursuant to the Endangered Species Act (Act) (16 U.S.C. 1531 et seq.), here we use the currently accepted name, Chloropyron maritimum ssp. maritimum. The species is divided into northern and southern coastal subspecies, and an inland subspecies. Chloropyron maritimum ssp. maritimum, the southern California coastal subspecies, is distinguished from the northern ssp. palustris, mainly by geographic distribution in that it occurs from Morro Bay south through southern California. It is also distinguished by branching patterns, growth habit, narrower and more acute leaves, and variations in seed size and floral traits (Chuang and Heckard 1973, 1993). The three intergrading subspecies have distinct ecological and geographical distributions. Chloropyron maritimus ssp. canescens (hoary salt marsh bird's-beak) is a widely distributed, but uncommon, plant of inland saline/alkaline wetlands of the Great Basin; Chloropyron maritimum ssp. maritimum (salt marsh bird's-beak), an endangered tidal marsh plant limited to few populations in southern California and Baja California, Mexico; and Chloropyron maritimum ssp. palustre (Point Reyes bird's-beak), a similar rare tidal marsh plant from San Francisco Bay to Oregon. (USFWS, 2013)

Historical Range

Historically, C. maritimum ssp. maritimum was widespread near the upper edges of coastal tidal marshes from Morro Bay in San Luis Obispo County to San Diego County and northern Baja California. (USFWS, 2013)

Current Range

Chloropyron maritimum subsp. maritimum is currently known to persist in seven coastal salt marshes: San Diego County at Tijuana Estuary (separated into Border Field State Park and

Tijuana Slough NWR), Naval Radar Receiving Facility (NRRF), and Sweetwater Marsh Unit of San Diego Bay NWR; Orange County at Upper Newport Bay (State) Ecological Reserve; Ventura County at Naval Base Ventura County, Point Mugu; Santa Barbara County at Carpinteria Salt Marsh; San Luis Obispo County at Morro Bay. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Bees are thought to be the principal pollinators of ssp. maritimum at other locations (Parsons and Zedler 1997).

Breeding Season

Adult: May to October (USFWS, 2009)

Reproduction Narrative

Adult: Chloropyron maritimum subsp. maritimum is a taxon of annual plants in the Orobanchaceae (broom rape family). The flowering period is between May and October (Munz 1974, p. 801; Naval Base Ventura County Point Mugu 2003, p. 1). Each flower may produce 10-40 seeds with an average of 15 to 20 seeds per capsule (Chuang and Heckard 1993, p. 1029). (USFWS, 2009)

Habitat Type

Adult: Estuarine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Requires water salinities between 5 to 33 parts per thousand and less than 12 parts per thousand for germination (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Requires periodic tidal inundation; prefers brackish to tidal marsh with low vegetative cover (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Plants have naturally patchy distributions in sites subject to only higher tidal influxes in coastal salt marshes. (USFWS, 2009). The range of salinity associated with growth of ssp. maritimum is 5 to 33 parts per thousand, but pulses of freshwater from flooding or rainfall are probably necessary for germination (Parsons and Zedler 1997). Salinity at the time of germination usually cannot exceed 12 parts per thousand (Newman 1981). Populations generally occur in areas with low salinity in the spring and low vegetative cover (Newman 1981, Dunn 1981). Cordylanthus maritimus spp. maritimus roots form haustoria to obtain water and nutrients through the roots of other host plants. Chloropyron maritimum ssp. maritimum can grow without host plants (Chuang and Heckard 1971), but hemiparasitism may permit them to flourish in the hot, dry, higher soil-salinity conditions of summer (Vanderwier and Newman 1984). (USFWS, 2013; USFWS, 2009)

Dispersal/Migration

Dispersal

Adult: High (USFWS, 2013)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals, especially birds (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Physical factors such as currents, tides, wave action, and sheet erosion are among the ways seeds are moved around within and between marshes. The seeds of C. maritimum ssp. maritimum have a honeycombed surface that traps air bubbles and makes them highly buoyant. They have been shown to float for up to 50 days and floatation may be the primary local dispersal mechanism for C. maritimum ssp. maritimum (Newman 1981). Animals, especially birds, may carry the seeds on their feet, or in their fur, feathers, or digestive systems (U.S. Fish and Wildlife Service 1985a). (USFWS, 2013)

Population Information and Trends

Population Trends:

Decline of >30% (NatureServe, 2015)

Number of Populations:

9 (USFWS, 2020)

Population Size:

30,000 (highly variable) (NatureServe, 2015)

Population Narrative:

CHMAMA is currently extant at nine coastal marsh complexes across the species' range, including seven marsh complexes in the United States [Morro Bay, Carpinteria Salt Marsh, Ormond Beach/Mugu Lagoon, Upper Newport Bay, San Diego River Mouth, San Diego Bay (including Sweetwater Marsh) and Tijuana Estuary], and two marsh complexes in Baja California, Mexico (Estero Punta Banda, and Bahía de San Quintín). One new population has been

established since the last 5-year review, at the San Diego River Mouth. Conservation efforts have occurred and are ongoing throughout the subspecies' range, including work to introduce CHMAMA at Magnolia Marsh, within the Huntington Beach Wetlands. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat loss (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Historically, Chloropyron maritimum subsp. maritimum occurred in many more salt marshes than it did at the time of listing. Many of these salt marsh areas were either filled in for development (e.g. Artesia and Long Beach in Los Angeles County) or cleared for marinas (e.g. Mesmer near Santa Monica in Los Angeles County). Diversion of fresh water from the salt marsh areas may also have led to the habitat becoming unsuitable to sustain C. maritimum subsp. maritimum populations. (USFWS, 2009)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Impacts from off-highway vehicles have been reported for some occurrences of Chloropyron maritimum subsp. maritimum (CNDDB 2008). These occurrences are in San Diego County in an area of the Tijuana Slough NWR in the Tijuana Estuary where OHV activity is controlled by the Refuge managers; in Orange County at Upper Newport Bay where OHV activity is controlled by managers of the Upper Newport Bay State Ecological Reserve; in Ventura County at Ormond Beach where OHV activity is controlled to a degree by the Coastal Conservancy and The Nature Conservancy's Conservation Easement, and at the Ventura County Naval Base Point Mugu (CNDDB 2008). Potential impacts from OHVs are currently minimal and management measures are in place to minimize these impacts. (USFWS, 2009)

Stressor: Hydrological changes (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Modification for natural tidal flow in Point Mugu Lagoon in Ventura County, noted as a threat in the listing rule, was completed in about 1980. As a result, a portion of the populations at the occurrence were destroyed, but most remained. Since listing, increased tidal flow at one site in the Carpinteria Marsh in 1984 reportedly created wetter conditions (CNDDB 2008, EO 17). However, there are no subsequent reports on the precise location of the site or condition of plants in the area and occurrences in the area are presumed to be extant (CNDDB 2008). Hydrological alterations to promote populations of endangered birds (e.g., light-footed clapper rail) have taken place at historical occurrence sites of Chloropyron maritimum subsp. maritimum, though the impact on plant populations is unknown. (USFWS, 2009)

Stressor: Global climate change (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: According to the Intergovernmental Panel on Climate Change (IPCC) there has been a general but measured increase in global average temperatures since the turn of the century (IPCC WG I 2007, p. 6). This translates to the fact that the average temperature of the ocean has also risen. The same is true for global average sea level (IPCC WG I 2007, p. 6). The total rise in sea level during the 20th century is estimated to be about 0.56 feet (0.17 meters). This means that the tidal flows will encroach further into all coastal marshes including those that support C. m. subsp. maritimum. The impact on distribution of associated vegetation and host plants is unknown. Although the degree of sensitivity Chloropyron maritimum subsp. maritimum to incremental changes in sea level is unknown, ultimately, it is likely that the full extent and distribution of populations will be affected and likely move inland or up the elevational gradient. The populations could potentially migrate inland in step with changes in the estuarine hydrology as long as the physiography of the site allowed. The physiography of each occurrence differs, which in turn dictates whether or not C. maritimum subsp. maritimum can naturally migrate to other suitable sites. The potential for adjacent habitats to become suitable for C. maritimum subsp. maritimum as the inundation regime changes also likely varies from occurrence to occurrence. Habitat for C. maritimum subsp. maritimum at generally broad open estuaries such as Tijuana Estuary in San Diego County and Point Mugu in Ventura County would persist more readily than that at Newport Bay in Orange County where the adjacent bluffs could preclude inland migration of the habitat. Sea level rise poses a significant rangewide threat to all extant occurrences of C. maritimum subsp. maritimum and coastal marsh areas under consideration for restoration and/or enhancement. (USFWS, 2009)

Stressor: Storm drain runoff (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, erosion from storm drain runoff is listed as a threat to occurrences in Upper Newport Bay in Orange County (CNBBB 2008). This runoff is generated by neighborhoods on the bluffs above the bay. Projections of precipitation as less snow and more rain (CEC 2006, p. 31) mean that there would likely be more runoff than is currently experienced. The amount and timing of runoff impacts coastal salt marsh habitat and any changes due to climate change likely result in changes to the condition and distribution of suitable habitat for Chloropyron maritimum subsp. maritimum. (USFWS, 2009)

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, herbivory by the microlepidopteran, salt marsh snout moth (Lipographis fenestrella) has been documented (Parsons and Zedler 1997, p. 259). This is listed in CNDDB as insect damage for a few of the occurrences (Appendix 1). The larvae of the moth consume capsules and even unfertilized ovaries, however, a large number of capsules escape attack (Parsons and Zedler 1997, p. 259). These authors report that although there was more damage between mid-May and mid-June there was no correlation with environmental variables. The extent and impact of herbivory to populations of Chloropyron maritimum subsp. maritimum is unknown. (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, new threats from trampling have been reported for occurrences at the Naval Radar Receiving Station (NRRF), San Diego County, Upper Newport Bay Ecological Reserve, Orange County, and at the south end of Morro Bay, San Luis Obispo County (Appendix 1). The extent and persistence of the threats from trampling is unknown. (USFWS, 2009)

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing nonnative plants (e.g. Limonium spp. (sea-lavender) and Carpobrotus spp. (sea-fig)) have been noted as a new threat to Chloropyron maritimum subsp. maritimum at occurrences in Santa Barbara County (e.g., Carpinteria) (CNDDB 2008) and San Luis Obispo County (e.g., Morro Bay) (CNDDB 2008). No specific impacts were provided, thus the nature and magnitude of this threat cannot be assessed at this time. These invasive plants may alter movement and availability of fresh water or otherwise preclude germination and growth of the Chloropyron maritimum subsp. maritimum and/or its hosts. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. Fifteen acres [6 hectares] of secured and protected high marsh habitat at appropriate elevations is required at a minimum of eight marshes for a period of at least five consecutive years. (USFWS, 2009)

Delisting Criteria:
1. Twenty acres [8 hectares] of secured, protected, and managed high marsh habitat at appropriate elevations is required at each of the 12 major marshes within the historical range of the plant for a period of ten consecutive years. (USFWS, 2009)

Recovery Actions:
- Conservation easements or fee-title purchase from willing sellers should be sought to place remaining undeveloped shoreline under protective ownership. (USFWS, 2013)
- Many of the threats facing the subspecies are aggravated by its small population size and limited range-wide distribution; therefore, population augmentation and initiation of new subpopulations in suitable unoccupied habitat at Morro Bay should be planned and implemented to reduce the risk of regional extinction. (USFWS, 2013)
- Morro Bay populations of Chloropyron maritimum ssp. maritimum are sensitive to trampling and disturbance and should be protected, by use of fencing, against recreational pressures from nearby residential areas and from park visitors. Access and trails should be routed away from sensitive habitat. Boat haulouts near populations of C. maritimum ssp. maritimum must be curtailed. Dredge disposal should be managed to minimize the risk of sand movement burying subpopulations of the species. (USFWS, 2013)
- Shoreline stands of Carpobrotus edulis (iceplant) should be eradicated and replaced with native marsh-upland ecotone vegetation. Other non-native plants should be controlled to

prevent crowding, shading, or other impacts to the salt marsh bird's-beak and its habitat. (USFWS, 2013)

- Populations of Chloropyron maritimum ssp. maritimum should be monitored annually for distribution, abundance, and reproductive output. (USFWS, 2013)
- Continuing and new threats should be identified and reported. Disturbances and sand dune movement should be monitored, and measures to address impacts—as well as to evaluate the success of these measures—should be developed. (USFWS, 2013)
- Management plans that address protective and population augmentation actions for Chloropyron maritimum ssp. maritimum should be developed and implemented for lands in public or conservation ownership. (USFWS, 2013)
- Resurvey historical and extant occurrences, especially inland salt marsh habitats, to detect presence and local distribution of plants. There is some potential for the inland occurrences to have persisted. (USFWS, 2009)
- Develop a threats-based recovery plan to guide conservation actions for the species. Incorporate SLAMM assessments of sea level change. (USFWS, 2009)
- Determine the distribution of genetic diversity at extant occurrences. This will assist us in identifying pollinators and pollen sources should pollen transfer among occurrences prove necessary. As part of this effort, verify the subspecific relationships of the occurrences in Morro Bay. (USFWS, 2009)
- Prepare site specific monitoring protocols to determine, if possible, fine-scale habitat requirements and species fidelity to those habitat requirements. This will allow us to discriminate between lack of seed dispersal and unsuitable habitat as explanations for discontinuities in plant distributions. (USFWS, 2009)
- Establish site and species monitoring protocols, based on those developed by VFWO at Point Mugu, to identify potential impacts of sea level changes associated with climate change. This will help detection of species responses to long term changes in sea level and associated vegetation. (USFWS, 2009)
- Work with partners to help conserve Chloropyron maritimum subsp. maritimum. Identify opportunities through the Service's Partners for Fish and Wildlife and Coastal Programs to seek habitat restoration and enhancement opportunities. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Continue to work with partners to expand the current distribution of CHMAMA, including planning, site selection, and augmentation and reintroduction efforts. 2. Collect voucher specimens and conduct genetic work to resolve taxonomic questions about the distribution of the listed entity, especially at Morro Bay. 3. Continue to support partners in removing nonnative Limonium from occupied marshes. Conduct additional research into CHMAMA seed tolerance to solarization when treating Limonium. 4. Engage stakeholders and species experts in CHMAMA sea-level rise planning. 5. Conduct additional research into environmental covariates important for CHMAMA abundance at marshes, using existing monitoring data where available. (USFWS, 2020)

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SPECIES ACCOUNT: *Cordylanthus mollis ssp. mollis* (Soft bird's-beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/20/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Chloropyron molle ssp. molle is an erect annual herb in the Orobanchaceae (broomrape) family. Mature plants range from approximately 10 to 40 cm (4 to 16 in) tall. Stems and leaves are gray-green, often purple-tinged, and covered with very fine hairs bearing glands as well as longer soft non-glandular hairs. Leaves and stems are sparsely to heavily covered with crystals of salt exuded from leaf glands. Leaves are typically 1.0 to 2.5 cm (less than 0.5 to 1.5 in long, oblong, and may be entire or pinnately lobed 3 to 7 lobes). The tubular flowers are pale cream to yellowish at the tip, and crowded together in spikes 5.0 to 15.0 cm (2 to 6 in long). The fruit is a capsule, approximately 8 mm (0.3 inch) long (Ruygt 1994). (USFWS, 2013)

Taxonomy

At the time Chloropyron molle ssp. molle was listed (as Cordylanthus mollis ssp. mollis), the genus Cordylanthus was placed in the Scrophulariaceae (figwort family). However, based on molecular systematic studies using DNA sequences of three plastid genes, Olmstead et al. (2001) transferred the hemiparasitic group Castillejiinae, including Cordylanthus, to the Orobanchaceae, thereby placing it in the genus Chloropyron. The species Cordylanthus mollis was split into two subspecies by Chuang and Heckard (1973), based on geographic variation in spike length, branching pattern, corolla hair density, seed size, and hair stiffness. Chloropyron mollis ssp. hispidus is distinguished from ssp. molle by its pronounced bristly stem and leaf hairs, and its growth habit of branching strongly from the base of the plant. The flowers of ssp. hispidus are sparsely hairy, not densely tomentose (woolly) as in ssp. mollis. Within its range, Chloropyron molle ssp. molle can be distinguished from two other taxa in the Scrophulariaceae that occur in brackish tidal marshes: Chloropyron maritimum ssp. palustre and Castilleja ambigua. When in flower, C. maritimum ssp. palustre is readily distinguished from C. molle by its rose-purple and pinkish-white flowers, and the presence of four fully developed stamens (not two plus two vestigial stamens, as in C. molle). The inner bracts of C. maritimum ssp. palustre are notched, not lobed, while the bracts of C. mollis are pinnately lobed. C. ambigua flowers in spring (variably late March to May) before C. molle. The bracts and leaves of C. ambigua are palmately cleft, not pinnately lobed as in C. molle. Although, typical C. ambigua ssp. ambigua has white and yellow flowers like C. molle, the Point Pinole population of ssp. ambigua and other historical San Francisco Bay populations have flowers that mature and senesce with a purplish tinge (P. Baye unpubl. data 1997-2000), as do the white-tipped bracts (Chuang and Heckard 1993). In contrast, the bracts of C. molle are gray-green or a blend of gray-green and dull dark purplish highlights, and its flowers are creamy yellow or yellowish-green and lack an open beak tip that allows the stigma to protrude (Chuang and Heckard 1993). (USFWS, 2013)

Historical Range

Endemic to California, reported from Contra Costa, Marin, Napa, Solano, Sonoma, Sacramento, and Del Norte counties. (NatureServe, 2015)

Current Range

The species is currently restricted to widely scattered populations in Napa, Solano, and Contra Costa Counties, from Point Pinole and Fagan Slough marsh through the Carquinez Strait to Suisun Bay. (USFWS, 2009)

Critical Habitat Designated

Yes; 4/12/2007.

Legal Description

On April 12, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cordylanthus mollis ssp. mollis (Soft bird's-beak) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in California (72 FR 18518-18553).

Critical Habitat Designation

The critical habitat designation for Cordylanthus mollis ssp. mollis includes five CHUs in Contra Costa, Napa, and Solano Counties, California. This species critical habitat encompasses approximately 2,276 acres (ac) (921 hectares (ha)) (72 FR 18518-18553).

Unit 1: Fagan Slough Marsh (Napa County): Unit 1 consists of approximately 384 ac (156 ha) located adjacent to the Napa River to the west, Napa County Airport to the east, Fagan Slough to the south, and Steamboat Slough to the north. This unit consists of 297 ac (120 ha) of Stateowned land (Fagan Slough Ecological Reserve), which is managed by the CDFG, 6 ac (2 ha) of county-owned land, 9 ac (4 ha) of land owned by the City of Napa, and 72 ac (29 ha) of privately owned land. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations regularly (NWI 2005) from the abovementioned tidal sloughs and the Napa River.

Unit 2: Hill Slough Marsh (Solano County): Unit 2 for Cordylanthus mollis ssp. mollis consists of approximately 525 ac (213 ha) located north of Potrero Hills between Grizzly Island Road and Highway 12. The unit consists of approximately 440 ac (178 ha) of Stateowned land (Hill Slough Wildlife Area), which is managed by the CDFG, and 85 ac (35 ha) of privately owned land. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations irregularly (not daily) (NWI 2005) from Hill Slough and a flood control channel along the western unit boundary.

Unit 3: Point Pinole Shoreline (Contra Costa County): Unit 3 consists of approximately 22 ac (9 ha) located along the Contra Costa shoreline in San Pablo Bay just east of Point Pinole. This unit consists of 13 ac (5 ha) of County-owned land (Point Pinole Regional Shoreline Park), which is managed by the East Bay Regional Park District, and 9 ac (4 ha) of Stateowned land. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations on a regular basis (NWI 2005) from natural and artificial (dredged) tidal channels within the unit. Additional special management considerations or protections beyond those discussed above may be required to minimize the impact of industrial or commercial encroachment from the south that could increase stormwater and wastewater runoff into the unit.

Unit 4: Rush Ranch/Grizzly Island Wildlife Area (Solano County): Unit 4 for Cordylanthus mollis ssp. mollis consists of approximately 1,181 ac (477 ha) located adjacent to Suisun Slough to the west, Cutoff and Montezuma Sloughs to the south, and Potrero Hills to the North. This unit consists of 231 ac (93 ha) of State-owned land (Joice Island portion of the Grizzly Island Wildlife Area), which is managed by the CDFG, and 950 ac (384 ha) of land owned and managed by the Solano Land Trust (local non-profit public land trust). Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations regularly (at least once daily) (NWI 2005) from the above-mentioned tidal sloughs).

Unit 5: Southampton Marsh (Solano County): Unit 5 consists of approximately 164 ac (66 ha) of State-owned land managed by the California Department of Parks and Recreation (CDPR) as a wetland natural preserve (CDPR 1991, p. 44). The unit is located in the Benicia State Recreational Area along Interstate Highway 780 and just northwest of the City of Benicia. Cordylanthus mollis ssp. mollis occupied the unit at the time of listing as identified in the final listing rule (62 FR 61916; November 20, 1997) and contains the features essential to the conservation of C. mollis ssp. mollis. The unit receives tidal inundations on a regular-to-irregular basis (NWI 2005) from natural and artificial (dredged) tidal channels within the unit. Additional special management considerations or protection of the PCEs beyond those discussed above may be required to minimize the impact of residential encroachment from the north that could increase stormwater and wastewater runoff into the unit.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cordylanthus mollis ssp. mollis critical habitat consists of three components (72 FR 18518-18553):

(i) Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);

(ii) Open channels that periodically contain moving water with oceanderived salts in excess of 0.5 percent; and

(iii) Gaps in surrounding vegetation to allow for seed germination and growth.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be occupied at the time of listing and that contain the PCEs may require special management considerations or protection. Most of the PCEs and the known occurrences of Cirsium hydrophilum var. hydrophilum and Cordylanthus mollis ssp. mollis are threatened by: (1) tidal wetland conversions to diked, managed, or muted tidal marshes; (2) changes to channel water salinity and tidal regimes; (3) mosquito abatement activities; (4) marsh invasions by nonnative plants; (5) plant-eating insects; (6) urban, industrial, and agricultural encroachment; (7) impacts from livestock overgrazing; (8) feral pigs (Sus scrofa); and (9) impacts from unauthorized foot and off-road vehicle traffic. These combined threats result in the loss and fragmentation of suitable habitat for C. hydrophilum var. hydrophilum and C. mollis ssp. mollis, which could significantly affect their

long-term survival. Individually, these threats may require special management considerations or protection as addressed under the critical habitat unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: July to September (NatureServe, 2015)

Reproduction Narrative

Adult: Cordylanthus mollis ssp. mollis is a hemiparasitic annual herb in the Orobanchaceae (broomrape) family with flowers that bloom from July to September. The number of seeds produced per plant ranged from 91 to 790, depending on year and microhabitat (Futrell in litt. 2013). C. mollis ssp. mollis can hybridize with C. mollis ssp. hispidus indicating sexual reproduction (USFWS, 2009; USFWS, 2013)

Habitat Type

Adult: Estuarine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Tidal flat/shore (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers higher soil salinity and hydroperiods (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Found in high marsh near limits of tidal action (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2013)

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: As a hemiparasitic plant, seedling survival in Cordylanthus mollis ssp. mollis is critically dependent on establishing an early connection with a suitable host plant. (USFWS, 2009)

Habitat Narrative

Adult: Cordylanthus mollis ssp. mollis is found predominantly in the high marsh (upper reaches) of salt grass-pickleweed marshes at or near the limits of tidal action (Stromberg and Villasenor

1986) and is associated with Salicornia virginica (pickleweed), Distichlis spicata (salt grass), Jaumea carnosa (fleshy jaumea), Frankenia salina (alkali heath), and Troglochin maritima (arrow-grass) (Stromberg and Villasenor 1986). Seedling survival in Cordylanthus mollis ssp. mollis is critically dependent on establishing a connection with a suitable host plant. Typical host plants include Distichlis spicata (salt grass) and Salicornia virginica (pickleweed) (Grewell et. al. 2003, Grewell 2004). Most known Cordylanthus mollis ssp. mollis occurrences are found in regularly flooded and permanently saturated habitats within mixed halophytic plant communities, that is, communities where plants are adapted to live and reproduce in salt or brackish water (NWI 2005) with extended tidal hydroperiods and somewhat higher soil salinity (Grewell 2004). (USFWS, 2009; USFWS, 2013)

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seeds may disperse short distances from parent plants by tidal inundations or animals (Grewell et al. 2003), but successful long-distance dispersal by these or other means has not been documented. Repeated surveys indicate that most dispersal occurs over short distances (Ruygt 1994) on the order of 10 meters [11 yds] or less (Grewell et al. 2003). (USFWS, 2009)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

11 (USFWS, 2009)

Population Narrative:

Although no recent comprehensive status surveys have been conducted, the latest information indicates that 11 extant populations of Cordylanthus mollis ssp. mollis are currently distributed within 50 percent of the historical range and that a large percentage of the remaining plants are in Solano County (Grewell et. al. 2003). In the final listing rule, it was reported that the number of individuals within the populations varied from 1 to 150,000 plants and that most sites varied between 1,000 and 6,000 plants (CNDDB 1996). (USFWS, 2009)

Threats and Stressors

Stressor: Altered tidal regimes (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since listing, continuation of altered tidal regimes still occurs in much of the potential habitat and represents both the most significant historical and current threat to Cordylanthus mollis ssp. mollis and its habitat. With respect to effects to C. mollis ssp. mollis, alteration of tidal regime includes muting of tidal flows, increases in freshwater runoff, or decreases in freshwater

inflows such as diversion of freshwater for agricultural and municipal uses, that increase salinity. (USFWS, 2009)

Stressor: Habitat loss (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Cordylanthus mollis ssp. mollis habitat in the San Francisco estuary has dwindled over the last 200 years, San Pablo Bay and Suisun Bay having experienced 70 and 79 percent reductions in tidal marsh, respectively (Goals Project 1999). Historically, a large portion of tidal marshes in San Pablo Bay were diked and managed for agricultural production and livestock grazing (discussed further under Factor E), whereas, in Suisun Bay, most historical tidal marshes were diked and managed for waterfowl, though cattle grazing also occurred. These historical reductions of habitat have affected the extent and composition of tidal marsh communities. As a result, many native halophytic (salt-tolerant) plants are exceedingly rare in tidal marshes within the estuary (Goals Project 1999). (USFWS, 2009)

Stressor: Muting tidal flows (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Some Cordylanthus mollis ssp. mollis occurrences exist in muted tidal marshes around the perimeter of high tidal areas near Hill Slough and Fagan Slough marshes, where they were once completely diked and managed. The occurrences of C. mollis ssp. mollis populations in muted marshes, though, may likely be a result of dormant seed banks and associated marsh conditions that still promote their establishment. These populations face the risk of extirpation if the levee fails or is unmaintained in the future. Also, future land use and management activities that further mute tidal flows in these marshes may rapidly alter marsh conditions to further restrict or exclude the subspecies from the local plant community (Goals Project 1999). Muting of tidal flows is known to have extirpated Cordylanthus mollis ssp. mollis in at least one instance. Mitigation for the expansion of the Potrero Hills Landfill, initiated in 2002, involved extending tidal flows into a mitigation area to support vernal pool species, thereby reducing, and in some cases eliminating, tidal flows from the Hill Slough area which supported C. mollis ssp. mollis. Continuous hydrologic recorders in place at the site since 2001 to support local restoration research documented the change in hydrology that resulted in negative impacts to C. mollis ssp. mollis. (USFWS, 2009)

Stressor: Freshwater inflow (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Changes to freshwater inflow have also modified the habitat for this species. For example, at BSRA, increased freshwater runoff from nearby urban development has replaced halophytic communities (including species such as Salicornia virginica (pickleweed) with freshwater emergent marsh communities not appropriate as host plants (Grewell, pers comm. 2007). (USFWS, 2009)

Stressor: Agriculture and municipal uses (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: Agricultural and municipal uses have diverted much historical annual inflow of freshwater from the Suisun Marsh and Delta, creating a more saline environment. In addition, artificially variable soil salinities may threaten Cordylanthus mollis ssp. mollis by reducing the distribution and abundance of its host plants. (USFWS, 2009)

Stressor: Sea level rise (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Sea level rise, such as that potentially associated with global climate change, and anticipated associated flood control responses, though not discussed in the listing rule, may impose significant long-term threats to conservation of Cordylanthus mollis ssp. mollis. Conservation of high marsh zones in the face of sea level rise requires landward migration of the marsh profile on broad, sloping plains (Field et al. 1999, Baye 2006). Many alluvial terraces and valleys adjacent to the estuary are bordered by steep levees or are already converted to intensive agriculture, residential, or commercial development. In Suisun and northern San Pablo Bay, however, some undeveloped grazing land remains. Conflicting needs for flood protection, agriculture, and marsh transgression could effectively compress tidal marsh zones to a point at which they could cease to support C. mollis ssp. mollis habitat (Grewell 2006). Land use planning and economic pressures that favor conversion of "underdeveloped" grazing lands contribute to the loss of potential transgressive high marsh habitat for long-term viability of the species (Baye 2006). (USFWS, 2009)

Stressor: Mosquito abatement (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Mosquito abatement activities noted in the final listing rule continue to threaten Cordylanthus mollis ssp. mollis populations, though to a lesser degree than the above threats. Specifically, ditch cleaning and dredging along first order channels for mosquito abatement purposes alter the natural hydrology of the habitat and chemical spraying of vegetation threatens the species as well. Off-road vehicle traffic associated with mosquito control (discussed under Factor A) continues to threaten Cordylanthus mollis ssp. mollis populations in most known locations (Grewell 2005; CNDDB 2006). Foot traffic in Suisun Marsh at the time of listing was believed to contribute to habitat degradation via trampling. Foot traffic remains a threat today, specifically via excessive recreational and research access (Grewell, pers. comm. 2007). (USFWS, 2009)

Stressor: Seed predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Intense seed predation by insects was reportedly observed at Joice Island and Hill Slough within the Suisun Marsh in Solano County (U.S. Fish and Wildlife Service 1997). Insect predation reportedly was responsible for decline in one of the largest populations of

Cordylanthus mollis ssp. mollis. Since the time of listing, much light has been shed on the specifics of C. mollis ssp. mollis seed predation which still poses a threat to populations in Suisun Marsh. Cordylanthus mollis ssp. mollis seed production can be significantly influenced by pre-dispersal seed predation from moth larvae (Saphenista spp., Tortricidae and salt marsh snout moth, Lipographis fenestrella, Pyralidae) (Ruygt 1994; Grewell et al. 2003). Areas with muted tidal regimes can support the subspecies (CDWR 1999), but increased tidal muting can constitute a threat to C. mollis ssp. mollis by increasing the prevalence of unsuitable host plants, and by changing the balance of seed production to seed predation maintained between the plant and seed-eating moths, such as various Saphenista species (Grewell 2004; Grewell 2006). The moth larvae burrow in the sediment during part of their life cycle, so reduced tidal flooding may improve their survivorship. Under full tidal regimes, the interaction between the rare Lepidopteran moth (Cordylanthus mollis specialist) and its rare plant host appears to be in balance (Grewell et al. 2003;Grewell 2004). (USFWS, 2009)

Stressor: Non-native plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Aside from the alteration of natural tidal cycles, the most significant threat to the species is that from invasion of non-native plants, especially winter annuals, which are inappropriate host plants. Since the time of listing, the threat posed by nonnative plant competitors and winter annuals as inappropriate host plants has become more defined. Lepidium latifoium (perennial pepperweed) and Spartina patens (salt-meadow cord grass) are two non-native species endangering native tidal marsh ecosystems in the range of Cordylanthus mollis ssp. mollis (Grewell 2005). Both plants are highly invasive, however L. latifolium is thought to be a more significant threat due to its proximity to C. mollis ssp. mollis occurrences, especially in Suisun Marsh. Lepidium latifolium is also of particular concern because it forms large monospecific patches that displace native marsh vegetation. L.C. Lee and Associates (2003) observed that one of the five most dominant associates of C. mollis ssp. mollis at Rush Ranch, based on canopy coverage in sample plots, was L. latifolium. Lepidium latifolium is a highly invasive non-native plant that forms monospecific stands that are very difficult to remove. Spartina patens also exists in the general vicinity of Cordylanthus mollis ssp. mollis habitat. It presents a more minor threat to C. mollis ssp. mollis because it is not known to exist along the high marsh edge. However, it does present a threat to the high marsh plant community in general in that the species displaces native habitat essential for a fully functioning ecosystem. (USFWS, 2009)

Stressor: Inappropriate hots plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: High levels of premature mortality were found to be correlated with the presence of non-native winter annual grasses in the immediate vicinity of C. mollis ssp. mollis seedlings (Grewell et al. 2003). Non-native winter annuals such as Hainardia cylindrica (bargrass) and Polypogon monspeliensis (annual rabbitsfoot grass) or native winter annuals such as Juncus bufonius (toad rush) are not suitable hosts since they typically die before C. mollis ssp. mollis can flower and produce seeds (Grewell et al. 2003, 2004). The prevalence of inappropriate plant hosts is correlated with muted tidal regimes (Grewell et al. 2003, 2004). (USFWS, 2009)

Stressor: Chronic pollution (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Oil spills and chronic pollution from point and non-point sources are unavoidable occurrences that continue to occur in or near habitat for Cordylanthus mollis ssp. mollis (U.S. Fish and Wildlife Service 2007). In particular, because of their location, Point Pinole and BSRA populations are the most threatened by oil spills and pollution (U.S. Fish and Wildlife Service 2006). (USFWS, 2009)

Stressor: Cattle grazing and feral hogs (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Cattle grazing still occurs and introduced feral hogs (Sus scrofa) roam Cordylanthus mollis ssp. mollis habitat in some locations (Grewell et al. 2003). Cattle and feral hogs can degrade habitat for the species by trampling and can also damage the plant itself by crushing fragile underground connections (haustoria) to host plants. These connections are critical to the hemiparasitic life history of C. mollis ssp. mollis. In fact, the Rush Ranch population described in the final listing rule was extirpated due to trampling by cattle around 1999 (Grewell, in litt. 2008). Populations at Hill Slough and Rush Ranch (the reintroduced population) are currently subject to rooting, wallowing, trampling, and grazing impacts from livestock and feral hogs that could result in damage or loss to C. mollis ssp. mollis populations or soil disturbance and compaction leading to a disruption in natural marsh ecosystem processes (U.S. Fish and Wildlife Service 2006). (USFWS, 2009)

Stressor: Random events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Since the time of listing, the distribution of the species within its range has not increased and the habitat of the species remains restricted due to fragmentation and historic conversion to other uses. The resulting small populations are still highly susceptible to extinction due to random natural and human-made events, such as pest outbreaks, extended drought, fire, oil spills, genetic or demographic problems or a combination of these events. (USFWS, 2009)

Stressor: Hybridization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: No new information exists regarding the threat of hybridization with Cordylanthus mollis ssp. hispidus, so we must assume the threat is still present. Also, though a permitted reintroduction effort involving seed harvesting and planting has been conducted (Grewell et. al. 2003), no new information exists regarding the threat of unpermitted seed harvesting and planting. We must also assume this threat still persists. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. The minimum area inhabited annually by the species in the Suisun Bay Area Recovery Unit must be 3,000 acres and the minimum area inhabited annually by the species around San Pablo Bay Recovery Unit must be 1,000 acres, over a period of five years. (USFWS, 2013)

2. A minimum of 5,000 acres of suitable habitat in the Suisun Bay Area and San Pablo Bay Recovery Units must be permanently preserved and under protective management. (USFWS, 2013)

3. Reduction in extant Lepidium latifolium populations in tidal areas (in and downgradient of the high marsh-upland ecotone) to less than ten percent cover for five years. (USFWS, 2013)

4. There must be less than ten percent total cover of other non-native, invasive perennial or non-native winter annual grass species (other than Lepidium latifolium), including, but not limited to, Apium graveolens (celery), Cotula coronipfolia (brass-buttons), Juncus gerardi (black-grass rush), Spartina patens (salt-meadow cordgrass), Polypogon monspeliensis (annual beard grass), Hainardia cylindrical (barbgrass), Parapholis incurva (sicklegrass), Crypsis schoenoides (swamp grass), and Lepidium latifolium within 50 feet of extant C. molle ssp. molle populations. (USFWS, 2013)

5. Natural tidal range must be restored at Hill Slough and the ponded area at Rush Ranch to return periodic tidal flooding. (USFWS, 2013)

6. At least nine populations must occur in the Suisun Bay Area Recovery Unit and at least four populations must occur around San Pablo Bay Recovery Unit. (USFWS, 2013)

7. Over five years of monitoring, each population must have a mean of at least 3,000 individuals. (USFWS, 2013)

8. The entire species must not fall below 500 individuals for two consecutive years over a period of five years. (USFWS, 2013)

9. There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant. (USFWS, 2013)

Delisting Criteria:
1. The minimum area inhabited annually by the species in the Suisun Bay Area Recovery Unit must be 6,000 acres and the minimum area inhabited annually by the species around San Pablo Bay Recovery Unit must be 2,500 acres over a period of eight years. (USFWS, 2013)

2. A minimum of 9,000 acres in the Suisun Bay Area Recovery Unit or around San Pablo Bay Recovery Unit must be permanently preserved and under protective management. (USFWS, 2013)

3. All conditions under downlisting criterion A/3 have been met. In addition, a plan must be developed and implemented for early detection and control of Lepidium latifolium following any future increase beyond ten percent cover in tidal areas (in and down-gradient of the high marsh-

upland ecotone). Also, a funding source must be secured to fund such actions in perpetuity. (USFWS, 2013)

4. All conditions under downlisting criterion number 4 must have been met. (USFWS, 2013)

5. All conditions under downlisting criterion number 5 must have been met. (USFWS, 2013)

6. Trampling damage by grazed cattle and feral pigs to C. molle ssp. molle and its haustorial connections to host plants must have been eliminated at all populations for eight years. (USFWS, 2013)

7. Reliable propagation and reintroduction methods must be developed and available. (USFWS, 2013)

8. Pre-dispersal seed predation on C. molle ssp. molle from moth larvae (Saphenista spp., Tortricidae and salt marsh snout moth, Lipographis fenestrella, Pyralidae) must, on average, fall below 15 percent. (USFWS, 2013)

9. At least ten separate populations must occur in the Suisun Bay Area Recovery Unit and at least eight separate populations must occur around San Pablo Bay Recovery Unit. (USFWS, 2013)

10. Over eight years of monitoring, each population must have a mean of at least 3,000 individuals; or if the species is widespread and abundant and is not divisible into separate populations, there must be a mean of at least 300,000 individuals in the Suisun Bay Area Recovery Unit and at least 300,000 individuals around San Pablo Bay Recovery Unit over a period of eight years. (USFWS, 2013)

11. The entire species must not fall below 1,000 individuals for two consecutive years over a period of eight years. (USFWS, 2013)

12. There must be an average of more than 10 seed capsules produced per plant, resulting in an average of more than 15 mature seeds per plant. (USFWS, 2013)

13. Seed banking of all extant populations and representative genetic diversity (per commonly accepted seed banking protocols) must be complete. (USFWS, 2013)

14. To minimize impacts sustained after oil spills occurring at or near populations, the San Francisco Bay and Delta Area section of the Sector San Francisco-Area Contingency Plan must be revised to place high priority on the emergency protection of C. molle ssp. molle. (USFWS, 2013)

15. High marsh/upland transition lands must be preserved or created as part of new marsh restoration efforts and managed to provide opportunity for landward migration of species in response to sea level rise. (USFWS, 2013)

Recovery Actions:

- Non-native plant control should target Lepidium latifolium at Hill Slough, Rush Ranch, BSRA, and other population locations. (USFWS, 2013)

- Adaptive management for and monitoring of ground-nesting and other native bees, particularly near C. molle ssp. molle populations, is needed. Protection of predatory wasps that feed on moth larvae infesting C. molle ssp. molle inflorescences should reduce losses of reproductive output to seed-eaters. (USFWS, 2013)
- Management of grazing should aim to reduce trampling and breaking of haustorial connections to host plants due to disturbance. (USFWS, 2013)
- Controls should be erected and maintained to prevent illicit off-road vehicle use in habitat of C. molle ssp. molle. (USFWS, 2013)
- Where urban runoff has displaced former tidal marsh habitat at BSRA with freshwater emergent marsh, solutions should be identified to direct the runoff away from sensitive habitat. (USFWS, 2013)
- Natural tidal range should be maintained or restored, since their resulting effects on vegetation and soil chemistry are important to the persistence of C. molle ssp. molle. (USFWS, 2013)
- Seed banking is recommended for C. molle ssp. molle, including banking from different population areas. (USFWS, 2013)
- In addition to monitoring needed for appropriate management and tracking of progress toward recovery, it is recommended that field surveys be conducted for additional, as-yet undiscovered populations of C. molle ssp. molle. (USFWS, 2013)
- Given the importance of a host plant community comprised of a matrix of native perennials, information on host plants within C. molle ssp. molle population patches should also be gathered. (USFWS, 2013)
- Research is needed on many aspects of life history and conservation of C. molle ssp. molle. (USFWS, 2013)
- Over the longer term, restoration of suitable tidal marsh habitat and introduction/ reintroduction of C. molle ssp. molle within its historic range will advance recovery of the species. (USFWS, 2013)
- A recovery plan for Cordylanthus mollis ssp. mollis should be developed which describes recovery strategies and specific tasks necessary for recovery of the species. A draft recovery plan for this species and five other listed tidal marsh species is currently in development at SFWO. (USFWS, 2009)
- Control of non-native competitor species and non-native winter annual species should be conducted at all appropriate sites. Lepidium latifolium should be targeted at Hill Slough Wildlife Area, Rush Ranch, BSRA, and other population locations where it presents a threat and Spartina patens (salt-meadow cord grass) should be targeted at BSRA. Nonnative winter annuals that invade upper tidal marsh habitats at the known locations should be controlled to increase survival of Cordylanthus mollis ssp. mollis seedlings (Grewell et al. 2003). Initially, surveys for these invasive plants should occur at each site in order to document the extent of spread and prioritize treatment efforts. (USFWS, 2009)
- Natural tidal cycles of San Pablo and Suisun Bays should be maintained or restored to the extent possible because middle to high marsh areas with periodic tidal flooding provide appropriate hydrology and help retain the healthy extent and composition of tidal marsh communities, including Cordylanthus mollis ssp. mollis. Additionally, natural tidal regimes encourage low abundance of damaging non-native winter annuals and seed predators. (USFWS, 2009)
- Surveys should be conducted within potential Cordylanthus mollis ssp. mollis habitat as well as at known population centers to identify potential new occurrences as well as to provide

an updated species status with which to make management decisions. (USFWS, 2009)

- Management of Cordylanthus mollis ssp. mollis habitat should involve reducing trampling and breaking of haustorial connections to host plants by grazed cattle and feral hogs. Removal of cattle and feral hogs or other protection of the populations from grazing should occur at Hill Slough and Rush Ranch populations, as well as other locations where trampling presents a threat to C. mollis ssp. mollis. A regional-scale feral hog eradication effort should be coordinated with CDFG to decrease that species' impact on habitat for sensitive plants. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations for future actions are based on the Service's Recovery Plan (2013) and incorporation of recent research and findings, such as the USGS' 2021 range wide survey and genomics study in Chloropyron molle ssp. molle. Surveying and Monitoring: • Recovery Actions A/1, A/2. Develop and implement an annual, range wide survey and monitoring plan for Chloropyron molle ssp. molle. As population sizes of C. molle ssp. molle can fluctuate dramatically between years, surveys that attempt near-exact counts rather than abundance estimates of populations should be the primary focus. Special attention should be given to acquire exact counts, annually, of the populations at regularly inhabited sites. Surveys should also include: the number and location of populations; estimates of area inhabited by each population. • Recovery Actions A/3, A/4. Work with partners to develop and implement a survey and monitoring plan for invasive species in areas inhabited by Chloropyron molle ssp. molle. Surveys should be focused on populations of Chloropyron molle ssp. molle and areas within 50 ft. of each population and they should be conducted based on the development and phenology of the identified invasive plants. These surveys should include: the location of the areas surveyed; survey frequency; invasive plants of interest at each site; abundance estimates of invasive plants found; and proximity to nearest population of C. molle ssp. molle. Known invasive plant threats currently include but might not be limited to: Lepidium latifolium, Hainardia cylindrica, Polypogon mospeliensis, Cotula coronopifolia. Cuscuta salina is native to the Bay-Delta, however, it should be included in such surveys based on the predicted inappropriate plant-host relationship it can form with C. molle ssp. molle. Survey follow-up and monitoring records should include information on historical, ongoing, and/or planned invasive mitigation and eradication techniques in collaboration with partners. • Recovery Action A/6. Develop and implement a survey and monitoring plan to focus on trampling and rooting damage by livestock and feral pigs to Chloropyron molle ssp. molle populations. This plan should cover how to monitor damage, the partners and groups responsible for organizing and conducting surveys and monitoring, the locations to be surveyed and monitored, and the frequency at which surveys/monitoring are needed. Restoration Activities: • Recovery Action A5. Develop a plan to restore tidal marsh, including restoration of periodic tidal flooding at Hill Slough and Rush Ranch pond areas. Complete the actions that are achievable within 5 years. Follow-up with a monitoring plan of tidal flooding at Hill Slough and Rush Ranch pond areas. • Recovery Action A/7. Renew efforts and advance methods for propagation, including a plan to scale-up propagation, of C. molle ssp. molle to be used in restoration and reintroduction / mitigation efforts. • Recovery Actions E/1d, E2. Develop and implement a seed banking plan for C. molle ssp. molle including development of seed storage protocol with estimates of storage effects on seed viability/longevity. Seed collection and banking efforts should be developed based in-part on current knowledge of the range wide distribution of genetic diversity. • Develop a plan to reintroduce 1-2 populations of C. molle ssp. molle that might serve as connector populations to promote gene flow between Fagan Marsh and Point Pinole populations in the west and all other populations of C molle ssp. molle in the eastern portion of the range. This plan should incorporate information from the USGS' 2021 range

wide survey of sites with potentially suitable habitat, as well as in-depth surveys of all existing public lands in the area for currently unknown sites of potentially suitable habitat. Source material for reintroductions should also rely on genotypic information and diversity estimates from the 2021 USGS study. Additional Future Actions for Consideration: • Genetic monitoring of populations, particularly those that appear to be at-risk of intraspecific hybridization with Chloropyron molle ssp. hispidum, and the western-most isolated populations at Fagan Marsh and Point Pinole that appear to be experiencing restricted gene flow. • Breeding trials between Chloropyron molle ssp. molle and C. molle ssp. hispidum to determine what level of threat intraspecific hybridization poses in the northeastern portion of C. molle ssp. molle's range. • Investigation(s) into seed ecology of C. molle ssp. molle to support seed banking efforts and to inform on the potential use of direct-seeding in restorations. • Investigation(s) into plant-pollinator relationships to inform on reproductive biology of C. molle ssp. molle and to aid in making predictions regarding current and future gene flow across the species range. • Quantitative genetics studies to estimate species' phenotypic plasticity (i.e., the capacity to respond to changing environmental conditions) especially to variation in hydrological factors. • Studies focused on the C. molle ssp. molle's plant-host relationships to better determine potential risk from inappropriate host relationships. • Conduct public outreach and education to develop potential partnerships with private landowners with property where C. molle ssp. molle might be present (USFWS, 2023).

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SPECIES ACCOUNT: *Cordylanthus palmatus* (Palmate-bracted bird's beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/01/1986; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

An annual herb in the broomrape family (Orobanchaceae) (Olmstead et al. 2001). The plants are 4-12 inches tall and highly branched. The stems and leaves are grayish green and sometimes are covered with salt crystals excreted by glandular hairs. Small pale whitish flowers, up to 1-inch long, are arranged in dense clusters (spikes) and are densely surrounded by herbaceous leaf-like bracts. The petals are divided into two lips. The upper one is shaped like a bird's-beak, leading to the common name of the genus. (USFWS, 2009)

Taxonomy

Tank et al. (2009) moved four species of Cordylanthus (maritimus, mollis, palmatus, and tecopensis) to Chloropyron. (NatureServe, 2015)

Historical Range

Historically, the species is known from scattered locations in the Sacramento and San Joaquin Valleys (Bittman 1985, 1986; Center for Conservation Biology 1991, 1992, 1993, 1994) (USFWS, 2009)

Current Range

The species ranges from the northern Sacramento Valley south to the San Joaquin Valley. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Dependency on Other Individuals or Species

Adult: Bumblebees (Bombus californicus, B. occidentalis, and B. vosnesenskii) were the primary pollinators of palmate-bracted bird’s-beak at the Springtown Alkali Sink in 1993. (USFWS, 1998)

Breeding Season

Adult: May to October (USFWS, 1998

Key Resources Needed for Breeding

Adult: Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993).

Reproduction Narrative

Adult: Palmate-bracted bird's-beak is an annual herb in the broomrape family (Orobanchaceae) (Olmstead et al. 2001). This species flowers from May until October (Skinner and Pavlik 1994). Both self- and cross-pollination can contribute to seed-set (Center for Conservation Biology 1993j, and individual plants can produce up to 1.000 seeds in a single growing season (Center for Conservation Biology 1991). Seasonal overland flooding may disperse seeds and promote seed germination by diluting the saline soils (Coats et al. 1993). Bumblebees (Bombus californicus, B. occidentalis, and B. vosnesenskii) were the primary pollinators of palmate-bracted bird's-beak at the Springtown Alkali Sink in 1993. (USFWS, 1998; USFWS, 2009)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal flooding (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to elevations of less than 155 m (500 feet) (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Small and isolated patches (USFWS, 2009)

Environmental Specificity

Adult: Very Narrow (USFWS, 2009)

Habitat Narrative

Adult: Palmate-bracted bird's-beak is restricted to seasonally-flooded, saline-alkali soils in lowland plains and basins at elevations of less than 155 meters (500 feet). It occurs in a mosaic pattern of small and isolated patches. Within these areas, palmate-bracted bird's-beak grows primarily along the edges of channels and drainages, with a few individuals scattered in seasonally-wet depressions, alkali scalds (barren areas with a surface crust of salts), and grassy areas. Suitability of microhabitats for palmate—bracted bird's beak depends primarily on soil pH and to a lesser extent on soil layering, salinity, and moisture. This species occurs on neutral to alkaline soils pH 7.2 to 9.5) under natural conditions (Coats et al. 1993, Center for Conservation Biology 1993, 1994). (USFWS, 1998; USFWS, 2009)

Dispersal/Migration

Dispersal

Adult: Moderate (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: The pattern of genetic variation within palmate-bracted bird's-beak populations support the hypothesis that the historical frequency and extent of seed dispersal by overland flooding has influenced population genetic structure. In brief: (1) sites that are more-frequently flooded or that have more extensive floods (leading to enhanced seed dispersal). (USFWS, 2009)

Population Information and Trends

Population Trends:

Declining (USFWS, 2009)

Number of Populations:

7 (USFWS, 2023)

Additional Population-level Information:

Historically, palmate-bracted bird's-beak was documented at nine sites between 1916 and 1982 (in Alameda, Colusa, Fresno, Madera, San Joaquin, and Yolo Counties), but only three were known to be extant at the time the species was listed in 1986: two natural populations (Springtown Alkali Sink and southeast of Woodland, which is now known as Alkali Grasslands Preserve) and one transplanted population (Mendota Wildlife Area) (Service 1986, p. 23767). As of our 2009 status review, the species was known to occurr as a mosaic of small, isolated patches on approximately 1,500 acres of occupied habitat at eight sites ranging from the northern Sacramento Valley south to the San Joaquin Valley (Sacramento, Colusa, and Delevan National Wildlife Refuges (collectively referred to as the Refuges); Alkali Grasslands Preserve; Springtown Alkali Sink; Western Madera County; Alkali Sink Ecological Reserve; and Mendota Wildlife Area) (Service 2009, p. 20). The Sacramento Refuge population was introduced in 1990 (Service 1998, p. 35); additional sites were located through intensive survey efforts. There have been few changes in the distribution of palmate-bracted bird's-beak since our 2009 status review. The population in Western Madera County is likely extirpated based on recent vernal pool mapping showing that the four occurrences were disked and later converted to agriculture (Witham 2021, unpaginated geodatabase). In addition, no new information is available for the Mendota Wildlife Area population, which may have been extirpated by changing conditions prior to the 2009 status review (USFWS, 2023).

Population Narrative:

The palmate-bracted bird's-beak has declined significantly over the past century. Several palmate-bracted bird's-beak species experts have suggested that (a) except, perhaps, for Sacramento National Wildlife Refuge Complex there are fewer palmate-bracted bird's-beak today than when the species was originally listed and (b) population trends are down. Of the eight known occurrences (up to 10 populations reported historically), five are located on public lands and are protected from development. The constrained dispersal abilities of C. palmatus can limit its ability to withstand changes in climate. (USFWS, 2009)

Threats and Stressors

Stressor: Urban sprawl (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: Urban sprawl and associated human activities have also been identified as the leading cause of species imperilment – including the palmate bracted bird's-beak -- in the State (National Wildlife Federation 2001). Sprawl (low density, automobile dependent development into natural areas outside of cities and towns) results in habitat loss, habitat degradation (including the disruption of natural processes, wildfire suppression, noise pollution, and high-impact outdoor recreation), habitat fragmentation (including blocking wildlife movement and edge effect), and loss of species diversity (including an increase in exotic species and changing ecosystem dynamics). (USFWS, 2009)

Stressor: Habitat loss (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: These widespread and ongoing threats include: the conversion of native habitat into irrigated agricultural fields (e.g., palmate-bracted bird's-beak sites at Woodland, Sacramento Valley, San Joaquin Valley); installation of pipelines and transmissions lines (Woodland); drainage facilities (Springtown residential development); gas and water pipelines (Springtown); and off-road vehicle use (Springtown). (USFWS, 2009)

Stressor: Cattle grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, cattle grazing was identified as a major factor (Service 1986:23767). Cattle grazing has undoubtedly altered the plant species composition of the areas occupied by the palmate-bracted bird's-beak, but the specific effects and mechanisms were not indicated. Existing grazing levels, at that time, did not appear to threaten those areas still supporting the palmate-bracted bird's-beak. Cattle grazing as a management tool, it now appears, can be beneficial as well as harmful to the palmate-bracted bird's-beak. Grazing can enhance the conservation status of the palmate-bracted bird's-beak through the removal of invasive non-native plants that compete with the palmate-bracted bird's-beak for resources or displace host plants (Wingo-Tussing et al., 2005; Wingo-Tussing 2006). (USFWS, 2009)

Stressor: Invasive non-native plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Invasive non-native plant species are a potential threat to palmate-bracted bird's-beak and associated native host plants at Colusa NWR and Delevan NWR (Wight 2000; Wingo-Tussing et al. 2005; WingoTussing 2006). Populations of the annual ryegrass (Lolium multiflorum), tall wheatgrass (Elytrigia pontica ssp. pontica), broad-leaved pepperweed (Lepidium latifolium), and fleshy-leaved Russian-thistle (Salsola soda) have been increasing in habitat occupied by palmate-bracted bird's-beak, and associated (host) plants such as Great Valley gum plant (Grindelia camporum var. camporum), pappose spikeweed (Hemizonia parryi spp. rudis), alkali heath (Frankenia salina), and saltgrass (Distichlis spicata; host plant). These plants compete with the palmate bracted bird's-beak for resources (e.g., space, water, and nutrients) and can displace host plants. (USFWS, 2009)

Stressor: Accidental flooding (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Accidental flooding of palmate-bracted bird's-beak during the dry period (June to September) from rice field run-off has also impacted one palmate bracted bird's beak patch at Colusa NWR (J. Silveira, in litt., 2006). Extensive and unseasonal flooding can kill palmate-bracted bird's-beak plants, as well as allow other plants to invade after the waters recede. Deep flooding that persists over several weeks can kill individual plants. (USFWS, 2009)

Stressor: Decline of pollinators (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Another widespread threat to palmate-bracted bird's-beak is the loss of pollinators through the spraying of malathion and other pesticides. Bees are important pollinators of the palmate-bracted bird's-beak in California (SaulGershenz et al., 2004). Malathion application to bees and the vegetation where they occur may be a specific threat to the genetic diversity of palmate-bracted bird's-beak by reducing pollination. The effects of malathion application are extremely local given that bees typically range only about 300-400 meters (about 980-1300 feet) from the nest to a flower (Kroodsma 1975; Keasar et al., 1996; Capaldi et al., 2000; Kwak 2002). (USFWS, 2009)

Stressor: Pesticides (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The Sacramento/Yolo Mosquito Vector Control District (Undated) also has an ongoing program to control the West Nile virus through the aerial application of pyrethroids and other insecticides that may affect palmate-bracted bird's-beak pollinators. It is not clear if sites with palmate-bracted bird's-beak are being sprayed or if palmate-bracted bird's-beak pollinators are being affected.

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Due to the highly restricted range of palmate-bracted bird's beak, climate change in the Central Valley could have a particularly negative effect on the species. As stated previously, the palmate-bracted bird's-beak is restricted to the Sacramento Valley and the San Joaquin Valley under a unique set of geographic (flat) and climatic (hot and dry) conditions (Figures 1-3). The range of palmate-bracted bird's-beak is restricted by soil type (alkaline-saline). Some climate change models predict for California an overall warming of 1.7 degrees Centigrade – 5.8 degrees by 2100 (Cayan et al. 2006), but they vary in their predictions for precipitation. VanRheenen et al. (2004) predict a decrease in precipitation in the San Joaquin Valley. Changes in annual precipitation have a large effect on the abundance of palmate-bracted bird's-beak, as typical of desert annuals (Germano et al. 2005; Warrick 2006). (USFWS, 2009)

Stressor: Ozone (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Another potential threat to palmate-bracted bird's-beak is ozone due to photochemical smog. Numerous studies have documented the negative effects of ozone on plants, such as pronounced foliar injury and growth reduction (e.g., Miller 1992; Grantz and Yang 1996; Bytnerowicz 2002), but no studies have been performed specifically on palmate-bracted bird's-beak. The California Air Resources Board (2006) reported for southern portions of the San Joaquin Valley as many as 26 days per year above the national 1-hour ozone standard and as many as 116 days per year above the national 8-hour ozone standard during the period 2002 - 2005. (USFWS, 2009)

Stressor: Excessive dust (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: An additional potential threat to the palmate-bracted bird's-beak is excessive dust. Dust may affect photosynthesis, respiration, and transpiration, as well as allow the penetration of phytotoxic gaseous pollutants (Farmer 1993). No research, however, has analyzed the effects of dust specifically on palmate-bracted bird's-beak. From 1996 – 2005, Bakersfield – in the southern portion of the San Joaquin Valley – on average surpassed the State of California 24-hour PM10 (particulate matter with an aerodynamic diameter of 10 microns or less) standard 170 days per year and surpassed the national 24-hour PM2.5 (particulate matter with an aerodynamic diameter of 2.5 microns or less) standard 16 days per year (California Air Resources Board 2006). In 2005, the primary sources of particulate matter (PM10 and PM2.5) in Kern County, for example, were farming operations, road dust, and fugitive windblown dust (California Air Resources Board 2006). (USFWS, 2009)

Recovery

Reclassification Criteria:
1. Protection of occupied habitat A) 95 percent of occupied habitat on public lands is secured and protected, and B) 75 percent or more of the population at Springtown Alkali Sink and 75 percent or more of the occupied area and upland habitat for pollinators within 300 meters (984 feet) of the population margins is secured and protected, and C) Two or more populations are secured and protected in the San Joaquin Valley. (USFWS, 2009)

2. A management plan that includes the survival of palmate-bracted bird's-beak as an objective has been approved and implemented for all protected areas identified as important to continued survival. (USFWS, 2009)

3. The populations are stable or increasing through a precipitation cycle. (USFWS, 2009)

Delisting Criteria:
1. Eight or more distinct populations, including two or more in the San Joaquin Valley are secured and protected. (USFWS, 2009)

2. 95 percent or more of the occupied habitat [under Service ownership] of Colusa National Wildlife Refuge, Delevan National Wildlife Refuge, and Sacramento National Wildlife Refuge is secured and protected. (USFWS, 2009)

3. 95 percent or more of the occupied habitat [under CDFG ownership] of the Alkali Sink Ecological Reserve-Mendota Wildlife Area (San Joaquin Valley) is secured and protected. (USFWS, 2009)

4. 260 hectares (640 acres) or more of any occupied habitat [under any ownership] elsewhere in the San Joaquin Valley, including western Madera County, is secured and protected. (USFWS, 2009)

5. 90 percent or more of the plants and occupied habitat [under ownership by City of Livermore, Federal Communications Commission, or private] of the Springtown Alkali Sink is secured and protected. (USFWS, 2009)

6. Two or more distinct populations each about 260 hectares (640 acres) [under any ownership] in the Sacramento Valley are protected. (USFWS, 2009)

7. A management plan has been approved and implemented for all protected areas identified as important to the continued survival of the species. (USFWS, 2009)

8. There is no decline after downlisting. If the population is declining, then the Service should determine the cause and reverse the trend. (USFWS, 2009)

Recovery Actions:

- Recovery actions are not available.
- Protection of palmate-bracted bird's-beak habitat on private lands. One of the most important goals for the conservation of this species is the protection of occupied palmate-bracted bird's-beak habitat primarily at three sites. (USFWS, 2009)
- General and applied ecological research of palmate-bracted bird's-beak. Little is known about the basic biology of this species or how it responds to management practices (C. Feldheim, in litt., 2007). (USFWS, 2009)
- Over the next 5 years, genetic variation at the remaining sites should be characterized and synthesized with existing knowledge. The genetic variation at all sites should then be compared leading to a ranking of sites to guide conservation efforts according to the nature and extent of differences, as well as the importance of rare or unique alleles. A seed collection, based on the site rankings, should also be completed. (USFWS, 2009)
- Natural resource managers should consider the negative impacts of invasive nonnative species in order to enhance conservation and restoration programs for the palmate-bracted bird's-beak. Controlled grazing (see Wingo-Tussing et al. 2005; Wingo-Tussing 2006) and controlled burns (see Wight 2000) may enhance the conservation status of the palmate-bracted bird's-beak. (USFWS, 2009)
- The continued survival of the palmate-bracted bird's-beak depends on many demographic factors. The natural variation of these factors, though, is poorly understood (Fleishman et al., 1994, 1996). An outline for future actions that incorporates demographic monitoring of the several populations and minimum levels of demographic parameters maintained should

be established. (USFWS, 2009)
- The scientific name should formally be changed in the Code of Federal Regulations from Cordylanthus palmatus to Chloropyron palmatum.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the palmate-bracted bird's-beak. Some of these recommendations have already been discussed in our previous status review (Service 2009, pp. 37–39) and remain valid. 1. Conduct surveys at known occurrences to monitor population trends and habitat changes, including occurrences that are likely extirpated in Madera County and Mendota Wildlife Area to confirm status. 2. Pursue protection of the Springtown Alkali Sink and Woodland Regional Park occurrences through conservation easements and map the net occupied area of these populations. 3. Review existing management plans and revise them to include an objective for survival of palmate-bracted bird's-beak if this objective is missing. 4. Determine the most effective methods for controlling invasive non-native species at sites where palmate-bracted bird's-beak occurs and ensure the results are shared with land managers. 5. Consider historical hydrologic connection within populations to maintain genetic variation when collecting and distributing seed. Genetic isolation of populations occurring in vernal pools in the same locality should be maintained. However, seed should be collected and distributed from throughout the population where historical overland flow has been impeded by manmade barriers. 6. Evaluate the need for additional re-introductions and the effectiveness of seeding methods currently employed at the Alkali Grasslands Preserve. 7. Change the scientific name in the Code of Federal Regulations from Cordylanthus palmatus to Chloropyron palmatum (USFWS, 2023).

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SPECIES ACCOUNT: *Cordylanthus tenuis ssp. capillaris* (Pennell's bird's-beak)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; California/Nevada (Region 8)

Physical Description

A branching herbaceous annual of the broomrape family (Orobanchaceae). The plant grows 30 to 60 centimeters (12 to 24 inches) tall, with yellow-green hairless herbage that becomes purplish with age. The leaves are entire (with smooth edges), or those of the primary stem three-parted, and threadlike. The floral bracts are three-parted up to two-thirds of their length, with fine marginal hairs on bracts and calyx (collective term for the sepals or outermost whorl of flower parts). The tubular corolla (collective term for all the petals) is 1.5 centimeters (0.6 inch) long (Chuang and Heckard 1986), and gamet-brown laterally, paler dorsally (Pennell 1950). Each capsule contains 10 to 16 seeds (Chuang and Heckard 1986). (USFWS, 1998; USFWS, 2019b)

Taxonomy

Cordylanthus capillaris (Pennell's bird's-beak) was first described by Pennell (1950). Chuang and Heckard (1986) reclassified the Cordylanthus genus and considered Pennell's bird's-beak to be a subspecies: C. tenuis ssp. capillaris. At the time of listing, the genus was considered within the snapdragon family (Scrophulariaceae). Presently, the genus Cordylanthus is considered within the broomrape family (Orobanchaceae) (Olmstead et al. 2001). (USFWS, 2011)

Historical Range

Known only from the Outer North Coast Ranges floristic province of Sonoma County, California, a range of a few square miles (vicinity of unincorporated Camp Meeker area). (USFWS, 2019b)

Current Range

Known only from the Outer North Coast Ranges floristic province of Sonoma County, California, a range of a few square miles (vicinity of unincorporated Camp Meeker area). (USFWS, 2019b)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (self-incompatible) (USFWS, 2011)

Lifespan

Adult: 1 year (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Members of the Cordylanthus genus require bees for effective pollination (Chuang and Heckard 1986).

Breeding Season

Adult: June to July (USFWS, 2011)

Reproduction Narrative

Adult: Pennell's bird's-beak is an herbaceous annual of the broomrape family (Orobanchaceae) (Olmstead et al. 2001) and it flowers from June through July (Chuang and Heckard 1986). Members of the Cordylanthus genus require bees for effective pollination (Chuang and Heckard 1986). The fruit are capsules containing 10 to 16 seeds (Chuang and Heckard 1986). C. tenuis ssp. capillaris were found to be self-incompatible (Chuang and Heckard 1986). Members of the bird's-beak group require bees for effective pollination (Chuang and Heckard 1986). (USFWS, 2019b)

Habitat Type

Adult: Terrestrial (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral communities (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to elevations from 45 to 245 meters (148 to 804 feet) (USFWS, 2011)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2011)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2011)

Habitat Narrative

Adult: Cordylanthus tenuis ssp. capillaris grows only on serpentine soils among chaparral and closed pine forests (Chuang and Heckard 1986) and are found in colonies. Occurrences range in elevation above mean sea level from 45 to 245 meters (148 to 804 feet) (Calflora 2011, CNPS 2011). Cordylanthus tenuis ssp. capillaris is associated with Sargent's cypress (Cupressus sargentii), Baker's manzanita, and coffeeberry (Rhamnus californica) (Chuang and Heckard 1986). (USFWS, 2011)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019a)

Number of Populations:

4 (USFWS, 2019a)

Population Size:

Unknown; fluctuates from well over 10,000 to a few individuals at each location (USFWS, 2019a)

Population Narrative:

In 2011, Pennell's bird's-beak was recognized to occur in five separate locations (USFWS 2011). Currently, Pennell's bird's-beak is known from four locations (CNDDB 2018). California Natural Diversity Database lists occurrence #1 as mainly within the Harrison Grade Ecological Reserve, owned and managed by CDFW. The fifth occurrence is combined with occurrence #4. Two occurrences (#2 and #4) are within what is now the Bohemia Ecological Preserve. This property is protected under a conservation easement, which is owned and managed by Land Paths since 2012 (E. Mullen, pers. comm. 2018). Occurrence #3 is located on the privately owned Twin Valley Ranch near Porter Creek, about 11 kilometers (6.8 miles) northeast of occurrence #2. However, this site has not been surveyed in the past 20 years. While the status of this population remains unknown, it is assumed to be extant. Anecdotal reports suggest many Pennell's bird's-beak populations exist on private property outside of the before mentioned occurrences in areas where botanical surveys have not been done (G. Cooley, pers. comm. 2018). Biologists with CDFW have observed Pennell's bird's-beak on private properties outside of the reserve boundaries at the Harrison Grade Ecological Reserve (J. Bjerke, in litt. 2018b). The full extent of the population remains unknown. (USFWS, 2019a)

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, development and associated road construction on the private lands containing occurrence 1, which would result in loss, modification, and destruction of Cordylanthus tenuis ssp. capillaris habitat, were considered potential threats. Development plans had included the donation of 87 hectares (including C. tenuis ssp. capillaris habitat) to the county for use as a park (Service 1998). However, although some roads were constructed, the development never took place, and the land was subsequently sold. Habitat for Cordylanthus tenuis ssp. capillaris along Bohemian Highway has been significantly reduced within the past 23 years (Herrick, in litt. 2011). Parts of the talus and bank have been removed and a windrow has been planted in areas known to be previously colonized by C. tenuis ssp. capillaris (Herrick, in litt. 2011). (USFWS, 2011)

Stressor: Vineyards (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Presently, within the past 5 to 10 years along Stoetz Lane parcels of land have been converted vineyards. The conversion to vineyards of potential C. tenuis ssp. capillaris habitat continues to threaten populations at CNDDB occurrence 2 (Herrick, in litt. 2011). (USFWS, 2011)

Stressor: Timber harvest (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: CNDDB Occurrence 1 is located on property where timber harvesting has occurred since the time of listing (G. Hale, Sonoma Land Trust, in litt. 2011). Similarly, timber harvesting has occurred on the property where Occurrence 6 is located, and may continue in the future (Robertson 2011, Zito 2011). Timber harvesting can cause significant changes in the species richness and diversity in the herbaceous plant layer (Battles et al. 2001, Macdonald and Fenniak 2007). Although some effects of canopy removal can be short-lived, many other effects persist over a much longer timeframe (e.g., disturbance-mediated limitations to dispersal) (Gilliam 2007). Such effects could be detrimental to populations of C. tenuis ssp. capillaris. Roadside maintenance such as mowing has been reported at occurrence 4, and cattle grazing was reported at occurrence 5 (CNDDB 2011). (USFWS, 2011)

Stressor: Mowing and grazing (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Mowing and grazing before the plants flower, typically June through July (Chuang and Heckard 1986) would prevent the generation of seeds. As an annual herbaceous plant species, C. tenuis ssp. capillaris relies on seed banks to maintain population levels. Horses and deer were reported to browse on Cordylanthus tenuis ssp. capillaris. The site of occurrence 5 has been used for cattle grazing (CNDDB 2011). In general, however, the number of plants damaged by grazing continues to be unknown. (USFWS, 2011)

Stressor: Diseases (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Due to the hemiparasitic nature of Cordylanthus tenuis ssp. capillaris, diseases to potential host species may threaten C. tenuis ssp. capillaris populations. Phytophthora cinnamomi is a pathogen causing mortality in a number of native forests and chaparral communities in northern California (Swiecki, in litt. 2008, p. 2). Phytophthora ramorum is another pathogen known to cause sudden oak death in at least four coastal California oak species (Garbelotto et al., 2001; Rizzo and Garbelotto 2003). The Service lacks adequate information to determine the potential effects of these pathogens on Cordylanthus tenuis ssp. capillaris. (USFWS, 2011)

Stressor: Increasing human populations (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Increasing human populations in central California coastal counties were reported to place a great strain on undeveloped wild-lands, such as those found on the serpentine soils (Service 1995). Listed factors include pedestrian and off-road vehicle traffic, hiking and bicycle trails, and unauthorized garbage dumping. These factors can lead to increased erosion, the establishment of non-native, invasive plants, and the fragmentation of the native plant

populations (Service 1995). In turn the native plant populations are increasingly susceptible to natural factors that can negatively affect viability, such as fire and disease (Brigham and Schwartz 2010). The limited number and isolated conditions of the Cordylanthus tenuis ssp. capillaris populations, resulting from these natural and manmade factors, can render the species susceptible to stochastic extinction (Brigham and Schwartz 2010). (USFWS, 2011)

Stressor: Roadside maintenance (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Roadside maintenance, such as mowing and spraying, and vehicular traffic were mentioned as threats to Cordylanthus tenuis ssp. capillaris in the 1995 listing (Service 1995). Unauthorized dumping of articles ranging from appliances to bottles also was mentioned as factors affecting C. tenuis ssp. capillaris (Service 1995). Whereas light road grading was thought to facilitate establishment of C. tenuis ssp. capillaris, heavy road disturbance may increase the invasion of non-native plant species (Service 1995). (USFWS, 2011)

Stressor: Habitat fragmentation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Leimu et al. (2006), in meta-analyses of plant studies published between 1987 and 2005, determined that the negative effects of habitat fragmentation (e.g., reduced genetic variation, increased demographic stochasticity) are more common among self-incompatible and rare plant species. Cordylanthus tenuis ssp. capillaris is not only rare, but also self-incompatible (Chuang and Heckard 1986). Although natural selection pressures have acted over time to create a niche for C. tenuis ssp. capillaris on serpentine soils, the fragmented nature of serpentine habitats can leave rare plants dependent upon them susceptible to vagaries of stochastic events Indeed, populations of C. tenuis ssp. capillaris vary among years (CNDDB 2011), and the causes for annual variations are not readily apparent. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time. (USFWS, 2011)

Stressor: Ozone (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Ozone due to photochemical smog is another potential threat to Cordylanthus tenuis ssp. capillaris. Several studies have documented harmful effects of increased nitrogen deposition, such as increased foliar injury and growth reduction (e.g., Miller 1992; Grantz and Yang 1996; Bytnerowicz 2002), yet no information exists specifically for C. tenuis ssp. capillaris. (USFWS, 2011)

Stressor: Pesticide Use (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Research analyzing the potential effects of pesticide use is becomingly increasingly important, particularly in areas where agriculture is prevalent such as the wine-growing region of Sonoma County, California. The Environmental Protection Agency (Agency) recently released the final biological evaluations assessing the effects of labeled use of three neonicotinoid pesticides on listed species (Agency 2022a, entire; Agency 2022b, entire; Agency 2022c, entire). The three pesticides (clothianidin, imidacloprid, and thiamethoxam) are registered for use on a variety of agricultural crops; there are also some non-agricultural applications. The three pesticides target insect species by acting on their neurotransmitters to cause excessive nervous stimulation, paralysis, and death. Members of the bird's-beak group require bees for effective pollination (Chuang and Heckard 1986, p. 24). The Agency's final biological evaluations determined that all three pesticides are highly toxic to bees, have the potential to result in bee brood and colony reductions, and if affected bee colonies decline near Pennell's bird's-beak, there is a potential for the three pesticides to indirectly adversely affect the species (Agency 2022a, pp. 4, Appendix 4-1; Agency 2022b, pp. 2, Appendix 4-1; Agency 2022c, pp. 3, Appendix 4-1). The Agency anticipates releasing amended proposed interim decisions and the Service is working on a national Section 7 consultation with the Agency (USFWS, 2023).

Recovery

Reclassification Criteria:
1. The two confirmed populations of Cordylanthus tenuis ssp. capillaris (Harrison Grade and Bohemian Highway) are (1) fully protected and managed with the primary intention of preserving the populations in perpetuity; and (2) shown to be stable or increasing over a minimum of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring). (USFWS, 1998)

2. Seed collected from both remaining natural populations is stored at a minimum of two Center for Plant Conservation certified botanic gardens. (USFWS, 1998)

3. Reliable seed germination and propagation techniques for the species are understood. (USFWS, 1998)

Delisting Criteria:
A/1: Areas of occupied habitat are secured or established and voluntarily protected in perpetuity for at least ten known sites large enough to incorporate the seasonal and spatial variation of new colonies. Protected areas are at least 12 hectares (30 acres), unless future research indicates otherwise. (USFWS, 2019b)

A/2: The breadth of current genetic variation is represented at protected sites. (USFWS, 2019b)

A/3: No damage is recorded over the course of 20 years due to trampling or vandalism. (USFWS, 2019b)

E/1: Plants that are nonnative to serpentine habitats are monitored and controlled at a level that allows for the increase, establishment, and persistence of Pennell's bird's-beak in protected areas on suitable habitat. (USFWS, 2019b)

Recovery Actions:

- 1. Establish or protect additional populations of Pennell's bird's-beak. 1.1 Conduct botanical field surveys to discover additional populations. (Priority 1). 1.2 Protect additional populations through voluntary conservation agreements or land acquisitions. (Priority 1). 1.3 Collect and introduce Pennell's bird's-beak seeds in areas of appropriate habitat on protected lands. (Priority 1). 1.4 Survey reintroduction sites annually to determine abundance and extent. (Priority 2). (USFWS, 2019b)
- 2. Conduct research to increase understanding of Pennell's bird's-beak life history and annual establishment. 2.1 Conduct research to determine the full range (area and extent). of the species. (Priority 3). 2.2 Conduct demographic surveys and long-term monitoring that includes, but is not limited to, habitat surveys, genetic research, host-parasite dynamics, and annual establishment. (Priority 1). 2.3 Investigate and monitor potential management methods to maximize population success. Adapt and modify management as necessary. (Priority 2). (USFWS, 2019b)
- 3. Conduct genetic research to determine if genetically distinct populations exist outside of protected areas. (Priority 3). (USFWS, 2019b)
- 4. Monitor and manage Pennell's bird's-beak populations on protected lands. 4.1 At locations where the plant is protected, establish management plans to ensure the quality of existing habitat is maintained and/or degraded habitat is restored. (Priority 2). 4.2 Conduct regular patrols to deter illegal dumping in habitat. If needed, mitigate the 51 effects of illegal dumping on habitat. (Priority 3). 4.3 Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2). 4.4 Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019b)
- Until research shows otherwise, recovery should target securing populations containing a minimum of 2,000 plants each (but preferably more). The probability of population persistence over the long-term is expected to be higher for larger populations because large size decreases the likelihood of reduced viability or population extirpations due to random demographic or genetic events (Barrett and Kohn 1991, Ellstrand and Elam 1993). (USFWS, 1998)
- Protecting and managing populations at the two remaining locations by working with the California Department of Fish and Game and private landowners to ensure long-term survival of the species. Populations on private land should be protected by land acquisition, conservation easements, or other means. In general, the largest possible block of serpentine

habitat should be protected at each site. Protection should, at least, involve securing the populations themselves as well as a 150- meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. In addition, other unoccupied habitat at the sites that might provide space for expansion of the populations and habitat for pollinators and seed dispersers must be protected. Management plans emphasizing Cordylanthus tenuis ssp. capillaris and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized annual monitoring of Cordylanthus tenuisssp. capillaris populations to determine demographic trends. The plans should also include strategies to minimize known threats at the sites as well as to identify new threats as they may appear. In particular, threats from off road vehicle use, dumping, and roadside maintenance must be eliminated. If new threats (e.g. invasion of non-natives) are identified or other new information becomes available, management plans need to be reevaluated and revised. (USFWS, 1998)

- Collection and banking of seed in Center for Plant Conservation certified botanic gardens is also a high priority recovery action for Cordylanthus tenuis ssp. capillaris. Seed banking is prudent to guard against extinction of the species from chance catastrophic events and to provide potential material for enhancement efforts in existing populations, repatriations, andlor introductions to new sites. In the absence of genetic data for Cordylanthus tenuis ssp. capillaris, seed banking should include collections from all known populations. Care should be taken to ensure that seed collection does not adversely affect the donor populations. (USFWS, 1998)
- Other suitable serpentine habitat should be surveyed to determine whether undiscovered populations exist. If new populations are discovered, they should be protected and managed as discussed above. During these surveys, potential introduction sites might also be identified. (USFWS, 1998)
- Research on seed germination and propagation techniques that take into account the hemiparasitic nature of the plant, the use of burning as a management strategy, and basic research on demography (including soil seed bank) and reproduction (including mating system and pollination). Demographic research would be valuable to identify limiting life history stages. (USFWS, 1998)
- Recommended Future Action from 2011 5-Year Review: Protect known occurrences from threats by acquiring the private lands from willing sellers where Cordylanthus tenuis ssp. capillaris is known to occur. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Design and implement a comprehensive survey method for Cordylanthus tenuis ssp. capillaris. Survey designs should incorporate geographic information systems (G.I.S.) technology to identify additional suitable sites for C. tenuis ssp. capillaris. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Work with land owners and land managers to gain access to known and potential suitable sites for Cordylanthus tenuis ssp. capillaris populations. Annual population surveys of known occurrences should be reported to the CNDDB. (USFWS, 2011)
- Recommended Future Action from 2011 5-Year Review: Scientific studies should be conducted to identify ideal host species. Chuang and Heckard (1971) have inferred suitable host species for Cordylanthus tenuis ssp. capillaris, yet individual plant fitness varies with host plant relationships. Studies remain to identify decisively the optimal host species. (USFWS, 2011)

- Recommended Future Action from 2011 5-Year Review: Ascertain the importance of habitat disturbance to Cordylanthus tenuis ssp. capillaris. Current occurrences are openings among chaparral and conifer woodlands. Management strategies should evaluate the effectiveness of timber removal and fire ecology for the propagation of the species. (USFWS, 2011)
- Recommended Future Action from 2019 5-Year Review: Survey to identify potential habitat. A comprehensive and systematic survey of serpentine habitats for the presence of Pennell's bird's-beak has yet to be conducted. A new occurrence was discovered in 1997 during surveys for a different serpentine plant (CNDDB 2018). Anecdotal reports suggest additional populations might exist on private property. By identifying these areas and working with local landowners, additional occurrences might be protected inperpetuity. (USFWS, 2019a)
- Recommended Future Action from 2019 5-Year Review: Conduct research to better understand Pennell's bird's-beak life history, demographics, annual establishment, etc. Very little is known about the demographics and life history of Pennell's bird's-beak. Future research should be focused on informing conservation and management decisions. Current occurrences indicate that site disturbance might promote colonization, yet the role of disturbance mechanisms such as fire and flooding is unknown. Conducting long-term 4 demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics and annual establishment would further recovery goals. (USFWS, 2019a)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Survey to identify potential habitat. A comprehensive and systematic survey of serpentine habitats for the presence of Pennell's bird's-beak has yet to be conducted. A new occurrence was discovered in 1997 during surveys for a different serpentine plant (CNDDB 2018). Anecdotal reports suggest additional populations might exist on private property. By identifying these areas and working with local landowners, additional occurrences might be protected in perpetuity. Conduct research to better understand Pennell's bird's-beak life history, demographics, annual establishment, etc. Very little is known about the demographics and life history of Pennell's bird's-beak. Future research should be focused on informing conservation and management decisions. Current occurrences indicate that site disturbance might promote colonization, yet the role of disturbance mechanisms such as fire and flooding is unknown. Conducting long-term demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics and annual establishment would further recovery goals. (USFWS, 2019a)
- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of Pennell's bird's-beak. Some of these recommendations have already been discussed in our previous status review (Service 2019a, pp. 3–4) and remain valid. 1. Conduct surveys at known occurrences to monitor population trends and habitat changes. 2. Conduct a comprehensive and systematic survey of serpentine habitats to locate additional occurrences of Pennell's bird's-beak. Anecdotal reports suggest additional occurrences exist on private property. By identifying these areas and working with local landowners, these might be protected in perpetuity and contribute towards species recovery. 3. Conduct studies to evaluate and monitor potential management methods to maximize population success such as introducing disturbance through vegetation clearing or burning. Disturbance has been suggested to promote colonization yet the role of disturbance mechanisms such as fire and flooding is unknown. Understanding these mechanisms would aid in management and recovery of the species. 4. Conduct long-term demographic surveys and monitoring that include habitat surveys, genetic research, host-parasite dynamics, and evaluation of seed germination and propagation techniques to improve annual establishment and further recovery goals. 5. Review

existing management plans and revise them to include an objective for standardized monitoring of Pennell's bird's-beak if this objective is missing. Assess the need for annual and quantitative monitoring to achieve recovery objectives (USFWS, 2023).

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SPECIES ACCOUNT: *Coryphantha minima* (Nellie cory cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/7/1979; Southeast Region (R2) (USFWS, 2016)

Physical Description

E. minima has ovoid to cylindrical, tuberculate, solitary or branching stems from to 1.0 to 4.0 cm (0.4 to 1.6 in) tall and 0.6 to 2.5 cm (0.2 to 1.0 in) wide; when cultivated, the plants often form caespitose clusters with numerous stems. Dense, appressed, peg-like spines, from 15 to 27 per areole, obscure the stems. The flowers have pink to reddish-purple perianths from 1.5 to 2.7 cm (0.6 to 1.1 in) wide. The fruits are green to yellowish, from 1.5 to 7.0 mm (0.06 to 0.3 in) long, and the dark brown to black, pitted seeds are up to 1.0 mm (0.04 in) long. (USFWS, 2012)

Taxonomy

First reported by Baird (1931). There is debate over the systematics of the cactus family. Recognized scientific names for Escobaria minima include: Coryphantha minima Baird (Baird 1931; Benson 1982; Zimmerman and Parfitt 2011b; Tropicos 2011b; U.S. Fish and Wildlife Service 2011b); Coryphantha nellieae Croizat (Croizat 1934); Escobaria minima (Baird) D.R. Hunt (Hunt 1978; Anderson 2001; Poole, et al. 2007; Integrated Taxonomic Information System 2011b; Natural Resources Conservation Service 2011b); Escobaria nelliae (Croizat) Backeb (Backeberg 1961) and Mammillaria nelliae (Croizat) Croizat (Croizat 1942). Common names used for Escobaria minima include: Birdfoot cactus (Poole et al. 2007); Dwarf cory cactus (Poole et al. 2007); Least cory cactus (Poole et al. 2007); Nellie cory cactus (Poole et al. 2007; Center for Plant Conservation 2011b; Natural Resources Conservation Service 2011b; U.S. Fish and Wildlife Service 2011b); Nellie's cory cactus (Poole et al. 2007); Nellie's cory-cactus (Anderson 2001); and Nellie's pincushion cactus (Zimmerman and Parfitt 2011b). The Service will continue to classify this species as Excobaria minima. Further systematic revisions are expected in the E. viridiflorus complex, particularly as genetic studies provide new tools to reveal the phylogeny of the cactus family. (USFWS, 2012)

Historical Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Current Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2012)

Lifespan

Adult: Not available, but clearly perennial (USFWS, 2019)

Breeding Season

Adult: April - May (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2012)

Reproduction Narrative

Adult: Weniger (1979a, 1979b) observed that E. minima flowered in April and May and the fruits ripened by mid-summer. The species is insect pollinated and reproduce entirely by sexually-produced seeds. It begins flowering at three to four years of age. E. minima plants produce up to four fruits per year containing 80 to 100 seeds each (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Creosote bush-mesquite shrub, Chihuahuan Desert scrub (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 - 1,350 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Caespitose clusters (USFWS, 2012)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012 and NatureServe, 2015)

Habitat Narrative

Adult: Inhabits rock crevices on novaculite outcrops (a hard, fine-grained, silica-rich rock), in full sun, among sparse Chihuahuan Desert scrub at 1,200-1,350 m elevation (NatureServe, 2015). Within the Caballos formation, E. minima grows in novaculite cracks and fragments, often in association with Selaginella peruviana (club-moss) (Weniger 1979a, 1979b; U.S. Fish and Wildlife Service 1984a, 1984b; Poole et al. 2007). The vegetation map of Frye et al. (1984) classifies the vegetation of the Caballos novaculite outcrops and of the surrounding valley floors as creosote bush - mesquite shrub (Larrea tridentata – Prosopis glandulosa) and tobosa - blackgrama grasslands (Hilaria mutica – Bouteloua eriopoda), respectively. Poole et al. (2007) describe the specific habitats of the endemic plants of the Caballos novaculite as sparse Chihuahuan Desert scrub or sparsely vegetated desert or semi-desert grasslands or shrublands. E. minima plants typically occur as dense, caespitose clusters (USFWS, 2012).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2012)

Dispersal/Migration Narrative

Adult: The seeds apparently fall near the parent plants as fruits decompose and are dispersed by the surface flow of rain water (USFWS, 2012).

Population Information and Trends

Population Trends:
Not available

Number of Populations:
2 (NatureServe, 2015)

Population Size:
> 1 million (USFWS, 2012)

Minimum Viable Population Size:
Unable to determine (USFWS, 2019)

Population Narrative:
Known from only 1 site, 2 populations (NatureServe, 2015). McKinney (2000) estimated that total populations of E. minima were more than 1,000,000 (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Livestock grazing, wildfires, herbicide usage, and mining are potential and/or minor threats (USFWS, 2012).

Stressor: Collection (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The evidence of the threat of illicit and unscrupulous collection to E. minima is clear; the species has been extirpated from its type location on a publicly-accessible highway ROW – a site well-known to cactus collectors for decades. This cactus species is offered for sale over the internet (B & T World Seeds 2011a, 2011b; High Country Gardens 2011a, 2011b), presumably cultivated legally and ethically from propagated seed or tissue culture rather than seeds or plants collected from the wild. There is no information on the current extent of illicit collection from the remaining wild populations. The restricted access to these remote sites and the vastness of the landscape may provide the best possible protection from this threat (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Herbivory by insects, rodents, and perhaps other animals constitutes a potential threat to E. minima (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Changes in temperature and rainfall amounts and patterns could alter the species competitive advantages in the unique micro-habitats it occupies. Regardless of how these changes may affect its autecology, the altered synecology may be far more significant. For example, this species might benefit from higher winter temperatures that extend its growing season. Conversely, it might face new threats from a migration of tropical cactus parasites and pathogens into their habitat (USFWS, 2012).

Recovery

Reclassification Criteria:
The downlisting criteria for Nellie's cory cactus are based on the minimum conditions that justify reclassification of the species. We will consider reclassifying Nellie's cory cactus to threatened status when: (USFWS, 2019)

1. Ten or more viable metapopulations are legally protected and managed for the purpose of conserving Nellie's cory cactus and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with private landowners. (USFWS, 2019)

2. The 10 or more protected metapopulations described in the previous criterion must each have a minimum viable population size of 1,300 or more mature individuals. (USFWS, 2019)

Delisting Criteria:
Nellie's cory cactus will be considered for delisting when: (USFWS, 2019)

1. Periodic monitoring indicates that the minimum viable population levels of 1,300 mature individuals within each of 10 protected metapopulations (the criteria for downlisting to threatened) have remained stable or have increased over a period of 25 years. Monitoring (censuses) of each protected metapopulation must be conducted at least once every five years. (USFWS, 2019)

Recovery Actions:
- Develop a cooperative agreement with private landowners for the protection and management of the Nellie cory cactus population (USFWS, 1984).
- Initiate and support studies on the population biology and ecology of the Nellie cory cactus (USFWS, 1984).
- Develop a comprehensive trade management plan for all cacti (USFWS, 1984).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The 2012 5-year review recommended revising the recovery plan to establish both downlisting and delisting criteria that comply with updated recovery planning guidance. We have now amended the recovery plan and recovery criteria (USFWS 2019). The other recommendations from the 2012 5-year review have not been accomplished, and are continued here: • Explore means to monitor the species and its habitats that are acceptable to landowners in the Marathon Basin as well as scientifically verifiable. Specific objectives should include a more complete determination of the species' ranges, distributions, population sizes, demographic trends, and threats. • Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6-funded grants, cooperative efforts with Natural Resources Conservation Service, or non-governmental partners. Establish a private landowner support group for conservation of the Caballos novaculite rare plants, similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus). • Support continued research on the population dynamics, reproductive biology, and genetic structure of the wild populations. (USFWS, 2020)

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SPECIES ACCOUNT: *Coryphantha ramillosa* (Bunched cory cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/06/1979; Southwest Region (R2) (USFWS, 2016)

Physical Description

The stems of Coryphantha ramillosa are dark grayish green, solitary or rarely with a few branches, 6—9 cm (2.4—3.6 in.) long, and 6—9.5cm (2.4—3.7 in.) in diameter. There are 3—6 central spines per areole: 1 inner, and 2—5 but usually 3 outer. The inner central spine is 25—140 mm (1—1.6 in.) long, and the outer central spines, 17—38.5 mm (.7—1.5 in.) long. The lull white to pale gray radial spines are 12—30 cm (.5—1.2 in.) long. The flowers are 38—65 mm (1.5—2.6 in.) long and 30—50 mm (1.2—2 in.) in diameter. The fruits are 1—2.5 cm (.4—1 in.) long. The seeds are finely raised—reticulate, reniform, reddish—brown, and 1.14—1.5 mm (.06 in.) long (USFWS, 1989). The longer, curving, twisting spines and purplish flowers of C. ramillosa distinguished it from the yellow-flowered C. scheeri and C. scolymoides (Weniger 1979, p. 2). C. ramillosa has flattened, overlapping tubercles, relatively few stems, sulca extending from the apex to the base of the tubercles, entire outer perianth segments, and ovoid fruits less than 2 cm long, while C. macromeris has cilindrical, widely-spaced ubercles, large numbers of stems, sulca extending only half of the tubercle length, frilled outer perianth segments, and elongate fruits over 3 cm long (Weniger 1979, p. 2; Heil et al. 1985, p. 29). (USFWS, 2018)

Taxonomy

A.R. Davis, of Marathon, Texas, first observed bunched cory cactus at the head of Reagan Canyon in 1936. Cutak (1942) described Coryphantha ramillosa based on specimens Davis collected in 1939 (A.R. Davis s.n., MO #12L12260). Weniger (1970) published the species invalidly as Mammillaria ramillosa (USFWS 1989, p. 3). Coryphantha ramillosa has consistently been recognized as a distinct, valid species. However, since the easternmost populations in Coahuila, Mexico, are now recognized as a distinct subspecies, santarosa, the listed entity, bunched cory cactus, is recognized as subspecies ramillosa. (USFWS, 2018)

Historical Range

The bunched cory cactus is known only from Brewster and Terrell Counties, Texas and central Coahuila, Mexico. Presumably the present and historic ranges of the bunched cory cactus are similar (USFWS, 1989).

Current Range

As a subspecies, bunched cory cactus is now somewhat more narrowly endemic to a portion of northern Coahuila, Mexico, and portions of Brewster and Terrell Counties in the Big Bend region of Texas. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 1989)

Dependency on Other Individuals or Species

Adult: Halictidae sweat bee (USFWS, 1989)

Breeding Season

Adult: mid-September to October (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Rocks (USFWS, 1989)

Other Reproductive Information

Adult: Although the breeding system of bunched cory cactus has not been documented, Zimmerman (1985, p. 137) stated that most Coryphantha species are obligate outcrossers. Schmalzel et al. (1999, p. 20) learned from local observers who were familiar with bunched cory cactus that it flowers from mid-September to October, following rain; the flowers open for 2 or 3 days; populations can flower more than once per season; fruits mature in about 6 to 8 weeks; and fruits persist 1 to 2 months. Stems expand and contract according to the amount of water they contain, confounding direct growth measurements. Consequently, Schmalzel et al. (1999, p. 33) estimated growth by painting the spine clusters of young tubercles and observing tubercle production at intervals for two years. They observed that flowers arose only from tubercles produced during the same season. Based on their estimates of size-age relationships, plants become reproductive at about 9 years, corresponding to a diameter of 40 mm (p. 35). They were unable to observe pollinators, seed dispersal, or seedling recruitment (p. 37). (USFWS, 2018)

Reproduction Narrative

Adult: The bunched cory cactus begins blooming at an age of 5 years. Reports of flowering time vary: Weniger (1979) states April to May, Warnock (1970) states June, and Heil et al. (1985) state July to August. The major pollinator is thought to be a green sweat bee in the family Halictidae. Fruits form from October through December (Heil et al., 1985). In its natural habitat and in cultivation virtually 100 percent of the flowers produce fruits. However, such high fruit set is only likely when plant densities are such that cross pollination is assured (A. Zimmerman, Chihuahuan Desert Research Institute, pers. comm., 1986). There are about 75 seeds per fruit. The best place for seedling survival is under rocks or deep in the cracks of rocks where the seeds are protected from dessication and predation (USFWS, 1989).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chihuahuan Desert Scrubland (USFWS, 1989)

Geographic or Habitat Restraints or Barriers

Adult: 2,500 - 3,500 ft. elevation (USFWS, 1989)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 1989)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1989)

Habitat Narrative

Adult: It occupies limestone gravel, alluvial soil on foothills and ridges. It is found on the Bouquillas and Santa Elena limestone formation; distributed along cracks in rock ledges at edges of canyons and on hilltops (NatureServe, 2015). It is found primarily as widely scattered populations or individuals. The bunched cory cactus grows In the Chihuahuan Desert Scrubland (Brown and Lowe, 1980). The elevation range for bunched cory cactus is between 750 and 1,050 meters (2,500—3,500 ft.). In the northern part of its range, the species is mostly confined to rocky, well—drained, and full sunlit sites on steep canyon sides and hill summits along the canyons of the Rio Grande (USFWS, 1989).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 1989)

Dispersal/Migration Narrative

Adult: The fruits ripen in December and the seeds are distributed by rodents and ants (USFWS, 1989).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

7+ (NatureServe, 2015)

Population Size:

Estimated to be > 10,000 individuals (USFWS, 2018)

Minimum Viable Population Size:

Not yet calculated (USFWS, 2018)

Population Narrative:

Schmalzel et al. 1999 obtained permission to conduct surveys of private ranches in Terrell County with the help of Mr. Jim Talbot, a resident of Sanderson, Texas. They confirmed 17 new population sites; Talbot reported three additional sites that the investigators were not able to verify (pp. 21-28). They found 228 bunched cory cactus individuals along 2 km (1.24 mi) of Red House Canyon. Assuming that this density is representative of all populated sites, they estimated the total population would be 10,260 over a span of 90 km in Red House, Lion, Sanderson, Cook, Isinglass, Washboard, and Cedar canyons, and one unnamed canyon (pp. 15-16). Since other populations occur at Reagan, Big, and Rio Grande canyons, as well as a mesa near Seminole Canyon, 10,000 is a conservative estimate of the U.S. population within 30 km

(18.6 mi) of the mouth of Sanderson Canyon (p. 16). However, in contradiction of earlier reports by Weniger (1979, pp. 5,7), the species has never been documented at Black Gap Wildlife Management Area (BGWMA) (Bonnie McKinney, cited in Schmalzel et al. 1999, pp. 27-28), and surveys of Maravillas Canyon (BGWMA) and Mariscal Mountain (BBNP) by Schmalzel's team did not detect bunched cory cactus. They concluded that bunched cory cactus is not rare and should not be listed as threatened under ESA (p. 39). (USFWS, 2018)

Threats and Stressors

Stressor: Habitat or Range destruction, modification, or curtailment (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Intensive range management practices, such as root-plowing and seeding with buffelgrass or other introduced, invasive grasses remains a potential threat, but has not been reported and is unlikely to occur due to the steep terrain and marginal capacity of the habitats for forage production. Some bunched cory cactus individuals may have been trampled at BIBE, due to their proximity to an archeological site (Schmalzel et al. 1999, p. 19). We have no evidence that trampling or habitat destruction has occurred due to increased recreational activity along the Rio Grande scenic river. (USFWS, 2018)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: From a total of about 75 individuals along transects at BIBE, two disappeared; due to their proximity to visitor access they may have been stolen by poachers (Schmalzel et al. 1999, p. 19). We have no additional evidence of the current extent of illegal collection of this species. Since cactus collection continues to be a popular activity, and rare species collected from the wild are especially valuable to some collectors, bunched cory cactus will probably remain vulnerable to a persistent, low-grade threat of illegal collection. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Schmalzel et al. (1999, pp. 19-20) did not observe signs of mammalian herbivory in populations of bunched cory cactus where goats, javelina, and aoudad were abundant. However, they did observe insect frass on stems, indicating the presence of insect parasites (p. 19). Insect parasites cause populations collapses of other small cactuses, such as Tobusch fishhook cactus (USFWS 2017, pp. 27-28, 31, 39-40), and may also cause significant mortality of bunched cory cactus. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:

Narrative: The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the populations of bunched cory cactus at BIBE. Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south and west Texas. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the ESA, in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (U.S. Department of Homeland Security 2008). Additional border wall construction has been proposed by the current Administration. If implemented, the border wall and related infrastructure may affect populations and habitats of bunched cory cactus that occur along the Rio Grande. In particular, the only protected population of bunched cory cactus, at BIBE, is near the Rio Grande and could be adversely affected by new construction in that area. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally-listed with these statuses. Bunched cory cactus was listed as threatened by the State of Texas on April 29, 1983. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands, including BGWMA, without a TPWD permit. (USFWS, 2018)

Stressor: Demographic and genetic consequences of small population sizes (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Small, isolated plant populations are often vulnerable to genetic drift, loss of genetic diversity, and inbreeding depression. However, the population genetics of bunched cory cactus has not been investigated; we have no evidence of the extent of the actual impacts of these potential threats. (USFWS, 2018)

Stressor: Climate change (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: We do not know whether the climate changes that have already occurred have affected the populations or distribution of bunched cory cactus, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, it is unlikely that this species could migrate, without facilitation, fast enough to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species' fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could reduce mortality from freezing. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, bunched cory cactus might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete

with it. Conversely, extended drought could reduce pollinator populations, resulting in pollen limitation and reduced reproductive output. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of bunched cory cactus populations and habitat. Therefore, we will continue to monitor the species' status and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2018)

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Identify at least three sites where the species can be protected and then carry out protective management measures. One site should be on private land in northeastern Brewster or southwestern Tyrrell County, one site should be in Big Bend National Park, and one site should be in Mexico. Each site should initially contain at least 500 plants and should have enough available habitat to permit population expansion and growth (USFWS, 1989).

2. Monitoring and habitat surveys indicate that a total of a least 10,000 plants is being sustained at the protected and managed sites (USFWS, 1989).

Recovery Actions:

- Remove threats to the bunched cory cactus by enforcement of existing regulations and management for protection. Because of the rarity of the bunched cory cactus the populations must be protected by the enforcement of existing Federal, and State regulations and by management to remove threats to the species. (USFWS, 1989)
- Gather information for use in management. A thorough understanding of the population biology and ecology of the bunched cory cactus is needed to help manage healthy natural populations. (USFWS, 1989)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine which species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial artificial propagation program. Strategies for effective law enforcement under ESA, CITES, Lacey Act, and State laws need to be developed. The trade study should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1989)
- Refine propagation techniques to provide nursery stocks and seeds to reduce collecting pressure . The collecting pressure on natural populations could possibly be reduced by refining commercial propagation techniques. This task will be undertaken if findings of the trade management plan indicate that increased commercial propagation is an advisable means of reducing collecting pressure on natural populations. (USFWS, 1989)
- Establish populations at the botanical gardens of research institutions. Even though plants in botanical gardens cannot substitute for healthy populations in natural. habitats, a living collection could still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent well documented and accessible living collection, together with appropriate seed banking, could provide an important source of material for

non—destructive research, maintenance of wild populations, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1989)

- Develop public awareness, appreciation, and support for preservation of the bunched cory cactus . Public education is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of many recovery measures. (USFWS, 1989)
- Recommended Actions from 2018 5-Year Review: To ascertain the degree to which the recovery criteria of bunched cory cactus have been met, we recommend the following: • Develop efficient, quantitative, verifiable methods to estimate population sizes and trends using representative samples of potential habitats and valid statistical analyses. • Recruit Mexican botanists and support studies of the size and geographic distribution of populations in Coahuila and Nuevo León. (USFWS, 2018)
- Recommended Actions from 2018 5-Year Review: The most important recovery actions during the next five years include, but are not limited to, the following: • Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria, including the length of the monitoring period needed to detect demographic trends. Revise the population size criterion to the provisional minimum viable population level of 1,000 to 1,500 mature, reproductive individuals per metapopulation. • Continue to improve the potential habitat model as we learn more about the ecological requirements. • Explore the potential to conserve populations of bunched cory cactus on private lands in Brewster and Terrell counties, Texas through private landowner agreements or other appropriate measures. • Communicate with Mexican agencies, non-profit conservation organizations, and academic institutions to promote the conservation and management of Coryphantha ramillosa subspecies in Mexico. • Investigate the population genetics to determine the genetic structure, genetic diversity and extent of inbreeding, evidence of gene flow, and other parameters that will be useful in the conservation and recovery of bunched cory cactus. (USFWS, 2018)

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SPECIES ACCOUNT: *Coryphantha robbinsiorum* (Cochise pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/09/1986; Southwest Region (R2) (USFWS, 2016)

Physical Description

A spiny succulent with a solitary round stem, 3-5 cm tall. Pale green-yellow flowers appear in March-April, followed in July and August by orange-red fruits (NatureServe, 2015).

Taxonomy

The Cochise pincushion cactus was originally named Cochiseia robbinsorum by W.H. Earle (1976). The genus Cochiseia was rejected almost immediately. Dr. A.D. Zimmerman (1978) assigned the species to the genus Coryphantha, which is currently the most frequently accepted placement. The only other synonym for the species is Escobaria robbinsorum, which is subject to an unresolved controversy (USFWS, 1993).

Historical Range

The Cochise pincushion cactus is known from the San Bernardino Valley, southwestern Cochise County, Arizona, and northern Sonora, Mexico (Lopresti 1984) (USFWS, 1993).

Current Range

It occurs in Cochise Co., Arizona and Sonora, Mexico (NatureServe, 2015). It is restricted to three small limestone hills in Cochise County, Arizona, along the U.S./Mexico border (USFWS, 2007). The Cochise pincushion cactus is known from among several Permian limestone hills in southeastern Cochise County, Arizona. Once thought to have occurred in northern Sonora, Mexico, the species has never been found in that country (USFWS,2020).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Breeding Season

Adult: March - April (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 1993)

Reproduction Narrative

Adult: Lower reproduction rate than most cacti - estimated average annual production is 3 fruits with 20 seeds per plant (NatureServe, 2015). Flowering begins in mid-March extending to mid-April (USFWS, 2016). Zimmerman (1985) noted the small bees Perdita opuntiae, Ashmeadiella opuntiae, and (rarely) Dialictus sp. visiting the flowers of Coryphantha robbinsorum (USFWS, 1993). At least 100 species of bees are using the Cochise pincushion cactus habitat; the rare cactus specialist bee, Macrotera parkeri, is the primary (but not the only) pollinator of Cochise pincushion cactus (USFWS, 2020).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Semidesert grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sunlight (USFWS, 2007)

Geographic or Habitat Restraints or Barriers

Adult: 1,280 - 1,544 m elevation (USFWS, 2016); dense vegetation (inferred from USFWS, 2016)

Spatial Arrangements of the Population

Adult: Scattered with a few dense clumps (USFWS, 2007)

Environmental Specificity

Adult: The Cochise pincushion cactus is known from among several Permian limestone hills in southeastern Cochise County, Arizona (USFWS, 2020).

Dependency on Other Individuals or Species for Habitat

Adult: The primary pollinator, Macrotera parkeri, is a widespread, but rare bee species and is on the Texas list of species of greatest conservation need (USFWS, 2020).

Habitat Narrative

Adult: Inhabits grey limestone hills within a semidesert grassland, with small shrubs, other succulents, and grama grasses (NatureServe, 2015). Found only on one type of high-calcium limestone outcrop in the Mexican Highland vegetation community at elevations of 1,280-1,433 meters (4,200 feet). Soils are thin with a soil crust of lichens, mosses, and algae, and bedrock is very near the surface at occupied sites. Plants tend to be in the open, not underneath other plants. Overall vegetation at occupied sites is sparse (USFWS, 2016). The soils are low in nutrients, with a pH of 7.9 to 8.0. Plants require well-drained substrates and grow in full sunlight. Within their limited habitat (10-16 sq. km), the plants are found scattered, with a few dense clumps ranging from 100-1,000 individuals (Zimmerman 1985) (USFWS, 2007).

Dispersal/Migration

Dispersal

Adult: Moderate (inferred from USFWS, 1993)

Dispersal/Migration Narrative

Adult: Zimmerman (1985) speculates that seeds are disseminated by rock wrens (Salpinctes obsoletus), cactus wrens (Campylorhynchus brunneicapillus), mockingbirds (Mimus polyglottos), black-throated sparrows (Amphispiza bilineata), thrashers (Toxostoma sp.), and house finches (Carpodacus mexicanus). The bright red, fleshy fruits probably attract the birds. He notes that his unpublished study of rock wrens in a population of Coryphantha robbinsorum showed that these birds fly from one Coryphantha population to another during their daily activities (USFWS, 1993).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Declining (USFWS, 2007); Between 1989 and 2006, Cochise pincushion cactus individuals in 3 circular plots were monitored 14 times and all 3 plots had an overall declining trend (USFWS, 2020). The work since 2009 paints a different picture than the plots of 1989-2006. The population is thought to be stable (USFWS, 2020).

Population Growth Rate:

There appears to be a good distribution of Cochise pincushion cactus size classes, including some smaller and larger individuals, though most were intermediate sized individuals (USFWS, 2020).

Number of Populations:

2 (NatureServe, 2015)

Population Narrative:

It occupies 8.8 acres of rangeland (in U.S.?). This species is known only from 1 population in southeastern Arizona and 1 in adjacent Sonora, Mexico (NatureServe, 2015). The known range is very small and limited (USFWS, 2016). Population numbers appear to be declining based on current data (USFWS, 2007). The Cochise pincushion cactus is known from among several Permian limestone hills in southeastern Cochise County, Arizona. Once thought to have occurred in northern Sonora, Mexico, the species has never been found in that country (USFWS, 2020).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Threats include grazing by livestock and wildlife, and oil/mineral exploration activities. Changes in grazing patterns by the local landowner have minimized the potential effects from livestock grazing. Impacts to populations from mining activities have not been a significant factor. However, each of these activities continues to be a potential threat to populations of Cochise pincushion cacti. Impacts from these threats could increase if land ownership changes or incentives for oil and mineral exploration increase. A new threat that has been escalating over

the past 10 years is related to illegal immigration and drug smuggling, and associated law enforcement activities. Plants can be trampled or otherwise damaged or injured. Cochise pincushion cactus habitat is destroyed or altered by foot and vehicle traffic, and there is the potential for the increased incidence of fire. Impacts from border activities have been documented within areas occupied by the Cochise pincushion cactus, but increased law enforcement efforts have, at least temporarily, reduced illegal traffic in the area (USFWS, 2007). In 2006, Cochise pincushion cactus plots were reported vandalized with many nails and tags removed; trash and other evidence of human visitation was also present (USFWS, 2020). Cochise pincushion cactus habitat continues to be used by cross-border violators, as evidenced by trails and litter in some areas (USFWS, 2020).

Stressor: Invasive plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: An additional threat comes in the form of invasive plant species, especially grasses. Of particular note is the spreading threat to Sonoran and Chihuahuan desert ecosystems resulting from the invasion of buffelgrass (Pennisetum ciliare). Buffelgrass can compete for resources with Cochise pincushion cactus, and it also increases the frequency and intensity of fire on the landscape as compared to natural conditions. Such a change in the fire regime could increase Cochise pincushion cactus mortality and alter important habitat microclimates. The recent development of a cold-tolerant strain of buffelgrass by the Agricultural Research Service (2005) increases the potential for this species to invade areas occupied by the Cochise pincushion cactus. Lehmann's lovegrass (Eragrostis lehmanniana) is another invasive grass species in southeastern Arizona (USFWS, 2007).

Stressor: Collection (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The desirability of this species, coupled with its limited distribution, increases the potential for significant impacts to populations if illegal collection were to occur. No evidence of illegal collection within known populations has been observed. However, collection remains a real threat to this species due to its limited numbers and distribution. Cochise pincushion cacti are available commercially on a limited basis, but if interest in this species increases or commercial availability decreases, pressure to collect plants from the wild may increase. The unique, rare nature of this species increases its desirability among collectors (USFWS, 2007). In 2019, a Cochise County Sheriff's Deputy provided a tip to U.S. Fish and Wildlife Service refuge law enforcement that a German national would be in the area to see and photograph Cochise pincushion cactus. Further investigation ultimately led to the man's arrest at the Denver Airport as he was attempting to smuggle Cochise pincushion cactus seeds out of the country. The man was found with 111 bags of cactus seed, including a purposefully mislabeled collection of Cochise pincushion cactus. The suspect admitted to collecting the seed from public lands and was arrested, released on $5,000 bond, and returned to Germany (USFWS, 2020).

Stressor: Insect depredation (USFWS, 2007)
Exposure:
Response:

Consequence:
Narrative: Depredation by insects was documented in the Cochise pincushion cactus long-term monitoring plots in 1994. As a result, mortality of individual plants during that year nearly doubled from the highest mortality previously recorded (see Figure 2). The documentation of this significant depredation event points to the potential for the distribution of this species to be driven by density-dependent insect depredation. As the density of Cochise pincushion cacti increases in a local population, it becomes more vulnerable to insect depredation. At some point, densities may become high enough that conditions favor a significant insect depredation event. Density of cacti is reduced, as is the subsequent depredation by insects. This cycle may repeat itself over time within each of the local populations of Cochise pincushion cactus. As a result, there may be a number of high-density populations within the landscape; however, the density of these populations would eventually be reduced by insect depredation. Low-density populations will gradually increase in density during favorable environmental conditions until they reach a point that favors insect depredation events. In order to determine if this cycle of depredation is indeed a natural component of the population dynamics of the Cochise pincushion cactus, monitoring techniques must be modified to sample the population across its range. Depredation may be a significant driver of the distribution and density of this species. Depredation effects would be amplified in populations suffering from others stressors such as drought (USFWS, 2007).

Stressor: Drought (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Ongoing, long-term drought is occurring within the range of the Cochise pincushion cactus. Drought increases mortality of adults and juveniles and reduces reproduction in populations of this species. Because of the limited number of individual plants and the limited distribution of this species, drought effects may significantly affect its ability to persist on the landscape. A return to normal winter and monsoon precipitation patterns is needed to decrease this threat. The declining trend in numbers of cacti within monitoring plots is likely evidence of the effects of drought on known populations (USFWS, 2007). Not only does climate affect plants directly, it has been shown that climate coupled with other stressors, can have a cumulative impact resulting in greater than anticipated decline in rare species (USFWS, 2020).

Stressor: Pesticides (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Application of pesticides within or adjacent to the range of the Cochise pincushion cactus could adversely affect these insects and associated ecosystem functions. The potential application of pesticides is most likely associated with rangeland grasshopper control. The application of pesticides remains a potential threat to insects that benefit the Cochise pincushion cactus (USFWS, 2007).

Stressor: Small mammal herbivory (USFWS, 2020)
Exposure:
Response:
Consequence:

Narrative: Researchers noted that between 2016 and 2019, small mammal herbivory was much increased and associated flowering forbs were much decreased ; this is believed to be associated with ongoing drought in the region (USFWS, 2020). Recently documented extensive herbivory by small mammals has led to the removal of many adult plants, for example in 2019, 25 of 31 individuals monitored over time were removed by recent herbivory (USFWS, 2020). Despite this, small plants have appeared around the perimeter of missing plants (USFWS, 2020).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
Recovery of this species will require permanent protection and management of the habitat, trade protection through retention of the species on the Highly Safeguarded List of the Arizona Native Plant Law and CITES list following delisting, and demonstration through ten years of monitoring that viable populations are being maintained (USFWS, 1993).

Recovery Actions:

- Conduct biological studies necessary for effective management of the species (USFWS, 1993).
- Develop and implement a habitat management plan in cooperation with the private landowner and Arizona State Land Department (USFWS, 1993).
- Study the population biology of Cochise pincushion cactus to determine the effects of management (USFWS, 1993).
- Protect Cochise pincushion cactus from loss of individuals and habitat (USFWS, 1993).
- Establish an ex situ conservation and research program (USFWS, 1993).
- Define the range and distribution of Cochise pincushion cactus (USFWS, 1993).
- Modify the current monitoring protocol to expand the area monitored within the known range of the species. Design the protocol to more effectively evaluate the status of the species across the landscape. Monitoring should be designed to investigate possible density-dependent depredation issues and identify the distribution of both high-density and low-density populations (USFWS, 2007).
- Update the recovery plan with quantifiable criteria for delisting. For example, a goal of establishing 15,000 plants in 50 populations (Recovery Criteria #2) may not be realistic based on current information of the density and distribution of this species (USFWS, 2007).
- In conjunction with #2, evaluate the existing recovery actions outlined in the existing recovery plan and decide which are still appropriate for the species' recovery, based on current information (USFWS, 2007).
- Evaluate the results of Dr. Tom Van Devender's 2007 work on this species in Mexico and increase monitoring efforts in Mexico, if appropriate (USFWS, 2007).
- Continue to coordinate with and involve the landowners/lessees and SBNWR in recovery actions related to the Cochise pincushion cactus (USFWS, 2007).
- Evaluate the genetics of this species to determine variation within and among populations. This information is useful in determining if population augmentation or establishment of new populations is warranted (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following are recommendations for future actions to conserve Cochise pincushion cactus and its habitat: 1) Work toward the purchase of some portion of Cochise pincushion cactus populations by a Federal entity (such as the expansion of the Buenos Aires National Wildlife Refuge). This would enable land management to benefit the species, and enable easy access to populations for monitoring, scientific study, and augmentation efforts. 2) Work toward building relationships with current landowners that would enable ease of access by researchers and land managers to survey, monitor, manage, and protect Cochise pincushion cactus. 3) Survey for additional Cochise pincushion cactus populations in appropriate limestone habitats in Arizona, New Mexico, and Mexico. 4) Continue annual monitoring of all accessible Cochise pincushion cactus populations, including attempting to relocate historical plots for re-measurement. 5) Work toward an understanding of stressor, threats, and conservation measures needed to help protect Cochise pincushion cactus. 6) Continue work at botanical gardens both developing plants for potential outplanting and periodically collecting seeds from a genetically diverse group of individuals for longterm storage. 7) Work toward public and partner education of the rarity and importance of Cochise pincushion cactus and the need for teamwork to conserve the species. (USFWS, 2020)
- Continue work at botanical gardens both developing plants for potential outplanting and periodically collecting seeds from a genetically diverse group of individuals for long-term storage
- Work toward the purchase of some portion of Cochise pincushion cactus populations by a Federal entity (such as the expansion of the Buenos Aires National Wildlife Refuge). This would enable land management to benefit the species, and enable easy access to populations for monitoring, scientific study, and augmentation efforts.
- Survey for additional Cochise pincushion cactus populations in appropriate limestone habitats in Arizona, New Mexico, and Mexico.
- Continue annual monitoring of all accessible Cochise pincushion cactus populations, including attempting to relocate historical plots for re-measurement.
- Work toward public and partner education of the rarity and importance of Cochise pincushion cactus and the need for teamwork to conserve the species.

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USFWS 2007. Cochise Pincushion Cactus (Coryphantha robbinsorum) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Arizona Ecological Services Office Phoenix, Arizona

Recovery of this species will require permanent protection and management of the habitat, trade protection through retention of the species on the Highly Safeguarded List of the Arizona Native Plant Law and CITES list following delisting, and demonstration through ten years of monitoring that

viable populations are being maintained (USFWS, 1993). USFWS. 2020. Cochise pincushion cactus (Coryphantha robbinsorum) 5-Year Review: Summary and Evaluation. 21 pp.

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U.S. Fish and Wildlife Service. 1993. Cochise Pincushion Cactus (Coryphantha robbinsorum) Recovery Plan. USD1 Fish and Wildlife Service, Albuquerque, New Mexico. 44 pp.

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SPECIES ACCOUNT: *Coryphantha scheeri var. robustispina* (Pima pineapple cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: PPC

Listing Status: Endangered; 10/25/1993; Southwest Region (R2)

Physical Description

Individuals of C. scheeri var. robustispina are small, hemispheric to cylindrical, stem succulent perennials of the Cactaceae (cactus family). Individual stems reach 5 to 46 centimeters (cm) (1.9 to 18.1 inches (in)) in height and 5 to 21 cm (1.9 to 8.3 in) in diameter, are comprised primarily of tough, fleshy pulp, and are protected by a leathery outer skin. Stems may be singular or form clumps. The surface of the stems is covered in 2 to 3 cm (0.8 to 1.2 in) long rounded projections called tubercles, each of which is grooved along the upper surface and contains one to several extra- floral nectaries (place that secretes nectar to attract pollinators) along the groove.. At the tip of each tubercle, arising from small bumps called areoles, are groupings of 7 to 20 straw-colored spines that darken with age (Roller 1996a, p. 9; Parfitt and Gibson 2004, p. 226). There is an average of two thick central spines, one of which is generally hooked and averages 1.7 millimeters (mm) (0.07 in) thick and 3 cm (1.2 in) long (Baker and Butterworth 2013, p. 996). There are 6 to 16 thinner radial spines about 1.1 to 3.5 cm (1.43 to 1.38 in). The young areoles are densely covered with deciduous wool. The stems of C. scheeri ssp. robustispina arise from taproots that are deeper than most Sonoran Desert cacti at about 15 cm deep. Lateral roots are found between 2 and 5 cm below the soil surface and extend approximately 1 m (3.28 ft) in length. The flowers of C. scheeri ssp. robustispina average 6.5 cm (2.6 in) long with pale yellow tepals (petals and sepals) that are variously tinged with red pigments. Flowers generally open early to mid-July following summer rains; fruit matures a few weeks later. The pale green fruits are narrowly ellipsoid, 3.2 to 5.7 cm (1.25 to 2.25 in) long and 1.3 to 1.9 cm (0.5 to 0.75 in) wide, with a soft rind and juicy sweet pulp surrounding a mass of brown to black seeds. (USFWS, 2018a)

Taxonomy

Arthur Schott originally described the taxon as Mammillaria robustispina from a collection he made from near El Sásabe, Sonora, Mexico (holotype MO 2017438) and the name was published by George Engelmann in 1856 (M. robustispina Schott ex Engelmann). Britton and Rose (1923, pp. 33-34) transferred the species to Coryphantha (C. robustispina). The name of the taxon was recombined by Benson (1982, p. 820) to C. scheeri var. robustispina and then again to C. robustispina (Schott ex Engelm.) Britton & Rose ssp. robustispina by Taylor (1998, pp. 17-18). According to Taylor, the species name C. robustispina has priority over the epithet C. scheeri. This view is accepted by Anderson (2001, p. 196). Within the 2018 Recovery Plan, however, we refer to the taxon as C. scheeri var. robustispina, the name in use when the taxon was listed as endangered under the Act in 1993 and how the taxon has been referred to in Service documents since that time. A morphometric study in 2004 suggested that a taxonomic cline exists between all C. robustispina occurring between Arizona and Texas and therefore no varieties are valid (Schmalzel et al. 2004, p. 553). Three varieties; robustispina, uncinata and scheeri, have been investigated recently and were shown to be geographically isolated (Baker 2005, p. 6),

significantly different morphologically (Baker 2003, p. 17), and significantly different genetically (Butterworth 2010, p. 14; Baker and Butterworth 2013, p. 996), warranting subspecific division. We accept this varietal differentiation in this document. (USFWS, 2018a)

Historical Range

See Current Range. There is no indication that the historical range of the taxon differs widely from the current known distribution. (USFWS, 2018a)

Current Range

Found across roughly 152,920 ha (377,873 ac) of land within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including some lands that connect the two valleys. (USFES, 2018a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrosser

Lifespan

Adult: Variable, can be 30 or more years (USFWS, 2018a)

Dependency on Other Individuals or Species

Adult: Pollinators

Breeding Season

Adult: Early to mid-July or five to seven days after the first summer rains of at least 3 mm and continues through the monsoon season. (USFWS, 2018a)

Other Reproductive Information

Adult: Flower buds begin to appear in mid-May and the timing is related to photoperiod and rainfall (Roller 1996a, p. 58). Flowering usually occurs in early to mid-July or five to seven days after the first summer rains of at least 3 mm and continues through the monsoon season (Kearney and Peebles 1951, p. 577; Roller 1996a, p. 58; Kidder 2014, entire). Flowers persist for a single day, yet the timing of flowering may assist with pollination, as there are few cactus species which bloom at this same time, resulting in a greater potential for pollination success (McDonald and McPherson 2005, p. 531). Schmalzel (2014, p. 4) suggests that plants do not reach maturity and begin to flower until they are more than 12 years of age and likely between 20 and 25 years of age. (USFWS, 2018a)

Reproduction Narrative

Adult: Pollinators of C. scheeri var. robustispina are fairly well known. Flowers of the taxon are morphology typical for the subgenus Cactoideae and exhibit characteristics considered generalized with respect to pollination, that is, the pollen being easily accessible to many

different types of pollinators. Known pollinators include both native insects and the nonnative European honeybees (Apis mellifera) (Roller 1996a, p. 63). Coryphantha scheeri var. robustispina become isolated from potential pollination after 600 m (1,968.5 ft) and since the taxon is not able to self-pollinate (Service 2000a, p. 4), they are likely to be genetically isolated or inbred after 900 m (2,953 ft; McDonald 2005, p. 30). Pups (offsets of the parent cactus that are genetically identical) produced vegetatively will not increase genetic diversity of the population. (USFWS, 2018a)

Habitat Type

Adult: Semi-desert grasslands, desert scrub and the transition area between the two vegetation types.

Dependencies on Specific Environmental Elements

Adult: Open and transitional areas; deep, silty and gravely, alluvial soils (USFWS, 2018a)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2018a)

Tolerance Ranges/Thresholds

Adult: Found at elevations between 728 and 1,280 m (2,388 and 4,200 ft) (USFWS, 2018a)

Habitat Narrative

Adult: Coryphantha scheeri var. robustispina is typically found in open areas within the Sonoran Desert-scrub and desert-grassland vegetation types and in areas transitional between these vegetation communities. Routson (2003, p. 3) found that individuals of C. scheeri var. robustispina within the Altar Valley occurred most frequently in disclimax (displaced climax due to disturbance) desert-grassland among woody vegetation on well-drained soils. Many studies describe the subshrubs Zinnia species (desert zinnia), Gutierrezia sarothrae (snakeweed), Isocoma tenuisectus (burroweed), and Eriogonum spp. (buckwheat) as common associates. Schmalzel (2000c, p. 2) noted greater rates of mortality among C. scheeri var. robustispina occurring under the canopies of Prosopis velutina (velvet mesquite). Similarly, Kidder (2014, entire) found occupied sites were characterized by overall high incoming solar radiation (Kidder 2015, p. 110). McPherson (2002, p. 3), however, found individuals occur more frequently under the canopy of perennial plants than at a distance of at least 1 m (3.28 ft) from the canopy edge. (USFWS, 2018a)

Dispersal/Migration

Motility/Mobility

Adult: Low

Dispersal

Adult: Rabbits and rodents act as seed disperses.

Dependency on Other Individuals or Species for Dispersal

Adult: Rabbits and rodents for seed dispersal (USFWS, 2018a)

Dispersal/Migration Narrative

Adult: Fruit and seed dispersal for the taxon is probably facilitated, for the most part, by rodents and, perhaps less so, by ants. It has also been hypothesized that jack rabbits (Lepus spp.) may play a key role in fruit and seed dispersal (Westland 2005, p. 33; Schmalzel and McGibbon 2010, p. 11). In 2001, Westland (2005, p. 33) examined jackrabbit dung and discovered intact C. scheeri var. robustispina seeds within. They noted that dung increased around plants at the time fruits are maturing. A study conducted by Baker and Routson beginning in 2002 documented that ants were mostly associated with extrafloral nectaries, however there were multiple cases of ants eating the fruits and transporting seeds (Baker 2013, p. 21). This study also documented the presence of a single seed in jackrabbit feces, which supports the jackrabbit dispersal hypothesis (Baker 2013, p. 33). In a study of antelope jackrabbit (Lepus alleni) habitat structure and vegetation characteristics, Altemus (2016, p. 10) did not detect a spatial association between the jackrabbits and the presence of C. scheeri var. robustispina, but suggested further study was warranted, as this was a habitat selection study for the herbivore and did not emphasize the distribution of fruits. Additionally, Harris' antelope squirrels (Ammospermophilus harrisii), (USFWS, 2018a)

Additional Life History Information

Adult: Ample seed production, however, does not necessarily equate to persistant seedbanks or recruitment (e.g. see Godinez-Alvarez et al. 2003, p. 183; Aragon and Lasso 2018, p. 1). One field study reported the results of two trials where 200 or more C. scheeri var. robustispina seeds were planted in close proximity to in situ C. scheeri var. robustispina adult plants and germination was followed (Schmalzel 2002, p. 7). In the first trial, 16 of 220 seeds germinated in the first year and none in the second. In the second trial, 35 of 200 seeds germinated; 30 in the first year and 5 in the second year of study (Schmalzel 2002, p. 7). In another study, field germination testing from 5 study sites found that C. scheeri var. robustispina seeds had high germination rates of 88 percent (Roller 1996a, p. 75). Observations from laboratory and shadehouse over a 22-month period showed continuous germination indicating that there is no set dormancy period for the seeds (Roller 1996a, p. 72). (USFWS, 2018a)

Population Information and Trends

Population Size:

Roughly 8000 individuals and 152,920 ha (377,873 ac) of habitat (USFWS, 2018b)

Additional Population-level Information:

Between 1995 and 2007, 45 individual C. scheeri var. robustispina were monitored in an exclosure on Coronado National Forest land in the Santa Cruz Valley. In 2010, no living plants were found (Coronado National Forest 2010, entire), however, in a partial survey of this area in 2015, some C. scheeri var. robustispina were found both within and outside of this exclosure (Service 2015b, entire). Similarly, plants are monitored regularly on the Pima County and Palo Alto Pima Pineapple Cactus Conservation Bank properties. On one portion of the County-owned Conservation Bank property in 2006, 67 plants were mapped; when last counted in 2014, 13 of the original 67 plants remained alive and 11 new plants had been found (Pima County 2015, p. 1). Within or adjacent to the Palo Alto Conservation Bank property, 49 plants were found in 2001; as of September, 2015, 9 of the original individuals remained alive and 11 new plants were discovered, for a total of 24 known C. scheeri var. robustispina (Westland 2015, p. 2). (USFWS, 2018a)

Population Narrative:

We are aware of roughly 8,000 individuals and 152,920 ha (377,873 ac) of habitat within the Altar and Santa Cruz Valleys in Pima and Santa Cruz Counties, Arizona, including acreage of some lands that connect the two valleys. Maintaining linkages for pollinators and lands dominated by native plants are important for the survival of the taxon. Long-term monitoring plots of Coryphantha scheeri var. robustispina indicate overall decreases in the number of individuals monitored over time. Attempts at transplanting individuals out of the path of development has resulted in a mix of successes and failures. We are aware of at least 1,837 individuals and tens of thousands of acres of habitat that have been lost, primarily due to development. (USFWS, 2018b)

Threats and Stressors

Stressor: Habitat loss due to commercial development (2018a)
Exposure:
Response:
Consequence:
Narrative: The primary habitats of C. scheeri var. robustispina are open areas on flat ridge tops or areas with less than 10 percent slope, which are also areas very well suited for human development. Urban and suburban development in the areas south and west of Tucson, Green Valley, and Nogales, Arizona, and mining in the Sierrita Mountains and Green Valley, threats first recognized in the 1980s (Phillips et al. 1981, p. 11; Mills 1991, p. 7; Reichenbacher 1985, p. 21; Service 2000a, p. 7), are responsible for complete and permanent modification of lands that previously supported C. scheeri var. robustispina and its pollinators. By 2000, the Service estimated that 43 percent of the total habitat surveyed to date had been modified or destroyed due to urbanization (Service 2001a, p. 6). For example, 143 ha (353 ac) of habitat and 47 individual plants were lost to a single housing development project in 1998 (Service 1998c, p. 16). In 2014, 197 ha (487 ac) of suitable C. scheeri var. robustispina habitat and 99 individual plants were lost to a single infrastructure development project (Service 2014a, p. 33). (USFWS, 2018a)

Stressor: Habitat loss due to nonnative plant invasion and altered fire regimes (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: Coryphantha scheeri var. robustispina occur in both the desert-grassland and desert-scrubland plant communities, especially in the ecotone of the two (Roller 1996a, p. 9). Invasive nonnative grasses in both communities compete with native plants for water and nutrients, reduce community composition and structure, and alter fire frequency and intensity. Historically, low severity fires that occured every 10 to 20 years in grasslands, or every 250 years in deserts, likely posed no threat to the long-term survival of C. scheeri var. robustispina individuals. When invaded by invasive nonnative grasses, fire frequency and intensity increase, leading to the deterioration of both natural grassland and desert communities. Invasive nonnative grasses produce more fine fuels than native vegetation, allowing for a more uniform and higher intensity burn compared with the discontinuous fuels of some native grasslands and deserts, thus reducing the number of microsite refuges safe from fire. Coryphantha scheeri var. robustispina is not fire adapted, but may survive fires through refugia (e.g. older soils or spaces between native plants), chance, shrinking into the ground, reproducing through basal resprouting, or possibly recolonization from a surviving seedbank, barring adequate rainfall to allow for survival. Further

research into the relationship of fire, drought, nonnative species, soil types, and C. scheeri var. robustispina and their seedbanks would help to better understand the tolerance of this taxon to wildland and prescription fires. Research into desert-scrubland and desert-grassland restoration (e.g. removal of nonnative grasses and the establishment of native plants) is also essential, as this is a large-scale problem currently without large-scale solutions. (USFWS, 2018a)

Stressor: Effects of Livestock Grazing (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: Some livestock grazing practices that occurred in the past have resulted in enduring landscape-level impacts, because recovery in dryland ecosystems is slow or stagnant. Historically overgrazed lands have altered microclimate and hydrology, increased soil compaction and erosion, reduced structural complexity and abundance of the vegetation community, and species composition; all of which may impact the current suitability of habitat for C. scheeri var. robustispina in certain areas of its range. In general, poorly managed livestock grazing may negatively impact C. scheeri var. robustispina seedlings and adult plants through soil erosion, soil compaction, hydrologic and micro-climatic changes, and invasion or expansion of invasive nonnative grasses. Low to moderate intensity grazing however, may also aid C. scheeri var. robustispina through the creation of open areas temporarily free of competition and with reduced fuels (Service 2000a, p. 9). Additional research into the relationships between livestock use and C. scheeri var. robustispina is needed to determine both the benefits of grazing and the threshold at which disturbance no longer benefits the taxon. In addition, research is needed into restoration of native species and fire regimes on desert grasslands and desertscrub. (USFWS, 2018a)

Stressor: Recreation and Border Activity (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: Off-road vehicle use and illegal border activity contribute to the overall degradation of C. scheeri var. robustispina habitat. In addition, individual C. scheeri var. robustispina have been run over by off-road vehicles. Although these activities could impact individual C. scheeri var. robustispina, off-road vehicles and illegal border activity are not likely significant sources of mortality for the taxon as a whole. (USFWS, 2018a)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: Illegal collection of C. scheeri var. robustispina is difficult to detect and only one incident has been reported in recent years. Although illegal collection could impact C. scheeri var. robustispina, it is not as significant a threat for the taxon as previously thought. The determination to not designate critical habitat for the species has helped reduce this threat by not making maps publically available, and continued outreach and education related to the issue of illegal collection remain important tools in the conservation of this taxon. (USFWS, 2018a)

Stressor: Disease or Predation (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: In general, cacti are susceptible to attacks from numerous types of insects, and C. scheeri var. robustispina is no exception. The interior flesh of cacti provides both a nesting area and food source for beetles, weevils, and other insects. Once an infestation has occurred, cacti can die from the feeding and tunneling activities of insects or from the introduction of fungus or disease. Plants already stressed from prolonged drought are more susceptible to insect attack and disease, as drought may cause physiological stress responses in plants, such as limiting their photosynthesis and cell. Predation by mammals and insects occurs on both adult C. scheeri var. robustispina and seedlings. Primary insect predators of C. scheeri var. robustispina are the native Gerstaeckeria sp. (cactus weevil), the native Moneilema sp. (cactus beetle), and the native Cactobrosis sp. (pyralid moth). Ants have been documented on C. scheeri var. robustispina and will consume seed, however they are not specialists of C. scheeri var. robustispina. O'Dowd and Hay (1980, p. 539) suggest that ants may also aid in reducing the seedbank of competing plant species. Predation of Coryphantha scheeri var. robustispina by mammals is well-documented. Harris' antelope squirrel), antelope jackrabbits and desert cottontails are known to eat stem material of C. scheeri var. robustispina, especially when other food sources are scarce, such as in times of drought. Researchers have documented C. scheeri var. robustispina mortality caused by javelina (Pecari tajacu). These and other animals can also impact cacti by digging under stems, or, at least for larger animals, knocking over or trampling stems. In summary, there are many insect and mammalian predators to C. scheeri var. robustispina adults and seedlings. Predation increases during times of drought and following damage to a cacti's protective spines, such as post-fire. Many individual C. scheeri var. robustispina die or become disposed to death annually from predation which has been recorded on numerous occasions over the past decade. (USFWS, 2018a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: Because most C. scheeri var. robustispina occur on private and State Trust lands, they and their habitats are not subject to Federal protection unless there is a Federal nexus to a proposed action. Habitat loss due to urbanization remains a substantial threat to C. scheeri var. robustispina on these lands. Although best management practices may be implemented with regard to development, nonnative plant invasion and associated alteration of fire regimes, recreation, border issues, and the presence of livestock, management is not continuous across the range of the species and C. scheeri var. robustispina remain vulnerable to these threats and stressors. There are no regulations in place that address stressors to C. scheeri var. robustispina and its habitat from predation, drought and climate change, or small population size. (USFWS, 2018a)

Stressor: Drought and Climate Change (USFWS, 2018a)
Exposure:
Response:
Consequence:

Narrative: Cacti are vulnerable to disturbance because they grow slowly, their germination and establishment occurs with low frequency, and they have little capability to recover from disturbance (Portilla 2011, p. 509). Disturbance can reduce recruitment, survival, fecundity, and population growth; disturbance coupled with drought, however, can exacerbate negative impacts on cacti. In summary, since the late 1990s, the southwestern United States has been experiencing drought conditions and increasing high temperatures. Climatic predictions suggest continued less frequent, but perhaps more intense, summer precipitation, reduced winter precipitation, and increasing temperatures in this region. Drought and increased temperatures increase C. scheeri var. robustispina stress, reduce defenses to predation and disease, and reduce reproduction, among other impacts. These impacts will continue to affect C. scheeri var. robustispina and its habitat throughout its range into the foreseeable future. (USFWS, 2018a)

Stressor: Small Population Size and Isolation (USFWS, 2018a)
Exposure:
Response:
Consequence:
Narrative: High species diversity within the vegetative community is important to the survival of C. scheeri var. robustispina, as this cactus is not abundant enough to sustain its main pollinators. A key pollinator for C. scheeri var. robustispina is Diadasia rinconis, a cactus specialist bee which requires species of Cylindropuntia, Opuntia, and Ferocactus to survive. C. scheeri var. robustispina is a sparsely distributed plant that requires habitat connectivity and proximity to other plants for effective pollination. Large scale threats and stressors such as habitat degradation and regional drought increase the potential for isolation and genetic loss. Current information indicates that roughly 98 percent of all known C. scheeri var. robustispina occur within 900 m (2,952.8 ft) of one another. Should development or other threats or stressors remove or cause the deterioration of corridors and connectivity, this could result in genetic isolation and inbreeding. (USFWS, 2018a)

Recovery

Reclassification Criteria:
1. Threats and Habitat Criterion: At least 8,094 hectares (ha) (20,000 acres [ac]) of C. scheeri var. robustispina habitat per recovery unit are documented to be of optimal quality and remain that way through successful resource management, land conservation, and restoration techniques such as in situ germination. At least 24,281 ha (60,000 ac) of C. scheeri var. robustispina habitat per recovery unit are documented to be of good quality and remain that way in perpetuity. Habitat is considered optimal quality when it: is protected for conservation purposes; is managed in a manner that promotes the long-term survival of C. scheeri var. robustispina; has less than 20 percent cover of C. ciliaris, E. lehmanniana, or other invasive nonnative plant species that alter ecosystem function; contains contiguous habitat and corridors for pollinators; and the C. scheeri var. robustispina population is observed to be stable or increasing. Habitat is considered good quality when the cover of C. ciliaris, E. lehmanniana, or other nonnative plants that alter ecosystem function remains between 20 and 35 percent; the land is managed in such a way that promotes the continued existence or expansion of long-term survival of C. scheeri var. robustispina. Collectively, this represents approximately 42 percent of the known range of C. scheeri var. robustispina. Additional acres of lesser quality C.scheeri var. robustispina also exist throughout the range of the species; some of whichoccurs on lands where ongoing efforts may continue to improve habitat quality. (USFWS, 2018a)

2. Conserve, protect, and restore mature C. scheeri var. robustispina individuals, theirseedbanks (approximately 10 meters), and habitat for pollinators (approximately 900 meterradius) in each recovery unit through resource management, land conservation, andrestoration techniques such as in situ germination. Quantitative monitoring, using a standardized monitoring protocol, of established plots across a variety of land ownerships and land management scenarios, with landowner support, is conducted within each of the two recovery units every 3 to 5 years. Plots demonstrate that the population is stable or increasing a minimum of 10 years over a 15-year period. (USFWS, 2018a)

Delisting Criteria:
The first two criteria for downlisting must be met or surpassed, and monitoring must demonstrate that the population is increasing for a minimum of 20 years over a 30-year period. The additional time necessary to achieve delisting ensures continued population viability. Additionally, it will allow land managers to continue to reduce threats to C. scheeri var. robustispina from nonnative species invasion achieved during downlisting and track the long-term effectiveness of management. The additional time will also allow land managers to develop methods to reduce anticipated cost and effort needed to maintain habitat and population viability absent the protections of the Act. (USFWS, 2018a)

Recovery Actions:
- Conserve existing and newly discovered C. scheeri var. robustispina and associated habitat, including unoccupied areas that provide habitat and connectivity for pollinators. Promote urban planning for compact urban development, increase open space preservation and management (e.g. restrictions on trash dumping, off road vehicle use, placement of pedestrian trails, etc.), and connective habitat corridors. Engage in land acquisition to reduce habitat fragmentation and increase connectivity. Develop conservation easements for the protection of C. scheeri var. robustispina on private lands. Develop and monitor conservation mitigation banking to promote the protection of C. scheeri var. robustispina habitat. (USFWS, 2018a)
- Restore quality C. scheeri var. robustispina habitat in the U.S. and Mexico. Develop and implement land management plans that support and promote the taxon, including through the reduction of nonnative plant species and unnatural fire regimes, soil erosion, soil compaction, and headcutting. Work toward a better understanding of transplanting and seeding requirements for C. scheeri var. robustispina which could be implemented in appropriate habitat. (USFWS, 2018a)
- Develop range-wide standardized long-term monitoring of individuals in established plots, as well as their habitats, threats, and stressors. Monitor individuals in established plots across the range of the taxon using a tested standard protocol to enable an understanding of the long-term trend of the species, its habitat, threats, and stressors. Check the effectiveness of management actions by monitoring individuals subjected to natural and prescribed fire, mechanical site disturbance, various grazing regimes, various restoration techniques, and other management considerations. Monitor in situ grown and transplanted individuals for effectiveness of sowing, planting, and transplanting protocols. (USFWS, 2018a)
- Encourage scientific study to improve our understanding of C. scheeri var. robustispina biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitats, distribution, and genetics in the United States and Mexico.

Identify information gaps, compatible land uses, threats, stressors, and appropriate management actions that lead to the conservation of the taxon. Conduct surveys in appropriate habitat, using a tested standard protocol, to better understand the geographic range and habitat requirements of the taxon. Investigate the feasibility of alternative survey methodologies, such as the use of detection dogs, drones, and distance sampling. Conduct research related to the biology, ecology, abundance, status, threats, stressors, viability, propagation, restoration of individuals and of habitat, and genetics of the taxon. (USFWS, 2018a)

- Maintain plants in captivity at botanic gardens and seeds at seed storage facilities; encourage research into propagation, in situ seed planting, and transplanting methods. Promote the propagation and planting of individuals ex situ at botanic gardens for conservation and public education purposes. Maintain seed from plants across the geographic range of the taxon for conservation purposes. Develop effective approaches to in situ conservation. (USFWS, 2018a)
- Develop public outreach, collaborative partnerships, and agreements with private landowners in the United States and Mexico that encourage C. scheeri var. robustispina conservation. Increase public outreach regarding threats, stressors, and conservation measures relating to C. scheeri var. robustispina in both the United States and Mexico. Develop collaborative partnerships and agreements with private landowners that result in management plans or that otherwise encourage C. scheeri var. robustispina conservation in the United States and Mexico. Develop a recovery implementation team comprised of species experts, agency and non-government agency partners, landowners, and stakeholders to meet regularly, review progress, discuss problems, and revise this plan as needed. (USFWS, 2018a)

Conservation Measures and Best Management Practices:

- The principle recovery strategy is to conserve the habitat of Coryphantha scheeri var. robustispina by protecting habitat, restoring habitat, and protecting Coryphantha scheeri var. robustispina individuals, their seedbanks, and habitat for their pollinators. Providing conservation and restoration of the taxon and its habitat will allow a stable, self-sustaining population to persist with some level of connectivity and opportunities for expansion and dispersal. Additional actions needed include monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors. Several recovery actions listed in the Recovery Plan are already under way, including protection of land from development (USFWS, 2018)..

References

USFWS. 2018a. Recovery plan for Pima pineapple cactus (Coryphantha scheeri var. robustispina). U.S. Fish and Wildlife Service, Southwest Region, Tucson, Arizona. 76 pp + 2 Appendices.

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USFWS. 2018b. Pima pineapple cactus (Coryphantha scheeri var. robustispina), 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Tucson, Arizona. 2 pp. https://ecos.fws.gov/docs/five_year_review/doc5814.pdf

USFWS. 2018. 5-Year Review: Summary and Evaluation Pima pineapple cactus (Coryphantha scheeri var. robustispina). 2 pp.

SPECIES ACCOUNT: *Coryphantha sneedii var. leei* (Lee pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/26/1979; Southwest Region (R2)

Physical Description

Both the Sneed and Lee pincushion cacti are many branched, forming tight clumps of up to 100 or more stems. Individual stems are cylindroid or spherical to club-shaped, 2.5-7.5 cm long (1.0-2.9 inches) and 1-3 cm in diameter (0.4- 1.2 inches) with tubercles up to 3mm long (0.12 inches). The tubercles are persistent and hard after fall of the spines. The spines hide the stem. The central spines are acicular, white, tipped with pink and brown, 3-14 cm long (1.2-5.5 inches) and about 6-17 per areole. The radial spines are white, 3-12 mm long (0.2-0.47 inches) and 35-90 per areole. The flowers are about 1.2 cm tall (0.5 inches) and of equal diameter, not opening widely; they are brownish-pink to pale rose with pink filaments and bright orange anthers. The fruits are greyish-green, or greenish tinged with brown, or rarely pinkish when ripe. They are clavate up to 1.5 cm long (0.6 inches) and 6 mm in diameter (0.24 inches). The seeds are reddish-brown, 0.7-1 mm long (.027-.039 inches), and 1.25-1.5 mm broad (.049-.059 inches) (Benson, 1982). In the Lee pincushion cactus, the spines are deflexed on medium and small stems, slanting from the top of the tubercle toward the main portion of the stem; the flowers are dull medium brownish-pink; the seeds are 1 mm long (.039 inches) and 1.5 mm broad (.059 inches) (Benson, 1982).(USFWS, 1986)

Taxonomy

In the recent taxonomic publications (Kartesz 1999; Baker and Johnson 2000; Anderson 2001), both varieties of Coryphantha sneedii are placed in the genus Escobaria Britton and Rose. Baker and Johnson (2000) note that this genus is sometimes considered a subgenus of Coryphantha. Anderson (200 1) uses the genus Escobaria in his book "The Cactus Family," stating that the International Cactaceae Systematics Group has accepted this genus. (USFWS, 2015)

Historical Range

Coryphantha sneedii var. leei is known only from the Guadalupe Mountains in New Mexico (Eddy County), within, and immediately adjacent to, Carlsbad Caverns National Park. At the time of listing, it was known to only occur in "several canyons" (Weniger 1969). (USFWS, 2015)

Current Range

Occurs in the Guadalupe Mountains (Eddy County) of New Mexico (NatureServe, 2015). This subspecies includes individuals from six canyons scattered in populations of low abundance over approximately 22 kilometers (14 miles) of the Guadalupe Mountains including BLM lands (Carlsbad District). (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (USFWS, 1986; see dispersal narrative); sexual (inferred from USFWS, 1986)

Breeding Season

Adult: March - April (USFWS, 1986)

Key Resources Needed for Breeding

Adult: Winter and spring moisture, soils seed bank (USFWS, 1986)

Reproduction Narrative

Adult: Most Lee pincushion cacti bloom after 3 - 4 years. Plants bud in late March or early April; fruit formation is from August to November. Winter and spring moisture is important for bud set. Each fruit produces about 26 seeds and a flowering stem produces about 6 fruits. A typical plant may produce over 1,000 seeds per year. Since seeds can remain viable for up to 10 years, the soil probably contains a sizeable seed bank (USFWS, 1986).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,220-1,800 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: It is restricted to the Tansil Limestone Formation and grows only on north-facing limestone ledges, slopes and ridgetops, at 1,220-1,800 m elevation; precipitation averages 30 cm/year, in interior chaparral communities. The limestones are generally hard, resistant to erosion, and support a sparse vegetation of low shrubs, some rosette-forming perennials, many cacti, and both annual and perennial herbs (USFWS, 1986; NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 1986)

Dispersal/Migration Narrative

Adult: Only about 10% of all stems are of the non-flowering type, and these are broken off by animals or shifting rocks and may root, establishing new plants. Most fruits are eaten by insects or rodents who probably scatter a few seeds in the process. Birds have also been observed to feed on the fruits and should at least occasionally serve as dispersal agents. If a fruit is not

eaten, weathering breaks down the fruit wall causing the seeds to be dispersed by wind or rain (USFWS, 1986).

Population Information and Trends

Population Trends:
Not available

Number of Populations:
6 (USFWS, 2015)

Population Size:
1,000 - 2,000 (USFWS, 1986)

Population Narrative:
Presently, Coryphantha sneedii var. leei is known from very limited portions of six canyons in the Guadalupe Mountains (USFWS, 2015). There are an estimated 1,000 - 2,000 plants (Heil and Brack, 1985a) (USFWS, 1986).

Threats and Stressors

Stressor: Fire (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Presently, the threat of wild and prescribed fires in or around occupied Coryphantha sneedii var. leei habitat could prove problematic to its survival. Most of the park has burned since 1941 (NPS 2005, map, p. 6). While lightning ignitions probably took place frequently in the Guadalupe Mountains, most fires were likely quite localized and less intense prior to fire suppression (NPS 2005). Fire suppression in many ecosystems creates more uniform fuel loads that support more landscape-scale high intensity fires (NPS 2005). Specific impacts of wild and prescribed fire on Coryphantha sneedii var. leei are inconclusive (USFWS, 2015).

Stressor: Longhorn cactus beetle (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: There has been one observation of adult Moneilema armatum (longhorn cactus beetle) on C. sneedii var. leei, eating portions of this cactus. It is unknown what impact, if any, longhorn beetles have on this species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and

because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend. Munson et al. (20 14) predicts declines in vegetative cover including cacti in Chihuahuan Desert habitats due to climate change. Coryphantha spp. are likely to have experienced and rebounded from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species (USFWS, 2015).

Recovery

Reclassification Criteria:
Not applicable. (USFWS, 1986)

Delisting Criteria:
TheLee pincushion cactus will be considered for delisting when:

1. All core populations demonstrate stable or increasing trends in abundance over a 20-year period. This will be based on periodic demographic trend monitoring and analysis implemented under the recovery actions. (USFWS, 2019)

2a. Maintain a minimum of three geographically separated core populations for each species over a 20-year period. (USFWS, 2019)

2b. A minimum of one new core population will be discovered (use Criterion 1) or established outside the current range and wholly separated geographically from the other core populations, and remain occupied for 10 years out of the 20-year survey period. (USFWS, 2019)

3a. Maintain genetic diversity within all core populations as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)

3b. Maintain presence in 80 percent of subpopulations over 20-year monitoring period and outside of the core populations, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)

4. Develop and implement a Habitat Management Plan (HMP) for Sneed and Lee pincushion cacti conservation. (USFWS, 2019)

5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

Recovery Actions:
- Remove threats of collecting by enforcement of existing regulations. Because of the rarity of the Lee pincushion cactus, the populations must be protected by enforcement of existing international, Federal, and State regulations. Determine the extent and impacts of collecting. Develop and implement a law enforcement strategy. Publicize successful law enforcement actions. (USFWS, 1986)
- Manage existing habitat for protection of the cactus. Habitat management for the Lee pincushion cactus should be done through existing agency management procedures and

through cooperation with private landowners. The following should be accomplished. Agencies should remain informed of the location and status of Lee pincushion cactus populations. Develop and implement habitat management plans for all populations on public lands. Seek cooperation of landowners to protect and maintain populations on private lands. (USFWS, 1986)

- Gather information for use in management. In-depth knowledge of the plant's growth, distribution, population biology and ecology is needed to understand habitat requirements. The knowledge gained can be used to help sustain and manage healthy natural populations. Study population biology and ecology. Develop techniques to artificially propagate and transplant the Lee pincushion cactus. Inventory known populations and search for new populations in the Franklin and Guadalupe Mountains. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1986)
- Develop public awareness, appreciation and support for preservation of the Lee pincushion cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential to the ultimate success of the foregoing recovery measures. (USFWS, 1986)
- Recommendations for Future Actions from 2015 5-Year Review: • Determine if the genus associated with this species needs to be changed from Coryphantha to Escobaria on all future Service documents. • Revise the recovery plan for these species to incorporate new information on taxonomy, biology, ecology, and threats with management recommendations. Objective and measurable recovery criteria for down and de listing of the species should be developed which address all listing factors relevant to this species. • Develop a Coryphantha sneedii var leei and C. sneedii var. sneedii multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. • Develop standardized survey and monitoring protocols for these species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. Incorporate fire and climate change factors into long-term monitoring data collection. • Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). • Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. • Provide legally grown seeds and plants of Coryphantha sneedii var. leei and C. sneedii var. sneedii, as the known populations allow, to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti thr.oughout its range. • Provide viable Coryphantha sneedii var. leei and C. sneedii var. sneedii seeds to a seed bank operating under the Center for Plant Conservation guidelines. • Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of these species. • Determine microhabitat needs of these species ("nurse" plants, pollinators, precipitation needs- amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and

mitigation site. (USFWS, 2015)

References

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USFWS. 2019. Amendment 1 to Recovery plan for Coryphantha sneedii var. sneedii (Sneed pincushion cactus) and Coryphantha sneedii var. leei (Lee pincushion cactus). U.S. Fish and Wildlife Service, Southwest Region, Albuquerque, New Mexico. 17pp.

SPECIES ACCOUNT: *Coryphantha sneedii var. sneedii* (Sneed pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/07/1979; Southwest Region (R2)

Physical Description

Both the Sneed and Lee pincushion cacti are many branched, forming tight clumps of up to 100 or more stems. Individual stems are cylindroid or spherical to club-shaped, 2.5-7.5 cm long (1.0-2.9 inches) and 1-3 cm in diameter (0.4- 1.2 inches) with tubercles up to 3mm long (0.12 inches). The tubercles are persistent and hard after fall of the spines. The spines hide the stem. The central spines are acicular, white, tipped with pink and brown, 3-14 cm long (1.2-5.5 inches) and about 6-17 per areole. The radial spines are white, 3-12 mm long (0.2-0.47 inches) and 35-90 per areole. The flowers are about 1.2 cm tall (0.5 inches) and of equal diameter, not opening widely; they are brownish-pink to pale rose with pink filaments and bright orange anthers. The fruits are greyish-green, or greenish tinged with brown, or rarely pinkish when ripe. They are clavate up to 1.5 cm long (0.6 inches) and 6 mm in diameter (0.24 inches). The seeds are reddish-brown, 0.7-1 mm long (.027-.039 inches), and 1.25-1.5 mm broad (.049-.059 inches) (Benson, 1982). In the Sneed pincushion cactus, the stems have spines that are not deflexed but spread parallel to the stem surface; the flowers are pale, or medium to rose, magenta; the seeds are 0.75 mm long (.03 inches), and 1.25 mm broad (.049 inches) (Benson, 1982). (USFWS, 1986)

Taxonomy

In the recent taxonomic publications (Kartesz 1999; Baker and Johnson 2000; Anderson 2001), both varieties of Coryphantha sneedii are placed in the genus Escobaria Britton and Rose. Baker and Johnson (2000) note that this genus is sometimes considered a subgenus of Coryphantha. Anderson (2001) uses the genus Escobaria in his book "The Cactus Family," stating that the International Cactaceae Systematics Group has accepted this genus. Further elucidation of the taxonomic relationships of the C. sneedii complex, including Escobaria guadalupensis, is needed in order to understand the distribution and abundance of C. sneedii var. sneedii (USFWS, 2015).

Historical Range

Coryphantha sneedii var. sneedii is a regional endemic along the Texas/New Mexico border (USFWS, 2015). It was historically known only from the Anthony Gap area of the Franklin mountains in Dona Ana County, New Mexico. (USFWS, 1986)

Current Range

It occurs in western Texas and nearby southern New Mexico (between El Paso and Las Cruces) (NatureServe, 2015). It possibly occurs in the Guadalupe Mountains; in Dona Ana and Eddy Counties, New Mexico, and El Paso County in Texas (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (USFWS, 1986); sexual (inferred from USFWS, 1986)

Breeding Season

Adult: March - April, sometimes July - August (USFWS, 1986)

Key Resources Needed for Breeding

Adult: Rocks (USFWS, 1986; NatureServe, 2015)

Reproduction Narrative

Adult: A second blooming season has rarely been observed in July and August usually following summer rains. The best seedling survival is under rocks or deep in the cracks of rocks where seedlings are protected (USFWS, 1986; NatureServe, 2015). One type of stem remains small and probably serves to start new plants when they break off. Most Sneed pincushion cacti bloom after 3 - 4 years. Plants bud from March to April with the principal blooming period in April and fruit formation from august to November. Fruits from slaughter Canyon averaged about 18 seeds per fruit. With about 11 flowering stems per plant, about 140 seeds per plant are produced each year (USFWS, 1986).

Habitat Type

Adult: Terrestrial (USFWS, 1986; NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert and desert grassland (USFWS, 1986; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,220-1,800 m elevation (USFWS, 1986; NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1986; NatureServe, 2015)

Habitat Narrative

Adult: It is restricted to limestone ledges and the rocky slopes of limestone mountains in desert and desert grassland habitats; 1,22 0- 1,800 m elevation; precipitation 19.7 - 40.0 cm/year; and grows in cracks on vertical cliffs or ledges. The limestones are generally hard, resistant to erosion, and support a sparse vegetation of low shrubs, some rosette-forming perennials, many cacti, and both annual and perennial herbs (USFWS, 1986; NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low to moderate (inferred from USFWS, 1986)

Dispersal/Migration Narrative

Adult: The fruits have a prune-like odor when ripe and attract rodents which are likely dispersal agents. Birds have been noted to feed on the fruits and should serve as dispersal agents. Some

fruits crumble with age, and water disperses the seeds (USFWS, 1986).

Population Information and Trends

Population Trends:
Not available

Number of Populations:
20 (USFWS, 1986)

Population Size:
Possibly > 100,000 (USFWS, 1986)

Population Narrative:
There are 20 documented localities for this taxon. Heil and Brack (1985a) have estimated the total number of sneed pincushion cacti in Carlsbad Caverns National Park to exceed 100,000. This figure needs verification through quantitative sampling (USFWS, 1986).

Threats and Stressors

Stressor: Fire (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Most of the park has burned since 1941 (NPS 2005, map, p. 6). While lightning ignitions probably took place frequently in the Guadalupe Mountains, most fires were likely quite localized and less intense prior to fire suppression (NPS 2005). Fire suppression in many ecosystems creates more uniform fuel loads that support more landscape-scale high intensity fires (NPS 2005). However, specific impacts of wild and prescribed fire on C. sneedii var. sneedii are still inconclusive (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Growing seasons are becoming longer and warmer in many regions (Parmesan 2007) including the southwest (Cayan et al. 2001; Easterling 2002; Lenart et al. 2007; Enquist and Gory 2008). Earlier soil moisture stress would result in decreased flowering and reproduction, and because this cactus has a limited distribution, we would predict a substantial population reduction with a long-term warming trend. Munson et al. (20 14) predicts declines in vegetative cover including cacti in Chihuahuan Desert habitats due to climate change. Coryphantha spp. are likely to have experienced and rebounded from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species (USFWS, 2015).

Recovery

Reclassification Criteria:

Downlisting of the Sneed pincushion cactus to threatened can be initiated when:

1. Six or more secure populations are established with at least three each near the eastern (Guadalupe Mountains) and western (Franklin Mountains and southern Organ Mountains) limits of the plant's known range. Populations will be considered secure when land managing agencies, organizations or individuals have developed and implemented habitat management plans for the Sneed pincushion cactus. At a minimum, the plans should contain methods for securing populations against present and future potential threats, methods for accurately quantifying population sizes, and methods for monitoring populations to determine their stability, growth, or decline. (USFWS, 1986)

2. When the known number of plants in these six secure populations totals 20,000. (USFWS, 1986)

Delisting Criteria:
The Sneed pincushion cactus will be considered for delisting when:

1. All core populations demonstrate stable or increasing trends in abundance over a 20-year period. This will be based on periodic demographic trend monitoring and analysis implemented under the recovery actions. (USFWS, 2019)

2. Maintain a minimum of three geographically separated core populations for each species over a 20-year period. (USFWS, 2019)

3a. Maintain genetic diversity within all core populations as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)

3b. Maintain presence in 80 percent of subpopulations over 20-year monitoring period and outside of the core populations, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)

4. Develop and implement a Habitat Management Plan (HMP) for Sneed pincushion cacti conservation. (USFWS, 2019)

5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

Recovery Actions:
- Remove threats of collecting by enforcement of existing regulations. Because of the rarity of the Sneed pincushion cactus, the populations must be protected by enforcement of existing international, Federal, and State regulations. Determine the extent and impacts of collecting. Develop and implement a law enforcement strategy. Publicize successful law enforcement actions. (USFWS, 1986)
- Manage existing habitat for protection of the cactus. Habitat management for the Sneed pincushion cactus should be done through existing agency management procedures and through cooperation with private landowners. The following should be accomplished. Agencies should remain informed of the location and status of Sneed pincushion cactus

populations. Develop and implement habitat management plans for all populations on public lands. Seek cooperation of landowners to protect and maintain populations on private lands. (USFWS, 1986)

- Gather information for use in management. In-depth knowledge of the plant's growth, distribution, population biology and ecology is needed to understand habitat requirements. The knowledge gained can be used to help sustain and manage healthy natural populations. Study population biology and ecology. Inventory known populations and search for new populations in the Franklin and Guadalupe Mountains. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. (USFWS, 1986)
- Develop public awareness, appreciation and support for preservation of the Sneed pincushion cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential to the ultimate success of the foregoing recovery measures. (USFWS, 1986)
- Recommendations for Future Actions from 2015 5-Year Review: • Determine if the genus associated with this species needs to be changed from Coryphantha to Escobaria on all future Service documents. • Revise the recovery plan for these species to incorporate new information on taxonomy, biology, ecology, and threats with management recommendations. Objective and measurable recovery criteria for down and de listing of the species should be developed which address all listing factors relevant to this species. • Develop a Coryphantha sneedii var leei and C. sneedii var. sneedii multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. • Develop standardized survey and monitoring protocols for these species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. Incorporate fire and climate change factors into long-term monitoring data collection. • Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). • Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. • Provide legally grown seeds and plants of Coryphantha sneedii var. leei and C. sneedii var. sneedii, as the known populations allow, to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti thr.oughout its range. • Provide viable Coryphantha sneedii var. leei and C. sneedii var. sneedii seeds to a seed bank operating under the Center for Plant Conservation guidelines. • Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of these species. • Determine microhabitat needs of these species ("nurse" plants, pollinators, precipitation needs- amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2015)

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SPECIES ACCOUNT: *Crescentia portoricensis* (Higuero de sierra)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/4/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

A vine-like shrub or small tree which may reach up to 6 meters (20 feet) in height and 8 centimeters (3 inches) in diameter. The bark is gray and the branches long and slender. The glabrous leaves vary from 5 to 15 centimeters (2 to 6 inches) in length and 2 to 8 centimeters (3/4 to 3 inches) in width and are whorled in groups of 3 to 5 at the nodes. The leaves are simple, widest above the middle, entire, leathery, dark shiny—green above, with a rounded or blunt apex and a tapered base. The petiole is from 1 to 2 centimeters (1/4 to 5/8 inch) long (Little et al., 1974, Vivaldi and Woodbury 1981) - The perfect flowers are solitary at the axil of the leaves or along the branches. The calyx is leathery, tubular, 2-lobed, and about 2 centimeters (3/4 inch) long. The corolla is yellowish— white with the 5 united petals forming a bell-shaped tube approximately 4 centimeters (1 and 1/2 inches) long. The four stamens are attached to the base of the petals. The fruit is dark green when mature, cylindric, hard and leathery, indehiscent, approximately 10 centimeters (4 inches) long and 3 centimeters (1 and 1/4 inches) wide (Little et al. 1974, Vivaldi and Woodbury 1981). (USFWS, 1991)

Taxonomy

A member of the Bignoniaceae family (USFWS, 1991).

Historical Range

This species is endemic to Puerto Rico and found only in the Maricao Commonwealth Forest and the Susua Commonwealth Forest (USFWS, 1991).

Current Range

Presently known from only 7 sites in Puerto Rico: five within the Maricao Commonwealth Forest and two within the nearby Susua Commonwealth Forest (USFWS, 1991). Specific locations include Quebrada Piedras and Río Seco in the Maricao Commonwealth Forest, and Quebrada Peces in the Susúa Commonwealth Forest. Within the Susúa Forest, Breckon et al. (1992) reported three main populations comprised by 10 localities along three water bodies (Quebrada Grande, Río Loco and Quebrada Peces), all tributaries of the Río Loco drainage. Three populations within the Maricao Commonwealth Forest are located in the Rio Maricao watershed, steep slopes along the Quebrada Seca river, and along a small tributary of the Rio Lajas river below El Salto de Curet. Additional MCF populations are found along the Quebrada Piedras, Rio Bonelli, Rio Cupeyes and Rio Postrero (USFWS, 2017).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 1991)

Key Resources Needed for Breeding

Adult: Likely bat pollinators (USFWS, 1991)

Other Reproductive Information

Adult: Breckon and Kolterman (1993) stated that the species is in danger of hybridization with the introduced Crescentia cujete. These authors reported a natural population of C. linearifolia (native to Puerto Rico) located along State Road PR 116 in the Lajas Valley that was apparently hybridizing with C. cujete. They mentioned that trees that appear to be "pure" C. linearifolia are infrequent in the population; the majority of the trees are apparently hybrids. Crescentia cujete is probably native to Mexico and north Central America. Cancel (2010) recorded individuals of C. cujete within the Susúa Commonwealth forests in the proximity of a population of C. portoricensis. Nonetheless, Cancel (2010) did not find evidence of hybridization in any of the wild C. portoricensis populations he studied. However, he recorded evidence of hybridization in several ex situ collections of C. portoricensis (i.e., Quebradillas and Caguas Botanical Garden). (USFWS, 2017).

Reproduction Narrative

Adult: Produces fruits year round and is probably pollinated by bats (EPA, 2016). Sprouting has been observed in some individuals but the importance of this vegetative reproduction is unknown (USFWS, 1991). All surveys have found no evidence of natural seedling establishment which indicates that the species is apparently depending on asexual reproduction (Breckon et al. 1992; Breckon and Kolterman 1993; Breckon and Kolterman 1994; and Breckon and Kolterman 1996; Cancel 2010). Breckon et al. (1992) and Breckon and Kolterman (1993) observed evidence of asexual or vegetative reproduction, which occurred when the terminal portion of the arching branches came in contact with the ground and layering (producing roots). In particular, Breckon and Kolterman (1994) observed that a portion of the plant tagged as #168 in the Susúa Commonwealth Forest, had separated from the parent plant, had rooted, and was in good condition. (USFWS, 2017).

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist and wet forest, riparian (USFWS, 1991))

Geographic or Habitat Restraints or Barriers

Adult: ~820 to 2624 ft. elevation (USFWS, 1991)

Habitat Narrative

Adult: Subtropical moist and wet forest life zones. Found along banks of streams, usually within a meter of the water's edge. Topography is mountainous with steep slopes and ravines. Vegetation in the forests is semi-evergreen to deciduous. Serpentine-derived soils, area has serpentine outcrops interspersed with Nipe and Rosario clay soils (derived from serpentine). Occurs around 820 to 2624 ft. elevation (USFWS, 1991).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by water (flooding of streams) (USFWS, 1991).

Population Information and Trends

Population Trends:
Not available

Number of Populations:
16 (USFWS, 2022)

Population Size:
~568 total (USFWS, 2022)

Population Narrative:
It is found in only two areas of southwestern Puerto Rico. A total of approximately 100 individuals occur in the 7 populations known (USFWS, 1991). 16 populations with an estimated 568 total individuals (USFWS, 2022)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 1991). As of 2019: the majority of the suitable habitat for the species is protected and managed for conservation, and the impacts by forest management do not occur on a regular basis and are limited to maintenance of existing trails and recreational areas. Therefore, destruction, modification or curtailment of their habitat (Factor A) is considered a low and non-imminent threat for this species. (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Historically, the most important factors affecting the abundance and distribution of Crescentia portoricensis have been both the direct and indirect effects of deforestation. Much of the Susua Forest and parts of the Maricao Forest were cut for cultivation, grazing, charcoal production, and wood prior to their designation as public forests. Land use practices in upland areas resulted in increased flash flooding and erosion of stream banks, the habitat for this species. Small intake dams, trails, and recreational use of the more accessible areas also threaten the species (USFWS, 1991). This includes road construction and activity, particularly along State Road PR 362. (USFWS, 2017).

Stressor: Flash floods (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: The “Quebrada Peces” population in Susua, composed of only six known individuals, although within a protected Commonwealth Forest, is located close to a heavily traveled access road to the Forest. All known individuals are located on steep stream banks and are exposed to the threat of elimination by erosion and flash flooding. The Maricao populations are also subject to a variety of threats. Here the species is found along drainage areas subject to flash floods which may uproot plants (USFWS, 1991).

Stressor: Erosion (USFWS, 2017).

Exposure:
Response:
Consequence:
Narrative: All populations are threatened with increased erosion by deforestation and poor management practices occurring upstream outside the forest. According to Cancel (2010), erosion may explain why the numbers of individuals in the Río Lajas and Quebrada Seca in Maricao, and Arroyo del Tanque in Susúa have decreased as compared to the data provided by Breckon and Kolterman from 1991 to 1995. Moreover, the loss of individuals in the Río Maricao could be explained by the construction of a small dam in the river and the effect of hurricanes. Based on the monitoring of this population by Breckon and Kolterman (1992), and by Cancel (2010), there was a decline in number of individuals likely due to river overflow and erosion of the river bank during hurricanes events (i.e., Hurricane Georges in 1998). Despite documentation of additional populations, loss of individuals due to erosion along river margins and landslides may have a major detrimental effect on the species, particularly since recruitment is not documented on these populations. (USFWS, 2017).

Stressor: Rattus rattus predation (USFWS, 2017). Considered the most significant threat as of 2019. (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Breckon et al. (1992) found several fruits of C. portoricensis that had been gnawed on, and in some cases the contents had been eaten; presumably by the introduced rat, Rattus rattus. Breckon et al. (1992) recommended further studies to determine if rat predation of fruits accounted for the absence of seedlings in the wild. Cancel (2010) also found evidence of rat predation in the C. portoricensis population at Quebrada Peces, Susúa commonwealth Forest. The predated fruit found by Cancel was green and was still hanging on the plant at the time of his observation. Evidence of predation was also observed in 2010 by Service biologist O. Monsegur, along the headwaters of Río Maricao (Maricao Commonwealth Forest). A ripe fruit was found submerged in the river with clear rodent teeth marks around the pericarp, with intact seed material that was set for germination and showed 80% germination. Although other Crescentia spp. have been reported to be dispersed by rodents (Kubitzki and Ziburski 1994), the existing evidence of predation and the lack of natural recruitment of the species, lead us to concur with Breckon et al. (1992), who suggested that exotic rats (Rattus rattus) might be negatively impacting C. portoricensis. It is likely that the majority of the fruits are eaten before the seed material has fully developed and any seed (embryo) left by rodents might be immature and not able to germinate. (USFWS, 2017). There is evidence that the absence of recruitment is being caused by rats preying on (Factor C) and/or damaging the fruits and seeds ofhigiiero de sierra (USFWS 2017). It is likely that the majority of the fruits are eaten before the seed material has fully developed and any seed (embryo) left by rodents might be immature and not able to germinate. (USFWS, 2019).

Stressor: Genetic diversity and hybridization (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: Along with a small population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay

and Jacquemyn 2007), which may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). This may be due to the founder effect or a genetic bottleneck during the history of the species. This might well be the case of C. portoricensis following the massive deforestation island wide in Puerto Rico, and that reached its peak prior to the designation of the Maricao and Susúa forests as conservation areas (Cancel 2010). Species with low fruit set and no evidence of natural recruitment as the case of C. portoricensis were likely adversely affected by this deforestation. Thus, another factor that would be expected to contribute to a low genetic diversity in C. portoricensis is its apparent reliance on asexual reproduction. A preponderance of asexual reproduction on this species would be expected to be reflected in genetic differences of individuals among different river drainages (Cancel 2010). Moreover, in the absence of natural recruitment, where seedlings are a result of crosspollination among adult individuals, the clones produced through asexual reproduction are expected to reduce the genetic variability of the species. Additionally, it is known that species of the genus Crescentia hybridize with related species (Gentry 1980), but Cancel (2010) did not find evidence of hybridization in any of the wild populations he studied. Nonetheless, Cancel (2010) reported plants of C. portoricensis with fruits of intermediate size and shape, suggesting hybridization on cultivated material in the municipality of Quebradillas. Hybridization of C. portoricensis also has been documented in the nursery of Para La Naturaleza (O. Monsegur, USFWS, pers. obs., 2009). Hybridization with other species of the genus should be avoided both in situ and ex situ, to safeguard the integrity of this narrow endemic species. (USFWS, 2017).

Stressor: Natural recruitment (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: Neither Breckon et al. (1992), Cancel (2010), nor any Service biologist has documented evidence of seedlings in the wild despite the evidence of high germination rates (about 80%) of seed material collected from wild populations when propagated in nursery conditions. Factors such as the lack of a native seed disperser and/or appropriate microhabitat conditions for germination may explain the absence of natural recruitment in the wild. Nonetheless, the Maricao and Susúa Commonwealth Forests harbor very good stands of native vegetation, including some remnants of pristine forest, suggesting that ecological conditions are suitable. However, available evidence strongly suggests that predation of fruits by rats is a major factor preventing the establishment of seedlings of C. portoricensis (see Factor C), and thus compromise the long term recovery of the species. (USFWS, 2017).

Recovery

Reclassification Criteria:
Existing populations and their habitats are protected and at least four new populations are established in protected areas (USFWS, 1991). At least four new populations capable of self-perpetuation have been established within suitable protected areas such as Commonwealth forests. The plan specifies that these four populations should be considered a minimum requirement, and should be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. (USFWS, 2017).

The plan also specifies that if new populations of the species are discovered, it may be preferable to place greater emphasis on protection, rather than on propagation, to achieve a

minimum number of plants. (USFWS, 2017).

Recovery Priority Number: 5

Delisting Criteria:
1. Existing eleven (11) populations of higiiero de sierra within the Maricao and Susua Commonwealth Forests are enhanced and managed such that they show a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factor A, C, and E). (USFWS, 2019).

2. Threats reduction and management activities (e.g., control of predation by rats, best management practices during forest management activities) have been implemented to a degree that the species will remain viable for the foreseeable future (addresses Factor A, C, and E). (USFWS, 2019).

Recovery Actions:
- Monitor existing populations (USFWS, 1991).
- Provide protection for existing populations and their habitat (USFWS, 1991).
- Conduct research on the life history of the species, evaluate methods of propagation, and locate introduction sites (USFWS, 1991).
- Propagate and produce seedlings for enhancement of existing populations and for the establishment of new populations at identified sites (USFWS, 1991). Added in 2017: The populations that are actively producing fruits should be monitored to collect seed material for recovery purposes. (USFWS, 2017). Added in 2019: Develop a protocol for the propagation and reintroduction of higiiero de sierra in collaboration with partners. The protocol should address avoiding hybridization and insect pests. This revised action supplements Task 4: Establishment of new populations. (USFWS, 2019).
- 2017 Recommendation 1. Develop a plan for the long term monitoring of the known populations of C. portoricensis in order to establish population trends and to record any evidence of natural recruitment. (USFWS, 2017).
- 2017 Recommendation 2. Conduct further studies to address possible adverse effects of fruit predation by rats (Rattus rattus), and to determine if rats provides some mechanism for seed dispersal or if they damage the seed embryo. (USFWS, 2017). Refinement in 2019: Research should be conducted focused on the potential factors that affect higiiero de sierra recruitment in the wild in order to assess the need to control rats in the wild or the need for other actions to enhance recruitment. This new action should be included ithin Task 3: Research. (USFWS, 2019).
- 2017 Recommendation 3. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability and to manage populations effectively. (USFWS, 2017). Refinement in 2019: Assess higiiero de sierra genetic structure along its known range that may inform the need for specific propagation efforts and the need for long-term seed banking. This new action should be included within Task 3: Research. (USFWS, 2019).
- 2017 Recommendation 4. Further studies should be conducted on the species reproductive biology to address other limiting factors (e.g., lack of pollinators or seed dispersers). (USFWS, 2017).

- Although there is no documentation that Crescentia portoricensis has been taken for horticultural purposes, it may be recognized as having ornamental potential in the future. Propagation has been attempted by cuttings and seed by the Fairchild Tropical Garden of Miami, Florida. Germination of the many small seeds collected in August 1989, has been successful, however, it is not known yet whether ex situ propagation could provide a source of material for reintroduction of the species in Puerto Rico (C. Lippincott pers. comm.) (USFWS, 1991).
- The Puerto Rico Department of Natural Resources has constructed barriers along the Susua Forest access road in order to discourage parking. In addition, the Department has installed a fence at the entrance to the "Quebrada Feces" in order to reduce visitation to the area (USFWS, 1991).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. Develop a plan for the long-term monitoring of known Higüero de sierra populations to establish population trends and to determine any evidence of natural recruitment. 2. Conduct further studies to address possible adverse effects of fruit predation by rats, and to determine if rats provide some mechanism for seed dispersal or if they damage the seed embryo. 3. The populations that are actively producing fruits should be monitored to collect seed material for recovery purposes. Due to the absence of natural recruitment in the wild, enhancement of natural populations with propagated material should be considered a priority for the species. 4. Evaluate the feasibility for the long-term conservation of seed material (seed banking). Due to the lack of natural recruitment in the wild, ex situ conservation efforts should be considered a priority for Higüero de sierra. 5. Studies should be conducted to determine the patterns of genetic variation within and among populations to develop a plan to preserve the species genetic variability and to manage populations effectively. 6. Further studies should be conducted on the species reproductive biology to address other limiting factors (e.g., lack of pollinators or seed dispersers). (USFWS, 2022)

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SPECIES ACCOUNT: *Crotalaria avonensis* (Avon Park harebells)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

Avon Park harebells (Crotalaria avonensis) is a spreading, perennial herb with one to three moderately hairy, flowering stems that may grow 2 to 10 cm above the surface. It has a large taproot, up to 14 mm thick and 40 cm long. The leaves of this plant are 8 to 19 mm long, broadly elliptic or round, somewhat succulent, and coated with white or yellowish-white hairs. The stems terminate in flowering racemes. Flowering is from March until June. The flower, shaped like a typical pea flower, has a yellow corolla 8 to 9 mm long. The seed pods are inflated and 14 to 25 mm long. These pods are tan to grey or maroon, and can be nearly as long as the upright stems that hold them in place. The pods contain up to 18 seeds, chestnut to maroon in color and 3.4 to 3.8 mm long by 2.4 to 2.6 mm wide. The plant generally appears to resemble clusters of fuzzy grayish leaves hugging the ground and sometimes appears bushy (DeLaney and Wunderlin 1989). (USFWS, 1999)

Taxonomy

C. avonensis is a member of the pea family (Fabaceae/Leguminosae). This small herb with large seed pods was not named until 1989, evidently because very few specimens had ever been collected and they had not been examined by taxonomists. This species is most closely related to C. rotundifolia, a variable species that ranges from Virginia to Panama (DeLaney and Wunderlin 1989). Crotalaria is a very large, mostly tropical genus that includes a number of robust annual weeds, all with inflated “rattlebox” seed pods. It has been suggested that this endemic is a relic of the Miocene on the southern Lake Wales Ridge (DeLaney and Wunderlin 1989). (USFWS, 1999)

Historical Range

See Current Range.

Current Range

Avon Park harebells is one of the most narrowly distributed of the Lake Wales Ridge endemics, having only been identified at three sites in Polk and Highlands counties. Its distribution includes the Avon Park Lakes acquisition area and the Saddleblanket Lakes State Preserve in Polk County, and the Carter Creek acquisition area in Highlands County. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated

Breeding Season

Adult: Flowering begins in mid-March and continues until June. (USFWS, 1999)

Other Reproductive Information

Adult: Flowering begins in mid-March and continues profusely until June. After flowering, this deciduous plant enters a vegetative phase, forming clusters of stems that give a clumped or rosette appearance. They are then dormant from late fall or early winter until March (DeLaney and Wunderlin 1989). Demographic information on pollinators, seed dispersers, and seed viability is lacking for this species. (USFWS, 1999)

Reproduction Narrative

Adult: Avon Park harebells are pollinated by insects, but visitation rates are very low. The plant is reproductively challenged, with less than 10 percent of flowers producing fruits. Seeds contribute to a persistent seed bank lasting at least three years. Seedlings have moderate survival and commonly begin flowering after 6-8 years (Menges et al. 2016). (USFWS, 2019)

Habitat Type

Adult: Scrub flatwoods rosemary scrub and pine scrub

Environmental Specificity

Adult: Very Narrow (USFWS, 1999)

Habitat Narrative

Adult: This species inhabits scrub communities found on the Lake Wales Ridge where it typically grows in full sun, on bare white sand, or in association with clumps of Cladonia lichens. However, it may also occur in the partial shade of other plants (DeLaney and Wunderlin 1989). It may also grow along trails, open edges, or previously disturbed roadbeds. The soils associated with this species have been classified as Archbold and Satellite sands (The Nature Conservancy 1991). Like other small scrub endemics, it appears to depend on bare patches of sand to become established. (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available (USFWS, 1999)

Population Information and Trends

Number of Populations:

4 (USFWS, 2023)

Additional Population-level Information:

The Avon Park harebells has a very narrow known historical distribution (Service 2007 and references therein). There are currently only four populations of Avon Park harebells, one of which is an introduced population. In 2012, 400 seeds and 84 transplants of C. avonensis were introduced to a site within management unit SL8 of the Silver Lake Tract of the Lake Wales Ridge Wildlife and Environmental Area (LWRWEA) (Smith et al. 2013, pp. 22, 25) (Figure1). The site included both scrubby flatwoods and rosemary scrub, both being vegetation types with which

the presence of Avon Park harebells is most often associated (Smith et al. 2013, p. 20) (USFWS, 2023).

Population Narrative:

Historically and currently, the species is known from just two populations. One population occurs partially in the unprotected Avon Park Lakes subdivision and continues to decline as vacant lots supporting the plant are developed (Menges et al. 2016). Part of this population is protected at a second site, The Nature Conservancy's Saddle Blanket Scrub Preserve. The second population is at the Florida Fish and Wildlife Conservation Commission's (FWC) Carter Creek unit of the Lake Wales Ridge Wildlife Management Area (LWRWEA). The unprotected Avon Park Lakes site hosts the largest number of plants, likely consisting of thousands. The Saddle Blanket site supported 531 plants in 2006 (Service 2007). The size of the Carter Creek population is unknown, but likely is in the thousands, based on Menges et al. (2016). Avon Park harebells has been reintroduced at two conservation sites which have to date been successful in establishing plants that have flowered and produced seed. The FNAI 2015 Element Tracking Summary (FNAI 2015) identifies 6 occurrences, 2 of these are protected at Saddle Blanket Preserve, and represent portions of the larger Avon Park Lakes population. Two others are FWC protected areas that represent the Carter Creek population. The final two occurrences represent unprotected portions of the Avon Park Lakes population. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:

Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Stressor: land development (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The primary threat to Avon Park harebells in regard to Factor A is still land development. Projections expect an increase of up to 23 percent in the amount of developed land in central Florida, bringing the total to almost half of the land in the region (Carr and Zwick 2016, p. 23). While development directly decreases the amount of available habitat, it can also decrease the ability of land managers to utilize prescribed fire as a tool for maintaining the types of habitats in which Avon Park harebells are most often found (Melvin and McIntyre 2017, entire; Service 2019, p. 3). Development is also often associated with an increase in the use of various types of pesticides. The components of these pesticides can have a range of effects on insect pollinators, from inhibition of neurological or immune function to lethal outcomes (Sponsler et al. 2019, pp. 1020-1021). The loss of pollinators could be potentially devastating for Avon Park harebells, as they are dependent on pollination for successful reproduction (USFWS, 2023).

Stressor: Herbivory (USFWS, 2023)
Exposure:

Response:
Consequence:
Narrative: Herbivory (under Factor C) has been shown to affect around 16 percent of plants annually, but these rates are highly variable between years (Menges et al. 2016, p. 565). The reduction of herbivory using protective cages around plants was also found to provide significant positive effects on survival, growth rates, and flowering, indicating that herbivory is a significant threat to Avon Park harebells (USFWS, 2023).

Recovery

Reclassification Criteria:
Not developed. (USFWS, 1999)

Delisting Criteria:
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub and scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:
- Determine current distribution of C. avonensis. This species' known distribution is isolated to Polk and Highlands counties. Additional surveys of scrub habitat with appropriate soils should be conducted in these two counties. A geographic nformation systems database should be developed to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review and in land acquisition activities. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or residential development. The remaining habitat is fragmented into small parcels and in many cases, isolated. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring needs to be developed for this and other listed scrub species to determine the effect of management actions. (USFWS, 1999)
- Provide public information about C. avonensis. It is important that governmental agencies, conservation organizations, and private land owners be appropriately informed about this species. (USFWS, 1999)
- Establish reclassification criteria. Once the population is stabilized, research and monitoring results may provide data necessary to develop reclassification criteria. (USFWS, 1999)

- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities • Continue applying prescribed fire when possible to maintain scrub habitat for Avon Park harebells. • Conduct further augmentation and introduction projects to expand the range of the species and increase the number of populations. • Acquire land within the range of Avon Park harebells and restore scrub habitat to these areas. Monitoring / Research Activities • Develop a consistent monitoring protocol to occur at regular intervals in areas that are occupied by Avon Park harebells and are accessible for survey.

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SPECIES ACCOUNT: *Cryptantha crassipes* (Terlingua Creek cat's-eye)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1991; Southwest Region (R2) (USFWS, 2016)

Physical Description

A silvery-gray perennial herb with erect stems, 1.5-2.5 dm tall, growing out of a mound of basal leaves. Flowers (late March-early June) are white with yellow throats (NatureServe, 2015).

Taxonomy

Cryptantha crassipes belongs to the Borage (Boraginaceae) family (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

Only occurs in in southern Brewster Co., Tex. in gypseous clays (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 1993)

Lifespan

Adult: Unknown; long-lived perennial (USFWS, 1993)

Breeding Season

Adult: March - June (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Insect pollinators, likely bees (USFWS, 1993)

Reproduction Narrative

Adult: This species is long-lived perennial nature with apparently low and/or erratic recruitment. Flowering can begin as early as late March and continue until early June. Recent study by Hughes (1992) has confirmed heterostyly, and he found the two forms in approximately a 1:1 ratio. Such heterostyly suggests that the species is an obligate outcrosser, thus requiring some sort of pollinator. Although the exact identity of the pollinator(s) is not known, preliminary studies indicate that the agents are small bees (Hughes 1992). How long individual plants live is not known (USFWS, 1993). Terlingua Creek cat's-eye is a valid, distinct species; a recent phylogenetic analysis reveals that it should be classified in the genus Oreocarya. Although the species most often flowers from March to June, flowering can also occur from October through

February if weather is favorable. It reproduces primarily or entirely by outcrossing, and has low fecundity and recruitment. It is very narrowly endemic to unique, nearly barren, high-gypsum soils found in a small part of western Brewster County, Texas. The 10 known populations (EOs) occupy a range of 41.8 km2 (16.1 mi2), and the potential habitats are distributed over a range of 182 km2 (70.3 mi2). Most genetic variation occurs among individuals rather than among populations, and there is gene flow between populations. The populations have undergone a genetic bottleneck in the past, but are currently stable and have less inbreeding and more genetic structure than other gypsum-endemic Oreocarya species. (USFWS, 2020)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Trans-Pecos shrub savannah (USFWS, 1993)

Geographic or Habitat Restraints or Barriers

Adult: 3,150 - 3450 ft. elevation (USFWS, 1993)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015 and USFWS, 1993)

Habitat Narrative

Adult: Low hills and gentle slopes composed of a platy, yellowish limestone formation with a high level of clay and gypsum. These areas are nearly devoid of vegetation due to the gypsum soils and the very dry nature of the site. (NatureServe, 2015). The Terlingua Creek cat's—eye grows on xeric, barren, gypsiferous, low rounded hills and gentle slopes composed of small platelets of silty limestone in the Trans-Pecos shrub savannah. Site elevations vary from 3,150 to 3,450 feet. Vegetation cover is less than 10% (USFWS, 1993).

Dispersal/Migration

Dispersal

Adult: Low to moderate (inferred from USFWS, 1993)

Dispersal/Migration Narrative

Adult: Dispersal is probably carried out by water, insects, or small mammals (USFWS, 1993).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Unknown (USFWS, 1993)

Number of Populations:

1 (inferred from USFWS, 1993)

Population Size:

>12,000 (USFWS, 2020)

Population Narrative:

It is known from 10 sites within a six-mile (10 kilometer) radius in west Texas. Less than 5000 plants are known. It is not known whether populations are stable, increasing, or declining (USFWS, 1993). Eight new population sites were discovered in 2012 and 2016, bringing the total known population size to over 12,000 individuals. The new sites are near two existing EOs and may or may not be combined with them. All known populations are on private land, and none are legally protected, but a fence was constructed in 2012 to curtail trespass by ORVs into several population sites. A database of landowners was created to aid communication and outreach with owners of potential habitats. Sul Ross State University had 26 live propagated plants, and Desert Botanical Garden has 1,873 seeds in a long-term seed bank. The recovery criteria call for 20 protected populations, with at least 1,000 individuals each, within 3 population centers (metapopulations). However, the recovery plan does not describe how populations and metapopulations should be delineated. Most populations have not been observed for more than 30 years, and most of the potential habitat has not been surveyed; hence, we cannot determine the extent that recovery criteria have been met. (USFWS, 2020)

Threats and Stressors

Stressor: Habit destruction and modification (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Ranch tracks and numerous subdivision roads have been blazed across the area, probably destroying some plants in their path and fragmenting the habitat and some populations. These routes have also opened the way for modern recreational use (off—road vehicles ((ORVs)), mountain bikes, hiking and horseback riding groups). Although road maintenance is minimal and few tracks have been observed in the habitat, the area lacks any fencing or gates to confine wheeled vehicles. Tracks and roads take scores of years to disappear in this extremely arid environment. A significant portion of the known individual plants are on various 5, 10, and 20 acre (2, 4, and 8 hectare) tracts sold by a local resort developer. The potential for habitat destruction, if owners develop these tracts, is a threat to some plants.

Stressor: Stochastic events (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Cryptantha crassipes is particularly vulnerable to impacts and threats because of its narrow habitat specificity, extremely limited distribution, and low numbers of individuals. The species is found only on an uncommon rock formation, which is scattered within the geologic mosaic of the Big Bend region. The small occupied area and low numbers make the species vulnerable to chance extinction events from disease, natural or man-caused catastrophes, genetic drift (loss of genetic variability and thence adaptability), etc. In addition, the habitat is quite arid, which in many growing seasons may limit the species from reaching its full reproductive potential. If numbers fall below critical levels, populations may no longer be able to survive cycles with several seasons that do not allow successful reproduction (USFWS, 1993).

Stressor: Loss of pollinators (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Pollinators are potentially very important. The species is likely an obligate outcrosser reliant on insects that are probably also narrow endemics (known only from a limited geographic area). Conditions or activities that harm these pollinators could secondarily harm Cryptantha crassipes (USFWS, 1993).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
Develop and implement management plans that insure the long-term protection and stability of a minimum of three population centers. There should be a total of at least 20 viable populations across the three population centers with each population comprised of no fewer than 1000 plants and being capable of long-term, self-perpetuating reproduction (USFWS, 1993).

Recovery Actions:

- Establish protected sites and develop management plans (USFWS, 1993).
- Maintain reserve seed bank/cultivated populations (USFWS, 1993).
- Gather biological information necessary for management decisions (USFWS, 1993).
- Search for new populations (USFWS, 1993).
- Develop plans for augmentation and/or establishment of new populations, if feasible, at suitable sites (USFWS, 1993).
- The only conservation measure initiated so far is seed storage collection. The National Seed Storage Lab in Fort Collins, Colorado contains 200 field—collected seeds and the Desert Botanical Garden in Phoenix, Arizona retains 820 field collected seeds (USFWS, 1993).
- Barry Hughes, a graduate student at Sul Ross State University, has begun studies on the reproductive biology of Cryptantha crassipes, about which little is known. He has reported germination rates of about 75% and 40—50% in two trials and has developed some simple techniques to increase success in transplanting seedlings (Hughes, pers. comm., 1993) during cultivation studies (USFWS, 1993).
- The Desert Botanical Garden in Phoenix, Arizona, working with the Center for Plant Conservation, has performed two germination experiments to determine the best growing medium for germination and seedling growth (Pritchett-Kozak and Ecker 1992) (USFWS, 1993).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS. 1. Amend the recovery plan to clarify the recovery criteria. Use the MVP level and population delimitation distances described in this review as components of recovery criteria that address resilience and redundancy. Adopt the provisional recovery units discussed in this review to develop recovery criteria that address the species' ecological and genetic representation. 2. Promote awareness and conservation of Terlingua Creek

cat's-eye in western Brewster County. 3. Contact landowners of sites within the potential habitat area, and seek permission to survey and monitor populations on private land. 4. Conduct up-to-date censuses of the accessible populations and revise the TXNDD EO records. 5. Work cooperatively with private landowners who are interested in conserving and managing the species on their lands. Seek voluntary measures to confer long-term protection for populations on private lands, such as conservation agreements and conservation easements. 6. Propagate the species, using seeds at the Desert Botanical Garden seed bank, to establish seed production plots, renew the seed bank, and reintroduce populations in appropriate sites that can be protected. 7. Obtain additional support for conservation actions from the Cooperative Endangered Species Conservation Fund (Section 6) or other grant sources. (USFWS, 2020)

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SPECIES ACCOUNT: *Cucurbita okeechobeensis ssp. okeechobeensis* (Okeechobee gourd)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/11/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

A vigorous annual vine. Stems are nearly smooth. Leaves are alternate and paired, and have with long helical tendrils. The leaf blades have 5-7 shallow lobes. Flowers are cream-colored to nearly white, 6-7 cm long, narrowly bell-shaped. (NatureServe, 2015)

Taxonomy

Small (1922, 1930) originally described the gourds he found in the pond apple forest surrounding Lake Okeechobee as Pepo okeechobeensis. Bailey (1930) transferred the Okeechobee gourd to the genus Cucurbita, which includes pumpkins and squashes. Bailey (1943) subsequently described two new gourd species, C. martinezii and C. lundelliana. These two gourds were proven to be closely related to the Okeechobee gourd. Closely related gourds with cream-colored corollas (all others in the genus Cucurbita are bright yellow) are found in Florida and in Mexico, near the Gulf Coast. The Florida plants were described as the Okeechobee gourd (Bailey 1930) and the Mexican plants were designated (Bailey 1943) as the Martinez gourd (C. martinezii). However, Robinson and Puchalski (1980) showed through isozyme analysis that there was only a single allelic difference between the two varieties. The (ESA) does not allow Federal listing of disjunct populations of widespread plant species. Since the Mexican gourds are moderately abundant, and considering the findings of Robinson, the FWS originally opposed listing of the Okeechobee gourd. A later study by Walters and Decker-Walters (1991), also using isozyme analysis, showed a difference of just one allele. However, they calculated an estimated time since divergence of about 450,000 years between the Martinez and Okeechobee gourds, and concluded that they should be considered distinct at the subspecies level. Walters and Decker-Walters (1993) rearranged the nomenclature, designating the Florida gourds as Cucurbita okeechobeensis (Small) Bailey ssp. okeechobeensis, and assigning the Mexican gourds to the subspecies C. okeechobeensis ssp. martinezii (Bailey) Andres and Nabhan ex T. Walters and Decker Walters. The FWS concurred with this finding, and because the ESA allows protection of distinct subspecies, the Okeechobee gourd was subsequently listed as endangered. (USFWS, 1999)

Historical Range

Historically found on the southern shore of Lake Okeechobee, in Palm Beach County, Florida, and formerly in the Everglades area of Florida. (USFWS, 1999)

Current Range

Overall, the current range of Okeechobee gourd is limited to the shoreline and islands around the northwestern and southern portions of Lake Okeechobee in Glades and Palm Beach Counties and both sides of the St. Johns River from Lake Beresford south to Lake Monroe and along the western side of Lake Jessup along the Volusia and Lake County line and into Seminole County. These two populations are separated by over 100 miles and do not exhibit much genetic variation. Because Okeechobee gourd plants are difficult to count, we are unable to

estimate the abundance of this subspecies. Surveys in 2007 indicated that the subspecies was present on four of the islands in Lake Okeechobee and on 12 sites along the St. Johns River. (USFWS, 2021) Most of the known occurrences in the Lake Okeechobee population are on public land, but extent of management is not reported. Consistent data showing fruit production at least every other year on Kreamer, Torry, and Ritta Islands and the southern Rim Canal of Lake Okeechobee have not been obtained. There are no stable, self-sustaining populations known to exist within the South Florida Ecosystem outside of Lake Okeechobee, except for the introduced population on private land west of Lantana in Palm Beach County. Finally, additional research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages is needed for evaluation with the water regulation schedule for Lake Okeechobee (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1999)

Reproduction Narrative

Adult: Pollination occurs via insects. Based on closely related gourds, a variety of insects are likely to be available, including bees, flies, and squash beetles. Typically, male flowers greatly outnumber female flowers and where pollinators are rare, decreased fruit set may be observed (M. Minno, Eco Cognizant, Inc., personal communication 1998) (USFWS, 1999).

Habitat Vegetation or Surface Water Classification

Adult: Forested wetland, temporary pool, field (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Low water levels (USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: Originally found in swampy forests and hammocks on muck soils. Today, this species is restricted to disturbed areas that are not cultivated, such as ditch banks and wet road shoulders. It is sensitive to changes in hydrology and freezing. (NatureServe, 2015). Occurs at Lake Okeechobee and the other along the St. Johns River; limited to areas along the shoreline and a few islands in the lake and along the St. Johns River. Inhabits open organic soils exposed by low water levels (EPA, 2016). The gourd is ephemeral by nature, often only growing when habitat conditions are favorable, and its growth habit of climbing amongst the tree canopy precludes the ability to count individual plants. This subspecies employs a strategy of growing on open organic soils exposed by low water levels with little to no competition, producing numerous seeds with somewhat long viability, and experiencing vegetative decline when competition

increases or water levels rise (Moyroud 2009b) (USFWS, 2009). The gourd readily climbs any plant that will provide a trellis; in both Lake Okeechobee and the St. Johns River, the Okeechobee gourd grows on elderberry (Sambucus canadensis) and buttonbush (Cephalanthus occidentalis). Around Lake Okeechobee, the gourd is frequently associated with alligator nests. These disturbed sites provide areas where competition is reduced and elevated areas that promote the growth of elderberry, button bush, and other erect bushes and shrubs. Around Lake Okeechobee, the gourd relies on pond apple trees to support its vines above rising water levels during the wet season.

Dispersal/Migration

Dispersal

Adult: Unknown (USFWS, 1999)

Dependency on Other Individuals or Species for Dispersal

Adult: Possibly march rabbits (USFWS, 1999)

Dispersal/Migration Narrative

Adult: High lake levels facilitate dispersal. Although the exact mechanism for seed dispersal of the Okeechobee gourd is unknown, Walters et al. (1992) suggest that Okeechobee gourds disperse by floating in water bodies (in canals and along the shore of islands in Lake Okeechobee); however, no information is available regarding the distances seeds may disperse. Walters et al. (1992) also indicate that marsh rabbits are the main terrestrial disperser of gourd seeds, but others suggest that rabbits are only a predator of these seeds and are unlikely to be significant seed dispersers (M. Minno, Eco-Cognizant, Inc., personal communication 1998) (USFWS, 1999).

Population Information and Trends

Population Trends:

> 95% decline (NatureServe, 2015)

Species Trends:

Declining (USFWS, 2009)

Number of Populations:

2 (USFWS, 2009)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

At least 50 gourds were found at one site by Walters and Decker-Walters in 1990-1991. In winter and early spring of 1990-1991 Walters and Decker-Walters found the Okeechobee gourd at 11 sites along the lake shores (Martin, 1992). The estimated population size is up to 1,000 individuals. The species Has already lost 95% of its former range (J.K. Small, 1930) (NatureServe, 2015). The species status is declining; fires destroyed no plants were found on the spoil islands that once supported substantial populations. The Okeechobee gourd is only found in Florida in

two natural populations, one on Lake Okeechobee and the other along the St. Johns River. Very little genetic variation was observed within any of the three populations evaluated, and differences between populations were minor with nothing to differentiate between the Lake Okeechobee and St. Johns River populations of the Okeechobee gourd (Decker-Walters 2002c) (USFWS, 2009).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Continued habitat degradation and loss threaten the existence of Okeechobee gourd. Decker-Walters (2002c) stated that factors that reduce the availability of habitat (e.g., lack of fluctuation in water levels and aggressive weeds) pose a large threat to the subspecies. In addition, several factors related to human values (e.g., water storage, flood control, navigation) and ecological values (e.g., waterfowl, fisheries, littoral zone vegetation, water quality, snail kite recovery, and others) that affect management decisions can potentially conflict (Service 1999). At this time, the habitat seems stable along the St. Johns River; however, proposed water withdrawals for alternative public water supplies may affect suitability for the Okeechobee gourd (Minno 2009). Permanent inundation of suitable soils prevents germination of gourd seeds, and changes in water level management that would reduce the likelihood of low water can threaten the subspecies. Within the range of Okeechobee gourd in the Lake Okeechobee region, the human population is predicted to grow from nearly 11,000 to over 17,000 in Glades County between 2005 and 2060 and from approximately 1,270,000 to over 2,700,000 in Palm Beach County (Zwick and Carr 2006). Population growth is expected to increase water demands and recreational pressure on the lake. Within the range of the St. Johns River gourd population, the number of residents in Volusia County is projected to increase over the same time period from nearly 500,000 to over 940,000 and nearly triple in Lake County from just over 260,000 to more than 700,000 (Zwick and Carr 2006) (USFWS, 2009).

Stressor: Competition (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Okeechobee gourd plants are not strong competitors and are often outcompeted by more aggressive plant species (Decker-Walters 2002c). Weed competitors include moonflower, common reed (Phragmites australis), Virginia saltmarsh mallow (Kosteletzkya virginica), camphorweed (Pluchea sp.), melaleuca (Melaleuca quinquenervia), Sesbania sp., and Polygonum spp. (Decker-Walters 2002a; 2002c) (USFWS, 2009).

Stressor: Herbicide usage (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Although necessary for control of exotic plants, herbicide use also poses a threat to the Okeechobee gourd. The occurrences at one of the sites along the St. Johns River were destroyed in 2005 where herbicide was sprayed, and the site is no longer suitable (Minno and

Minno 2005). Herbicides are routinely sprayed around Lake Okeechobee to keep waterways free of aquatic vegetation (USFWS, 2009).

Stressor: Disease (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Minno and Minno (1998) reported finding powdery mildew fungus (Sphaerotheco fuliginea), a hyperparasitic fungus (Ampelomyces quisqualis), mites (e.g., Bevipalpus sp., Propvioseius meridionalis, and Galendromus mcgregori), melonworm (Diaphania hyalinata), pickleworm (Diaphania nitidalis), sowbugs, grasshoppers, leaf-footed bugs, and scales (Saissetia neglecta) on leaves of the Okeechobee gourd along the St. Johns River. Little damage to the plants was observed except as a result of the powdery mildew fungus, melonworm, and pickleworm in which older leaves were killed and infected fruit was aborted (Minno and Minno 1998). During the 2002 survey on Lake Okeechobee's Torry Island, Okeechobee gourd plants appeared productive but unhealthy, and plants tested positive for several viruses, including cucumber mosaic virus, squash mosaic virus, and watermelon mosaic virus (Decker-Walters 2002a). Signs of viral infection (leaf puckering) were also seen on one of the FWC spoil islands, but few vines from the St. Johns River population exhibited signs of viral infection (Decker-Walters 2002a). The author believed that the Lake Okeechobee population may be affected by more diseases and insects as a result of local agricultural activities in the area, such as the production of squash, but suggested that reproduction may not be substantially affected (Decker-Walters 2002a) (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Insect predation was observed on Okeechobee gourd plants on one of the FWC spoil islands on Lake Okeechobee in 2002 (e.g., striped cucumber beetle [Acalymma vittatum], pickleworm, and melonworm) (Decker-Walters 2002a). Extensive herbivory by marsh rabbits (Sylvilagus palustris) was observed on one of the FWC spoil islands on Lake Okeechobee and appeared to have devastated the plants on this island; the other spoil island seemed to be unaffected by herbivory (Decker-Walters 2002c). Decker-Walters (2002c) suggested that rabbits, as well as wild pigs (Sus scrofa), present a threat to the subspecies through predation of seeds. Plants in the St. Johns River population were healthier in 2002 and exhibited no signs of insect damage (Decker-Walters 2002a) (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Small populations are susceptible to inbreeding depression, which compounds the effects of other threats, such as reduced resistance to herbivore damage and viral infections (Stephenson et al. 2004). Because Okeechobee gourds are ephemeral in nature, they tend to appear and disappear from sites, depending upon growing conditions (Service 1999). No stable core population remains south of the lake to ensure survival as a result of poor growing conditions (e.g., the permanent inundation of suitable soils as a result of water-level regulation)

(Service 1999). Even during natural environmental fluctuations, the subspecies may be more vulnerable to localized extinction because of small population sizes (Nee 2009). The presence of the large core population in the pond-apple forest around the lake in the past may have maintained viability of the ephemeral populations on the islands by providing a source for seeds (Nee 2009). Fewer individuals occur along the St. Johns River, making this small population more susceptible to catastrophic events than the lake population (Decker-Walters 2002a). Growing near water and in swamps helps to buffer plants from winter freezes which can kill exposed stems and leaves (Minno 2009). Because plants of the St. Johns River population survive mostly from stems growing along the ground or through dense vegetation, they may be more susceptible to the effects of freezes (Minno 2009) (USFWS, 2009).

Recovery

Reclassification Criteria:

1. The Okeechobee gourd is protected at all known sites within Lake Okeechobee (USFWS, 1999).

2. Plants on Kreamer, Torry and Ritta Islands and the southern Rim Canal of Lake Okeechobee produce fruit at each of these locations at least every other year (their [i.e., fruit] absence for a period of two or more consecutive years will violate this requirement) (USFWS, 1999).

3. The distribution of fruiting plants is expanded within Lake Okeechobee either by the discovery of additional sites or by translocation (USFWS, 1999).

4. One or two sites are established outside of the southeastern quadrant of Lake Okeechobee (outside of Palm Beach County) (USFWS, 1999).

5. A stable, self-sustaining population of the Okeechobee gourd is established within the South Florida Ecosystem outside of Lake Okeechobee (USFWS, 1999).

6. Measures of vitality are developed and monitored at each of the sites described above (USFWS, 1999).

7. Based on the results of research on the viability of seeds following prolonged submergence and the survival of plants under rising water stages, the water regulation schedule for Lake Okeechobee is found not to jeopardize the continued existence of the Okeechobee gourd (USFWS, 1999).

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factor A) (USFWS, 2019)

2. Populations (as defined in criterion 1) occur in marsh and swamp habitats and are distributed across the historical range of the species. (addresses Factors A and E) (USFWS, 2019)

3. Populations (as defined in criterion 1) must be protected via a conservation mechanism or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (addresses Factors A and E) (USFWS, 2019)

Recovery Actions:

- Maintain information on the distribution and status of the Okeechobee gourd. Conduct regularly scheduled surveys. Individuals should be encouraged to provide information on sightings of the Okeechobee gourd. (USFWS, 1999).
- Protect and enhance existing populations. Ensure that spraying for control of aquatic vegetation does not harm or kill Okeechobee gourd plants. Assess the effect of Melaleuca and Brazilian pepper control efforts (both cutand- squirt and aerial spraying methods); use techniques to avoid direct impact on Okeechobee gourd plants. Use provisions of section 7 of the ESA to protect the Okeechobee gourd. Augment natural populations of the Okeechobee gourd. (USFWS, 1999).
- Initiate research on the life history and genetics of the Okeechobee gourd. Test experimentally the viability of Okeechobee gourd seeds kept submerged for long periods (1 to 3 years). Characterize the range of soil conditions where the Okeechobee gourd currently grows and provide detailed mapping of soil types in southeastern Lake Okeechobee. Through field surveys, determine dates of germination under natural conditions. Test experimentally the effect of seasonally rising water level on the survival of young plants. After information is available from the research studies described above and the annual field surveys, conduct population viability and risk assessment studies particularly with respect to water regulation schedule alternatives for Lake Okeechobee. Investigate the role of animals in dispersing seeds of the Okeechobee gourd. Document the potential ecological relationship between the American alligator and the Okeechobee gourd. Investigate the genetic distance between the two known populations of the Okeechobee gourd. (USFWS, 1999)
- Monitor existing populations of the Okeechobee gourd. Determine the most effective approach to monitor the condition of the Okeechobee gourd. After determining the most effective methods and indices, onduct monitoring on an annual basis. (USFWS, 1999)
- Increase public awareness about the Okeechobee gourd. Public awareness can be addressed through a variety of strategies, including, but not limited to, classroom programs, newspaper and magazine articles, public information displays at boat ramps in Lake Okeechobee, and outreach to fishing and airboating clubs. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing Okeechobee gourd habitat. Restore areas to suitable habitat. Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation. Monitor habitat/ecological processes. Increase public awareness of ecological relationships, environmental stressors, and restoration activities in the South Florida Ecosystem. (USFWS, 1999)
- Conduct regular surveys to monitor growth and reproduction, especially from late November through mid-February when many trees are leafless and fruit are easy to see (USFWS, 2009).
- Monitor the spoil islands of Lake Okeechobee to evaluate how the plants respond in a restricted environment with other competitive colonizers and observe the establishment of the seed bank (USFWS, 2009).
- Monitor future translocation sites (USFWS, 2009).
- Continue research to evaluate temporal changes in the prevalence of the three viruses found and to determine the extent to which the fitness of Okeechobee gourd populations is being negatively impacted (USFWS, 2009).

- Conduct experiments on dry fruits from plants grown under controlled conditions (e.g., in the greenhouse) to explore the buoyancy of dried-fruit seeds in greater detail (USFWS, 2009).
- Continue to assess dormancy mechanisms and test viability limits through longer immersion periods of seeds (USFWS, 2009).
- Conduct buried seed experiments in Lake Okeechobee or St. Johns River soils (USFWS, 2009).
- Directly evaluate each gourd population for viral loads, determine the percentage of progeny that may carry the squash mosaic virus, and conduct off-site viral-inoculation experiments of progeny to evaluate degree of tolerance and reproductive impacts (USFWS, 2009).
- Re-evaluate the relationships amongst subspecies of Cucurbita okeechobeensis using modern molecular techniques and new morphological characteristics (USFWS, 2009).
- Continue research on fluctuations in abundance of the gourd in response to water conditions, particularly extended periods of high water, to determine the level of risk to the long-term survival of the subspecies (USFWS, 2009).
- Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation (USFWS, 2009).
- Conduct population viability and risk assessment studies, particularly with respect to water regulation schedule alternatives for Lake Okeechobee (USFWS, 2009).
- Eradicate exotic weeds (e.g., Ipomoea alba) in locations that support gourds and take care when planting native trees to prevent introduction of these weeds (USFWS, 2009).
- Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes (USFWS, 2009).
- Prevent cultural (i.e., human caused) eutrophication of lakes and marshes (USFWS, 2009).
- Avoid disruptive changes to the riparian habitat along the St. Johns River where the population occurs (USFWS, 2009).
- Ensure that water-level regulation is compatible with management needs of the Okeechobee gourd (USFWS, 2009).
- Ensure aquatic vegetation management practices are compatible with recovery of the subspecies (USFWS, 2009).
- Consider Okeechobee gourd and the creation of habitat in planning phases of Everglades restoration (USFWS, 2009).
- Restore habitat by planting pond apple and cypress where appropriate (USFWS, 2009).
- Establish a translocation protocol, locate potential sites, and translocate plants to identified sites (USFWS, 2009).
- Ensure that the St. Johns River and Lake Okeechobee populations are not grown together in collections to avoid hybridization. If hybridization is suspected, hybrid material should not be used for reintroduction (USFWS, 2009).
- Develop recovery criteria for the Okeechobee gourd population along the St. Johns River (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Surveys: Conduct regular surveys to monitor growth and reproduction, especially from late November through mid-February when many trees are leafless and fruit are easy to see. Monitor the spoil islands of Lake Okeechobee to evaluate how

the plants do in a restricted environment with other competitive colonizers and observe the establishment of the seed bank. Identify sites appropriate for future translocations. Conduct and monitor future translocation sites. These actions continue to be top priorities for the recovery of the Okeechobee gourd. Research: Continue research to evaluate temporal changes in the prevalence of the three viruses found in association with the gourd, and determine the extent to which the fitness of Okeechobee gourd populations is being negatively impacted. Conduct experiments on dry fruits from plants grown under controlled conditions (e.g., in the greenhouse) to explore the buoyancy of dried-fruit seeds in greater detail. Continue to assess dormancy mechanisms and test viability limits through longer immersion periods of seeds. Conduct buried seed experiments in Lake Okeechobee or St. Johns River soils. Directly evaluate each gourd population for viral loads, determine the percentage of progeny that may carry the squash mosaic virus, and conduct off-site viral-inoculation experiments of progeny to evaluate degree of tolerance and reproductive impacts. Re-evaluate the relationships amongst subspecies of Cucurbita okeechobeensis using modern molecular techniques and new morphological characteristics. Continue research on fluctuations in abundance of the gourd in response to water conditions, particularly extended periods of high water, to determine the level of risk to the survival of the subspecies in the long term. Research the acute and long-term tolerance of the Okeechobee gourd and other wetland plants to herbicides commonly used to control nuisance species of aquatic vegetation. Conduct population viability and risk assessment studies, particularly with respect to water regulation schedule alternatives for Lake Okeechobee. These actions continue to be top priorities for the recovery of the Okeechobee gourd. Management: Eradicate exotic weeds (e.g., Ipomoea alba) in locations that support gourds and take care when planting native trees to prevent introduction of these weeds. Use controlled burns to open up areas of overly dense herbaceous and/or shrubby vegetation in lake littoral zones and marshes. Prevent cultural eutrophication of lakes and marshes. Avoid disruptive changes to the riparian habitat along the St. Johns River where the population occurs. Ensure that water-level regulation is compatible with management needs of the Okeechobee gourd. Ensure aquatic vegetation management practices are compatible with recovery of the subspecies. Consider Okeechobee gourd and the creation of habitat in planning phases of Everglades restoration. Restore habitat by planting pond apple and cypress where appropriate. Establish a translocation protocol, locate potential sites, and translocate plants to identified sites. Ensure that the St. Johns River and Lake Okeechobee populations are not kept together in collections to avoid hybridization. If hybridization is suspected, hybrid material should not be used for reintroduction. These actions continue to be top priorities for the recovery of the Okeechobee gourd. (USFWS, 2021)

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SPECIES ACCOUNT: *Cyanea dolichopoda* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/14/2010; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea dolichopoda (haha) is a shrub in the bellflower family (Campanulaceae). Shrub, 1 m tall, erect, with stem unbranched. Leaf blades ovate or oblong, 6.5-10 cm long, 3.7-5.8 cm wide, bases cordate, often markedly asymmetric. Petioles 9-16 cm long, slender. Inflorescences (not fully expanded) spreading or pendent, 8-11-flowered. Corollas (in bud) pinkish. (NatureServe, 2015; USFWS, 2016)

Current Range

Cyanea dolichopoda was first collected in 1990 at Blue Hole, Kauai. The only mature individual and two seedlings could not be relocated after Hurricane Iniki in 1992. Currently, there are no known individuals. (USFWS, 2017)

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cyanea dolichopoda (`Akoko) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for Cyanea dolichopoda includes three CHUs in Kauai County, Hawaii. Note: This species may no longer occur naturally in the wild, therefore there is no known occupied critical habitat for this species. The critical habitat units for this species have been determined to be essential to the conservation of the species because the area provides for the reestablishment of populations within the species' historical range (75 FR 18960-19165).

Kauai—Wet Cliff—Section 1: Wet Cliff–Section 1 consists of 190 ac (77 ha) in the wet cliff ecosystem, including cliffs along the rim of Kalalau Valley from Alealeau to Pihea, on Stateowned land in the Na Pali Coast State Park and the Hono o Na Pali NAR (Figure 6-A). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70b, and is occupied by the plant Chamaesyce remyi var. remyi. This section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 1 is not known to be occupied by the plants Chamaesyce remyi var. kauaiensis, Cyanea dolichopoda, Cyrtandra oenobarbara, C. paliku, Dubautia plantaginea ssp. magnifolia, Lysimachia iniki, L. pendens, L. venosa, and Platydesma rostrata, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 2: Wet Cliff–Section 2 consists of 784 ac (317 ha) in the wet cliff ecosystem, and includes the cliffs at the headwaters of the Wailua River or ''Blue Hole,'' on State (778 ac, 315 ha) and privately owned (6 ac, 3 ha) land in the LihueKoloa Forest Reserve (Figure 6-B). There are 489 ac (198 ha) within previously designated critical habitat and 296 ac (120 ha) of newly designated critical habitat on State-owned land. The portion of the section that is in previously designated critical habitat falls within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36b. The newly designated portion of the section comprises Critical Habitat Unit 18 of 50 CFR 17.99(a)(1), Map 217a. This section is occupied by the plants Chamaesyce remyi var. kauaiensis, Cyrtandra oenobarba, Dubautia plantaginea ssp. magnifolia, Lysimachia iniki, L. pendens, and Platydesma rostrata. The section includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 2 is not known to be occupied by the plants Chamaesyce remyi var. remyi, Cyanea dolichopoda, Cyrtandra paliku, and Lysimachia venosa, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Wet Cliff—Section 3: Wet Cliff –Section 3 consists of 61 ac (24 ha) in the wet cliff ecosystem, including cliffs below Kekoiki, on State (8 ac, 3 ha) and privately owned (53 ac, 22 ha) land in the Halelea, Moloaa and Kealia forest reserves (Figure 6-C). There are 23 ac (9 ha) of newly designated critical habitat on privately owned land within this section. That portion of the section that falls within previously designated critical habitat is within Critical Habitat Unit 4 of 50 CFR 17.99(a)(1), Map 5a. The newly designated portion of the section comprises Critical Habitat Unit 19 of 50 CFR 17.99(a)(1), Map 217b. This section is occupied by the plant Cyrtandra paliku, and includes the wet cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the wet cliff ecosystem (Table 3). Although Wet Cliff–Section 3 is not known to be occupied by the plants Chamaesyce remyi var. kauaiensis, C. remyi var. remyi, Cyanea dolichopoda, Cyrtandra oenobarbara, Dubautia plantaginea ssp. magnifolia, Lysimachia iniki, L. pendens, L. venosa, and Platydesma rostrata, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cyanea dolichopoda critical habitat consists of one component (Wet cliff) (75 FR 18960-19165):

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., ''sustained yield'') in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses Andropogon sp. and Setaria sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry

Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., Schiedea attenuata). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: obligate outcrosser (USFWS, 2021c)

Lifespan

Adult: short (USFWS, 2021c)

Habitat Type

Adult: Terrestrial (inferred from NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliffs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High rainfall (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at approximately 2,300 feet (USFWS, 2010)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2010)

Habitat Narrative

Adult: Cyanea dolichopoda occurs in a deep and extremely wet valley head surrounded on three sides by vertical cliffs 900 meters (m) (2,953 feet (ft)) high and laced with waterfalls. The vegetation is an unusual mix of shrubland and low-statured rainforest on saturated rocky ground. The canopy is just 1 to 3 m (3.3 to 9.9 ft) tall, and the ground layer is rich in ferns and fern allies (Lammers and Lorence 1993). The canopy is Metrosideros polymorpha (ohia) lowland wet shrubland with the associated native species Cyanea asarifolia (haha), Cyrtandra sp. (haiwale), Kadua elatior (awiwi), Lysimachia filifolia (NCN), Pipturus albidus (mamake), Touchardia latifolia (olona) (NTBG 1990; Lammers and Lorence 1993). (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

0 (USFWS, 2021c)

Population Size:

0 (USFWS, 2021c)

Population Narrative:

In June 1990, a single mature individual and a few seedlings of an undescribed species of Cyanea was discovered on the south side of Blue Hole, a relatively inaccessible site located at the headwaters of the Wailua River, at about 700 m (2,297 ft) elevation (NTBG 1990; Lammers and Lorence 1993). The species was named Cyanea dolichopoda. In October 1992, six weeks after Hurricane Iniki, a survey revealed that all known individuals of this species had been destroyed. It is likely that additional plants survive on cliffs surrounding Blue Hole, although the vertical aspect and great height of the cliffs makes them difficult to explore (Lammers and Lorence 1993; Perlman 2007, as cited in USFWS 2010a). Numerous surveys have been conducted at the holotype region, along with nearby locations, but no individuals have ever been located (Wood 2015). (USFWS, 2017). Island Distribution: Kauai? (USFWS, 2021c) Number of Populations: 0 (USFWS, 2021c) Estimated Number of Individuals: 0 (USFWS, 2021c) Populations and Life History Characteristics: Known from only one population and obligate outcrosser (USFWS, 2021c)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.

Stressor: Predation and herbivory (USFWS, 2010)
Exposure:
Response:
Consequence:

Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to Cyanea dolichopoda throughout its range due to , and documented mechanical damage by nonnative invertebrates (USFWS, 2010).

Stressor: Small populations (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Cyanea dolichopoda has not been confirmed to persist in the wild. This species is not in storage or propagation, but individuals familiar with this species believe it may possibly remain extant and that much of its suitable habitat (lowland mesic, lowland wet, and wet cliff) on Kauai remains to be surveyed (USFWS, 2010).

Stressor: Established ecosystem-altering invasive plant modification and destruction of habitat (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community. Invasive introduced plants impacting Cyanea dolichopoda are Erigeron karvinskianus (daisy fleabane), Psidium spp. (guava), and Toona ciliata (Australian red cedar) (KRCP 2014). (USFWS, 2017)

Stressor: Lack of adequate hunting regulations (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Nonnative feral ungulates pose a major ongoing threat to native species through destruction and modification of habitat, and by direct herbivory or predation. Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (i.e., sustained yield) in some areas, with one animal allowed per day; to other areas with as few as one animal allowed per year (DLNR 2010). Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation. The only known population of Cyanea dolichopoda occurred in a State hunting area in Lihue-Koloa Forest Reserve (mammal hunting area). This area is not fenced. (USFWS, 2017)

Stressor: Lack of adequate biosecurity legislation (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Invasion of the State of Hawaii by invasive nonnative plant species, and destruction of habitat and competition by nonnative plants are threats to Cyanea dolichopoda. The U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, is authorized to prevent the introduction or dissemination of animal and plant pests on all ships, aircraft, and their cargo and baggage arriving in the U.S. and its territories; however, pest species continue to enter the State. In addition, Federal import regulations do not address

many species that could be pests in Hawaii (CGAPS 2009; Ikuma et al. 2002). (USFWS, 2017)

Recovery

Reclassification Criteria:
To meet the interim stage of recovery of Cyanea dolichopoda, 600 mature individuals are needed in one population and all major threats must be controlled around the population designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The population must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2017)

In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes: major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2017)

Number of populations and individuals needed to meet Preventing Extinction Stage based on population and life history characteristics: 1 Populations, 200 Mature Individuals per Population (USFWS, 2021c). Number of populations and individuals needed to meet Interim Stage based on population and life history characteristics: 1 Population, 1,200 Mature Individuals per Population (USFWS, 2021c). Number of populations and individuals needed for Downlisting based on population and life history characteristics: 5 Populations, 1,000 Mature Individuals per Population (USFWS, 2021c).

Delisting Criteria:
In addition to achieving 5 to 10 populations with 1,000 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2017)

Number of populations and individuals needed for delisting based on population and life history characteristics: 5 Populations, 1,000 Mature Individuals per Population (USFWS, 2021c).

Recovery Actions:

- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys. (USFWS, 2010)
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units. (USFWS, 2010)
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys. (USFWS, 2010)
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range. (USFWS, 2010)
- Conduct research on control methods for introduced slugs and avian malaria. (USFWS, 2010)
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction. (USFWS, 2010)
- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security. (USFWS, 2010)
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems. (USFWS, 2010)
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations. (USFWS, 2010)
- Surveys and inventories—Survey suitable habitat to find new populations. Consider utilizing Unmanned Aerial Vehicles to survey inaccessible cliff habitat to confirm extirpation from the Blue Hole known location. (USFWS, 2017)
- Ungulate monitoring and control—Fence any populations found to protect them from the impacts of feral ungulates. Control feral ungulates within fenced exclosures. (USFWS, 2017)
- Invasive plant monitoring and control—Control invasive plant species around any populations found. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Collect material for genetic storage and propagation for reintroduction from any individuals found. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017)
- Based on the recovery criteria above, consider development of a recovery plan. (USFWS, 2017)
- Not available.

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SPECIES ACCOUNT: *Cyanea magnicalyx* (haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea magnicalyx, a member of the bellflower family (Campanulaceae), is a shrub with branched stems, from 1.5 to 3 meters (5 to 10 feet) tall. Leaves are glabrous, 36 to 55 centimeters (cm) (14 to 22 inches (in)) long and up to 27 cm (11 in) wide with pinnately cleft margins 0.4 to 4.5 cm (0.2 to 1.8 in) wide between the segments. Racemes are 6- to 15-flowered. Flowers are yellowish-white and striped with purple, 65 to 70 mm (2.6 to 2.8 in) long, glabrous, with corolla tube laterally compressed. Mature fruit and seeds are not described (Lammers 2004). (USFWS, 2018)

Taxonomy

This species was first described as Cyanea grimesiana subsp. grimesiana. The distribution of this subspecies at that time included the islands of Oʻahu, Molokaʻi, Lānaʻi, and Maui. Subsequently, Lammers (1998) recognized morphological differences in the broadly circumscribed Cyanea grimesiana group and published new combinations for the plants reported from Maui (C. mauiensis) and Lānaʻi (C. munroi). Plants reported from Molokaʻi were identified as either C. munroi or C. grimesiana subsp. grimesiana. In 2004, Lammers recognized further differences in the plants reported from Maui and described a new species, C. magnicalyx, known only from west Maui. The range of C. grimesiana subsp. grimesiana now includes only Oʻahu and Molokaʻi (Lammers 1998; Lammers 2004). We evaluated the effects of the five factors described in section 4(a)(1) of the Endangered Species Act on C. magnicalyx and determined that this species warranted endangered status under the Act (78 FR 32014, May 28, 2013). Cyanea magnicalyx is recognized as a distinct taxon in Lammers (2004) and in Wagner et al. (2012) the most recently accepted Hawaiian plant taxonomy. (USFWS, 2018)

Historical Range

Historically, two populations of Cyanea magnicalyx from west Maui were formerly classified as C. grimesiana subsp. grimesiana. (USFWS, 2018)

Current Range

Cyanea magnicalyx is found in west Maui. (USFWS, 2018). Location: Maui (USFWS, 2021)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cyanea magnicalyx (Haha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Cyanea magnicalyx includes 14 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 2 (and) Palmeria dolei—Unit 3—Lowland Wet (and) Pseudonestor xanthophrys—Unit 3— Lowland Wet (and) Newcombia cumingi—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant Santalum haleakalae var. lanaiense. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, or Wikstroemia villosa, by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), or by the Newcomb's tree snail (Newcombia cumingi), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) Palmeria dolei—Unit 4—Lowland Wet (and) Pseudonestor xanthophrys—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants Bidens conjuncta, Cyanea asplenifolia, and Pteris lidgatei. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) Palmeria dolei—Unit 5—Lowland Wet (and) Pseudonestor xanthophrys—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native

plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants Bidens conjuncta and Cyanea asplenifolia. These units also contain unoccupied habitat that is essential to the conservation of this these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) Palmeria dolei—Unit 6—Lowland Wet (and) Pseudonestor xanthophrys—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) Palmeria dolei—Unit 7—Lowland Wet (and) Pseudonestor xanthophrys—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, Bidens micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum

sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) Palmeria dolei—Unit 8—Lowland Wet (and) Pseudonestor xanthophrys—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant Alectryon macrococcus. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) Palmeria dolei—Unit 9—Lowland Wet (and) Pseudonestor xanthophrys—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) Palmeria dolei—Unit 19—Montane Mesic (and) Pseudonestor xanthophrys—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuehunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Lysimachia lydgatei, Remya mauiensis, and Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants Geranium hillebrandii, Huperzia mannii, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) Palmeria dolei—Unit 20—Montane Mesic (and) Pseudonestor xanthophrys—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant Geranium hillebrandii, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) Palmeria dolei—Unit 21—Montane Mesic (and) Pseudonestor xanthophrys—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) Palmeria dolei—Unit 22—Montane Mesic (and) Pseudonestor xanthophrys—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Remya mauiensis and Santalum haleakalae var. lanaiense, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) Palmeria dolei—Unit 35—Wet Cliff (and) Pseudonestor xanthophrys—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants Alectryon macrococcus, B. conjuncta, Ctenitis squamigera, Cyrtandra munroi, Remya mauiensis, and Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants Bidens campylotheca ssp. pentamera, Bonamia menziesii, Cyanea glabra, C. lobata, C. magnicalyx, Cyrtandra filipes, Dubautia plantaginea ssp. humilis, Gouania vitifolia, Hesperomannia arborescens, H. arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Lysimachia lydgatei, Plantago princeps, Platanthera holochila, Pteris lidgatei, or Tetramolopium capillare, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) Palmeria dolei—Unit 36—Wet Cliff (and) Pseudonestor xanthophrys—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants Cyrtandra filipes and C. munroi, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. conjuncta, Bonamia menziesii, Ctenitis squamigera, Cyanea glabra, C. lobata, C. magnicalyx, Dubautia plantaginea ssp. humilis, Gouania vitifolia, Hesperomannia arborescens, H. arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Lysimachia lydgatei, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Tetramolopium capillare, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. conjuncta, Bonamia menziesii, Ctenitis squamigera, Cyanea glabra, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Dubautia plantaginea ssp. humilis, Gouania vitifolia, Hesperomannia arborescens, H. arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Lysimachia lydgatei, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Tetramolopium capillare, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cyanea magnicalyx critical habitat consists of three components. Lowland wet (west Maui), Montane mesic (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma,

Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid

creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: Short (USFWS, 2021)

Breeding Season

Adult: This species flowers primarily from September to October (Lammers 2004). (USFWS, 2018)

Reproduction Narrative

Adult: This species flowers primarily from September to October (Lammers 2004). (USFWS, 2018)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 450 meters (1,476 feet) elevation (USFWS, 2018)

Habitat Narrative

Adult: This species is found in lowland wet, montane mesic, and wet cliff ecosystems on West Maui. (NatureServe, 2015); Typical habitat for this species includes mesic forest and shrubland at 450 meters (1,476 feet) elevation on west Maui (Lammers 2004). Cyanea magnicalyx occurs on west Maui in at Kaluanui Stream in a subgulch of Honokōhau Valley and in Olowalu Gulch in Metrosideros polymorpha–Cibotium spp. (ʻōhiʻa–hāpuʻu) mesic forest with the associated native plant species Antidesma platyphyllum (hame), Broussaisia arguta (kanawao), Cheirodendron trigynum (ʻōlapa), Clermontia kakeana (ʻōhā wai), Cyanea angustifolia (hāhā), C. lobata (hāhā), Cyrtandra grayana (haʻiwale), C. grayi (haʻiwale), Dicranopteris linearis (uluhe), Diplazium sandwichianum (hōʻiʻo), Dodonaea viscosa (ʻaʻaliʻi), Freycinetia arborea (ʻieʻie), Ilex anomala (kāwaʻu), Kadua acuminata (au), Melicope hawaiensis (mokihana kūkae moa), Myrsine lessertiana (kōlea lau nui), Nestegis sandwicensis (olopua), Polyscias hawaiensis (ʻohe), Syzygium sandwicensis (ʻōhiʻa hā), and Xylosma hawaiiense (aʻe) (Wood 2009, in litt.). In ʻĪao Valley on west Maui, the vegetative community is Pisonia (pāpala kēpau) forest with Metrosideros polymorpha and associated native species including Antidesma platyphyllum, Asplenium nidus (ʻēkaha), Chrysodracon auwahiensis (hala pepe), Cyrtandra grayi, Charpentiera obovata (pāpala), Cheirodendron trigynum, Claoxylon sandwicense (poʻolā), Freycinetia arborea, Kadua acuminata, K. affinis (manono), Nothocestrum longifolium (ʻaiea), Perrottetia sandwicensis (olomea), Pittosporum glabrum (hōʻawa), Planchonella sandwicensis (ʻālaʻa), Psychotria mauiensis (ʻōpiko), and Xylosma hawaiiense (Oppenheimer 2009, in litt.; Wood 2009, in litt.). (USFWS, 2018)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

3 (USFWS, 2023)

Population Size:

2-3 wild individuals, 82 outplanted individuals surviving (USFWS, 2023)

Population Narrative:

Currently there are two to three wild individuals of Cyanea magnicalyx at three locations on Mauna Kahālāwai (west Maui). Five translocated and augmented populations are provided

protection by fencing and nonnative plant control. Rodent control is conducted at one translocated population and slug control is conducted at one translocated population. Seed collections, propagation, and augmentation and translocation are ongoing, with approximately 82 of the 134 recently reintroduced individuals surviving. All known wild plants are represented in seed storage, propagation, and translocations. (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, fire, landslides, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (pigs , rats, and slugs) is considered an ongoing threat to Cyanea magnicalyx throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Stochastic events—Reduced viability due to low numbers (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Small, isolated populations often exhibit reduced levels of genetic variability, which diminishes the species' capacity to adapt and respond to environmental changes, thereby lessening the probability of long-term persistence (Barrett and Kohn 1991; Newman and Pilson 1997). The problems associated with small population size and vulnerability to random

demographic fluctuations or natural catastrophes are further magnified by synergistic interactions with other threats, such as anthropogenic impacts like habitat loss from human development or predation by nonnative species. Cyanea magnicalyx is currently known from only three wild individuals on west Maui (Oppenheimer 2018, in litt.). Although reintroduction of individuals is ongoing, fewer than 50 percent of those individuals persist beyond five years (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2017a). (USFWS, 2018)

Stressor: Ungulate degradation of habitat (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Feral ungulates modify and degrade habitat by disturbing and destroying vegetative cover, trampling plants and seedlings, reducing or eliminating plant regeneration by damaging seeds and seedlings, and increasing erosion by creating large areas of bare soil (Loope 1998; van Riper and van Riper 1982). Feral pigs (Sus scrofa) and evidence of their activities have been observed at wild and reintroduced occurrences of Cyanea magnicalyx at Honolua-Kaluanui-Honokōhau, ʻĪao Valley, Kahana, and Pūehuehu Nui-Launiupoko (Keir et al. 2015; NTBG 2004a, 2004b, 2004c, PEPP 2010, 2012, 2013, 2015). (USFWS, 2018)

Stressor: Established ecosystem-altering invasive plant modification and degradation of habitat (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Invasive introduced plant species modify habitats occupied by native plant species by changing the availability of light, altering soil-water regimes, modifying nutrient cycling, and changing the fire characteristics of the native plant community (Cuddihy and Stone 1990). Habitat modification and destruction by invasive introduced plants negatively affects Cyanea magnicalyx at all locations where it occurs on west Maui. The nonnative plants with the greatest impacts include Ageratina adenophora (Maui pāmakani), Blechnum appendiculatum (no common name), Buddleja asiatica (dog tail), Casuarina equisetifolia (ironwood), Clidemia hirta (Koster's curse), Cordyline fruticosa (ki), Grevillea robusta (silk oak), Psidium cattleianum (strawberry guava), P. guajava (common guava), Rubus rosifolius (thimbleberry), Schinus terebinthifolius (christmasberry), and Tibouchina herbacea (cane tibouchina) Keir et al. 2015; NTBG 2004a, 2004b, 2006a). (USFWS, 2018)

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Landslides have been reported as a threat to individuals of Cyanea magnicalyx at ʻĪao Valley and Honolua-Honokōhau (Keir et al. 2015; PEPP 2010, 2011, 2012). Landslides and erosion due to natural weathering destabilizes substrates, damages and destroys individual plants, and alters hydrological patterns (Stearns 1985). (USFWS, 2018)

Stressor: Drought degradation of habitat (USFWS, 2018)
Exposure:
Response:

Consequence:
Narrative: Drought is observed to be a threat to Cyanea magnicalyx at Pūehuehu Nui-Launiupoko, Honokōhau, Olowalu, ʻĪao Valley, and Kahana (PEPP 2010, 2012, 2013, 2014, 2015, 2017a). Over the past 100 years, the Hawaiian Islands have experienced an annual decline in precipitation from just over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz et al. 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.). (USFWS, 2018)

Stressor: Climate change loss or degradation of habitat (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. At the time of the analysis, individuals of Cyanea magnicalyx were believed to be C. grimesiana subsp. grimesiana, and the assessment concluded that the subspecies is vulnerable to the impacts of climate change with a vulnerability score of 0.497 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Those individuals on west Maui now known as Cyanea magnicalyx have a much smaller range than C. grimesiana subsp. grimesiana, and may be more vulnerable. Therefore, additional management actions are needed to conserve this taxon into the future. We will update this information for C. magnicalyx as it becomes available. (USFWS, 2018)

Stressor: Rodent predation or herbivory (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Herbivory by rats is noted to be a threat to Cyanea magnicalyx at Honolua, Kaluanui-Honokōhau, ʻĪao Valley, Pūehuehu Nui-Launiupoko, Kahana, and Waikapū (NTBG 2004a, 2004b, 2004c; Oppenheimer 2018, in litt.; PEPP 2010, 2011, 2012, 2013, 2014, 2015). Rats eat virtually every part of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoots, seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals and complete lack of recruitment. (USFWS, 2018)

Stressor: Invertebrate predation or herbivory (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Herbivory by slugs has been noted as a threat to this species at Honolua, Kaluanui-Honokōhau, ʻĪao Valley, Pūehuehu Nui-Launiupoko, Kahana, Waikapū, and Olowalu (NTBG 2004a, 2004b, 2004c; PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2017a). The effects on plants range from reduced vigor and decreased reproduction to mortality of individuals. (USFWS, 2018)

Stressor: Lack of adequate hunting regulations (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Current and historic habitat of Cyanea magnicalyx at Olowalu and Pūehuehu Nui is within State hunting areas. Public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS, 2018)

Recovery

Reclassification Criteria:
To meet the interim stage of recovery of Cyanea magnicalyx, 300 mature individuals are needed in each of three populations and all major threats must be controlled around the populations designated for recovery at this stage. There should also be demonstrated regeneration of seedlings and growth to at least sapling stage for woody species and documented replacement regeneration within each of the target populations. The populations must be adequately represented in an ex situ collection as defined in the Center for Plant Conservation's guidelines (Guerrant et al. 2004). Adequate monitoring must be in place and conducted to assess individual plant survival, population trends, trends of major limiting factors, and response of major limiting factors to management. (USFWS, 2018)

In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim stage, all target populations must be stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions are not ruled out. Downlisting should not be considered until an adequate population viability analysis (PVA) has been conducted to assess needed numbers more accurately based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to downlist. Information necessary for the PVA that should be available through monitoring (ideally annually) includes major limiting factors, breeding system, population structure and density, and proven management methods for major threats. (USFWS, 2018)

Number of populations and individuals needed for each plant species to meet Preventing Extinction Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 50. (USFWS, 2021) Number of populations and individuals needed for each plant species to meet the Interim Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 300. (USFWS, 2021) Number of population and individuals needed for downlisting based on population and life history characteristics: Number of Populations: 5. Mature Individuals per population: 500. (USFWS, 2021)

Delisting Criteria:
In addition to achieving 5 to 10 populations with 500 mature individuals per population and all of the goals of the interim and downlisting stages, all target populations must be stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but ecosystem-wide management

actions are not ruled out if there are long-term agreements in place to continue management. These numbers are initial targets, but may be revised upward as additional information is available, including adequate PVAs for individual species based on current management and monitoring data collected at regular intervals determined by demographic parameters of the species, although they should only be one of the factors used in making a decision to delist. Genetic analyses should be conducted to ensure that adequate genetic representation is present within and among populations compared to the initial variation assessed in the interim stage. Numbers need to be considered on a species-by-species basis. (USFWS, 2018)

Number of populations and individuals needed for delisting based on population and life history characteristics: Number of Populations: 10. Mature Individuals per population: 500. (USFWS, 2021)

Recovery Actions:

- Surveys and inventories—Continue to survey for populations of Cyanea magnicalyx in areas of potentially suitable habitat. (USFWS, 2018)
- Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations and reintroductions to prevent imminent extinction. (USFWS, 2018)
- Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations. Continue to control invasive nonnative plant species that compete with Cyanea magnicalyx. (USFWS, 2018)
- Rodent predation or herbivory control—Continue to implement effective measures to control rodents around all populations. (USFWS, 2018)
- Invertebrate predation or herbivory control—Continue to implement effective measures to control slugs around all populations. (USFWS, 2018)
- Captive propagation for genetic storage and reintroduction—Continue to secure ex situ stocks with complete representation of remaining individuals. (USFWS, 2018)
- Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2018)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and drought. (USFWS, 2018)
- Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2018)
- Alliance and partnership development—Continue to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2018)
- Not available.

Conservation Measures and Best Management Practices:

- New Management Actions: • Monitoring and surveys—The Maui Plant Extinction Prevention Program (Maui PEPP) surveys for and monitors wild and translocated populations of Cyanea magnicalyx (Maui PEPP 2017, 2020). • Invasive nonnative plant management—In 2017, Maui PEPP conducted nonnative plant control at the Kahana and Launiupoko translocation and augmentation sites, and again in 2020 at Launiupoko (Maui PEPP 2017, 2020). • Collection and propagation for genetic storage and reintroduction— o In 2021, the Lyon Micropropagation Laboratory reported

propagation of 72 explants representing one founder at Honokōhau, 58 explants representing one founder at ʻĪao Valley, and 20 explants representing one founder at Launiupoko. The Lyon Arboretum Seed Conservation Laboratory also has seeds from an additional founder from ʻĪao Valley stored in their seed bank (Lyon Arboretum 2022). o In 2019, the Olinda Rare Plant Facility (ORPF) reported propagation of 25 plants representing two founders at Honokōhau, 16 were reported as sent out for translocation to Helu. Twenty plants were propagated representing two founders from a reintroduction at Kahana, five of which were sent out for translocation. One hundred seven plants were propagated representing three founders at ʻĪao Valley, 23 of which were sent out for translocation, and 10 plants were propagated representing one founder at Launiupoko (ORPF 2023). o Maui PEPP collects fruit from wild and translocated plants at Kahana and Launiupoko (Maui PEPP 2017, 2020). • Translocation and Augmentation—Maui PEPP reported augmentation of five individuals to two translocated populations at Launiupoko and nine individuals to Panaʻewa Natural Area Reserve (Maui PEPP 2020, 2023) (USFWS, 2023).

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are updated or reiterated for the 5-year review for 2023. • Surveys and inventories—Continue surveys for populations of Cyanea magnicalyx in historical locations and in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to maintain exclosures to protect individuals from the negative impacts of habitat destruction and browsing by feral ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with C. magnicalyx at all populations. • Climate change adaptation strategy—Assess the modeled effect of climate change on this species and use to determine future landscape needed for its recovery. • Predator and herbivore monitoring and control— o Implement effective methods to control predation by rodents at all populations. o Determine effective methods to control invertebrates (slugs) and implement at all populations • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts to secure ex situ stock with complete representation of remaining individuals. • Reintroduction and translocations—Continue to augment and translocate individuals into suitable habitat within historic range that is managed for known threats to this species. • Build resiliency, redundancy, and representation—Increase numbers of individuals and populations throughout historic range to reduce impacts from landslides and drought. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2023).

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

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SPECIES ACCOUNT: *Cyanea pinnatifida* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub 0.8-3 m tall. Stems are unbranched or sparingly branched. Slightly curved flowers are greenish white with purplish stripes at the base. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the Waianae Mountains of Oahu. The last known wild individual died in 2001, although the species remains in cultivation (USFWS, 2012).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cyanea pinnatifida (Haha) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Cyanea pinnatifida (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Cyanea pinnatifida includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Cyanea pinnatifida includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cyanea pinnatifida critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Cyanea pinnatifida was known historically (last observed > 20 yrs ago) from indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Cyanea pinnatifida to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Reproduction Narrative

Adult: This species reproductive strategy is sexual. This species has been observed flowering in August (BISH 24360). (USFWS, 1998; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 490 and 520 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: Cyanea pinnatifida typically grows on steep, shady ravines, wet, rocky slopes in diverse mesic forest at an elevation of 490 to 520 meters (1,600 to 1,700 feet) in association with mamaki and ferns (USFWS 1995). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

2 (USFWS, 2014)

Population Size:

~20 (USFWS, 2014)

Population Narrative:

In 2008, there were two populations of Cyanea pinnatifida at Ekahanui at Honouliuli and at the reintroduction site at Kaluaa containing approximately 10 individuals at each population totaling 20 individuals (Plant Extinction Prevention Program 2008). In 2010, 10 individuals remained at the reintroduction site at Kaluaa (Plant Extinction Prevention Program 2010); the number of individuals at Ekahanui was not reported. (USFWS, 2012)

Threats and Stressors

Stressor: Feral pigs (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: As early as 1778, European explorers introduced livestock, which became feral, increased in number and range, and caused significant changes to the natural environment of Hawaii. The pig is originally native to Europe, northern Africa, Asia Minor, and Asia. European pigs became feral and invaded forested areas, especially wet and mesic forests and dry areas at high elevations. Feral pigs are currently present on Oahu and inhabit rain forests and grasslands. While rooting in the ground in search of the invertebrates and plant material they eat, feral pigs disturb and destroy vegetative cover, trample plants and seedlings, and threaten forest regeneration by damaging seeds and seedlings. They disturb soil and cause erosion, especially on slopes. Alien plant seeds are dispersed on their hooves and coats as well as through their digestive tracts, and the disturbed soil is fertilized by their feces, helping these plants to establish. Feral pigs are a primary vector in the spread of many introduced plant species (Smith 1985; Stone 1985; Medeiros et al. 1986; Scott et aZ. 1986; Tomich 1986; Cuddihy and Stone 1990; Wagner et al. 1999). Currently, the individuals of C.pinnatijida outplanted in Honouliuli Preserve are threatened by feral pigs that degrade the habitat. (USFWS, 2007)

Stressor: Alien plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, Cyanea pinnatifida was threatened by competition with and habitat degradation by alien plants such as Clidemia hirta (Koster's curse) (56 FR 55770). Currently, the nonnative plant species that impact the historical range and the outplanting area in Honouliuli are Clidemia hirta, Passiflora suberosa (huehue haole), Melinus minutiflora (molasses grass), Psidium cattleianum (strawberry guava), Psidium guajava (common guava), and Schinus terebinthefolius (Christmas berry) (TNCH 2006b). The outplanting site mentioned above is maintained by periodic weed control (TNCH 2006b). (USFWS, 2007)

Stressor: Herbivory by rats and slugs (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: In 1998 when the Recovery Plan was published, Cyanea pinnatifida was potentially threatened by predation by rats and slugs (Service 1998). Rats occur on all the main Hawaiian Islands around human habitations, in cultivated fields, and in dry to wet forests. Rats are known to eat the fruit and strip the bark of some native plants, particularly fruits of plants in the bellflower (Campanulaceae) family with fleshy stems and fruits (Tomich 1986; Cuddihy and Stone 1990). Rats are being controlled at the outplanting area by the use of bait stations and snap traps as part of the habitat protection program at Honouliuli Preserve (TNCH 2006b). New information in the U.S. Army's 2005 Status Report for the Makua Implementation Plan indicates that slugs can be a threat to all species of Cyanea (Makua Implementation Team 2003). Field experiments conducted by Alvin Yoshinaga and Curt Daehler demonstrated that slugs could reduce the survival of Cyanea spp. seedlings by as much as 80 percent (Makua Implementation Team 2003). Graduate student Stephanie Joe has been recently been hired by the Army as a Natural Resources Research Specialist, and included among her duties is the investigation of control of slug herbivory. Her research on slug impacts on Cyanea seedlings has revealed similar levels of mortality, approximately 53 percent (Joe 2006). (USFWS, 2007)

Stressor: Small population size and local catastrophes (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Species like Cyanea pinnatifida that are endemic to a small portion of a single island are inherently more vulnerable to extinction than widespread species because of higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. All of the existing plants descend from a cutting that was collected from one known wild plant {Service 2005; Nellie Sugii, Lyon Arboretum, pers. comm. 2006). Cyanea pinnatifida was also threatened by collection and trampling by humans on or near trails (Factor E), but the current outplanting site is fenced (TNCH 2006b). When the Recovery Plan was published in 1998, the last individual of C. pinnatifida was located on the side of a gulch wall and was threatened by mortality due to environmental disturbances such as washouts and falling rocks and trees, but this type of disturbance does not affect the current outplanting site (Service 1998; TNCH 2006b). (USFWS, 2007)

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2012)

Stressor: Climate change loss or degradation of habitat (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Cyanea pinnatifida is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.913 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat in areas outside of its known range. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials.

(USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Surveys are needed of appropriate habitat in historical locations to determine if any other extant populations of this plant exist. (USFWS, 1998)
- Monitor the remaining wild plant for changes in status and threats and implement management actions to protect remaining wild plant, if possible. Potential management actions include weeding and control of feral pigs, slugs, and rats if they are determined to be threats. (USFWS, 1998)
- Monitor the remaining wild plant for changes in reproductive status. Collect seeds for ex-situ propagation if fruits are produced. Continue cloning if feasible. (USFWS, 1998)
- Enhance wild populations and establish new populations. Once adequate propagated material is available, and fencing, rat control, and weed control, as appropriate, are underway in the area of the remaining in situ population, these populations should be enhanced by outplanting. Establishment of new populations within the historical range of Cyanea pinnatfida should be initiated in areas that are managed to minimize the impacts of feral ungulates, rats and alien plants. (USFWS, 1998)
- Formulate a plan to maintain or increase genetic variability of Cyanea pinnatifida. (USFWS, 2007)
- Conduct surveys of appropriate habitat in historical locations to determine if any other extant populations of Cyanea pinnatifida exist. (USFWS, 2007)
- Reintroduce additional populations of Cyanea pinnatifida within its historical range. (USFWS, 2007)
- Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. (USFWS, 2012)
- Reintroduce the species back into its known historical range. (USFWS, 2012)
- Control invasive introduced plant species around reintroduced populations. (USFWS, 2012)
- Conduct research to develop a plan to maintain or increase genetic variability of Cyanea pinnatifida. (USFWS, 2012)
- Conduct thorough surveys of all suitable habitats where Cyanea pinnatifida was historically seen. (USFWS, 2012)
- Conduct studies to develop and implement control methods for slugs around all known populations. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of drought and landslides and flooding. (USFWS, 2012)
- Work with the Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year reviews in 2007 and 2012. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and monitoring—Conduct thorough surveys of all suitable habitat within the historic range of Cyanea pinnatifida to possibly find more wild individuals. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect reintroduced individuals from the negative impacts of habitat degradation and browsing by feral pigs. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species, and those that compete with Cyanea pinnatifida. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Predator and herbivore control—Continue to implement slug control at of all reintroduced populations of Cyanea pinnatifida. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o Conduct research to develop a plan to maintain or increase genetic variability in reintroduced populations. • Reintroduction and translocation—Continue to establish new reintroduction sites within historical habitat. • Alliance and partnership development—Work with the Hawai'i Division of Forestry and Wildlife and other land managers to contribute to implementation of ecosystemlevel restoration and management to benefit this species. (USFWS, 2019)
- New Management Actions: • Surveys, inventories, and monitoring—The Plant Extinction Prevention Program (PEPP) and the Hawaii Division of Forestry and Wildlife monitor and manage reintroduced populations of Cyanea pinnatifida (PEPP 2013, 2014, 2015, 2016, 2017, 2018). • Ungulate monitoring and control—The ANRP undertakes stabilization and management of endangered species to fulfill the requirements of the 2003 and 2008 Biological Opinions for U.S. Army activities in the Mākua and O'ahu training areas (U.S. Army Garrison Hawai'i 2010; USFWS 2003). Reintroduced populations of Cyanea pinnatifida occur within a fenced management unit managed by the ANRP (Kaluaa and Wai'eli MU) and benefit from actions conducted in this area including ungulate control (fencing) and nonnative plant control (U.S. Army Garrison Hawai'i 2010). A second reintroduction site at 'Ēkahanui is also fenced and is managed by the State of Hawaii and PEPP. • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum Micropropagation Laboratory reports 434 propagules in storage representing the last known wild individual of Cyanea pinnatifida (Lyon Arboretum 2018). The Lyon Arboretum Seed Conservation Laboratory reports an addition of over 10,000 seeds in storage collected from reintroduced plants at Kaluaa since 2010 (Lyon Arboretum 2018). All reintroduced plants represent the last known wild founder. o The ANRP reports over 5,000 seeds in storage (ARNP 2018). • Reintroduction—PEPP reports reintroduction of more than 44 plants at Kaluaa and 13 plants at 'Ēkahanui (8 remain) (PEPP 2013, 2014, 2015, 2016, 2017). In 2018, and additional 4 individuals were reintroduced at another site in Kaluaa (PEPP 2018). (USFWS, 2019)

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USFWS. 2019. 5-YEAR REVIEW Short Form Summary Species Reviewed: Cyanea pinnatifida (hāhā) Current Classification: Endangered. 10 pp.

USFWS. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, OR

SPECIES ACCOUNT: *Cyanea profuga* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An unbranched shrub 1.8-2.4 m tall. Flowers are white, and borne 9-12 per inflorescence. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to Molokai. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to Molokai (USFWS 2012). Distribution: Molokai (USFWS, 2021)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cyanea profuga under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Cyanea profuga includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania

tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) Palmeria dolei—Unit 40—Montane Wet (and) Pseudonestor xanthophrys—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. profuga, Phyllostegia hispida, and Pteris lidgatei, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by Adenophorus periens, Cyanea procera, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Melicope reflexa, Phyllostegia mannii, P. pilosa, Platanthera holochila, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) Palmeria dolei—Unit 41—Montane Wet (and) Pseudonestor xanthophrys—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by Adenophorus periens, Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. procera, C. profuga, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Melicope reflexa, Phyllostegia hispida, P. mannii, P. pilosa, Platanthera holochila, Pteris lidgatei, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant Melicope reflexa, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as

physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by Adenophorus periens, Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. procera, C. profuga, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Phyllostegia hispida, P. mannii, P. pilosa, Platanthera holochila, Pteris lidgatei, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cyanea profuga critical habitat consists of two components. Lowland mesic (Molokai) Montane wet (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other

Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes,

C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: Short-lived perennial shrub (USFWS, 2021)

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Habitat Narrative

Adult: This species is found in lowland mesic and montane wet ecosystems on Molokai (USFWS 2012). (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

4 (USFWS, 2016; USFWS, 2021; USFWS, 2023)

Population Size:

34 individuals (USFWS, 2016; USFWS, 2021; USFWS, 2023)

Population Narrative:

Currently, there are 4 occurrences totaling up to 34 individuals in the lowland mesic and montane wet ecosystems on Molokai (TNC 2007; Bakutis 2010, in litt.; Perlman 2010, in litt.). (USFWS, 2016)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, flooding, landslides, rockfalls, treefalls, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Flooding, landslides, rock falls, and treefalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (pigs, goats, rats, and slugs) is considered an ongoing threat to Cyanea profuga throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Cyanea profuga faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Cyanea profuga is known from fewer than five scattered occurrences in the montane wet ecosystem. This species is susceptible to predation by nonnative pigs and goats, as well as habitat degradation or destruction by these nonnative animals and by landslides, rock and tree falls, or flooding, or a combination of these (USFWS, 2013).

Recovery

Reclassification Criteria:

Number of populations and individuals needed for each plant species to meet Preventing Extinction Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 50. (USFWS, 2023) Number of populations and individuals needed for each plant species to meet the Interim Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 300. (USFWS, 2023) Number of population and individuals needed for downlisting based on population and life history characteristics: Number of Populations: 5. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Priority Number: 5

Delisting Criteria:
Number of populations and individuals needed for delisting based on population and life history characteristics: Number of Populations: 10. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Actions:
- Not available.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to conduct surveys for Cyanea profuga in historical locations and potentially suitable habitat. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species and those that compete with C. profuga. • Landslide destruction and degradation of habitat—Select reintroduction sites where landslides are less likely. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Predator and herbivore control— o Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. o Implement effective control methods for rats at all populations. o Implement effective control methods for slugs and nonnative snails at all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of landslides and reduced reproductive vigor. • Alliance and partnership development—Contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and monitoring—PEPP regularly monitors and surveys for occurrences of Cyanea profuga (PEPP 2010–2017). • Ungulate control—Most reintroductions of C. profuga are within a large landscape-scale fenced unit. • Established ecosystem-altering invasive nonnative plant control—An exclosure with reintroduced plants on private property is weeded regularly (PEPP 2015). • Predation and herbivory rats/ slugs /nonnative snails—Rat traps were deployed and are monitored at Kumuʻeli (PEPP 2014). • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum reports 28 explants representing three founders at Wāwāʻia. The Lyon Arboretum Seed Conservation Laboratory reports nearly 11,000 seeds in storage representing three individuals at Kumuʻeli and from seven individuals at Wāwāʻia (Lyon Arboretum 2019). o The National Tropical Botanical Garden (NTBG) reports 1,844 seeds in storage from plants at Wāwāʻia; however, their viability is uncertain since these were collected in 2002 (NTBG 2019). o

The Olinda Rare Plant Facility (VRPF) reports 80 plants in pots propagated from four founders at Kumuʻeli (65 were sent out to in situ) and one founder from Wāwāʻia; and seven fruit in storage from two founders at Kumuʻeli (VRPF 2019). • Reintroduction and translocation—PEPP reports outplanting 92 individuals in 2011 at Kumuʻeli; however, all were dead by 2016 (PEPP 2011–2016). PEPP reintroduced at least 19 individuals at a second site in Kawela by 2016 (PEPP 2019). PEPP reintroduced 37 individuals at a second site in Kawela (PEPP 2016). Twenty-five individuals were reintroduced on private property in 2012, however, by 2015 only four remained (PEPP 2012, 2014). There were six remaining wild individuals in Wāwāʻia in 2016; however, these plants are now gone (USFWS, 2020).

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SPECIES ACCOUNT: *Cyanea shipmanii* (Haha)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Cyanea shipmanii Rock is a small unbranched or sparsely branched shrub 8-13 ft tall (Lammers 1990). Young plants often have sharp outgrowths on the stem. Leaves are divided 3/4 to 7/8 of the distance to the midrib into 20 to 30 segments. The blades are 6.7-12 in long and 2.8-5.7 in wide. The leaf stalk (petiole) is 1.2-2.2 in long and is also muricate (spiny). Ten to 15 flowers are in a cluster at the tip of a main flower cluster stalk (peduncle) 0.4-1.2 in long. Each flower is subtended by a stalk (pedicel) 0.4-0.6 in long. The calyx and the petals are fused at the base into a tube (hypanthium) 0.16-0.2 in long and 0.12-0.16 in wide. The calyx has five small oblong lobes 0.12-0.2 in long and 0.02-0.04 in wide. Five lobed green-white petals 1.2-1.4 in long are fused below into a curved tube 0.1-0.2 in wide. The berry is elliptic, 0.5-0.6 in long, and 0.5 in wide. Flowers are pale greenish white. (USFWS, 1996; NatureServe, 2015)

Taxonomy

Formerly spelled 'Cyanea shipmannii' by the US Fish and Wildlife Service, but spelling was updated to 'Cyanea shipmanii' between September and December 2008. (NatureServe, 2015)

Historical Range

Cyanea shipmanii is known only from the eastern slopes of Mauna Kea, Hawaii. (USFWS, 1996)

Current Range

In 2007, the species had declined to only two extant wild individuals in Upper Waiakea Forest Reserve and Puu Kipu unit of the Kilauea Forest Reserve (Plant Extinction Prevention Program 2007, 2008; USFWS 2008). (USFWS, 2009)

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Cyanea shipmanii.

Critical Habitat Designation

Three critical habitat units encompassing 6,088 acres on the island of HI are designated for Cyanea shipmanii. Two of the units, ‘‘Hawaii 1—Cyanea shipmanii—a’’ and ‘‘Hawaii 30—Cyanea shipmanii—b,’’ are currently occupied. Each of these two units is essential to the conservation of C. shipmanii because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The unoccupied unit, ‘‘Hawaii 30—Cyanea shipmanii—c,’’ is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals.

Hawaii 1—Cyanea shipmanii—a [1,557 ha (3,898 ac)]: This unit contains Puu Akala and portions of Awehi, Honoliii, and Kapue streams. It is bordered by Kolekole watershed in the north and Wailuku in the south, with Honolii and Kapue watersheds in the central portion. The unit is completely within Hakalau Forest NWR; provides habitat for 3 populations of 300 individuals of C. shipmanii; and is currently occupied by 1 individual.

Hawaii 30—Cyanea shipmanii—b [62 ha (152 ac)]: This unit contains no named natural features, lies completely within the Wailoa watershed, and is completely within the Mauna Loa Forest Reserve. The unit provides habitat for 1 population of 300 individuals of C. shipmanii; and is currently occupied by 1 individual.

Hawaii 30—Cyanea shipmanii—c [825 ha (2,038 ac)]: This unit, which contains no named natural features, lies almost completely within the Wailoa watershed with a small segment of the southern portion lying in the Kaahakini watershed. The unit is completely within the OlaaKilauea Partnership. This unit provides habitat for 3 populations of 300 individuals of C. shipmanii; and is currently unoccupied.

Primary Constituent Elements/Physical or Biological Features

Features that are essential for this species including, but not limited to, mesic forest dominated by Acacia ko-aMetrosideros polymorpha.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that we have incomplete information regarding many of the primary biological and physical requirements for these species. However, both the Act and the relevant court orders require the Service to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Environmental Specificity

Adult: High, with several key requirements (USFWS, 1996)

Habitat Narrative

Adult: The habitat of Cyanea shipmanii is montane mesic forest dominated by Metrosideros polymorpha (ohia) on the windward slopes of the island, at elevations between 5,400 and 6,200 ft (1,650 and 1,900 m) (HFIiP 1991h, 59 FR 10305). Associated native plants include Zanthoxylum, Myrsine (kolea), Acacia koa (koa) and Metrosideros polymorpha (L. Pratt, pers. comm., 1995). The four individuals in Hakalau Forest National Wildlife Refuge are growing with Clermontia lindseyana (J. Jeffrey, pers. comm., 1995). (USFWS, 1996)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

2 (USFWS, 2009; USFWS, 2015)

Population Size:

8 wild (only 1 mature), 763 outplanted (USFWS, 2015)

Population Narrative:

In 2002, the taxon consisted of total of five populations with 12 individuals on State land in north Hilo, Upper Waiakea Forest Reserve; on Federal land in the Hakalau Unit of the Hakalau Forest National Wildlife Refuge (NWR); and on private land at Papaikou, south Hilo (USFWS 2002). However, by 2007 the species had declined to only two extant wild individuals in Upper Waiakea Forest Reserve and Puu Kipu unit of the Kilauea Forest Reserve (Plant Extinction Prevention Program 2007, 2008; USFWS 2008). (USFWS, 2009); In 2010, there were two populations containing two wild individuals of Cyanea shipmanii (Plant Extinction Prevention Program [PEPP] 2010). A new wild individual was found in the Ka‘u Forest Reserve (PEPP 2010). At Pu‘u Kipu, only one wild individual was observed from the four individuals originally found (PEPP 2010). In 2013, the Upper Waiakea Forest Reserve population contained four wild immature individuals of Cyanea shipmanii (PEPP 2014). There are 25 reintroduced individuals of C. shipmanii at Kipimana (PEPP 2014). In addition, two new seedlings were discovered near the original wild plant at Kipimana (PEPP 2014). At Kahuku, there are approximately 447 reintroduced individuals of C. shipmanii (PEPP 2014). There are two wild individuals (one mature and one immature) at Hakalau Forest National Wildlife Refuge (J. VanDeMark, PEPP, pers. comm. 2014). Overall, the numbers of individuals have increased from the four individuals reported in the previous 5-year review, to approximately eight wild individuals in 2014. Only one

of these individuals is mature. (USFWS, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Climate change destruction or degradation of habitat – Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Cyanea shipmanii is highly vulnerable to the impacts of climate change and identified as a wink-out species. Wink-out species are species projected to lose more than 99 percent of its current climate envelope (areas that contain the full range of climate conditions under which the species is known to occur) by 2100. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Herbivory by slugs (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Herbivory by slugs has been reported as a new threat to this species (PEPP 2011, 2014). (USFWS, 2015)

Stressor: Non-native plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In Puu Kipu, the outplanted population is threatened by competition from the introduced invasive plant species Ehrharta stipoides (meadow ricegrass) (PEPP 2011). At Hakalau Forest National Wildlife Refuge, the reintroduced population is threatened by competition from the introduced invasive plant species Rubus argutus (prickly Florida blackberry) and Ilex aquifolium (English holly) (PEPP 2011). (USFWS, 2015)

Stressor: Habitat destruction by pigs (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Feral ungulates and introduced invasive plant species remain as the major threats to the species and surrounding habitat (USFWS 2008). In particular, the remaining wild individual in the Upper Waiakea Forest Reserve is threatened from habitat destruction due to pigs (Sus scrofa) (Plant Extinction Prevention Program 2007). (USFWS, 2009)

Stressor: Herbivory by sheep and rats (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: The remaining wild individual in the Upper Waiakea Forest Reserve is threatened from predation by sheep (Ovis musimon), and the Kilauea populations are at risk from fruit and seed predation by rats (Rattus spp.) (Plant Extinction Prevention Program 2007; USFWS 2008). Rat herbivory on foliage, flowers and ripe fruit has been a continuous problem in Hakalau NWR (Jeffrey and Horiuchi 2008). Trapping and rodenticide bait stations provide relief, but the remoteness of the plants does not allow for continuous monitoring and baiting of traps. (USFWS, 2009)

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: A single human-caused or natural environmental disturbance could destroy a significant percentage of the wild individuals or cause the complete loss of a population. Reduced reproductive vigor due to the small number of individuals remains as a limitation to the survival of the species. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on the Big Island and at least one other island where it now occurs or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on the Big Island and at least 1 other island where they now occur or occurred historically, if it is not endemic to the Big Island. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- Propagation and maintenance of ex situ stock should be continued, and current populations protected from pigs and augmented. (USFWS, 1996)
- One new population will need to be established and numbers increased in order to meet recovery criteria. (USFWS, 1996)
- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Maintain existing fences and fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Control slugs (unidentified species) and rodents within the vicinity of all known C. shipmanii populations. (USFWS, 2015)
- Continue monitoring wild and outplanted individuals. (USFWS, 2015)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As a species likely to wink out by 2100, ensure that adequate genetic storage is maintained as viable material. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)
- Continue to collect genetic material for augmentation of extant populations and establishment of new populations within appropriate habitat areas protected from feral ungulates and non-native plant species. (USFWS, 2009)
- Protection of extant populations from feral ungulates and non-native rodents. (USFWS, 2009)
- Continue support of the Hakalau National Wildlife Refuge and the Tri-Mountain Alliance for ecosystem-level management of suitable habitat for Cyanea shipmanii, as funding is available. (USFWS, 2009)
- Map genetic diversity in surviving ex-situ populations. (USFWS, 2009)
- Research of the life history and biology of the taxon. (USFWS, 2009)
- Survey for populations in appropriate ecological habitats. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. Captive propagation for genetic storage and reintroduction o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. Ungulate monitoring and control – Maintain existing fences and fence remaining populations to protect them from the impacts of feral ungulates. Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. Predator / herbivore monitoring and control – Control slugs (unidentified species) and rodents within the vicinity of all known C. shipmanii populations. Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. Climate change adaptation strategy – Research the

suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As a species likely to wink out by 2100, ensure that adequate genetic storage is maintained as viable material. Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- New management actions: Surveys / inventories o A survey was conducted for wild individuals at Hakalau Forest National Wildlife Refuge; none were found (PEPP 2009). o At Puu Kipu, no new individuals were found during a survey of the area (PEPP 2011). o Surveys were conducted at Kipimana for new individuals. The original wild plant remained dead; however, two new seedlings were discovered nearby (PEPP 2014). o A survey was conducted at Kahuku around the dead wild individual of C. shipmanii; none were found (PEPP 2014). Ungulate monitoring and control o PEPP (2014) inspected the fenced exclosure at the Upper Waiakea Forest Reserve and extended fencing from the existing exclosure to protect a newly discovered seedling of C. shipmanii that was located outside of the fence. o In 2013, a fenced exclosure was constructed around two newly discovered seedlings at Kipimana. Population viability monitoring and analysis – PEPP (2010, 2011, 2012, 2013, 2014) monitored the wild and outplanted populations. Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013) has 12 individuals in their nursery from four locations. The Facility propagated 204 individuals for reintroduction next year. Meanwhile, 174 individuals were reintroduced at Kulani (28) and Hawaii Volcanoes National Park (146) in 2013. o The Lyon Arboretum's Seed Conservation Lab (2013) has more than 12,700 seeds in storage. o There are 266 accessions from two sources of C. shipmanii at the Harold L. Lyon Arboretum Micropropagation Laboratory (2013). o PEPP (2014) collected approximately 50 fruits and 3 cuttings of C. shipmanii that were damaged by fallen tree branches. Reintroduction / translocation o In 2014, 299 individuals of C. shipmanii were reintroduced into a 1.5 acre fenced exclosure in Kau (PEPP 2014). o In 2014, eight individuals were reintroduced at Kahuku in Kau (PEPP 2014). (USFWS, 2020)

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SPECIES ACCOUNT: *Cycladenia humilis var. jonesii* (Jones Cycladenia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/05/1986; Mountain-Prairie Region (R6) (USFWS, 2015)

Physical Description

A rhizomatous perennial herb 1-3.6 dm tall, with bright green, rounded, somewhat succulent leaves. Pink, woolly-haired flowers appear in May-June (NatureServe, 2015).

Taxonomy

The genus Cycladenia consists of one species Cycladenia humilis treated as having two varieties in California (var. humilis, var. venusta) (Hickman 1993) and a third variety, Jones cycladenia (Cycladenia humilis var. jonesii) found in Utah and Arizona. The closest taxonomic relative to Jones cycladenia is thought to be Mandevilla, a neotropical genus (Wolf et al. 1992) (USFWS, 2008).

Historical Range

At the time of listing, Jones cycladenia (Cycladenia humilis var. jonesii) was found in Emery, Grand, and Garfield Counties in Utah and known historically from a fourth indeterminate site named Pipe Spring, in the vicinity of Mohave County, Arizona, and Kane County, Utah (51 FR 16526, May 5, 1986). This historic site has since been relocated near Pipe Springs National Monument, Arizona (Sipes et al. 1994) (USFWS, 2008).

Current Range

The five Jones cycladenia complexes include: Joe Hutch Creek, San Rafael, Moab, and Greater Circle Cliffs in Utah, and Pipe Springs in Arizona (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily asexual: vegetative; sexual (NatureServe, 2015)

Lifespan

Adult: Long-lived perennial (USFWS, 2008)

Breeding Season

Adult: April - June (USFWS, 2008)

Reproduction Narrative

Adult: Very low potential for sexual reproduction; relies primarily on clonal growth (Boettinger 1997; Sipes and Wolf 1997; Sipes and Tepedino 1996) (NatureServe, 2015). A long-lived perennial that produces flowers from mid-April to early June. Fruit and seed production is

believed extremely limited (Sipes and Tepedino 1996) (USFWS, 2008).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert shrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 4,390 - 6,000 ft. elevation (USFWS, 2008)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits desert shrub community with barren gypsiferous clay hills that form the steep sides and lower slopes of mesas in the canyonlands section of the Colorado Plateau (FR 1986). Restricted to soils with a narrow range of morphological and physical properties, but not an obligate gypsophile (Boettinger 1997). The environmental specificity is narrow (specialist or community with key requirements common) (NatureServe, 2015). It occurs between 4,390 to 6,000 feet (1,338 to 1,829 meters) elevation in plant communities of mixed desert scrub, juniper, or wild buckwheat-Mormon tea. It is found on gypsiferous, saline soils of Cutler, Summerville, and Chinle Formations (USFWS, 2008).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

20 (USFWS, 2021a)

Population Size:

3,567 (USFWS, 2021a)

Population Narrative:

Jones cycladenia is endemic to the Colorado Plateau in Utah and Arizona. The taxon was listed as threatened on May 5, 1986 (51 FR 16526), under the Act. Jones cycladenia is in the dogbane family (Apocynaceae) and is one of three varieties within the Sacramento waxy dogbane (Cycladenia humilis Benth.) species. The total population contains an estimated 3,567 individuals (79,196 stems) in 20 populations in central and southern Utah (Emery, Grand, Garfield, San Juan, and Kane Counties) and northern Arizona (Mohave County)1 . These populations are organized geographically into four recovery units for the taxon: San Rafael

Swell, Greater Circle Cliffs, Moab, and Pipe Spring recovery units. Figure 1 shows the current range of Jones cycladenia, locations of the four recovery units, and the Joe Hutch Creek population on Tribal lands, which is not in a recovery unit. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Mountain biking and OHV use occurs near sites in Moab and San Rafael complexes; cattle grazing occurs at sites in the San Rafael complex; and uranium mining and tar sands extraction are foreseeable threats in the both the San Rafael and Greater Circle Cliffs complex (USFWS, 2008).

Stressor: Low reproduction (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Preliminary research (1988 to 1993) has shown that the plant has, at best, low fruit production and seed set, likely due to a complicated pollination system and inadequate pollinator abundance (i.e., pollinators may have been lost or may be migratory and appear episodically) (Sipes and Tepedino 1996). No seedling germination events have been documented (Sipes et al. 1994; Sipes and Tepedino 1996; D. Clark, pers. comm., 2007; T. Clark, pers. comm., 2007; K. Ivory, pers. comm., 2007; J. Spence, pers. comm., 2007). Genetic research at San Rafael (the Spotted Wolf Canyon site), Moab (two separate sites at Onion Creek and Castle Valley) and Greater Circle Cliffs complexes (one site at Deer Point, one site at Silver Falls Canyon, and one site at Purple Hills) indicates that these sites of Jones cycladenia are genetically distinct and not inbred, but may face other genetic limitations, such as genetic bottlenecking or genetic drift (Sipes et al. 1994). Several researchers have concluded that an ongoing lack of population recruitment may result in a permanent loss of genetically-important individuals or occupied sites (Sipes et al. 1994; Sipes and Tepedino 1996; Spence and Palmquist in draft). The species' fractured distribution could further complicate issues associated with limited natural reproduction, dispersal constraints, and genetic risks (Spence and Palmquist in draft; Sipes et al. 1994) (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: As a Tertiary relict, Jones cycladenia may be impacted by global climate change. Various emissions scenarios suggest that by the end of the 21st century, average global temperatures may increase 0.6 to 4.0°C (1.1 to 7.2°F) with the greatest warming expected over land (Intergovernmental Panel on Climate Change (IPCC) 2007). It is very likely that hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). Since 1991, overall mean temperatures have increased 1.5°C (2.7°F) in the Greater Circle Cliffs area (Spence and Palmquist 2007). Increased temperatures could result in the need for the species to colonize cooler, higher elevation sites (USFWS, 2008).

Recovery

Delisting Criteria:

1. Viable Jones cycladenia populations persist on conserved habitat across the species' historical range (USFWS, 2008).

2. All populations on Federal lands should be managed for the variety's protection (USFWS, 2008).

3. Threats to the species, primarily natural constraints, climate change, and human-caused habitat loss, will be sufficiently understood and if needed, sufficiently abated to ensure a high probability of survival at least 100 years into the future (USFWS, 2008).

Recovery Actions:

- Investigate Jones cycladenia's response to climate change (USFWS, 2008).
- Coordinate with genetic and taxonomic experts in Arizona, California, and Utah to resolve outstanding taxonomic issues (USFWS, 2008).
- Evaluate all known habitat components through a geographic information system database and conduct surveys for additional populations in areas containing habitat characteristics, particularly in Utah (USFWS, 2008).
- Continue ongoing monitoring efforts (USFWS, 2008).
- Expand monitoring programs to include a larger and more representative sample of occupied sites (rather than the easiest sites to visit) (USFWS, 2008).
- Identify sites in urgent need of habitat conservation, set protection priorities, and implement protective measures. As research improves our understanding of the species' needs, adjust management accordingly (USFWS, 2008).
- Where not possible to prevent oil and gas and mineral leasing at occupied sites, limit impacts of these activities through early planning and coordination (USFWS, 2008).
- Continue and expand research into Jones cycladenia's life history and ecology. It is essential to determine the role of sexual reproduction in Jones cycladenia populations including whether the species' pollinator has been lost. If the pollinator still exists, research should identify the pollinator's biological requirements so future conservation efforts address pollinator needs (USFWS, 2008).
- Not available

Conservation Measures and Best Management Practices:

- Recommendations on species status: After reviewing the best available scientific information and recovery criteria, we conclude that Jones cycladenia remains a threatened taxon. The taxon's status has improved since listing; however, the future threat of energy and mineral development remains (Service 2021). The draft delisting criteria for Jones cycladenia are not met (Service 2020). Therefore, we recommend no change in status to the species at this time. Recommended future actions: Based on recent discussions with other Federal agencies and partners, we recommend the following future actions: (1) Maintain a comprehensive database on surveys and monitoring for the taxon that includes plant survivorship, growth and reproduction and the presence of threats and stressors; (2) Continue to assess population trends and strengthen monitoring protocols, analysis, and reporting; (3) Develop stronger habitat protections for energy and mineral development; (4)

Develop a conservation agreement to provide long-term habitat protections; and (5) Collect seeds and tissues to preserve genetic diversity in ex-situ (offsite) collections (Service 2020). (USFWS, 2021)

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SPECIES ACCOUNT: *Cyrtandra crenata* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A few-branched shrub 1-2 m tall. Flowers are white. (NatureServe, 2015)

Taxonomy

In the manual of flowering plants of Hawaii, Wagner et al. (1999) considered Cyrtandra crenata a potential hybrid between C. hawaiensis and C. subumbellata, as the specimens presented characteristics intermediate between the two species. However, since C. subumbellata was not known to occur within the vicinity of the known specimens, the hybrid determination seemed untenable. Since that time, however, C. subumbellata has been found in the area, while no additional individuals of C. crenata have been found, therefore supporting the idea that C. crenata may indeed have been a hybrid (J. Lau, Botanical Consultant, pers. comm. 2010; W. Wagner, Smithsonian Institution, pers. comm. 2010). Wagner and Roalson are currently finalizing a monograph on Hawaiian Cyrtandra which should clarify this hybridization issue (W. Wagner, pers. comm. 2010). (USFWS, 2011)

Historical Range

Known historically from Waikane-Kahana area of Koolau Mountains of Oahu. (NatureServe, 2015)

Current Range

No current range. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species was observed in flower in June 1947 (USFWS 1996a). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wet environments (USFWS, 1998)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 380 and 730 meters (1,250 and 2,400 (feet) (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: Cyrtandra crenata typically grows in ravines or gulches in mesic to wet forests between elevations of 380 and 730 meters (1,250 and 2,400 feet) with associated plants such as ohia, uluhe, and Machaerina angustifolia (uki) (USFWS 1996a, Wagneret al. 1990). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

0 (USFWS, 2019)

Population Size:

0 (USFWS, 2019) last observed in 1947

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

No observations of this species have been made since 1947 (USFWS 1998, 2003). No current and 2 historical occurrences. (USFWS, 2011). The last observation of one occurrence of Cyrtandra crenata on O‘ahu was reported in 1947. There are no seed collections or any other genetic material in storage or propagation. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that C. crenata is highly vulnerable to the effects of climate change. The status of this species may be reconsidered following publication of a new monograph for Hawaiian Cyrtandra and publication of other pending genetic studies. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat predation by pigs, predation by rats and slugs, competition with invasive plants, and small population size (USFWS, 1998)
Exposure:
Response:
Consequence:

Narrative: The primary threats to this species are habitat degradation and predation by pigs, suspected predation by rats and slugs, competition with invasive alien plants (Koster's curse and strawbeny guava), and a risk of extinction from naturally-occurring events, and/or reduced reproductive vigor due to the species' restricted range and the small number of individuals, if any, in fact, remain (USFWS 1996a). (USFWS, 1998)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:
- Surveys of appropriate habitat in historical locations are needed to determine if any other extant populations of this plant exist. (USFWS, 1994)
- Maintain adequate genetic stock. To prevent extinction of this species, ex situ propagation should be initiated immediately if extant individuals are found. (USFWS, 1994)
- Enhance wild populations and establish new populations. Once adequate propagated material is available, and fencing, rat control, and weed control, as appropriate, are

underway in the areas of any remaining in situ populations, these populations should be enhanced by outplanting. Establishment of new populations within the historical range of Cyrtandra crenata should be initiated in areas that are managed to minimize the impacts of feral ungulates, rats and alien plants. (USFWS, 1994)

- Once new monograph of the genus is published, consider whether this species should be delisted. (USFWS, 2011)
- Survey historic locations to determine the current status of the species. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and monitoring—Continue to survey the last known locations of this species, and monitor individuals if found. • Invasive plant monitoring and control—If the species is relocated, control established ecosystem-altering nonnative invasive plant species, and those that compete with C. crenata. • Climate change adaptation strategy—If the species is relocated, research the suitability of habitat for reintroduction of this species in the future due to impacts of climate change. • Captive propagation for genetic storage and reintroduction—If the species is relocated begin collection and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—If the species is relocated, reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • When the new monograph of the genus is published, consider whether this species should be delisted. (USFWS, 2019)

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SPECIES ACCOUNT: *Cyrtandra subumbellata* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Cyrtandra subumbellata is a member of the Gesneriaceae (African violet family). It is a short-lived perennial shrub 2 to 3 m (6.6 to 10 ft) tall. The leaves are papery in texture, oppositely arranged, circular to egg-shaped, 12 to 39 cm (4.7 to 15.4 in) long, and 3 to 19 cm (1.2 to 7.5 in) wide. The white flowers are 18 to 20 mm (0.7 to 0.8 in) long and form dense umbelliform cymes of 5 to 15 flowers. The white berries are 1.0 to 1.5 cm (0.4 to 0.6 in) long and ovoid shaped. It is distinguished from other species in the genus by its leaf shape and texture; the number of flowers per cluster; and the length of bracts, flower stem, calyx lobes, floral tube, and styles (Wagner et al. 1999).

Taxonomy

Genus found throughout Pacific Basin, species endemic to Koolau mts. of Oahu. (NatureServe, 2015)

Historical Range

Historically, Cyrtandra subumbellata was known from the Koolau Mountains of Oahu.

Current Range

Currently, C. subumbellata is known from three occurrences in the north and central Koolau Mountains (U.S. Army 2003a) with a total of approximately 108 individuals: two individuals from Kahana on Waikane trail, six individuals from the south Kaukonahua drainage, and more than 100 individuals from the Punaluu Rim (U.S. Army 2003a; HINHP Database 2002; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cyrtandra subumbellata (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Cyrtandra subumbellata (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Ctenitis squamigera includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Cyrtandra subumbellata includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of

Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet

Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cyrtandra subumbellata critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Cyrtandra subumbellata occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (E) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Cyrtandra subumbellata to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Cyrtandra subumbellata has been observed in fruit in September. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (Service 1998a).

Habitat Type

Adult: Wet forest and gulch slopes

Habitat Narrative

Adult: Cyrtandra subumbellata typically grows on moist, forested slopes or gulch bottoms dominated by Metrosideros polymorpha wet forest or mixed M. polymorpha-Dicranopteris linearis-Acacia koa wet forests between 345 and 790 m (1,132 and 2,591 ft) in elevation. Associated native plant species include Boehmeria grandis, Broussaisia arguta, Dryopteris sp., and Machaerina sp. (HINHP Database 2001; Service 1998a; Wagner et al. 1999).

Dispersal/Migration

Population Information and Trends

Number of Populations:
three (USFWS, 2019)

Population Size:
<= 213 (USFWS, 2019)

Population Narrative:
Currently, C. subumbellata is known from three occurrences in the north and central Koolau Mountains (U.S. Army 2003a) with a total of approximately 108 individuals: two individuals from Kahana on Waikane trail, six individuals from the south Kaukonahua drainage, and more than 100 individuals from the Punaluu Rim (U.S. Army 2003a; HINHP Database 2002; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). Currently, there are at most 213 individuals of Cyrtandra subumbellata, but likely substantially fewer individuals, in three populations in the Koʻolau mountains with the largest population of 200 individuals last seen in 2001, and another population showing sharp decline over ten years between 2000 and 2010. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that C. subumbellata is highly vulnerable to the effects of climate change. No surveys, seed collections, or other management actions have occurred since the last 5-year review. (USFWS, 2019)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The primary threats are competition with the noxious alien plant Clidemic hirta (Koster's curse), feral pigs, and stochastic extinction and/or reduced reproductive vigor due to the small number of extant populations and individuals. (NatureServe, 2015)

Stressor: Climate change loss or degradation of habitat (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative

inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that (at the species level) Cyrtandra subumbellata is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.763 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate change envelopes for outplanting efforts. (USFWS, 2019)

Recovery

Recovery Actions:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of Cyrtandra subumbellata. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions. Non-native plant species should be controlled or removed in the vicinity of all known occurrences of C. subumbellata. The threats from fire need to be addressed, especially on State land at Kaukonahua and private land at Puu Ohulehule. The threat from rats should be evaluated at all known occurrences of C. dentata. Rats should be controlled in the vicinity of all threatened occurrences using established and approved rodenticides. Rats should also be controlled across a broader landscape by using aerial dispersal of rodenticides, when this method is approved (Service 1998a). Ongoing Conservation Actions: Cyrtandra subumbellata is being propagated at the Lyon Arboretum and seeds are in storage at the National Tropical Botanical Garden (Service 2002; U.S. Army 2003a). The Service is currently not aware of any other conservation efforts for this species.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year reviews in 2008 and 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and monitoring—Continue to conduct surveys in suitable and historical habitat for additional populations. • Ungulate monitoring and control—Construct and monitor fenced exclosures to protect individuals from the negative impacts of habitat degradation and browsing by feral pigs. • Ecosystem-altering invasive plant species control—Control nonnative invasive plant species at all populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Herbivory by rats—Implement control methods for rats at all populations. • Herbivory by slugs—Implement control methods for slugs at all populations. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o Continue to assess genetic variability within the extant populations and implement a plan for conserving the species' genetic diversity in ex situ and reintroduced populations. • Reintroduction and translocation—Reintroduce Cyrtandra subumbellata into areas protected from known threats within historical range. • Population biology research—Study Cyrtandra subumbellata populations with regard to hybridization to determine the extent of this threat. • Alliance and partnership development—Work with the U.S. Army, the Hawai‘i Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS,

2019)

- New Management Actions: • Captive propagation for genetic storage and reintroduction—The ANRP reports 68 seeds already in storage representing on founder from Kahana (ANRP 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Cyrtandra waiolani* (Ha`iwale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/18/2012; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A shrub 1-2 m tall. Leaves are covered with shaggy hairs. Flowers are white, and borne 1-2 per inflorescence. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to Koolau mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On September 18, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Cyrtandra waiolani (Ha`iwale) under the Endangered Species Act of 1973, as amended (Act) (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 25,112 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Cyrtandra waiolani includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Cyrtandra waiolani includes 11 critical habitat units, covering one ecosystem type, which encompasses approximately 25,112 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and

7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Cyrtandra waiolani critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Cyrtandra waiolani was known historically (last observed > 20 yrs ago) from the indicated ecosystem in the Koolau Mountain caldera complex (Note: This species may no longer occur in the wild):

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Cyrtandra waiolani to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat

areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet forests (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Found in partly sunny gulches; shady, moist banks above creeks; and wet gulch bottoms in lowland wet ecosystems (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Historically found at elevations between 800 and 3,000 feet (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2012)

Habitat Narrative

Adult: Cyrtandra waiolani (haiwale), a small shrub in the African violet family (Gesneriaceae), is found in rich, partly sunny gulches; shady, moist banks above creeks; and wet gulch bottoms in the lowland wet ecosystem (Wagner et al. 1999, p. 781; HBMP 2008; Lau 2011, in litt.). Cyrtandra waiolani was historically known from at least seven locations: five in the southern Koolau Mountains and two in the northern Koolau Mountains, at elevations between 800 and 3,000 ft (240 and 900 m) (HBMP 2008). (USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

0 (USFWS, 2019)

Population Size:

0 (USFWS, 2019)

Population Narrative:

This species was last collected in 1943. There are no current and 7 historical occurrences. Individuals likely representing Cyrtandra waiolani, based on vegetative characteristics, were seen in 1994 along the ridge between Kaipapau and Maakua, and in 2005 in Kahana, but these plants are no longer alive" (J. Lau, in litt. 2009 cited by USFWS 2011). It is thought that the species may be rediscovered with more intensive survey (Bakutis 2008; J. Lau, in litt. 2009 cited by USFWS 2011). (NatureServe, 2015). There are no known individuals of Cyrtandra waiolani; however, botanists believe this species may be found with more thorough surveys. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants and animals (pigs). The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The projected effects of climate change will likely exacerbate the effects of the other threats to the species (USFWS, 2012).

Stressor: Predation and herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to Cyrtandra waiolani throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2012).

Stressor: Small populations (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Cyrtandra waiolani faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The last confirmed observation of C. waiolani in the wild was approximately 40 years ago. The identification of a possible wild individual of C. waiolani in 2005 was confirmed not to be this species. In addition, there are no tissues, propagules, or seeds in storage or propagation that have positively been identified (USFWS, 2012).

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:
- Not available.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Conduct surveys for Cyrtandra waiolani in historical locations and potentially suitable habitat. • Ungulate monitoring and control—If individuals are discovered, construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—If individuals are discovered, control established ecosystem-altering nonnative invasive plant species and those that compete with Cyrtandra waiolani. • Captive propagation for genetic storage and reintroduction—If individuals are discovered, collect seeds for storage and begin propagation efforts for maintenance of genetic stock. • Rodent predation or herbivory—Implement effective control methods if herbivory by rats is observed. • Invertebrate predation or herbivory—Implement effective control methods for slugs if herbivory is observed. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change • Build resiliency and redundancy— If individuals are discovered, increase numbers of populations and individuals within suitable habitat within its historic range that is managed for known threats . • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2019)

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SPECIES ACCOUNT: *Dalea carthagenensis floridana* (Florida Prairie-clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/6/2017; Southeast Region (R4)

Physical Description

Dalea carthagenensis var. floridana is a short-lived (less than 8 years) perennial shrub that is 2.6 to 9.8 ft (0.8 to 3.0 m) tall with a light brown woody stem and non-woody, light brown or reddish branches. The leaves are composed of 9 to 15 oval, gland-tipped leaflets, and are gland-dotted on the underside. The flowers are in small loose heads at ends of hairy, glandular stalks, less than 0.4 in long. The flower color is white and maroon; each of the petals is different lengths and shapes. The fruit is a small one-seeded pod, mostly enclosed by the hairy, gland-dotted calyx (bracts at base of each flower). (USFWS, 2017)

Taxonomy

Chapman (1886, p.102) was the first to report this taxon in Florida, calling it the tropical Dalea domingensis, based on specimens collected on Key Biscayne. Small (1913, p. 89) accepted this epithet but included the taxon in the genus Parosela, making the plant P. domingensis. Rydberg (1920, p. 114) renamed the plant, calling it Parosela floridana, which was retained by Small (1933, pp. 694-695). Clausen (1946a, p. 85) reviewed the taxonomy of Florida and West Indian Dalea and considered them all to be the same species. Clausen (1946a, p. 85) also found that the name D. domingensis was a homonym of D. emphysodes, and published the name D. emphysodes ssp. domingensis. Clausen (1946b, p. 572) later discovered that his use of the name D. emphysodes was in error, and renamed the plants D. carthagenensis ssp. domingensis. Long and Lakela (1971, p. 478) accepted this usage. Barneby (1977), in a monograph of the genus, also found that Florida plants were distinct from West Indian plants, citing differences in leaf characters, naming the Florida species D. carthagenensis var. floridana. Wunderlin (1998) has followed this treatment.(USFWS, 2017)

Historical Range

The historical range of Dalea carthagenensis var. floridana includes Miami-Dade, Monroe, Collier, and Palm Beach Counties in Florida (USFWS, 2017).

Current Range

In Florida, the current range of Dalea carthagenensis var. floridana includes Big Cypress National Park (Monroe and Collier Counties), three Miami-Dade County conservation areas, and three additional unprotected lands within the Cutler Bay region of Miami-Dade County. (USFWS ,2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, perennial (USFWS, 2017)

Lifespan

Adult: Less than 8 years (USFWS, 2017)

Reproduction Narrative

Adult: Dalea carthagenensis var. floridana appears to be a short-lived (less than 8 years) perennial with a persistent seed bank (Maschinski et al. 2014, p. 45; Lange et al. 2016, p.15). D. carthagenensis var. floridana produces flowers from October to March and fruit ripen from November to April. The seed maturation period is January to May, with a peak in February and March. Larger plants can produce over 500 seeds. Seedling recruitment varies widely from year to year, with lower recruitment in drier years. Seedlings and juveniles experience rapid growth in their first 2 years. (USFWS, 2017)

Habitat Type

Adult: Pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats (USFWS, 2017)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Woodland-Conifer

Dependencies on Specific Environmental Elements

Adult: Periodic fire is extremely important to maintaining habitat for this species. (USFWS, 2017)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2017)

Tolerance Ranges/Thresholds

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

Habitat Narrative

Adult: Dalea carthagenensis var. floridana grows in pine rockland, rockland hammock, marl prairie, and coastal berm, and in the ecotones between these habitats. It occurs in sparsely vegetated, well-lit, open areas that are maintained by disturbance. The dynamic nature of the habitat means that areas not currently open may become open in the future as a result of canopy disruption from hurricanes or invasive plant management, while areas currently open may develop more dense canopy over time, eventually rendering that portion of the hammock unsuitable for D. carthagenensis var. floridana. The species may also occur along roadsides within these habitats. The climate of south Florida where Dalea carthagenensis var. floridana occurs is classified as tropical savanna. (USFWS, 2017)

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining; habitat loss continues to occur in the species' range. (USFWS, 2017)

Species Trends:
Declining (USFWS, 2017)

Number of Populations:
15 occurrences (USFWS, 2023)

Population Size:
Approximatly 1000 individuals in 15 populations, ranged from one to 372 plants per population (USFWS, 2023)

Population Narrative:
The extant populations occur in the Big Cypress National Park (Monroe and Collier Counties, Florida), in several conservation areas in Miami-Dade County (R. Hardy Matheson Preserve, Charles Deering Estate, Virginia Key, and Crandon Park) , and on three additional unprotected lands within the Cutler Bay region of Miami-Dade County (USFWS, 2017). Florida prairie-clover is a shrub in the pea family (Fabaceae) with a woody base that is endemic to the pine rockland, rockland hammock, marl prairie, and coastal berm habitats of southern Florida. The species is restricted to fifteen (15) populations found primarily in Miami-Dade County with some populations found in Monroe County. Although it has been extirpated from Palm Beach County, a population previously thought extirpated in Everglades National Park was rediscovered in 2018 (USFWS, 2023).

Threats and Stressors

Stressor: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands. (USFWS, 2017)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2017)
Exposure:

Response:
Consequence:
Narrative: This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

Stressor: Disease or predation (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Scale insects (Coccoidea) and Cassytha filiformis (love vine, a parasitic plant) infestations have been noted as parasites for Dalea carthagenensis var. floridana (Maschinski et al. 2015, p. 39) and may also influence populations of other listed pine rockland plant species. However, the best available data do not indicate that disease or predation is a threat to Sideroxylon reclinatum ssp. austrofloridense, Digitaria pauciflora, Chamaesyce deltoidea ssp. pinetorum, or Dalea carthagenensis var. floridana. (USFWS, 2017)

Recovery

Reclassification Criteria:
Not defined.

Delisting Criteria:
Not defined.

Recovery Actions:
- Not defined.
- Conserve pine rocklands and suitable habitat through purchase or conservation easements.
- Restore understories by removing exotic plants or hardwoods.
- Provide regular prescribed burns to sites to maintain suitable habitat conditions.
- Monitor and manage the remaining small populations in Miami-Dade County.
- Consider and conduct augmentation and reintroduction, at suitable sites (Maschinski et al. 2005, p. 165).
- Conduct additional surveys in the Big Cypress region, including Florida Panther National Wildlife Refuge.
- Monitor known populations.
- Investigate ways to increase population viability.
- Study the introduced insect lobate lac scale to determine the extent of this threat and identify any necessary actions.
- Conduct studies to determine current level of genetic variation remaining in extant occurrences.
- Research presence and longevity of seed banks in different habitats.

Conservation Measures and Best Management Practices:
- RECOMMENDED FUTURE ACTIVITIES Recovery Activities This species does not have a final recovery plan. In the course of this status review, we have identified the following potential recovery activities which are included below. Ɣ Continue regular fire prescriptions (every 3-7 years) at R. Hardy Matheson Preserve. Ɣ Identify other occurrences which may be candidates for prescribed fire. Monitoring / Research Activities In addition to the continued monitoring of known occurrences, new occurrences ought to be sought out either through broadscale surveys or restoration. Ɣ Identify new occurrences through broadscale surveys for extant Florida prairie clover populations. This effort may be aided by education. By teaching the public to identify and report this species through widely available platforms like iNaturalist new occurrences may be identified. Restoration efforts should work to identify new mechanisms of management and areas of potentially suitable habitat. Ɣ Identify methods to mimic prescribed fire where the application of fire is impractical, like publicly owned conservation lands embedded within urban communities. Ɣ Identify open mesic to xeric shrub communities (pine rockland, marl prairie, coastal strand, and ecotones between each of these habitats and rockland hammocks) with a high probability of persistence given sea-level rise projections. Pursue the sustained restoration and preservation of these sites be they preserves, parks, or private property. ż One such location may be the Richmond Pine Rockland (USFWS, 2023).

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SPECIES ACCOUNT: *Dalea foliosa* (Leafy prairie-clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/1/1991; Southeast Region (R4) (USFWS, 2015)

Physical Description

A stout perennial herb, 2-8 dm tall, with several stems arising from a hardened root crown. Dense spikes of small purple flowers appear most abundantly from late July to early August, but may continue to bloom sporadically into September. (NatureServe, 2015)

Taxonomy

Dalea foliosa, a member of the legume family or Fabaceae, was first described as Petalostemonfoliosus by Asa Gray in 1868 (Gray 1868). The generic name Petalostemum A. Michaux, first published in 1803, has been conserved over the earlier Kuhnistera Lamarck of 1789, with the spelling of Petalostemon also conserved over the original Petalostemum (Greuter et al. 1988, Farr et al. 1979). Because the gender of Petalostemon is neuter, the correct name of leafy prairie-clover under this genus is Petalostemonfoliosuin A. Gray (USFWS, 1996).

Historical Range

The distributional center for Dalea foliosa is the limestone cedar glades of central Tennessee and northern Alabama, where the species is considered nearly endemic (Baskin and Baskin 1973) (USFWS, 1996).

Current Range

Mesic dolomite river-terrace prairies of northeastern Illinois, Middle Tennessee Limestone Glades, northern Alabama Limestone Glades. In Tennessee, occurs on only 13 USGS 7.5' quads in seven counties of the Central Basin. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, autogamy (USFWS, 2015)

Lifespan

Adult: 8 years (USFWS, 1996)

Dependency on Other Individuals or Species

Adult: Bombus spp. based on closely related species (USFWS, 1996)

Breeding Season

Adult: July - August (USFWS, 1996)

Key Resources Needed for Breeding

Adult: Insect pollinators; moist soil (USFWS, 1996)

Reproduction Narrative

Adult: Produces flowers July to August; seeds ripen by early October. Bumblebees, small bees, syrphrid flies have been observed visiting flowers. Bombus species are probably required for successful seed set (based on other species in the same genus). Emergence occurs in March for existing plants. Seeds germinate in April and have several leaves by May. Molano-Flores (2005) determined that Dalea foliosa is self-compatible and that self-pollination (i.e., autogamy) can occur in this species, despite that fact that it is protandrous (USFWS, 2015). Dalea foliosa is short-lived and has no capacity for vegetative spread (Baskin and Baskin 1973; Schwegman and Glass, unpublished data). Plants may take up to 3 years to flower under field conditions (Baskin and Baskin 1989). Adequate soil moisture is critical for seedling establishment. The oldest living plants monitored to date have reached 8 years (n=2) and 7 years (n=2) of age (Schwegman and Glass, unpublished data). Mature plants may not flower every year (USFWS, 1996).

Habitat Type

Adult: Terrestrial, riverine, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Spring, herbaceous wetland, riparian, barrens, grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sun, periodic fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 550-700 ft. elevation (USFWS, 1996)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Occurs in Tennessee and Alabama in open, thin-soiled limestone glades and limestone barrens. In Tennessee, the plants occur on wet calcareous barrens and moist prairies or cedar glades, usually near a stream or where some seepage from limestone provides seasonal moisture. Associates in these habitats are rose-pink (Sabatia angularis), and black-eyed Susan (Rudbeckia triloba). The species is disjunct in Illinois, where it is restricted to thin-soiled (< 4.5 dm), wet or moist, open dolomite prairies on river terraces in the northeastern part of the state. The plants require full sun and low competition for optimum growth and reproduction; periodic fire is needed to maintain these conditions. (NatureServe, 2015). Occurs in shallow silt to silty clay loams over flat, often fractured horizontally bedded limestone or dolomite at 550-700 ft. elevation.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by wind, gravity, small mammals, and birds. Seeds are dispersed from late fall to early spring

Population Information and Trends

Population Trends:

> 45% decline (NatureServe, 2015)

Species Trends:

Stable to declining (USFWS, 2015)

Number of Populations:

63 total (USFWS, 2022)

Population Size:

Unknown (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This species has declined by over 45% from historical occurrences due to the destruction of habitat, overgrazing, and habitat loss from encroachment by woody plants (Thompson et al. 2006). There are approximately 60 extant occurrences presently recorded, but about 25 occurrences are of poor or very poor quality. There are currently known extant occurrences in 3 states: 50 in Tennessee, 4 in Alabama, and 8 in Illinois. In Tennessee, only 10 occurrences are ranked as good or excellent (EO data in the NatureServe central database as of February 2012). The Tennessee records occur on only 13 USGS 7.5' quads in 7 counties of the Central Basin. Long-term survival is fair to poor unless more sites can be maintained with mowing or ecological burning (NatureServe, 2015). The species status is stable in IL and TN; monitoring data from these states display substantial interannual variability in total numbers of plants as well as for multiple life history stages. The species has declined in Alabama, where only two extant populations are known to exist. Low levels of genetic variation were documented in this species by Edwards et al. (2004) (USFWS 2015). Range wide Dalea foliosa occurs within 63 populations. Of those, 50 are located in central Tennessee, while 11 are disjunct in northeast Illinois and 2 in northwest Alabama (USFWS, 2022)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Nonetheless, several of the threats to Dalea foliosa habitat identified in the recovery plan still have the potential to affect this species even in protected sites, namely, degradation due to invasive exotic or native species encroachment, illegal outdoor recreational vehicle (ORV) use, and incompatible management of utility rights-of-way. Despite its protected status a

relatively large population was essentially lost to habitat destruction at the Sneed Road Cedar Glade DSNA site in Tennessee, which at the time was a Registered Natural Area owned by The Nature Conservancy. This site was severely impacted in 2001, apparently by activities associated with development of adjacent property that resulted in placement of fill material on areas where Dalea foliosa occurred. This population contained an estimated 300 or more plants in 1980, but had declined to 53 plants in 2000, despite removal of the fill material, and only 6 plants were observed there in 2003 (TDEC 2005a). Barbers and Wilhelm (2005) noted that the population at the Dellwood Park West site is periodically inundated by floodwater from the adjacent Illinois and Michigan Canal, which poses a threat to this population and to habitat restoration efforts at this site (USFWS, 2015).

Stressor: Succession (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The main threat to protected sites comes from the potential for either exotic or native, invasive plant species to displace Dalea foliosa from otherwise suitable habitat. Through the process of vegetation succession in the absence of disturbance (e.g., fire), native herbaceous and woody species also can pose a threat. Prescribed fire is used to manage most of the sites where Illinois populations occur on public lands. Efforts to develop a fire management program for lands managed by TDEC have met limited success, owing to insufficient funding, staff turnover, and challenges associated with burning in the urban interface (USFWS, 2015).

Stressor: Herbivory (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The recovery plan (Service 1996) identified intense livestock grazing and selective browsing by eastern cotton-tail rabbits (Sylvilagus floridanus) and white-tailed deer (Odoicoileus virginianus) as threats to D. foliosa. Molano-Flores (2004) observed herbivory at the Midewin NTP in 2002, with little evidence of recovery of affected plants during that growing season. McNicoll and Sivicek (2005) recorded evidence of damage caused by browsing animals in approximately 21 percent of the adult plants they counted at Keepataw Forest Preserve in 2005, and 483 of the 607 plants at Romeoville Prairie Nature Preserve in 2005 were impacted by herbivory (Key 2005). Taft et al. (2010) reported herbivory affecting 31.3 percent of adult plants at Keepataw Forest Preserve in 2010, which had increased from 12.5 percent in 2009. Because of the threat of browsing to seedlings, cages were used to protect at least a portion of the seedlings at each site where plantings occurred in 2008 as part of a project to reintroduce or augment populations (Redmer and Lah 2008) (USFWS, 2015).

Stressor: Small, isolated populations (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Edwards et al. (2004) found populations of Dalea foliosa "…were quite genetically depauperate" and that the isolated populations in Alabama and Illinois contained only a subset of the variation found in Tennessee populations. Measures of both polymorphism and expected heterozygosity were lower than reported averages for other endemic plant species (Hamrick and

Godt 1989 in Edwards et al. 2004). Population sizes tend to be small throughout the range of D. foliosa, which combined with spatial isolation could result in genetic drift exerting a dominant influence on population genetic structure. Increased incidence of inbreeding also is a risk associated with small populations, which can lead to a loss of fitness (i.e., inbreeding depression). These factors combined place many D. foliosa populations at a potentially heightened risk of localized extinction (Barrett and Kohn 1991). The ability of populations to adapt to environmental change is dependent upon genetic variation, a property of populations that derives from its members possessing different forms (i.e., alleles) of the same gene (Primack 1998). Small populations occurring in isolation on the landscape can lose genetic variation due to the potentially strong influence of genetic drift, i.e., the random change in allele frequency from generation to generation (Barrett and Kohn 1991). Smaller populations experience greater changes in allele frequency due to drift than do larger populations (Allendorf and Luikart 2007). Loss of genetic variation due to genetic drift heightens susceptibility of small populations to adverse genetic effects, including inbreeding depression and loss of evolutionary flexibility (Primack 1998) (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Both the final rule listing Dalea foliosa as endangered (Service 1991) and the recovery plan (Service 1996) identify drought as a threat to populations of this species. The recovery plan points out that the species possesses some life history traits (e.g., formation of persistent banks, dormancy response to drought) that enhance its resilience to this threat. However, threats associated with small population sizes and diminished genetic variation could combine with increased drought severity to diminish the species' resilience to this threat over time, leading to substantial declines through the cumulative loss of small, isolated populations. In the face of accelerated climate change, it is imperative that effective monitoring programs are instituted throughout the range of the species in order to track trends in the face of potentially more severe (i.e., frequent, intense, or prolonged) drought conditions. In a study using count data of seedlings/juveniles, non-flowering adults, and flowering adults from Midewin NTP, all stages and total annual census were positively correlated with snowfall. Flowering plants negatively correlated with fall days below 0 oC, seedlings negatively correlated with mean February temperature, and non-flowering adults positively correlated with September precipitation (Molano-Flores and Bell 2012). When the authors incorporated predicted effects of climate change, using projections for mean February temperature and September precipitation in September, into regression models, the majority of the climate models predicted that population size would decrease from the mean population size of 188 plants from 1997-2008 (Molano-Flores and Bell 2012). This provides further evidence to suggest that climate change presents an increased risk of extinction for Dalea foliosa, especially for smaller populations and those with reduced genetic variation, which could limit potential for adapting to changing conditions (USFWS, 2015).

Stressor: Herbivory (USFWS, 2022)
Exposure:
Response:
Consequence:

Narrative: Available data indicate that herbivory by eastern cottontail rabbit (Sylvilagus floridanus) and white-tailed deer (Odoicoileus virginianus) herbivory continue to threaten the species. The recovery plan (Service 1996) identified livestock grazing and selective browsing by eastern cottontail rabbits and white-tailed deer as threats to Dalea foliosa. We currently are not aware of any sites where livestock grazing poses a threat to the species (USFWS, 2022).

Recovery

Reclassification Criteria:
1. A minimum of three populations ranked as high viability are protected and managed in Alabama for a minimum of 5 years. (USFWS, 1996)

2. A minimum of three populations ranked as high viability are protected and managed in Illinois for a minimum of 5 years. (USFWS, 1996)

3. A minimum of twelve populations ranked as high viability are protected and managed in Tennessee. (USFWS, 1996)

4. Restored populations persist at high or moderate viability for a minimum of 10 consecutive years. (USFWS, 1996)

Recovery Priority Number: 5

Delisting Criteria:
1. A minimum of three populations ranked as high viability are protected and managed in Alabama for 10 years (USFWS, 1996).

2. A minimum of three populations ranked as high viability are protected and managed in Illinois for 10 years (USFWS, 1996).

3. A minimum of twelve populations ranked as high viability are protected and managed in Tennessee. (USFWS, 1996)

4. Restored populations persist at high or moderate viability for a minimum of 10 consecutive years (USFWS, 1996).

Recovery Actions:
- Identify and prioritize protection. management. and restoration needs for all high- and moderate-viability populations (and low-viability populations with recovery potential for each geographic region in order to achieve the recovery criteria. Of the21 known or presumed extant leafy prairie-clover populations only 2 (10 percent) rank as high viability, 7 (33 percent) rank as moderate viability, and 12 (57 percent) rank as low viability. To meet the recovery criteria established in this plan, recovery activities need to be implemented for at least 18 (86percent) populations. This includes all nine populations of high and moderate viability, at least five populations of low viability with recovery potential, and an estimated four new populations. One or more recovery actions can increase a population from a low or moderate viability to a high viability. Key management needs or threats are identified for all critical sites by geographic region below and are summarized in Table 10 of the Recovery

Plan. More detailed site recommendations are also provided. (USFWS, 1996)

- Initiate and complete preserve design and implement the protection and management required to meet recovery criteria. Develop preserve designs. Implement protection. Develop management plans. (USFWS, 1996)
- Develop and implement population monitoring programs. A monitoring program should be designed to gauge the status of naturally occurring populations over a period of time and to evaluate the status of population recovery and restoration actions. By relating the data to changing environmental or management conditions, the monitoring program will help determine if and what management or recovery actions are needed for population maintenance. Populations can be monitored by tracking the total census count and by using sampling or demographic dataand should at least include accurate mapping of locations (patches). Demographic monitoring is most important in the initial stages of population restoration. Tracking of individual survivorship, reproductive status, and recruitment will help determine ifand how these variables are related to changes in successional stage, management actions, or environmental stochasticity (sensu Shaffer 1981); e.g., drought. At a minimum, monitoring data for all populations should include growth stage (seedling,juvenile, mature, or dormant), flowering frequency, rate of herbivory, number offlowering and/or fruiting ramets per plant, and observations of general vigor. Reproductive potential and seed output can also be estimated. (USFWS, 1996)
- Conduct research needed to enhance recovery efforts. (USFWS, 1996)
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of leafy prairie-clover could greatly encourage landowner assistance in conservation efforts. However, informational material should not identify the plant's precise locations in order to discourage vandalism to, or collection of, wild populations. (USFWS, 1996)
- Recommendations for Future Actions from 2015 5-Year Review: A. The Service should coordinate with Drs. Brenda Molano-Flores (pers. comm. 2008) and Tim Bell on their efforts to develop a population viability analysis for D. foliosa across its entire range. If this effort were successful across the species range, it could be used in conjunction with the existing PVI to provide a better estimation of the extinction risk faced by individual populations and the species as a whole. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: B. Increase frequency of monitoring in Tennessee and Alabama populations, and standardize methods throughout the species' range, as feasible. Feasibility is a constraint in Tennessee, owing to the large number of populations and the fact that TDEC is the only agency currently monitoring this species at most sites in the state. The Service should work with TDEC to increase capacity by participating in monitoring activities. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: C. Increase use of prescribed fire, or other techniques, for maintaining open conditions with limited competing vegetation in areas with sufficient soil depth to support D. foliosa. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: D. Determine the number of populations that are represented by element occurrences throughout the range of D. foliosa. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct entities. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. It appears that the only circumstance in

Illinois where such a determination might be warranted is the case of the two “populations” at the Waterfall Glen Preserve in DuPage County (Appendix B), which might be more appropriately treated as a single population for recovery purposes. Most of the Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations. (USFWS, 2015)

- Recommendations for Future Actions from 2015 5-Year Review: E. Continue efforts to reintroduce/augment Illinois populations. (USFWS, 2015)
- Recommendations for Future Actions from 2015 5-Year Review: F. Collect data to calculate a current PVI for each protected population, in order to evaluate the species’ status with respect to recovery criteria. (USFWS, 2015)
- The Service should coordinate with Drs. Brenda Molano-Flores (pers. comm. 2008) and Tim Bell on their efforts to develop a population viability analysis for D. foliosa across its entire range. If this effort were successful across the species range, it could be used in conjunction with the existing PVI to provide a better estimation of the extinction risk faced by individual populations and the species as a whole (USFWS, 2015).
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- Increase use of prescribed fire, or other techniques, for maintaining open conditions with limited competing vegetation in areas with sufficient soil depth to support D. foliosa (USFWS, 2015).
- Determine the number of populations that are represented by element occurrences throughout the range of D. foliosa. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct entities. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the calculated PVI for those populations. It appears that the only circumstance in Illinois where such a determination might be warranted is the case of the two “populations” at the Waterfall Glen Preserve in DuPage County (Appendix B), which might be more appropriately treated as a single population for recovery purposes. Most of the Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations (USFWS, 2015).
- Continue efforts to reintroduce/augment Illinois populations (USFWS, 2015).
- Collect data to calculate a current PVI for each protected population, in order to evaluate the species’ status with respect to recovery criteria (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Since preliminary genetic testing reveals that genetic diversity in all Dalea foliosa populations is limited, evaluate whether a genetic management plan for potential movement of individuals between populations, potentially between states, is needed. • Determine the number of populations that are represented by element occurrences throughout the range of Dalea foliosa. This is of highest priority in Tennessee, where multiple occurrences within a single protected area are often tracked as distinct populations. This is especially relevant when calculating PVI values for populations, as aggregating multiple occurrences into what are believed to be biological populations could have the effect of increasing the population size, and in turn the

calculated PVI for those populations. The two Alabama occurrences appear to be separated by sufficient distance to warrant treatment as separate populations. All Illinois populations are distinct. • Across the species range, plan and implement strategies to increase resiliency of populations that are ranked as having low or moderate viability, prioritizing those on publicly protected lands or where landowners are willing to enter into conservation agreements for the species. • Standardize annual monitoring methods by applying the PVI framework from the recovery plan throughout the species' range (USFWS, 2022).

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SPECIES ACCOUNT: *Daphnopsis hellerana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/23/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

A dioecious shrub or small tree, which may reach 6 meters in height and 5 centimeters in diameter. The leaves are simple, alternate, elliptic to obovate in shape, and blunt or rounded at the apex. The leaves may reach 3 to 13 centimeters in length and 1.5 to 6 centimeters in width. Side veins are prominent and curved. The upper surface of the leaves is hairless and green but dries to a reddish—brown color. Both leaves and twigs are golden hairy when young. Flower clusters are borne at the ends of young branches. Male flowers are small (.8 centimeter) long, tubular and finely golden hairy outside. They have four spreading lobes, four scale-like petals and eight stalkless stamens attached to the inside of the petals in two rings. The female flowers are smaller and the calyx is bell shaped, less than .5 centimeters long, golden hairy outside and hairless inside. The fruit is an elliptic, one—seeded, white berry that is less than 2 centimeters long (Vivaldi and Woodbury 1981b, Little et al. 1974) (USFWS, 1992).

Taxonomy

The nomenclatural name of D. hellerana was published in the final rule. However, the correct name should have been published as Daphopsis helleriana. The Service intends to correct this nomenclature in 50 CFR 17.12 (USFWS, 2013).

Historical Range

Known from only four locations in Puerto Rico, to the west of the San Juan metropolitan area: the hills near Quebradillas/Isabela; the hills of Rio Lajas; the Nevarez hills; and near the National Institute of Health facility near Sabana Seca. A total of approximately 125 individuals are known from these sites. (USFWS, 1992)

Current Range

At present, D. helleriana is found in the municipalities of Isabela/Quebradillas, Arecibo, Vega Baja, Dorado, and Toa Baja. Introduced individuals, are located in Guajataca, Río Abajo, and Cambalache Commonwealth Forests (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1992)

Breeding Season

Adult: February - April (USFWS, 1992)

Reproduction Narrative

Adult: It has been observed in flower between February and April and has been collected in fruit as well. Little information is available on the ratio of female to male plants; however, the abundant seedlings which have been observed in two of the four population sites are evidence of successful pollination and production of viable seeds (USFWS, 1992).

Habitat Type

Adult: Terrestrial (USFWS, 1992)

Habitat Vegetation or Surface Water Classification

Adult: Semi-evergreen and evergreen seasonal forests (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: ~100 to 350 m elevation (USFWS, 1992)

Habitat Narrative

Adult: All populations of Daphnopsis hellerana occur in the semi-evergreen and evergreen seasonal forests of the limestone hills of northern Puerto Rico at elevations which range from 100 to 350 meters. Daphnopsis hellerana is restricted to the limestone region of the island. Soils in the limestone hill sites are shallow, well-drained, alkaline and interspersed between outcrops of hard limestone (USFWS, 1992).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2013)

Population Size:

~1,029 (USFWS, 2013)

Population Narrative:

The species status is stable; when D. helleriana was listed in 1988, only 14 plants were known from two localities (Toa Baja and Dorado). Additional information compiled in the office suggests that approximately 500 individuals occur at seven locations throughout northern Puerto Rico (i.e., Dorado, Toa Baja, Isabela/Quebradillas, Arecibo/Utuado, and Vega Baja). Only 1,029 individuals (33%) remain undisturbed in their natural localities (USFWS, 2013).

Threats and Stressors

Stressor: Urban development (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: The majority of the natural populations of D. helleriana occur in areas under high pressure for urban development and expansion. Residential, tourist and commercial development projects (e.g., landfills, construction of dwellings and roads, and limestone quarrying) threaten this species. In the expansion of Highway PR-10 from Ponce to Arecibo, a project of the Puerto Rico Highway and Transportation Authority (PRHTA), the goal was to minimize adverse effects to D. helleriana and to several other species that occur in the area. Even though the extensive efforts were made to conserve and protect D. helleriana, the relocation of the individuals was only 38% successful, resulting in the loss of more than seven hundred individuals. The PRHTA is currently planning the expansion of the Highway PR-22 from Hatillo to Aguadilla. The preferred proposed route is located south of one of the existing populations of D. helleriana in Isabela, where adverse effects are not anticipated on the species. However, if the PRHTA changes the preferred route, other alternative routes may affect the species restricting its habitat or eliminating the northern population of Isabela (USFWS, 2013).

Stressor: Low reproduction potential (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Daphnopsis helleriana is a dioecious plant (i.e., male and female flowers are born in different plants). This entails that a self-sustainable population needs to have both female and male specimens for them to reproduce. The best available information does not give us a good picture on demographic features of this plant. However, the low numbers in the currently known natural populations give us an indication that the populations are at risk. In addition, the low numbers may result in adverse effects in reproduction and genetic diversity, which may result in single sex individuals. This could be very significant because it may eliminate the population's ability to continue reproducing. In addition, with respect to the relocation of individuals to other suitable locations, this poses a risk that particular genotypes of each population may be lost due to the specific characteristics of that habitat (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Areas of privately owned populations are given protected status (USFWS, 2013).

2. At least three new self-sustaining populations in Commonwealth Forest units such as Vega Alta, Cambalache, or Guajataca Forests have been established (USFWS, 2013).

Recovery Actions:
- Monitor existing populations (USFWS, 1992).
- Protect privately-owned populations at sites (USFWS, 1992).
- Conduct research on the life history of the species and evaluate methods of propagation (USFWS, 1992).

- Propagate and produce seedlings and saplings for enhancement of existing populations and the establishment of new ones (USFWS, 1992).
- The recovery plan should be revised to establish measurable delisting criteria as new information is learned on this plant. The Service, in cooperation with the PRDNER and academia, needs to determine how many individuals constitute a self-sustainable population (USFWS, 2013).
- Efforts to protect privately-owned populations should be conducted. Private-lands initiatives (such as Partners for Fish and Wildlife and Coastal Program) are needed to further protect the areas where D. helleriana is known to occur naturally (USFWS, 2013).
- Foster a working partnership with regulatory agencies to address and minimize potential adverse effects of development projects on the species and its habitat (USFWS, 2013).
- Surveys are needed to have a better demographic perspective of the population (USFWS, 2013).
- Obtain information regarding pollination, seed dispersal, and population genetics for the D. Helleriana (USFWS, 2013).

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SPECIES ACCOUNT: *Deeringothamnus pulchellus* (Beautiful pawpaw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

The beautiful pawpaw is a low-growing, diminutive shrub of the Annonaceae family rarely exceeding 0.5 m in height. The stems may be annual or perennial and arise from a stout taproot that averages 32.5 cm long and is about 2.5 cm wide at its widest point. The leaves are alternate, leathery, deciduous, and 4.0-7.0 cm long with slightly revolute (curving under) margins. The leaf shape is oblong to oblong-ovate or spatulate, with a rounded or notched end. The base of the leaf is rounded or tapering to a 2.0-4.0 mm long petiole. Young leaves have sparse, short, red hairs on both sides. Maturing leaves become dark green to glossy green above and paler green below. The flowers of this species occur singly in leaf axils and have between 6 and 10 creamy-white petals that are about 2.0-3.0 cm long. The fruits are fleshy, smooth and yellow-green when ripe and are 4.0-7.0 cm long. The seeds are dark brown and from 1.0-1.5 cm long. (USFWS, 1999)

Taxonomy

The species was first named and described by John K. Small as the only species belonging to the genus Deeringothamnus and separated from the genus Asimina by its "dimorphous sterns, the flat or depressed receptacle, and the narrow nearly uniform unsculptured petals" (Small 1924). Rehder and Dayton (1944) discussed placing the species in the genus Asimina. Because the use of the combination Asimina pulchella did not meet nomenclatural rules, they retained the Deeringothamnus pulchellus name. A subsequent treatment of taxonomy is consistent with that of Small (Kral 1960). However, Ward (2001) suggested that, due to the presence of forms that appear to be intermediates between D. pulchellus and its congener D. rugelii, they should be treated as a single species and varieties should be used to distinguish the two forms. According to Ward's (2001) assessment, beautiful pawpaw should be named D. rugelii var. pulchellus. The scientific community has not fully embraced this taxonomic change, and Ward also now considers them as two separate species (Norman 2003, 2008). The Integrated Taxonomic Information System (2009) does not indicate any formal changes to the name D. pulchellus. (USFWS, 2009)

Historical Range

Historically occurred on poorly drained sands of slash and longleaf pine- saw palmetto flatwoods in Lee and Charlotte Counties in southwestern Florida and was also found in Orange County east of Orlando. (USFWS, 2009)

Current Range

In Florida, in Charlotte, Lee, and Orange Counties. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Research on the beautiful pawpaw has been conducted in the areas of phenology, pollination, reproductive structures, breeding system, germination, and hybridization (Norman 2003). Available information suggests that this species has poor fertilization, seed-setting, germination, and recruitment rates. Pollinators for this species are few, but those noted are a tumbling beetle (Mordella atrata) and two species of thrips (Frankliniella bispinosa and Thrips hawaiiensis) (Norman 2003). The reproductive biology of the species is not thoroughly understood, but the plant is thought to reproduce entirely by seed. Gopher tortoises (Gopherus polyphemus) may be an important seed disperser. Although not investigated in detail, ingestion of the seeds by gopher tortoises or other herbivores may be important for seed germination. However, seeds have been germinated without this type of treatment. On Pine Island, Lee County, plants begin flowering by mid-March and are at the peak of flowering the last week of April. Likewise, flowering was observed in Orange County in mid-March and lasted for 6 weeks (Norman 2003). Fruit is likely produced and dispersed during the summer. Because the species is thought to be long-lived, reproductive success is not critical every year (Service 1999). Other than follow-up monitoring during the first year after transplant of three transplanted populations, no long-term estimates of survival have been obtained for the species (Service 1998; Preston et al. 2004). No follow-up data have been collected. Additionally, no information has been reported on survival of individuals in natural occurrences, and life history stage and population structure data have not been collected. Limited experiments with seed collected from Orange County reported very low seedling survival, suggesting that the species may rely on a mycorrhizal fungal association to promote seedling survival (Norman 2009).

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The species occurs in two disjunct locations in central and southwest Florida. It grows in xeric, mesic, and hydric pine flatwoods in western Charlotte and Lee counties and eastern Orange County. Soils in these habitats are poorly drained, although slight elevations provide better drainage than surrounding soils that are wetter. In Lee County, the pawpaw exists on Pine Island, where it occurs in pristine and modified flatwoods, on road edges, and on mowed lots. In Charlotte County it is found in an area broadly known as the Charlotte Harbor flatwoods and includes sites along State Road 765 and FWC's Cecil M. Webb Wildlife Management Area.

Dispersal/Migration

Population Information and Trends

Number of Populations:

35 (USFWS, 2021)

Population Size:

~5,000

Population Narrative:

Surveys have been conducted intermittently in the past, but trend data are difficult to assess because surveys have generally only assessed a few occurrences at any one time and new occurrences have been discovered. Based upon the most comprehensive data available, there are currently thought to be approximately 5,000 pawpaw plants (FNAI 2008). The number of plants ranges from 1 to 2 plants on some sites to over 1,000 individuals on 3 sites (FNAI 2008). Nearly one-third of the occurrences were comprised of 15 or fewer pawpaws (FNAI 2008). Beautiful pawpaw is a long-lived shrub that occurs in open mesic flatwoods habitat within a disjunct range, occurring in Orange, Charlotte, and Lee Counties, Florida. The populations are fragmented and isolated within the range. Currently, there are an estimated 35 populations, though it is difficult to determine the status of each given the lack of monitoring. Consistent annual surveys are needed to evaluate long-term population trends and additional studies need to be completed on long-term survival, reproductive patterns, and population structure. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of beautiful pawpaw. Where plants occur on private sites, development has led to both direct destruction of habitat as a result of land clearing and habitat degradation from lack of management. One of the occurrences in Orange County has been extirpated (FNAI 2008). The property where this occurrence was reported was located adjacent to houses, the site was overgrown with Brazilian pepper (Schinus terebinthifolius), and trash was deposited in the area (FNAI 2008). It is likely that the plants were either crushed by debris or the habitat degraded to the point of being unsuitable for the species. (USFWS, 2009)

Stressor: Inadequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: The ESA provides protection for this species and its habitat through section 7. The beautiful pawpaw is also listed by the Florida Department of Agriculture and Consumer Services (FDACS) as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing Federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. Lee County offers some protection for the beautiful pawpaw through a listed species ordinance which requires mitigation for adverse effects to State and federally listed species (Lee County 1998). However, this ordinance does not apply to agricultural lands or those being re-zoned for agriculture, and part of the threat of habitat loss where pawpaws occur is a result of clearing for agricultural purposes. In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with pawpaws have been developed. Because this plant occurs in habitat which is desirable real estate for development along the southwestern coast and inland near Orlando, this species remains

vulnerable to development pressures where it occurs on private property. (USFWS, 2009)

Stressor: Inadequate fire or land management (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: This species occurs in pine flatwoods habitat, which is typically maintained by fire. This species is adapted to live in pine flatwoods habitat where frequent ground fires are not hot enough to kill mature pine trees but do remove or thin understory vegetation and reduce competition with larger grasses and shrubs. During the first growing season after fire, the beautiful pawpaw takes advantage of newly-created openings by flowering and setting fruit (Service 1999). Therefore, land management practices such as prescribed fire are very important to maintaining and working towards recovery of the beautiful pawpaw. - Lack of management is a concern on some protected sites. Vegetation restoration and management programs are costly, and the availability of resources is never assured; therefore, habitat degradation and modification from inadequate management even on protected lands remains an imminent, though moderate, threat. - On many privately owned sites, fire has historically been suppressed, and habitat has not received regular maintenance. Where this species occurs on fragmented landscapes interspersed with development, burning may be unlikely due to proximity to neighbors. In areas that cannot be readily burned, mowing is sometimes used as a management strategy. In mowed habitat, the growth habit of this species is more prostrate with woody stems lying on the ground, while in fire-maintained habitat, it grows more erect with arching sterns. (USFWS, 2009)

Stressor: Invasive plant species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In the absence of site maintenance, a threat to pawpaws is the establishment of invasive plant species such as Brazilian pepper, meialeuea (Melaleuca quinquenervia), and earleaf acacia (Acacia auriculifbrinis). However, herbicides used to control overgrowth, if not properly applied, also may pose a threat to the beautiful pawpaw. (USFWS, 2009)

Stressor: Natural events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The species' limited distribution and its limited reproductive capacity also renders it vulnerable to random natural events, such as hurricanes and drought. However, Hurricane Charley crossed the northwest portion of the species' range in Lee and Charlotte Counties in 2004, and no apparent damage occurred to the beautiful pawpaws (Woodmansee and Barry 2007). During this hurricane, storm surge did not impact the occurrences but could in cases where storm surge is greater. The possibility of future hurricanes and tropical storms striking Florida is likely; this threat is expected to continue. . (USFWS, 2009)

Stressor: All-terrain vehicls and feral hogs (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: A threat identified when the species was listed was damage by allterrain vehicles in at least a portion of the species' range. It is presumed that this threat continues on occurrence sites where access is not restricted. Feral hogs (Sus scrofa) may also pose a threat to beautiful pawpaw plants. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of D. pulchellus, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain pine flatwoods to support D. pulchellus (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Delisting Criteria:
1. When at least 30 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)

2. When populations (as defined in criterion 1) occur in pine flatwoods habitat distributed across the historical range of the species in order to maintain and enhance the species geographic patterns of genetic diversity. (Factor A) (USFWS, 2019)

3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, E) (USFWS, 2019)

Recovery Actions:
- 1. Determine current distribution of D. pulchellus. - Conduct surveys for D. pulchellus. - Maintain distribution of known populations and suitable habitat in GIS database. Use GIS to map existing populations and to assess the species' status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the Florida Natural Areas Inventory database. (USFWS, 1999)
- 2. Protect and enhance existing populations. - Acquire or otherwise protect habitat through acquisition, conservation easements, or agreements with landowners. - Protect populations on public lands. Develop management guidelines that allow for a fire regime that includes a mosaic of successional stages. - Use local or regional planning to protect habitat. Utilize available regional and county planning processes to encourage protection of suitable unoccupied and habitat occupied habitat of D. pulchellus. Protecting this species on private

property in Lee County is possible due to county ordinances that require conservation of listed plants. - Enforce available protective measures. Use local, State and Federal regulations to protect this species from overcollecting and damage from off-road vehicle use. Regulations should also be used to protect xeric vegetative communities where D. pulchellus lives. - Develop an ex situ collection. Ex situ collections are important for preserving genetic diversity, preventing extirpation, and determining ecological characteristics and habitat management needs of species. These collections will be instrumental in the recovery of D. pulchellus. Since longterm seed storage seems impossible for this species, cultivated populations are very important. Although D. pulchellus is not easily grown from cuttings, young plants should be kept for study and reintroduction material. - Augment natural populations of D. pulchellus. (USFWS, 1999)

- 3. Conduct research on life history characteristics of D. pulchellus. - Conduct research to determine demographic information, such as numbers of sites and populations, numbers of individuals in a population, recruitment, dispersal, growth, survival, and mortality. Observations of the relation of flowering to fire, pollination, seed production, and seedling biology will help to guide reintroduction efforts. - Once demographic data are known, conduct population viability and risk assessment analysis to determine the numbers of plants, sites, subpopulations/populations, and spatial distribution needed to ensure persistence of the species. - Conduct research to assess management requirements of D. pulchellus. Determine which natural populations can be stabilized or increased by habitat management. Surveys, research, and monitoring information will provide factors contributing to any declines at each site. Monitoring of populations should be in reference to various habitat management practices. Site-specific management guidelines should be provided to land managers and close coordination among land managers is essential to develop adaptive management techniques. - Assess feasibility of relocating D. pulchellus. Removing plants threatened with destruction may be the only conservation strategy available in some situations. Information on transplant techniques and plant survival are needed to assess whether transplanting should be pursued. (USFWS, 1999)
- 4. Monitor existing populations of D. pulchellus. - Develop monitoring protocol to assess population trends for D. pulchellus. - Develop a quantitative description of the population structure of D. pulchellus. This description will provide a baseline for monitoring population dynamics in response to natural environmental changes and management treatments. Data recorded should include morphology, survivorship, mortality, and reproduction for individual plants. Data about each plant's microsite (vegetation cover, litter depth, substrate, and closest neighbors) may prove helpful in future management. - Monitor reintroduced plants. Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole. Compare adult survival, seed production, germination rates, seed survival, seedling survival, and growth rates between transplanted plants and natural plants. Where monitoring indicates that the introduction has been unsuccessful, reevaluate protocol and methodology. (USFWS, 1999)
- 5. Provide public information about D. pulchellus. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. pulchellus and other rare species requires a self-sustaining, secure, number of natural

populations. (USFWS, 1999)

- 6. Establish delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Urbanization, fire suppression, and agricultural land uses have decreased the available habitat. - Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. - Continue habitat-level research projects. Study the response of D. pulchellus to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. - Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, etc., on the habitats where D. pulchellus occurs. - Provide public information about pine flatwood vegetative communities and their unique biota. Educational efforts, especially those conducted by private conservation organizations, have been successful in providing important information about pine flatwood plant communities to the public. The State's system of biological preserves depends for its funding and future success on a broad base of public understanding and support. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, the Florida Park Service, the Florida Native Plant Society and local garden clubs will play crucial roles in increasing public appreciation of pine flatwood plant communities and D. pulchellus. (USFWS, 1999)
- Management: • Continue management actions to include removal of hogs, debris, and exotic plants. Depending upon site, management efforts may include: licensed hunting or trapping of hogs, careful application of herbicides, controlling public access, and reintroduction of prescribed fire into the ecosystem. • Restore habitat in potential areas where plants could occur but are not currently reported, and provide follow-up surveys post-disturbance to determine if natural occurrences are present. • Identify additional reintroduction sites and establish reintroduced populations; augmentations should also be implemented. • Focus conservation efforts on marginal and small occurrences to preserve the genetic diversity of the species. (USFWS, 2009)
- Research: • Conduct research on the response of beautiful pawpaw to fire and fire prescriptions necessary to benefit the species. • Monitor burned and mowed sites to assess which technique is most beneficial to pawpaw reproduction and survival. • Continue research on the biology, ecology, genetics, and management needs of the species. • Conduct demographic studies to determine the age class structure and long-term viability of the species, especially in areas with active recruitment, and determine critical life stages. • Conduct genetic characterizations on occurrences, and apply this knowledge to future introductions and augmentations. • Continue to evaluate insect pollinators associated with the species over the long-term, and evaluate impacts to pollinators from aerial mosquito spraying. • Conduct seed germination studies and make efforts to develop additional outplanting techniques. • Continue propagation efforts and establish techniques for long-term germplasm storage; make sure all occurrences are represented in the Center for Plant Conservation's National Collection of Endangered Plants. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2009)

- Surveys: • Continue to survey potential habitat and pursue conservation agreements, implement management recommendations, and/or acquire land and investigate incentives to encourage land managers to manage pine flatwoods for ecosystem health and listed species. • Conduct additional surveys for beautiful pawpaw on all known (particularly Estero Bay Preserve State Park, Pine Island Flatwoods Preserve, and the newly acquired Babcock Ranch) and potentially suitable sites in the three counties of occurrence; provide updated information to FNAI for consistent tracking. • Continue monitoring both reintroduced and natural occurrences. (USFWS, 2009)
- Other: • Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities x Continue removal of hogs and invasive plants species around beautiful pawpaw populations. Depending upon site, management efforts may include licensed hunting or trapping of hogs and careful application of herbicides to invasive plants. x Continue applying prescribed fire and reintroduce fire to habitats where this species occurs. Use careful mowing with minimal ground disturbance where burning is not possible or in combination with burning as a mechanical treatment to open up habitat and make the vegetation structure more suitable for beautiful pawpaw growth. x Restore habitat in potential areas where plants could occur but are not currently reported and provide follow-up surveys post-disturbance to determine if natural populations are present. x Identify additional (re)introduction sites, donor sites, and if needed, rescue sites (private lands slated for development) and establish reintroduced populations; augmentations should also be implemented where small, non-viable populations occur. x Focus conservation efforts on marginal and small populations to preserve the genetic diversity of the species. Monitoring/Research Activities x Continue to survey potential habitat all counties of occurrence and in corridor counties. x Conduct surveys of previously documented populations on private lands with a focus on those that have not been visited in over 20 years, occur on larger tracts, and/or are adjacent to existing conservation lands. x Conduct research on the response of beautiful pawpaw to fire and fire prescriptions necessary to benefit the species. x Monitor burned and mowed sites more closely to assess which technique is most beneficial to pawpaw reproduction and survival. x Determine long-term effects of using careful roller-chopping as a mechanical treatment on population viability x Conduct demographic studies to determine the age class structure and long-term viability of populations, especially in areas with active recruitment, and determine critical life stages. x Develop and carry out a monitoring protocol for reintroduced/augmented populations to better characterize long-term survival of individuals and population viability. x Conduct further genetic research to determine the level of genetic diversity that remains and is protected and apply this knowledge to future introductions and augmentations. Also, conduct further research to determine the level of hybridization with D. rugelii (Rugel's pawpaw) and A. pygmaea (dwarf pawpaw) in populations not yet assessed and the level of hybridization with A. reticulata. Collect voucher specimens of known hybrids to document their morphological characters. x Continue to identify and evaluate insect pollinators associated with the species with a focus on conducting pollinator surveys at night when likely but undocumented insect visitors may be active. x Investigate potential seed dispersers and their effectiveness. x Conduct

additional seed germination trials and make efforts to develop additional outplanting techniques. x Continue propagation efforts and make sure all populations are represented in the Center for Plant Conservation's National Collection of Endangered Plants. x Support continued work and research into ex situ cryopreservation methods to preserve cell lines of this species. x Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. Outreach Activities x Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. x Actively engage and encourage private landowners to manage pine flatwoods for ecosystem health and listed species. x Seek opportunities to include the media in conservation efforts to provide information about this species to the public. (USFWS, 2021)

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SPECIES ACCOUNT: *Deeringothamnus rugelii* (Rugel's pawpaw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/27/1986; Southeast Region (R4)

Physical Description

A low, sparingly branched, scented shrub that grows from a stout taproot, rarely to 0.5 m tall. Leaves are alternate, erect, 1-7 cm long, oblong to oval in shape. Stems are arching or occasionally erect, seldom branched. Flowers are solitary in leaf axils with 9 yellow petals (NatureServe, 2015).

Taxonomy

Kartesz (1999) treats Deeringothamnus pulchellus and D. rugelii as distinct taxa. Ward (2001) treats D. pulchellus as a variety of D. rugelii (Novon 11(3): 360-365) (NatureServe, 2015).

Historical Range

D. rugelii is endemic to a small area of Volusia county (USFWS, 2018).

Current Range

D. rugelii is known to occur at Deep Creek Preserve, Longleaf Pine Preserve, Tiger Bay State Forest, Port Orange City Forest, Wiregrass Prairie Preserve, and Lake Monroe Conservation Area, which are all in Volusia County, FL (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 - 2 years (above ground) (USFWS, 1988)

Breeding Season

Adult: Germinates in spring (USFWS, 2018)

Key Resources Needed for Breeding

Adult: Fire (USFWS, 1988)

Reproduction Narrative

Adult: Blooms in the spring (Small 1933) (NatureServe, 2015). The above-ground stems bear seed and fruit the first year after a fire, and appear to live for only one or two years (Wunderlin et al. 1981) (USFWS, 1988).

Habitat Type

Adult: Flatwoods with an open canopy of slash pine (P. elliottii var densa) or longleaf pine. This species also occurs in pastures and in road and utility rights-of-way (USFWS, 2018).

Habitat Vegetation or Surface Water Classification

Adult: Groundcover assemblages within the flatwood communities include wiregrass (Aristida stricta) and a diverse array of other herbaceous plants (USFWS, 2018).

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Environmental Specificity

Adult: High

Habitat Narrative

Adult: Rugel's pawpaw occurs in flatwoods with an open canopy of slash pine (P. elliottii var densa) or longleaf pine. This species also occurs in pastures and in road and utility rights-of-way. It is found in mesic and wet flatwood enviroments, though one occurrence is known to occur in disturbed conditions. Soils that support this species are often deep, fine textured, poorly drained sand or sandy peats (USFWS, 2018). Fires limit the growth of larger shrubs that would otherwise compete with this species (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Stable (USFWS, 2018)

Species Trends:

Stable (USFWS, 2018)

Number of Populations:

22 Extant (USFWS, 2023)

Population Size:

2,142-4,538 (USFWS, 2018)

Population Narrative:

Rugel's pawpaw has only occurred in a small area of Volusia County in northeastern peninsular Florida. From the time of its initial discovery through 1998, 25 occurrences of D. rugelii had been located within Volusia County. In 1998, the number of plants reported from previous surveys among the known populations ranged from 2,142 to 4,538 individuals with 9 of the 25 occurrences including more than 100 plants. Many additional surveys were conducted since 1998 and as of 2017, there are 36 occurrences documented in Volusia County with 33 being natural occurrences. Eighteen occur on protected conservation lands and 15 occurrences on unprotected private lands or highway and utility rights-of-way. The introduced populations occur on two protected sites. When a separation distance between occurrences is used, 9

separate potential populations are evident. The species status is stable but range-wide surveys are needed to confirm presence on all sites and proper management of existing sites will provide long-term benefits to this species (USFWS, 2018). While the number and configuration of populations is unknown, currently, there are 42 known occurrence records (Table 1; Appendix A, Table A.1) with distribution occurring primarily between the Deland and Atlantic Coastal ridges in Volusia County, Florida. Of these occurrences, 22 are extant, 8 are extirpated, and the status of 12 are unknown. These occurrence records include Florida Natural Areas Inventory (FNAI) Element of Occurrence (EO) records, transplant sites, and additional sites identified through the Florida Native Plant Society (FNPS) Pawpaw Chapter's annual survey efforts. In 2021, 20 plants from the Bok Tower Gardens rescue and tissue culture collection were transplanted into a pre-selected site on the Longleaf Pine Preserve. Eighteen of these plants were sourced from tissue culture propagated plantlets and two were individuals rescued from the Defrates property (Edwards et al. 2021). As of 2023, no survival of transplanted individuals was recorded in this site (USFWS, 2023).

Threats and Stressors

Stressor: Habitat degradation and destruction (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The primary threat to this species is destruction and modification of habitat on private lands. Degradation of habitat resulting from a lack of adequate management on public and private lands remain a threat. Habitat loss and destruction from development is not a threat, degradation as a result of inadequate management is a concern. Additionally, elongated fire return frequencies and complete absence of periodic fire in some places has also led to habitat degradation (USFWS, 2018).

Recovery

Reclassification Criteria:
Ten (10) viable populations are established at secure sites (USFWS, 1988).

Delisting Criteria:
Twenty (20) viable populations are established at secure sites (USFWS, 1988).

Recovery Actions:

- Conduct a range-wide survey of all existing populations and historic sites where populations formally existed that have not been developed. For all populations occurring on conservation lands; document current abundance, population trends, demographic trends, and habitat suitability. Conduct a Population Viability Analysis (PVA) to help determine a minimum viable population number (USFWS, 2018).
- When surveying plants note any associations with caterpillars and collect insects for proper identification in order to better understand the relationship between the organisms (USFWS, 2018)
- Support further research on the effects of prescribed burning and other management tools on D. rugelii, its life history needs, and microhabitat requirements (USFWS, 2018).

- Support further research into population genetics to better understand basic biology of the species, genetic variation within and among populations and across landscape, and whether hybridization is occurring with related and co-occurring species (USFWS, 2018).
- Support further research into microbiome and whether specific microorganisms area associated with this species, which may serve to inform future introduction sites (USFWS, 2018).
- Continue collaboration with conservation land managers to increase habitat management and suitability of occupied habitat (USFWS, 2018).
- Collect habitat management activity information from conservation land managers to increase habitat management and suitability of occupied habitat (USFWS, 2018).
- Actively engage private landowners and public non-conservation land owners (e.g. roadside rights-of-way) to protect and increase management efforts to benefit occupied habitat (USFWS, 2018).
- Continue transplantings from threatened sites (USFWS, 2018).
- Conduct reintroductions and possibly augmentations on publically owned conservation lands with suitable habitat and develop best approaches for conducting introductions to assist in meeting recovery goals (USFWS, 2018).
- Develop a monitoring protocol that indicates frequency and timing for future consistency and long-term trend analysis (USFWS, 2018).
- Support continued work and research into ex situ cryopreservation to preserve cell lines of this species (USFWS, 2018).
- Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing threats identified in the recovery plan, as well as update information on the species distribution and biology (USFWS, 2008).
- Support further research on: a. The effects of prescribed burning and other management tools on D. rugelii. Continue working with public land managers to increase management efforts to benefit D. rugelii on their sites. B. Additional life history needs. C. The most appropriate methodology to germinate seeds or tissue cultures, grow seedlings, and successfully out-plat seedlings to native habitat (USFWS, 2008).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2008).
- Complete a rangewide survey to find all sites known to be occupied by or have the potential to be occupied by D. rugelii and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2008).
- Consider reintroduction and monitoring of D. rugelii on additional publicly owned lands with suitable habitat. Reintroduction of D. rugelii could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1986). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Increase collaboration with conservation area land managers to improve habitat conditions of occupied sites through the application of prescribed fire. Implement mechanical vegetation management such as mowing and hand removal in areas where burning is not possible or in combination with burning to restore and maintain habitat conditions for Rugel’s pawpaw. • Restore habitat on public and private

lands in areas where plants could occur but have not been documented and implement post-restoration surveys to determine if natural populations are present. • Prioritize and implement rescue on sites with focus on sites identified for possible rescue. • Identify and prioritize additional (re)introduction sites and establish reintroduced populations. • Identify and prioritize occupied private lands that are good candidates for conservation acquisition and work with partners to acquire high priority parcels. Monitoring/Research Activities • Develop and conduct annual surveys in occupied secure sites to evaluate long-term population trends. • Conduct surveys in areas of previously documented occurrences focusing on sites with an unknown status. • Conduct research on the effects of growing vs. dormant season burning to determine if seasonality of prescribed fire significantly influences flowering and fruiting. • Conduct studies to determine the minimum viable population size required for a selfsustaining population. • Develop and implement survey and monitoring protocol for reintroduced/augmented populations to better determine long-term survival of individuals and population viability. • Conduct further research to determine species boundaries between Rugel's pawpaw and beautiful pawpaw. • Conduct studies to identify potential overlap in timing of flowering between dwarf pawpaw and Rugel's pawpaw to determine how this may relate to incidence of interspecific hybridization. • Conduct studies to identify and evaluate insect pollinators associated with the species. • Continue propagation efforts and ensure all populations are represented in the Center for Plant Conservation's National Collection of Endangered Plants gardens (e.g., Bok Tower Gardens). • Support continued work and research into ex situ cryopreservation methods to preserve cell lines of this species. • Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. Outreach Activities • Increase collaboration with conservation land managers to provide annual reporting on habitat management activities and relevant observations in occupied areas. • Promote partnerships to share information, conduct collaborative research on pine flatwoods habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Actively engage and encourage private landowners to manage pine flatwoods for ecosystem health and listed species. • Seek opportunities to include the media in conservation efforts to provide information about this species to the public (USFWS, 2023).

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SPECIES ACCOUNT: *Deinandra (=Hemizonia) conjugens* (Otay tarplant)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Deinandra conjugens is an aromatic annual herb and has a branching stem that generally ranges from 5 to 25 centimeters (2 to 10 inches) in height with deep green or gray-green leaves covered with soft, shaggy hairs. Flower heads consist of 8-10 yellow ray flowers and 13-21 yellow disk flowers with black anthers. (USFWS, 2004; NatureServe, 2015)

Taxonomy

Deinandra conjugens (Otay tarplant) is an annual herbaceous plant in the sunflower family (Asteraceae) (Baldwin 2012, pp. 29, 298). Individual plants range in height from 1 to 5 decimeters (4-19 inches (in)) with lobed leaves covered with coarse hairs (Baldwin 2012, p. 298). The yellow flower heads consist of 7 to 10 ray flowers (3-6 millimeters (less than 1 in)) and 13 to 21 disk flowers (Baldwin 2012, p. 298). It can be distinguished from other members of its genus by its phyllaries, including its striated (ridged) phyllary body, red to dark purple anthers (part of flower that produced pollen), and by the number of disk and ray flowers (Baldwin 2012, p. 298). As characteristic of most other tarplants, D. conjugens is selfsterile with a self-incompatible pollination system; that is, it has one self-incompatibility gene and thus cannot be fertilized with its own pollen or with pollen from another plant that shares a self-incompatibility allele. Thus, an individual will only produce viable seeds when crosspollinated by an individual that does not share either allele (USFWS 2004, p. 5). The flowering period for D. conjugens is generally between May and June (California Native Plant Society (CNPS) 2023) but can extend into early fall (Bauder et al. 2002, p. 5). Deinandra conjugens has a discontinuous distribution in southwestern San Diego County, California in the United States and Baja California, Mexico. It is generally found on clay soils or clay subsoils associated with grassland, coastal sage scrub, or maritime succulent scrub habitats (USFWS, 2023).

Historical Range

Not available

Current Range

Restricted to a limited portion of southwestern San Diego County from Otay, south of San Diego, to the La Presa-Sweetwater Reservoir area ca. 8 mi ESE of San Diego, at 50-500 ft. Also collected 3 km southwest of La Presa, southeast of Tijuana, Baja, Mexico. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/10/2002.

Legal Description

On December 10, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Deinandra conjugens (Otay tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (67 FR 76030-76053).

Critical Habitat Designation

The critical habitat designation for Deinandra conjugens includes two CHUs in San Diego County, California. This species critical habitat encompasses approximately 6,330 acres (ac) (2,560 hectares (ha)) (67 FR 76030-76053).

Unit 1: Sweetwater/Proctor Valley Unit: The Sweetwater/Proctor Valley Unit encompasses approximately 1,440 ha (3,560 ac) at the northeastern limit of this species' distribution. This unit is south and east of State Route 54, south and west of State Route 94, and north of Upper Otay Reservoir. It includes portions of the Otay/Sweetwater Unit of SDNWR; lands belonging to the Sweetwater Authority around the Sweetwater Reservoir; lands belonging to the Otay Water District; lands that are proposed as preserve under the draft City of Chula Vista Subarea Plan; portions of two project areas within the draft City of Chula Vista Subarea Plan, but outside of the proposed preserve lands; and lands that are within major and minor amendment areas within the County of San Diego Subarea Plan. Two areas in this unit have not been designated as critical habitat, including the alignment for State Route 125 South and the San Diego County Park campground realignment and expansion, because these areas have been analyzed and determined not to be essential to the conservation of Deinandra conjugens. This unit contains several large populations of Deinandra conjugens, including a portion of the Rancho San Miguel population estimated to contain approximately 855,000 standing Deinandra conjugens plants during the 1995 and 1998 growing seasons (CNDDB 2002; Merkel & Associates, in litt. 1999). A portion of the Proctor Valley population not covered under the approved San Diego County MSCP, which had approximately 10,000 standing plants in the 1990 growing season (CNDDB 2002), is also included. This unit also contains an area on the north side of the Sweetwater Reservoir where reports indicate there are approximately 2,000 standing plants (Roberts 1997), and an area on the north portion of the SDNWR that had approximately 2,000 standing plants in 1993 (CNDDB 2002). As discussed in the Changes From the Proposed Rule section of this final rule, portions of lands containing the approximately 28,000 plants in the Rolling Hills Ranch population (i.e., the MSCP Neutral areas and proposed Chula Vista Subarea Plan reserve within the Rolling Hills Ranch project), and portions of other project lands (e.g., Bella Lago, Eastlake Woods) have been retained in the final rule while other areas were excluded. This unit contains multiple large Deinandra conjugens populations that are capable of producing large numbers of individuals in good years, which is important for this species to survive through a variety of natural and environmental changes, as well as stochastic (random) events. This unit contains populations in the northern and eastern extent of this species' historicaldistribution, which is essential for its conservation. Peripheral populations may have genetic characteristics essential to overall longterm conservation of the species (i.e., they may be genetically different than more central populations) (Lesica and Allendorf 1995). The populations in this unit can likely maintain genetic connectivity within and among themselves, and they may maintain genetic connectivity with the Otay Valley/Big Murphy's Unit. Therefore, the populations in this unit are essential to the conservation of the species.

Unit 2: Chula Vista Unit The Chula Vista Unit encompasses approximately 210 ha (520 ac) at the western portion of this plant's range. Most of the populations in this unit are found in the remaining habitat patches along canyon edges that were not developed. This unit contains lands that are proposed as preserve under the draft City of Chula Vista Subarea Plan, lands that are in a minor amendment area under the County of San Diego's Subarea Plan, and lands that are in a minor amendment area under the draft City of Chula Vista Subarea Plan. This unit contains the Rice Canyon population, which had more than 50,000 standing plants in 1994 (CNDDB 2002), and

the Poggi Canyon population that had a reported 10,000 standing plants in 1990 (CNDDB 2002). This unit contains populations in the western extent of this species' distribution, which although currently isolated from each other, may contain significant amounts of genetic diversity and are, therefore, essential to the conservation of the species. Unit 3: Otay Valley/Big Murphy's Unit The Otay Valley/Big Murphy's Unit encompasses approximately 910 ha (2,250 ac). It is east of Interstate 805, north of the International Boundary between the United States and Mexico on the east side, north of State Route 905 on the west side, west of Otay Mountain, and along the north rim of Otay Valley including Salt Creek and Wolf Canyon. This unit includes lands owned by INS, lands that are proposed as preserve under the draft City of Chula Vista Subarea Plan, and lands that are in major and minor amendment areas in the County of San Diego Subarea Plan. Areas in this unit that are within the alignment for State Route 125 South have not been designated as critical habitat because these areas have been analyzed and determined not to be essential. This unit contains several large populations of Deinandra conjugens, such as the Johnson Canyon population, estimated at approximately 480,000 individuals (Helix Environmental Planning, Inc. 2001), capable of producing large numbers of individuals in good years. These large populations are essential for this plant to survive through a variety of natural and environmental changes as well as stochastic events. The unit also contains the Otay River Valley population, which was reported to have approximately 4,000 standing plants (Roberts 1997), the Wolf Canyon population, which was reported to have approximately 4,000 standing plants (Roberts 1997), the Brown Field population, which had a reported 5,600 individuals in 1998 (U.S. Army Corps of Engineers 2000), and the upper Salt Creek population, which was reported to have over 1,000 standing plants (Roberts 1997). Unit 3 contains populations in the southern and eastern portions of this species' distribution that are essential to the conservation of the species. One population in this unit is located at the southwestern edge of this species' range in the United States. This population may have connectivity with Deinandra conjugens populations in northwestern Baja California, Mexico. Because of its connectivity, this population is essential to the conservation of the species. Based on the proposed preserve design for the draft City of Chula Vista Subarea Plan, and the designated preserve designs for the City and County of San Diego HCPs, these populations may all retain connectivity among themselves because the habitat mosaic does not have large gaps. The populations in this unit may also provide and receive pollen or seed from Deinandra conjugens populations in the Sweetwater/Proctor Valley Unit. This connectivity will facilitate gene flow within this unit and among other units which, in turn, may allow evolutionary processes that affect Deinandra conjugens to continue relatively unimpeded. Maintaining the Deinandra conjugens populations and their genetic connectivity (both within and among units) is essential to the conservation of this species. A Deinandra conjugens population north of Otay Valley and west of Otay Lakes is located within designated critical habitat. This population may provide important genetic connectivity between the Salt Creek and Otay Valley populations. Because this unit contains a number of large Deinandra conjugens populations, these populations will maintain genetic connectivity within and among themselves, they will maintain genetic connectivity with the Sweetwater/Proctor Valley Unit and possibly with plants in Mexico, therefore, the populations in this unit are essential to the conservation of the species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Deinandra conjugens critical habitat consists of one component (67 FR 76030-76053):

The primary constituent elements of critical habitat for Deinandra conjugens are those habitat components that are essential for the primary biological needs of the species. Based on our current knowledge of this species, the primary constituent elements for Deinandra conjugens consist of, but are not limited to, soils with a high clay content (generally greater than 25 percent) (or clay intrusions or lenses) that are associated with grasslands, open coastal sage scrub, or maritime succulent scrub communities between 25 m (80 ft) and 300 m (1,000 ft) elevation. These plant communities contain natural openings that provide habitat for Deinandra conjugens lifecycle, and pollen and seed dispersal agents.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 1 year (USFWS, 2004)

Key Resources Needed for Breeding

Adult: Likely pollinators of Deinandra conjugens include, but are not limited to: bee flies (Bombylliidae), hover flies (Syrphidae), digger bees (Apidae), carpenter and cuckoo bees (Anthophoridae), leaf mason and leaf cutting bees (Megachilidae), and metallic bees (Halictidae) (Krombein et al. 1979; Bauder et al. 2002; M. Dodero, pers. comm. 2001). (USFWS, 2004)

Reproduction Narrative

Adult: Deinandra conjugens is a glandular, aromatic annual plant in the family Asteraceae. D. conjugens, like most other tarplants, is sporophytically self-incompatible (Keck 1959; B. Baldwin in litt. 2001). Likely pollinators of Deinandra conjugens include, but are not limited to: bee flies (Bombylliidae), hover flies (Syrphidae), digger bees (Apidae), carpenter and cuckoo bees (Anthophoridae), leaf mason and leaf cutting bees (Megachilidae), and metallic bees (Halictidae) (Krombein et al. 1979; Bauder et al. 2002; M. Dodero, pers. comm. 2001). (USFWS, 2004

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 25 and 300 m (80 to 1,000 ft) (USFWS, 2004)

Environmental Specificity

Adult: Broad (inferred from USFWS, 2004)

Site Fidelity

Adult: Moderate (inferred USFWS, 2004)

Habitat Narrative

Adult: Deinandra conjugens is found in vegetation communities classified as, but not limited to grasslands, open coastal sage scrub, and maritime succulent scrub, as well as the margins of some disturbed sites and cultivated fields (U.S. Fish and Wildlife Service 2002 and references therein, including: Keck 1959; Keil 1993; California Native Plant Society 2001; California Natural Diversity Data Base 2002; D. Hogan in litt. 1990; B. Baldwin, pers. comm. 2001; M. Dodero, pers. comm. 2001; S. McMillan, pers. comm. 2001). The presence of Deinandra conjugens is strongly correlated with clay soils, subsoils, or lenses (Figure 2) (Beauchamp 1986, S. Morey in litt. 1994, Bauder et al. 2002). The elevational range for D. conjugens appears to be between 25 and 300 meters (80 and 1,000 feet) (U.S. Fish and Wildlife Service GIS database 2004). (USFWS, 2004). SDMMP has developed, funded, and implemented objectives to address gaps in our understanding of Deinandra conjugens habitat that can be used to improve management and the recovery strategy (SDMMP 2021, Table 4.4-1). In 2018 the SDMMP funded a study focused on identifying geographic areas to support the resilience of edaphic endemic species. The study determined that D. conjugens occurred on nutrient-poor soils that had unique physical and chemical soil properties (CBI 2018, pp. i, 9). There was also a positive relationship between D. conjugens and clay, sodium, magnesium, and low-fertility soils. In addition, in 2016 a study was conducted to determine potential pollinators and assess visitation rates. Beetles in the family Melyridae were the most common visitors, followed by bees and flies (Marschalek and Deutschman 2016, entire). Both pollinators that occur in high numbers and those that move quickly between flowers were hypothesized to be important for pollination and gene flow in D. conjugens (USFWS, 2023).

Dispersal/Migration

Dispersal

Adult: High (USFWS, 2004)

Dependency on Other Individuals or Species for Dispersal

Adult: Small to large-sized mammals and birds including mule deer, gray fox, coyote, black-tailed jackrabbit, bobcat, striped skunk, opossum, raccoon, California ground squirrel, and various small land birds. (USFWS, 2004)

Dispersal/Migration Narrative

Adult: Deinandra conjugens fruits (achenes) are each one-seeded and have the potential to be dispersed by small to large-sized mammals and birds based on the sticky nature of the remaining flower parts that are attached to the fruits and the discontinuous distribution of other tarplants (U.S. Fish and Wildlife Service 2002, and references therein). Potential seed/fruit dispersal organisms known to occur in the region include, but are not limited to, mule deer (Odocoileus hemionus), gray fox (Urocyon cinereoargenteus), coyote (Canis latrans), black-tailed jackrabbit (Lepus californicus bennettii), bobcat (Felis rufus), striped skunk (Mephitis mephitis), opossum (Didelphis virginiana), raccoon (Procyon lotor), California ground squirrel (Spermophilus beecheyi), and various small land birds. Additionally, in the late summer, dried D. conjugens plants may be blown by the wind (A. Davenport in litt. 2004) thereby moving seeds. (USFWS, 2004)

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

36 presumed extant (USFWS, 2023)

Population Size:

Millions (USFWS, 2023)

Population Narrative:

There are currently 34 extant occurrences of Deinandra conjugens. At listing, it was estimated that as many as 300,000 plants might exist under favorable conditions. Given that D. conjugens is self-incompatible, difficulties withstanding changes in habitat or random events would be expected. (USFWS, 2004). Deinandra conjugens is an endemic plant found in southwestern San Diego County, California in the United States and northern Baja California, Mexico. At the time of listing, we defined its distribution as 25 historical and 22 extant locations near Otay Mesa, as well as 2 locations in Baja California, Mexico (Roberts 1997, p. 1; USFWS 1998, p. 54939). Since listing, the known range of D. conjugens in the United States now extends to the north and northwest in San Diego County, based on herbarium records at the San Diego Natural History Museum and additional survey efforts (USFWS 2002, p. 76032). To update Deinandra conjugens occurrence status, we reviewed Element Occurrence (EO) data from the California Natural Diversity Database1 (CNDDB) and monitoring data from the SDMMP. As of 2023, there are 36 extant or presumed extant occurrences in the United States and no occurrences were extirpated since the last 5-year review in 2009 (Appendix A). Based on recent survey efforts, new occurrences and records were discovered throughout the U.S. range, slightly expanding the distribution of Deinandra conjugens relative to its historical distribution. Coarse population estimates in 2019 recorded greater than 8 million standing individuals, suggesting that the abundance of D. conjugens is potential much higher than previously reported and supporting the statement that the species can take advantage of favorable climate conditions. Since the last 5-year review, research has determined the presence of one genetic cluster for occurrences of D. conjugens within the United States. A study on soil characteristics determined a positive relationship between D. conjugens and clay, sodium, magnesium, and low fertility soils that can be used to guide future restoration and management efforts. Additionally, recent surveys reported that there are 15 extant or presumed extant occurrences in Baja California, Mexico, greatly increasing our understanding of the species distribution which was limited to one occurrence at listing (USFWS, 2023).

Threats and Stressors

Stressor: Loss and degradation of habitat (USFWS, 2004)
Exposure:
Response:
Consequence:
Narrative: As discussed in the final rule, the primary cause of the decline of Deinandra conjugens was the loss and degradation of occupied and suitable habitat, primarily due to urban development and agriculture, resulting in the fragmentation and isolation of remaining populations. Several populations of Deinandra conjugens are subject to impacts from off-road vehicle activity, even within conserved open space and within the San Diego National Wildlife

Refuge. Although implementation of the MSCP requires that these effects be alleviated, this activity continues to threaten some populations. (USFWS, 2004)

Stressor: Habitat fragmentation/isolation (USFWS, 2004)
Exposure:
Response:
Consequence:
Narrative: Habitat loss and degradation often result in the fragmentation of remaining habitat patches and the isolation of habitat from the surrounding biological community. The result is disruption or impairment of processes within the biological community upon which Deinandra conjugens depends. Remnant patches of native vegetation become habitat islands and are subject to changes in their physical environment and microclimate that can disrupt or curtail their ability to function as suitable habitat. The effects of these changes may be modified by the size, shape and location of the remnant habitat in relation to the surrounding landscape. Fragmentation and isolation of native habitat can affect abiotic factors such as temperature, wind, erosion, and soil nutrients and cycling. For example, fragmentation can lead to changes in temperature; smaller remnants and edges of larger patches may experience higher air temperatures resulting from increased radiation. Higher temperatures may change nutrient cycling and soil microorganisms, and lower soil moisture. Such changes may affect germination and reproduction, and alter the plant community composition (Saunders et al. 1991). As remaining populations of Deinandra conjugens are further fragmented by surrounding urban development, the remaining patches of habitat will be more susceptible to changes that affect vegetation and animal communities. Changes in the diversity, distribution, and abundance of plants and animals could adversely affect D. conjugens directly or indirectly through changes in habitat suitability, disruption of plant/pollinator relationships, changes in seed dispersal, and demographic changes in extant populations. (USFWS, 2004)

Stressor: Non-native plant interactions (USFWS, 2004)
Exposure:
Response:
Consequence:
Narrative: Extant populations of Deinandra conjugens often occur in areas dominated by persistent weeds. Anecdotal field observations indicate that D. conjugens does not compete well in areas of dense invasive weeds (A. Davenport, pers. comm. 2003; S. McMillan, pers. comm. 2003). Invasive weeds and the associated buildup of thatch can have significant impacts on local populations of D. conjugens (M. Dodero, pers. comm. 2004). Greenhouse experiments with D. conjugens have documented significant reductions in plant biomass, plant height, extent of branching on individual plants, and flower production in plants grown in high densities of invasive weeds (Bauder et al. 2002). These factors can reduce successful reproduction and seed set. The adverse effects of invasive weeds on D. conjugens may be greatest in years of abundant rainfall, resulting in depressed populations of D. conjugens when conditions would otherwise be most favorable for population growth (Bauder et al. 2002). (USFWS, 2004)

Stressor: Population dynamics (USFWS, 2004)
Exposure:
Response:
Consequence:

Narrative: As discussed under Life History and Ecology (section I.C above), Deinandra conjugens is an obligate out-crosser (i.e., is self-incompatible); individual plants exhibiting this trait will not set viable seed when pollinated by pollen from the same plant, and pollination between full siblings will result in significantly reduced fecundity and successful reproduction (e.g., DeMauro 1993). Consequently, cross pollination between unrelated individuals and annual seed set are essential for long-term population survival and recovery. Limited seed dispersal or cross pollination can result in populations with localized clusters of related individuals. Such situations in D. conjugens may significantly reduce compatible pollinations, resulting in lowered annual reproduction. A significant decline in a local population, coupled with other environmental and demographic factors and the extensive habitat/population fragmentation and isolation, could result in the complete extirpation of Deinandra conjugens from a reserve. It is unlikely that a locally extirpated and isolated population can be naturally recolonized from nearby sites through seed dispersal, especially if the sites are separated by urban development. The lack of connectivity between many extant populations of D. conjugens renders these populations susceptible to deterministic or stochastic extirpations (Gilpin and Soulé 1986, Lande 1988, Frankham and Ralls 1998), and increases the risk of species extinction. (USFWS, 2004)

Stressor: Genetics (USFWS, 2004)
Exposure:
Response:
Consequence:
Narrative: Genetic variation is positively correlated with population size and/or species range, and is inextricably linked to population viability and long-term species survival. Large populations occupying contiguous habitat, or ones that cover a large range, generally have higher levels of genetic diversity, while smaller populations, or species occurring within restricted ranges or on islands, have lower levels of genetic variation (Frankham et al. 2002). A reduction in population size, or permanent fragmentation of formerly contiguous populations can result in reduced genetic diversity. The current reserve design for Deinandra conjugens includes many fragmented populations surrounded by urban development. The level of genetic diversity across the range of the species, including diversity at the S locus, in D. conjugens is unknown; however, initial studies of two populations indicate that diversity is high (Bauder and Truesdale 2000). Maintenance of the genetic diversity and gene flow (through cross pollination and/or seed dispersal) between fragmented populations could be critical to long-term survival and recovery. Nevertheless, we anticipate that the remaining populations may lose varying (but currently unknown) levels of genetic diversity without active management. Completely isolated populations may experience adverse effects from increased genetic drift and inbreeding depression (lowered population growth, reduced fitness, and higher susceptibility to environmental catastrophes; Frankham et al. 2002). These effects can be accelerated in populations that experience repeated and dramatic fluctuations in population size (Hard 1995, Lande 1999), which has been observed in D. conjugens. (USFWS, 2004)

Stressor: Plant/pollinator interactions and ecology (USFWS, 2004)
Exposure:
Response:
Consequence:
Narrative: Due to the self-incompatible trait inherent in Deinandra conjugens, successful cross pollination between unrelated individuals is essential to the long-term survival of populations of the species. The impacts of fluctuating population size and increased population fragmentation

and isolation can be further complicated through changes in plant/pollinator interactions. Habitat fragmentation and degradation can be deleterious to both native pollinators and to the plants that depend upon pollination service. Increased fragmentation and/or decreased patch (population) size can lead to a reduction in frequency of pollinator visits and pollinator diversity, and decrease seed set (Jennersten 1988). If the distance between habitat patches is greater than the foraging range of pollinators, or if pollinators ignore small plant populations or small habitat patches, reduction in pollination service may result. Individual plant size, patch (population) size, and/or plant density of the target species can also contribute to pollination limitation; isolated plants or patches may receive fewer pollinator visits and/or reduced deliverance of pollen from conspecifics versus foreign pollen (Kearns et al. 1998 and references therein). Non-native plant densities may also affect plant/pollinator interaction. Bauder et al. (2002) noted much lower visitation to D. conjugens by potential pollinators in an area dominated by non-native vegetation, as opposed to a patch growing in proximity to native scrub vegetation. Further, non-native vegetation may reduce the floral display of D. conjugens, thereby reducing their attractiveness to potential pollinators, and likely reducing seed set. Some native pollinators may not find suitable nest conditions within the clay soils that sustain populations of D. conjugens. Further, insect populations relying on nectar as a food resource generally require a suite of flowers available throughout the year. Consequently, maintenance of the surrounding native vegetation/habitats must be considered in recovery of D. conjugens. Additionally, not all insects that visit D. conjugens flowers may provide pollen transfer among individual plants. More research is needed regarding the specific pollinators of D. conjugens and their biology/ecology. (USFWS, 2004)

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Impacts to Deinandra conjugens associated with climate change were not identified as a threat at the time of listing. Our analysis under the Act now includes consideration of ongoing and projected changes in climate conditions. The range of D. conjugens in southern San Diego County is projected to become more arid with forecasted increases in temperature and greater variability in precipitation, including the potential for prolonged droughts and extreme precipitation events (Cal-Adapt 2013b). Wildfire risk is also expected to increase due to more arid conditions and the increase in vegetation biomass and fuel load that follow high precipitation El Niño events. Increasing drought stress and wildfire risk are a threat to D. conjugens throughout its range in the United States and Mexico. SDMMP developed habitat suitability models for Deinandra conjugens under future climate scenarios (CBI 2018, p. 16). The results project that there would be no suitable habitat for this species in the region under any of the global climate models, representative concentration pathways (RCPs), and time periods used in their assessment. However, due to uncertainties it is difficult to reliably predict the species response over this time. Deinandra conjugens is also known to have a persistent soil seed bank due to its hard seed coat, which may help to ensure persistence into the future, but the length of seed dormancy is still largely unknown. We have limited, anecdotal information that field seed dormancy is at least 10 years based on a nonnative grass control project (CBI 2017, p. 1; SDMMP 2021, pp. 215–216) and laboratory germination studies (Birker 2023, pers. comm). Following these management actions, individuals germinated from the existing seed bank. This result suggests some ability to buffer against drought conditions; however, we currently lack data to predict the timing and magnitude of the species response to climate change effects (USFWS, 2023).

Stressor: Off-Highway Vehicle Use (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: In our listing rule, we identified OHV activity as a threat to Deinandra conjugens (USFWS 2002, p. 54946). In our previous 5-year review, we stated that OHV activity was recognized as a threat at 11 of 34 occurrences of D. conjugens (citing McMillan 2003, pp. 1–10), and continued to be so at 7 of 34 extant occurrences in 2009 (USFWS 2009, p. 20). OHV activity may modify D. conjugens habitat by promoting erosion, compacting the soil (especially if OHV activity occurs on wet soils), and encouraging invasion by nonnative plants (Kuss 1986, pp. 637–650). OHV activity can also crush or damage the above-ground portions of individual annual plants, depending on the timing of the activity, potentially disrupting reproduction. Impacts to D. conjugens associated with OHV activity was identified as a localized threat to 12 of 36 U.S. occurrences (Appendix A). Although we have no current, comprehensive surveys for all occurrences of Deinandra conjugens, annual San Diego MSCP Subarea Plan monitoring reports have provided information regarding the impact of OHV and other recreational activities at several locations. For example, monitoring was conducted in 2012 at multiple sites within the Otay Ranch Preserve to identify previously undetected plant and animal species, weeds, and the overall health of the preserve (RECON 2013a, pp. 9–10). Recreational access issues (and weeds) were described during surveys within the occupied Salt Creek occurrence of D. conjugens (EOs 18 and 42; RECON 2013a); however, management actions have been installed at some locations to minimize or eliminate access. For example, fencing and signs were installed at access roads and along the eastern boundary fence near the Salt Creek occurrence to limit OHV access (RECON 2013a, p. 24). Fencing was also installed along the southern boundary of the eastern portion of the Otay River occurrence (EOs 15 and 40) (also known as the Salt Creek FUDS area; RECON 2013a, p. 24). Within the City of San Diego MSCP Subarea Plan, management actions were conducted in 2012 to control public access in urban canyons. These included the removal of homeless encampments from the Paradise Canyon area (EO 60), and placement of rock barriers/pipe gates at several other urban canyons to prevent dumping, unwanted vehicle entry, and other impacts to native habitat (City of San Diego 2013, p. 12). Additionally, protective fencing and signage were installed in Rice Canyon (EO 9) in 2021 (RECON 2021, pp. 1–3). Ongoing management (i.e., fence repair) will be required in the future to ensure that this threat is reduced or eliminated at these and other occurrences that are accessible to the public (USFWS, 2023).

Stressor: Fuel Modification (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Fuel modification, the creation and maintenance of fire breaks or fuel breaks, is a practice often used for wildland fire management that may impact individuals or modify Deinandra conjugens habitat in the areas affected. Maintenance of firebreaks was mentioned in our 2004 recovery plan as a threat to D. conjugens at two CNDDB-defined occurrences – EO 3 and portions of (current) EO 10 (USFWS 2004, p. 13). Additionally, fuel modification is an identified threat at EOs 6, 34, 35, 37, 46, 49, 54, and 57, though most plants are not likely to be impacted on these eight occurrences because we expect that they will be avoided on conserved lands (CNDDB 2023, entire) (USFWS, 2023).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. Known populations (including naturally occurring seed banks) within areas identified for conservation under the MSCP are permanently protected from future development or other significant threats. (USFWS, 2004)

2. Permanent funding and management mechanisms that are required under the MSCP are in place and functioning. (USFWS, 2004)

3. Established reserves (i.e., MSCP preserve lands, land protected under other habitat conservation plans, National Wildlife Refuge lands, and State preserve lands) provide sufficient suitable habitats and space to sustain the full ecological needs of Deinandra conjugens. We expect these needs to include: a) connectivity to maintain natural gene flow among conserved populations, and b) sufficient habitat to maintain wild populations of native D. conjugens pollinators. (USFWS, 2004)

4. Populations of Deinandra conjugens are stable or increasing within established reserves. As discussed by Rice (1989), seed banks typically are "more developed in annuals than in perennials" and "more extensive in forbs than in grasses." For D. conjugens, an annual forb, population stability will depend on the long-term maintenance of the seed banks within each reserve. The primary factors that may threaten the long-term maintenance of D. conjugens and its seed banks include reduced or failed pollination (i.e., pollinators) and fruiting, excessive seed predation, loss of genetic variability and inbreeding, and impaired seed dispersal within and potentially among reserves. (USFWS, 2004)

5. Criteria 3 and 4 have been assessed through monitoring over an adequate length of time to incorporate year-to-year variability associated with known variations in climate (e.g., drought, El Niño/Southern Oscillation, etc.). We anticipate a period that encompasses three drought cycles; however, this time period may change should additional scientific information on the amount of time necessary to adequately determine the population trend of Deinandra conjugens indicate otherwise. If the species is delisted, the monitoring period will be extended for an additional 5 years after delisting, as required by the Endangered Species Act for species that are delisted due to recovery. (USFWS, 2004)

6. The current status (including a threats assessment) and distribution of Deinandra conjugens have been determined in Mexico.

7. Depending on the results from criterion 6, dialogue should be established with Mexican governmental and nongovernmental organizations to secure protection for Deinandra conjugens in Mexico. (USFWS, 2004)

8. Research on several critical aspects of the species' biology and ecology, as detailed in the Recovery Narrative section, has been completed to adequately assess the above recovery

criteria. Results should be published in readily available refereed journals. Results from this research may redirect the recovery strategy. (USFWS, 2004)

Recovery Actions:

- Stabilize and protect habitat supporting known populations within the conserved areas under MSCP control, outside of MSCP control, and in Mexico. (USFWS, 2004)
- Assess the status of all known populations to determine: population size (area and number of individuals), reproduction, distribution, threats to stability or viability, and land management objectives. (USFWS, 2004)
- Conduct surveys to search for new populations and implement actions to protect populations outside of established reserves when necessary to maintain genetic diversity and/or connectivity between larger reserves. (USFWS, 2004)
- Adaptively manage and monitor conserved areas. (USFWS, 2004)
- Identify research needs and conduct studies on the biology and ecology of Deinandra conjugens. (USFWS, 2004)
- Develop and implement a community outreach program. (USFWS, 2004)
- Implement and fully fund a management plan for the MSCP Preserve that includes adequate provisions for management of invasive, nonnative plants. (USFWS, 2009)
- Encourage permit holders to complete the MSCP Preserve on private lands, to include the targeted Deinandra conjugens occurrences, by identifying opportunities through the Service's Partners Program. (USFWS, 2009)
- Develop, implement, and monitor effective invasive species management actions for all conserved occurrences of Deinandra conjugens. (USFWS, 2009)
- Reevaluate recovery criteria for this species to incorporate meaningful measures of the degree to which recovery has been achieved. (USFWS, 2009)
- Identify and monitor measures for indicating species status that are separable or insulated from natural annual population expressions. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are based on outstanding actions from the 2004 Recovery Plan for Deinandra conjugens (Appendix C; USFWS 2004, entire), SDMMP management objectives (SDMMP 2021, Table 4.4-1), and threats identified in this review. Successful implementation of these actions will further reduce threats to D. conjugens and help to recover the species. 1. Work with partners to identify opportunities for conservation or preservation of Deinandra conjugens occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire D. conjugens habitat. 2. Adaptively manage Deinandra conjugens occurrences to maintain, enhance, or restore habitat and reduce threats. a. Continue to manage the threat of nonnative plants (i.e., invasive annual grasses) through de-thatching and direct control. b. Restore or augment small and/or declining extant occurrences once threats have been ameliorated. 3. Monitor occurrences (evaluate habitat quality) and assess management effectiveness. a. Conduct surveys to evaluate the status of populations that have not been visited in the last 10 years. b. Conserve Orcuttia californica seed in an off-site seed bank and develop associated storage techniques to support research, restoration, and management. 4. Improve habitat connectivity for pollinators and seed dispersers to maintain gene flow. a. Determine the level of variability in the self-compatibility allele within and among populations. b. Identify the habitat requirements of potential pollinators. c. Develop techniques for germination, propagation,

and habitat restoration to improve connectivity. 5. Extend the genetic study to new occurrences in Baja California, Mexico. 6. Protect habitat supporting known populations of Deinandra conjugens outside of MSCP participating jurisdictional control. 7. Develop conservation related outreach materials. 8. Engage with the Mexican government regarding measures to conserve known populations (USFWS, 2023).

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SPECIES ACCOUNT: *Deinandra increscens ssp. villosa* (Gaviota Tarplant)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/20/2000; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Deinandra increscens ssp. villosa has pale to deep yellow disk and ray flowers. The foliage is variable gray-green and soft hairy. The plants generally range from 12 to 35 in (30 to 90 cm) tall with stems that generally branch near the base. The lower leaves are 2 to 3.4 in (5 to 8.6 cm) long. The inflorescence is typically rounded to flattopped with the flower heads in tight groups or paired. The peduncles are generally shorter than the involucres with mostly 13 ray flowers per head, but can vary between 8 and 15 ray flowers, and generally have 16 to 32 disk flowers per head (Baldwin 2009). Each flower head of Deinandra increscens ssp. villosa and other species in the family Asteraceae produce one-seeded fruits called achenes. (USFWS, 2011)

Taxonomy

Baldwin (2009) states "Deinandra increscens subsp. villosa differs from subsp. increscens in having more congested and, on average, shorter (generally < 45 cm tall) capitulescences, with phyllaries shorter than associated peduncles and peduncular bracts strongly overlapping the phyllaries, sometimes forming a distinct calyculus. Compared to D. increscens subsp. increscens, D. increscens subsp. villosa often has larger heads, which can reach the largest sizes in D. increscens, with up to 14 (–15) rays and up to 32 discs per head, but head size overlaps strongly with that of D. increscens subsp. increscens. Deinandra increscens subsp. villosa is known only from Santa Barbara County, mostly from the vicinity of Point Conception to Gaviota and north to the northern slopes of the western Santa Ynez Mountains", with outlying populations at Point Arguello and a northern outlier at Lion's Head (near Point Sal) (Baldwin 2009; Baldwin, pers. comm.2010a, pers. comm. 2010b; Elvin 2010b). (USFWS, 2011)

Historical Range

Historically, Deinandra increscens ssp. villosa was originally known only from the immediate vicinity of the unincorporated town of Gaviota, with plants occurring up to several kilometers in either direction along the immediate coast. (USFWS, 2011)

Current Range

Currently, it has a highly localized distribution in western Santa Barbara County, California with seven main populations that range from the vicinity of Point Sal in the north to Gaviota in the south. (USFWS, 2011)

Critical Habitat Designated

Yes; 11/7/2002.

Legal Description

On November 7, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Deinandra increscens ssp. villosa (Gaviota Tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in

California (67 FR 67968-68001).

Critical Habitat Designation

The critical habitat designation for Deinandra increscens ssp. villosa includes three CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 9,709 acres (67 FR 67968-68001).

Sudden Peak Unit: The Sudden Peak Unit consists of a 5- km (3-mi) stretch of ridgeline in the western portion of the Santa Ynez Mountains west of Sudden Peak, and generally includes grasslands above the 215-meter (700-foot) contour line. This unit is 320 ha (791 ac) and is comprised entirely of privately owned lands. Vandenberg Air Force Base holds an easement on a portion of these private lands. This unit includes two populations of Deinandra increscens ssp. villosa that comprised over 1,000 individuals in 1998. This unit is known to support populations away from the immediate coast and is at higher elevation than any other known D. increscens ssp. villosa location (425 m (1400 ft)). As a result, the populations in this unit experience more extreme seasonal temperatures and a lack of summer fog than most other populations which occur directly on the coast.

Santa Ynez Unit: The Santa Ynez Unit consists of a 9.7-km (6-mi) stretch of ridgeline of the Santa Ynez Mountains, ranging from Canada de las Agujas east to Canada del Agua Caliente. This unit of 433 ha (1,070 ac) is comprised entirely of privately owned lands. Deinandra increscens ssp. villosa occurs at 305 m (1,000 ft) in this unit, on the sandy mountain ridgelines. This unit supports two known populations of D. increscens ssp. villosa that comprised approximately 400 individuals in 1998. The terrain here differs from most other known locations in that it is characterized primarily by slopes that intergrade with flatter areas, rather than a flat marine terrace.

Conception-Gaviota Unit The Conception-Gaviota Unit consists of a 51.5-km (23-mi) long stretch of habitat along the coast from Point Conception, east to Gaviota, and encompasses 3,176 ha (7,848 ac). At its widest point, this unit extends inland approximately 3.2 km (2 mi). This unit is comprised almost entirely of privately owned lands (98 percent). This unit also consists of State lands at Gaviota State Beach and lands in the process of being transferred to CDFG for the Gaviota Tarplant Reserve (2 percent). This unit is particularly important because it supports most of the known populations of Deinandra increscens ssp. villosa that occur along the immediate coast. This includes the Gaviota population which was once extensive but is currently in decline, two small patches discovered in 1998 between Gaviota and Point Conception, and an extensive population discovered in 2000 that ranges from Government Point to the area near Jalama Beach County Park. Given these recent observations and the proximity to existing populations, we believe that there may be additional unsurveyed areas within the unit that may support D. increscens ssp. villosa. The populations here occur on a flat marine terrace along the immediate coast and likely experience summer fog and a mild maritime climate.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Deinandra increscens ssp. villosa critical habitat consists of two components (67 FR 67968-68001):

(i) Sandy soils associated with coastal terraces adjacent to the coast or uplifted marine sediments at interior sites up to 5.6 km (3.5 mi) inland from the coast, and

(ii) Plant communities that support associated species, including needlegrass grassland and coastal sage scrub communities, particularly where the following associated species are found: Needlegrass species (Nassella spp.), California sagebrush (Artemisia californica), coyote bush (Baccharis pilularis), sawtooth golden bush (Hazardia squarrosa), and California buckwheat (Eriogonum fasciculatum).

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for the two taxa within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites, and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two taxa. We have outlined below the kinds of special management and protection that these two taxa would most likely require. These recommendations for management and protection are general in nature. Specific management actions should be developed according to local site conditions. Not all of these will apply to each plant taxon equally. (1) Existing soil conditions should be protected by avoiding activities that cause the erosion or compaction of soils. Maintaining an intact soil profile may be necessary to maintain edaphic features such as a horizon of permeable sandy soils on the surface layer. For example, Deinandra increscens ssp. villosa is thought to be restricted to acidic, fine sandy loams with a subsurface clay layer that may act as a reservoir of soil moisture. (2) Existing hydrologic conditions should be protected by avoiding activities that cause a change in surface or subsurface water flows upon which the plant taxa depend. For example, development of areas adjacent to a population may result in an increase in runoff and surface water flow. This alteration may affect the soil moisture content to which the local population has adapted. (3) In all plant communities where these taxa occur, invasive, non-native species, such as harding grass (Phalaris aquaticus), veldt grass (Ehrharta calycina), and iceplant (Carpobrotus edulis), should be actively managed. Invasive non-natives pose a serious threat to the survival of Deinandra increscens ssp. villosa and Eriodictyon capitatum and remaining habitat of the taxa. For example, accumulated dead leaves and stems (thatch) from nonnative grass species that dominate the habitat effectively prevent the establishment of D. increscens ssp. villosa at a site. Iceplant is known to invade native maritime chaparral vegetation occupied by Eriodictyon capitatum. Once non-native grasses and other invasive plants (e.g., iceplant) have become established, they cannot be removed without great expenditure of time and effort. (4) The composition of the native plant and animal communities associated with the taxa must be maintained. Native plant diversity may limit the ability of aggressive non-native plants to invade a population (Dukes 2002). In addition, a decline in biodiversity may increase the potential impact of invasive plants on a community (e.g., suppression of growth). Recent research suggests that grassland communities with fewer species may be more likely to decline as a consequence of invasion (Dukes 2001). In addition, native plant diversity may increase pollinator activity and therefore enhance the conservation of a plant species. Biologists have suggested that a plant population may persist as long as it occurs within an area of a diversity of plant species that are attractive to pollinators (Kwak 1988). Habitat fragmentation and isolation of species-rich grasslands, with intervening areas of no or low diversity of native plants, has been found to negatively affect plant-pollinator interactions (Stephann-Dewenter and Tscharntke 1999). (5) The local distribution of plant communities should be managed to provide for the physical requirements of the taxa (e.g., space for establishment). For some grassland areas, it may be important to maintain

openings within or between coastal scrub communities that might otherwise encroach upon grassland patches that support Deinandra increscens ssp. villosa. (6) Certain areas where these taxa occur may need fencing to protect them from accidental or intentional trampling by humans and livestock. Portions of three of the five units are currently used by livestock

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated.

Lifespan

Adult: 1 year (USFWS, 2011)

Breeding Season

Adult: June to September (NatureServe, 2015)

Other Reproductive Information

Adult: SBBG completed two new studies focused on Gaviota tarplant pollinators and other factors associated with pollination of the species at the Sudden Peak/Tranquillon Mountain population/occurrence 12 (Figure 1). In the first study, Knapp et al. (2021) found that Gaviota tarplant attracts a diversity of insect flower visitors in five orders: Coleoptera (beetles), Diptera (flies), Hemiptera (true bugs), Hymenoptera (sawflies, wasps, bees, and ants), and Lepidoptera (butterflies and moths). Of a total of 110 flower visitors observed during the study, 99 of them were using Gaviota tarplant and only 11 were using other co-occurring species. Therefore, Gaviota tarplant may be a magnet species within areas it occupies, such that it increases pollination of other less attractive, co-occurring species and is the main agent drawing pollinators to occupied areas. They also found that percent cover of Gaviota tarplant and sampling month were the most important factors affecting the model for flower visitor richness and abundance. Maximum pollinator activity occurred during the months of July and August, which corresponded to the peak robustness of Gaviota tarplant observed through the month of August. Other important variables, including distance to nearest wind turbine (because the study plots are located within a wind-energy construction site), number of Gaviota tarplant flowers present, richness of flowering species present, and cover of blooming, non-Gaviota tarplant species also contributed to the best fit model. But none of these other variables were statistically significant (USFWS, 2022)

Reproduction Narrative

Adult: Deinandra increscens ssp. villosa (Gaviota tarplant) is a self-sterile annual plant in the sunflower family (Asteraceae) (Tanowitz 1982; Keil 1993; B. Baldwin, University of California, Berkeley, Jepson Herbarium, in litt. 2001; Baldwin 2010). Each flower head of Deinandra increscens ssp. villosa and other species in the family Asteraceae produce one-seeded fruits called achenes.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands intergrading with coastal sage scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Soil pH of 5.0 or lower, prefers marine terraces and uplifted marine sediments ranging from 150 to 1,000 feet (46 to 305 m) (USFWS, 2011; NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Dependency on Other Individuals or Species for Habitat

Adult: Deinandra increscens ssp. villosa is associated with grasslands comprised of native Nassella spp. (needlegrass), nonnative species such as Avena spp. (wild oats) and Bromus diandrus (ripgut brome), and other herbs and grasses. The grasslands throughout the range of the species are interspersed with coastal sage scrub generally dominated by Artemisia californica (California sagebrush), Baccharis pilularis (coyote brush), Hazardia squarrosa (sawtooth golden bush), and Eriogonum fasciculatum (California buckwheat) (California Natural Diversity Database (CNDDB) 2010). (USFWS, 2011)

Habitat Narrative

Adult: Gaviota tarplant requires grassland habitats. Occupied areas often intergrade with coastal sage scrub communities and are dominated by nonnative, Mediterranean annual grasses such as wild oat (Avena spp.), bromes (Bromus spp.), false brome (Brachypodium distachyon), and nonnative forbs like storksbill (Erodium spp.). Native grasses and forbs can also co-occur with Gaviota tarplant but are typically less dominant. Shrubs are largely absent in stands occupied by the species, although shrubs may occur in intergrade zones and other successional areas, like sawtooth goldenbush (Hazardia squarrosa), California buckwheat (Eriogonum fasciculatum), and coyote brush (Baccharis pilularis). Areas that provide suitable grassland habitats for the species include marine terraces, coastal bluffs, active and inactive cattle ranches, undeveloped plains and prairie areas, and open fields (USFWS, 2022).

Dispersal/Migration

Dispersal

Adult: High (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Achenes of Deinandra spp. are most likely dispersed by adhesion of the sticky bracts clasping the ray achenes to animal fur or feathers (Baldwin, in litt. 2001). (USFWS, 2011)

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

27 (USFWS, 2022)

Population Size:

>1,000,000 at one site (USFWS, 2022)

Population Narrative:

Currently, Deinandra increscens ssp. villosa has a total of 26 known occurrences grouped among 7 populations ranging from the coastal terraces on the bluffs at Lion's Head near Point Sal to the mountains of the Western Transverse Ranges, to the coastal terraces on the bluffs at Point Conception and Gaviota (Service 2000, 2002, CNDDB 2010, CCH 2010; Baldwin 2009, 2010; Elvin 2010a, 2010b). The number of standing Deinandra increscens ssp. villosa plants has been shown to vary considerably within any given occurrence from year to year. (USFWS, 2011). Gaviota tarplant is now known from a total of 27 occurrences all within southwestern Santa Barbara County (Figure 1). Most of the occurrences are distributed across the same seven core populations identified in our 2011, 5-year review (Service 2011, pg. 6). From Gaviota, traveling north these include: 1. Gaviota Coast; 2. Hollister Ranch Coast; 3. Hollister Ranch/Santa Ynez Mountains; 4. Point Conception/Dangermond; 5. Sudden Peak/Tranquillon Mountain; 6. Point Argeullo; and 7. Point Sal/Lions Head. There are two new Gaviota tarplant occurrences, numbers 13 and 14 that are recently discovered colonies mapped along the coast, in areas north of Jalama Beach, predominantly on VSFB (VSFB 2022, pers comm). Portions of occurrence 14 were first mapped on VSFB in 2015 (ManTech SRS Technologies 2016, pg. 20; ManTech SRS Technologies 2020, pg. 12). There is also a historical herbarium record within occurrence 14 collected in 1928 (CCH2 2022, website). The rest of the colonies within occurrence 14, and all of occurrence 13, were mapped on VSFB in 2019 (ManTech SRS Technologies 2020, pg. 12 and 41). Therefore, we now recognize a new eighth population of Gaviota tarplant that we are referring to as Jalama Beach (USFWS, 2022).

Threats and Stressors

Stressor: Degradation and loss of habitat due to agriculture and urban development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Since the time of listing, threats to Deinandra increscens ssp. villosa and its habitat by degradation and loss of habitat have increased due to agriculture and urban development (Service 2000, CNDDB 2010). Populations on Hollister Ranch, along the coast, and in the Santa Ynez Mountains are affected by trampling from cattle and horses, discing for agricultural practices, and residential development (CNDDB 2010; M. Meyer, California Department of Fish and Game (CDFG), in litt. 2010a). For instance, CDFG issued an incidental take permit (ITP) for a single family house to be located within an area known to be occupied by D. increscens ssp. villosa (CDFG ITP permit 2018-2004-042-05) in 2004. Cattle and horses continue to graze in D. increscens ssp. villosa habitat between Gaviota State Park and Jalama Beach County Park (CNDDB 2010). Cattle grazing in some areas occupied by D. increscens ssp. villosa appears to have facilitated the displacement of D. increscens ssp. villosa and favored the dominance of D. fasciculata, (fascicled tarplant) a common native tarplant in other parts of southern California (Rindlaub, in litt. 1998). (USFWS, 2011)

Stressor: Invasion of additional nonnative species of eucalyptus (USFWS, 2011)
Exposure:

Response:
Consequence:
Narrative: Nonnative Eucalyptus trees were planted in the Gaviota area on adjacent private lands and along Highway 101 as visual screens, windbreaks, and landscaping during the early 1900s and have continued to spread since then. Several species of Eucalyptus are present on various private and public properties in the area. Some species are expanding and increasingly overtaking coastal grasslands and scrub-lands (e.g., Eucalyptus conferuminata, E. globulus) (Meyer, in litt. 2010a; Ritter, pers. comm. 2010; Ritter, in litt. 2011). (USFWS, 2011)

Stressor: Loss of habitat and indirect effects from wind energy development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Lompoc Wind Energy Project is a commercial wind energy facility proposed to be constructed and operated on approximately 2,950 acres (1,194 ha) in the Sudden Peak and Tranquillion Mountain area (CH2M Hill 2007). The project is planned to include the following components: 60 to 80 wind turbine generators, new access roads and road improvements, a communication system, meteorological towers, an operations and maintenance facility, onsite electrical collection and distribution lines, an onsite project substation, a new 7.85-mile (12.6km), 115-kilovolt Pacific Gas and Electric (PG&E) power line to the Lompoc area to interconnect with the PG&E electric grid, and upgrades to existing PG&E facilities in the area. Deinandra increscens ssp. villosa occurs throughout the central and western portions of the 2,950-acre (1,194-ha) project site and all 791 acres (320 ha) of the Sudden Peak Unit of critical habitat for D. increscens ssp. villosa occur within the project site (CH2M Hill 2007, Service 2002). This proposed project would likely have direct and indirect effects to occupied D. increscens ssp. villosa habitat. Effects from this project (direct and indirect) are estimated to include loss or modification of habitat; changes in hydrology; temporary or permanent loss of individuals; changes in vegetation; and an increase in nonnative or invasive species, night-lighting, dust, noise, and vehicle emissions (CH2M Hill 2007). The effects of competition with nonnative species is most problematic immediately adjacent to habitat that has been isolated or fragmented by development (Alberts et al. 1993). The development of wind energy projects in areas occupied by D. increscens ssp. villosa may also affect individuals or seed banks for this species and are further discussed in Factor E below. There are additional leases for wind energy development within the range of D. increscens ssp. villosa (Meyer, in litt. 2011), at the north end of the range near Point Sal and at the south end of the range near Point Conception. (USFWS, 2011)

Stressor: Sea level rise due to climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Sea level rise, as a result of global climate change, has the potential to alter and diminish the habitat of Deinandra increscens ssp. villosa because of its proximity to the coastline. At the time of listing D. increscens ssp. villosa, we did not discuss the potential effects of climate change on its long-term persistence (Service 2000). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The specific manner in which climate change could affect D. increscens ssp. villosa is unknown at this time due to the general nature of these predictions.

Because five of the seven populations of D. increscens ssp. villosa occurrences are on coastal terraces, erosion of these areas and corresponding loss or decreased quality of habitat could adversely affect these populations by causing habitat conversion within and adjacent to occupied habitat areas for this species. Climate change and sea level rise may also affect individuals or seed banks for this species. (USFWS, 2011)

Stressor: Development and alteration of habitat from mission operations at VAFB (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Facility maintenance and development for military and private commercial purposes planned at VAFB may result in loss and alteration of habitat occupied by Deinandra increscens ssp. villosa (U.S. Air Force 2008). Deinandra increscens ssp. villosa is known to occur in and around launch sites on VAFB (CNDDB 2010, Elvin 2010b). The U.S. Air Force conducts vegetation maintenance activities around launch facilities at VAFB to reduce the chance of fires. Additionally, the potential for deposition of exhaust products from launch vehicles could adversely affect D. increscens ssp. villosa and its habitat. Mission operations (e.g., antiterrorism operations, space launches), infrastructure support activities (e.g., road and utility maintenance), and environmental management programs (e.g., grazing and invasive species removal) may affect D. increscens ssp. villosa (U.S. Air Force 2008). Missile launch operations, such as adjacent to Space Launch Complex-6, could adversely affect habitats surrounding launch facilities. In 1993, a missile was destroyed shortly after launching at VAFB, and a series of brush fires caused by burning rocket fuel burned more than 400 acres (162 ha). Large fragments of metal blasted downward toward the ground caused physical damage to the habitat on base around the launch site (Wallace 1993). In September 1997, a 500-acre (200-ha) fire and a 1,500-acre (600-ha) fire burned near occupied habitat of Eriodictyon capitatum (Los Angeles Times 1997a). Fire containment lines constructed by bulldozers in the vicinity of the species were observed after the fire (J. Watkins, U.S. Fish and Wildlife Service, pers. comm. 1997). On November 1, 1997, a 1,225-acre (495-ha) fire that was accidentally set by an explosives disposal team at VAFB was partially contained by back-burning (Los Angeles Times 1997b). Mission operations may also have direct effects to individual D. increscens ssp. villosa plants and the seed bank and are further discussed in Factor E below. While mission operations at VAFB may have some adverse effects to D. increscens ssp. villosa and its habitat, the U.S. Air Force's mission at VAFB is expected to have long-term benefits to D. increscens ssp. villosa and its habitat because, in order to accomplish its mission at VAFB, the U.S. Air Force needs to maintain extensive tracts of undeveloped and encroachment-free property. These extensive tracts of undeveloped and encroachment-free property will likely allow D. increscens ssp. villosa to persist. (USFWS, 2011)

Stressor: Cattle grazing (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Service also stated that cattle grazing has occurred within the habitat of D. increscens ssp. villosa and that low levels of grazing may enhance the opportunities for it to propagate successfully, as it may serve to reduce competition from nonnative species. However, some evidence indicates that heavy grazing has affected individuals of D. increscens ssp. villosa by reducing their stature and the number of seeds that can be produced. Populations on Hollister Ranch, along the coast, and in the Santa Ynez Mountains are affected by cattle and

horse grazing (CNDDB 2010; Meyer, in litt. 2010a). VAFB leases grazing allotments that overlap with portions of all three populations on the base, the allotments are managed under a rest and rotation system that minimizes adverse effects and maximizes the reproductive success of populations that are grazed (U.S. Air Force 2008). An analysis of these threats is contained in the final rule and appears to remain currently valid. (USFWS, 2011)

Stressor: Flower beetle (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Service stated that approximately 50 percent of the disk and ray achenes of D. increscens ssp. villosa had been observed to be infested by an unidentified flower beetle (Rindlaub, in litt. 1998). (USFWS, 2011)

Stressor: Genetics issues as affected by small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Most species in the genus Deinandra (including D. increscens ssp. villosa specifically) are self-incompatible and cannot produce viable seeds without cross pollinating within their respective taxa (Baldwin, in litt. 2001). Evolutionary processes such as mutation, natural selection, genetic migration, and random genetic drift are known to adversely affect small populations (Barrett and Kohn 1991). Adverse effects from these evolutionary processes on self-incompatible species such as D. increscens ssp. villosa are magnified by its self-incompatibility (Keck 1959; Tanowitz 1982; Baldwin, in litt. 2001). Maintaining gene flow among the populations is essential to counter the adverse effects from the evolutionary forces mentioned above and to ensure the long-term survival and conservation of this species. Both theoretical and empirical evidence indicates that smaller populations (those also possessing lower genetic variation) tend to have higher mortality rates and reduced fecundity, which leads to demographic fluctuations (Lande 1988, Les et al. 1991, DeMauro 1993, Heywood 1993, Lacy 1997, Frankham et al. 2002). At the extreme, very small populations suffer from inbreeding depression and the adverse effects of genetic drift (Barrett and Kohn 1991, Les et al. 1991). In plant species exhibiting sporophytic self-incompatibility, such as D. increscens ssp. villosa, the potential for adverse effects from inbreeding and genetic drift are greater than in species with gametophytic self-incompatibility (Baldwin, in litt. 2001). A reduction in population size, due to demographic or environmental stochasticity or long-term fragmentation of populations, could reduce the pool of S alleles, thereby reducing successful cross-pollination and reproduction (Les et al. 1991, DeMauro 1993). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: It is clear that an increase in the rate of sea level rise has been predicted for the coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). In particular, beaches and coastal bluffs along the coast will be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 with an estimated rise

in sea level in Santa Barbara County at 5.28 feet (1.61 m) (CCC 2001, Heberger et al. 2009). Because many D. increscens subsp. villosa occurrences are on the terraces on coastal bluffs, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks in five of the seven populations of this species. See Factor A for additional discussions regarding climate change in relation to this species. (USFWS, 2011)

Stressor: Emergency response activities (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Many Deinandra increscens ssp. villosa populations occur on coastal bluffs or open areas in the Santa Ynez Mountains that are associated with grasslands and sparse coastal sage scrub. Many of the known populations of this species grow in and adjacent to large open areas that generally have little vegetation and a flat or level geography that also has easy access from paved roads. These features are attractive to and preferred by emergency response organizations for use as staging areas and command posts during emergency response situations such as wildfires or other law enforcement actions. Establishing staging areas and or command posts quickly and close to a developing situation is important and the agencies may not have the ability to check resource databases (e.g., CNDDB) before setting up these posts to conduct their essential operations. Establishing a staging area or command post on D. increscens subsp. villosa plants would result in the crushing of these plants and seeds. (USFWS, 2011)

Stressor: Nonnative, Invasive Weeds (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Nonnative, invasive weeds compete directly with native species for resources and degrade habitat quality. Further, buildup of thatch from nonnative, invasive weeds can inhibit and arrest germination of natives and suppress their seedbanks. Strauss, and other future development projects, will have ongoing operational and maintenance components that have potential to continue to adversely affect the species and its habitat via introduction and spread of nonnative, invasive weeds. Development increases habitat fragmentation, which increases edge effects around occupied areas, that results in expansion and spread of nonnative, invasive weeds and increased fire risk. In turn, shifts in the plant species community composition can adversely affect pollinators, and increased fire frequency typically results in increased spread and expansion of nonnative, invasive weeds (USFWS, 2022).

Stressor: Climate Change Effects (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Langridge et al. (2018) provides a comprehensive assessment of the climate changes that will affect California's Central Coast bioregion, which includes Santa Barbara County. Anticipated changes consist of increased maximum and minimum temperatures, slightly increased precipitation with substantially increased variability, increased locally extreme rainfall events, accelerated sea level rise, and increased drought (Langridge et al. 2018, pg. 6). The tolerance of Gaviota tarplant to these climate changes is unknown. We provide specific data for expected changes in precipitation and increased maximum and minimum temperatures at four

key locations throughout the species range (USFWS, 2022).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Develop a recovery outline and recovery plan for Deinandra increscens ssp. villosa. (USFWS, 2011)
- Work with the U.S. Air Force at VAFB to implement site-specific management activities (e.g., refining grazing regimes, eradicating nonnative species) to maintain suitable habitat on the base for this species. (USFWS, 2011)
- Work with partners to manage threats to this species throughout its range, such as increasing efforts to remove nonnative species and planning the timing of activities that occur within and adjacent to occupied habitat. (USFWS, 2011)
- Develop conservation and land use management plans or habitat conservation plans with the County of Santa Barbara, the agricultural community, developers, local landowners and stakeholders to facilitate this species occurring and migrating throughout its historical range. (USFWS, 2011)
- Conduct updated surveys throughout the range of the species. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access (if possible) to all mapped Gaviota tarplant occurrences to conduct comprehensive surveys of the status of the species and threats at these locations. Include estimates of numbers of individuals present, global positioning system (GPS) mapping of occupied spatial area, co-occurring and co-dominant vegetation, presence of natives versus nonnative species, timing of phenology, and observations of potential insect pollinators. Update information in resource agency databases (CNDDB) to ensure that these data remain accurate and current. 2. Create a standardized annual, quantitative Gaviota tarplant monitoring protocol that includes the parameters outlined in item 1 above. Organize occurrence landowners and other stakeholders to commit to conducting annual monitoring for a minimum of five consecutive years, in support of the next 5-year review. 3. Conduct experimental research on strategic, applied grazing as a management tool for Gaviota tarplant recovery and nonnative, invasive weed controls. 4. Implement management activities to ameliorate threats at each occurrence, including vegetation management such as trimming and removal, applied-strategic grazing, invasive weed abatement, and erosion controls. 5. Conduct research across the species range to improve and refine our understanding of taxonomy to achieve a consensus on morphological identification of the species. Data from this assessment will ideally resolve taxonomic ambiguities to inform rapid visual identification of Gaviota tarplant in the field. This work will also help us better understand the natural spectrum of variant morphologies associated with normal phenotypic plasticity, likely resulting from different ecological conditions (such as shallow soils and interior versus coastal populations). 6. Continue conducting genetics research to better understand

and delineate Gaviota tarplant from grassland tarweed using modern molecular techniques intended for these types of resolutions. This will improve our knowledge of how these two subspecies are separated genetically and help reach a standard for how genetic data should be used to define and interpret the listed entity. 7. Continue making accessions for conservation seed banking throughout the species range, so that all populations are represented in the collections. 8. Pursue opportunities to work with landowners and other stakeholders to augment extirpated and/or declining Gaviota tarplant occurrences and locate and prioritize other areas where introduction of the species via outplanting for recovery could be feasible. New introduction projects will focus on re-establishing and maintaining connectivity of other extant populations throughout the species range (USFWS, 2022).

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SPECIES ACCOUNT: *Delphinium luteum* (Yellow larkspur)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/26/2000; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

A perennial herb that grows from fibrous roots to 56 centimeters (22 inches) tall. The leaves are mostly basal, fleshy, and green at the time of flowering, which occurs from March to May. The flowers are cornucopia shaped with five conspicuous bright yellow sepals, with the posterior sepal elongated into a spur. The inconspicuous petals occur in two pairs: the upper petals are narrow and unlobed and the lower petals are oblong to ovate. The fruit is a follicle (USFWS, 2011).

Taxonomy

In the buttercup family (Ranunculaceae). Although Jepson (1975) reduced D. luteum to a variety of D. nudicaule (red larkspur), it is currently recognized as a full species (Warnock 1993) (USFWS, 2011).

Historical Range

See current range/distribution.

Current Range

Historically occurred within northwestern Marin and southwestern Sonoma counties, California (USFWS, 2011).

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Delphinium luteum (Yellow larkspur) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (68 FR 12834-12863).

Critical Habitat Designation

The critical habitat designation for Delphinium luteum includes three CHUs in Sonoma and Marin Counties, California. Approximately 2,525 ac (1,022 ha) of Federal, State, and private land are being designated as critical habitat for Delphinium luteum. (68 FR 12834-12863).

Unit L1: Bodega Bay, Sonoma County, California.

Unit L2: Estero Americano, Marin County, California

Unit L3: Estero de San Antonio, Marin County, California

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Delphinium luteum critical habitat consists of four components (68 FR 12834-12863):

(i) Plant communities, including north coastal scrub or coastal prairie communities, including but not limited to: Arabis blepharophylla (rose rockcress), Calochortus tolmei (Tolmei startulip), Mimulus aurantiacus (orange bush monkeyflower), Dudleya caespitosa (sea lettuce), Polypodium californicum (California polyploidy), Eriogonum parviflorum (sea cliff buckwheat), Toxicodendron diversilobum (poison oak), Romanzoffia californica (California mistmaiden), Hesperevax sparsiflora (evax), Pentagramma triangularis (goldenback fern), and Sedum spathulifolium (broadleaf stonecrop).

(ii) Relatively steep sloped soils (30 percent or greater) derived from sandstone or shale, with rapid runoff and high erosion potential, such as Kneeland or Yorkville series soils.

(iii) Generally north aspected areas; and

(iv) Habitat upslope and downslope from known populations to maintain disturbance such as occasional rock slides or soil slumping that the species appears to require.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the physical and biological features and primary constituent elements that are essential for the conservation of Delphinium bakeri and D. luteum within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two species. As noted in the Critical Habitat section, ‘‘special management considerations or protection’’ is a term that originates in the definition of critical habitat. We believe the designated critical habitat units may require special management considerations or protection because remaining populations of Delphinium bakeri and D. luteum are extremely rare, contain few individuals, and are subject to threats which could extirpate them. In addition to the risk due to random natural events that can result in the extinction of species with very few, small, and highly isolated populations, potential threats to the habitat of D. bakeri include overcollection, application of herbicides, and sheep grazing, and potential threats to the habitat of D. luteum include overcollection, road widening, sheep grazing, fire suppression, and hybridization. Currently, no legally operative plans or agreements have been developed that address the maintenance and improvement of the primary constituent elements important to the species, or that provide management for the long-term conservation of D. bakeri or D. luteum. We have outlined below the most likely kinds of special management and protection that the habitat features and primary constituent elements essential to the conservation of Delphinium bakeri and D. luteum may require. The following actions apply to both species, unless otherwise noted: (1) In all plant communities where these taxa occur, invasive, nonnative species need to be actively controlled; (2) The quality of water must be maintained to keep it free from levels of herbicides or other chemical or organic contaminants that would be deleterious to the species; (3) Certain areas where these species occur may need to be fenced to protect them from accidental or intentional trampling by humans and livestock; (4) Aerial application of herbicides and insecticides that are likely to be deleterious to the species

needs to be curtailed in the critical habitat. Exposure to deleterious herbicides and insecticides from drift needs to be avoided; (5) The appropriate level of soil disturbance needs to be maintained (this applies only to Delphinium luteum); and (6) Existing hydrologic conditions may need to be protected by avoiding activities that cause a change in surface or subsurface water flows.

Life History

Food/Nutrient Resources

Lifespan

Adult: Probably at least 10 years (USFWS, 2011)

Breeding Season

Adult: Flowers from March to May (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Hummingbirds (and possibly bumblebees) for pollination (USFWS, 2011)

Reproduction Narrative

Adult: Flowering is from March to May. Hummingbirds (and possibly bumblebees) for pollination. Lifespan is unknown, but is at least 10 years. (USFWS, 2011).

Habitat Type

Adult: Terrestrial (USFWS, 2011)

Habitat Vegetation or Surface Water Classification

Adult: Coastal prairie and coastal scrub areas, which typically have no overstory vegetation (USFWS, 2011)

Dependencies on Specific Environmental Elements

Adult: Moderate to steep slopes, generally near areas showing evidence of some level of ground disturbance in the past (USFWS, 2011).

Geographic or Habitat Restraints or Barriers

Adult: Elevations ranging from sea level to 300 ft (USFWS, 2011)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2003)

Habitat Narrative

Adult: The species occurs in Coastal prairie and coastal scrub areas, which typically have no overstory vegetation, on moderate to steep slopes, at elevations ranging from sea level to 300 ft, and are generally near areas showing evidence of some level of ground disturbance in the past, including landslides. Typical soil types include the Kneeland series in Sonoma County and the Yorkville series in Marin County. These soils derive from sandstone or shale, and share qualities of rapid runoff and high erosion potential (USFWS, 2011). Primary constituent elements of critical habitat include Relatively steep sloped soils (30 percent or greater) derived

from sandstone or shale, with rapid runoff and high erosion potential, such as Kneeland or Yorkville series soils; generally north aspected areas, and habitat upslope and downslope from known populations to maintain disturbance that the species appears to require (USFWS, 2003).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal information is not described in the 5-year review (USFWS, 2011).

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Species Trends:

Decline of 30-50% (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2011)

Population Size:

Approx 200 individuals (USFWS, 2011)

Population Narrative:

Due to its small population size, low population number and apparently low reproductive rate, this plant is vulnerable. Grazing and home development threaten sites in the short term (30-50% decline). If the 7 historical and extirpated sites are truly gone, this represents a 58% decline over the past 100 yrs (long-term decline of 50-70%). Delphinium luteum is known from approximately 200 individuals total, in three drainages two in Marin County and one in Sonoma County (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction is still considered the greatest immediate threat for Delphinium luteum, with quarry activities, erosion, and disturbance of roadside locations listed as factors (USFWS, 2011).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of Listing Rule in 2000, unrestricted collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants was said to be a threat

(65 FR 4156). Overcollecting may still be a threat. Delphinium luteum is the only known yellow flowered larkspur. Due to this distinctive morphology, it has been and continues to be of horticultural interest, and some of the historical decline to D. luteum can be attributed to overcollecting (USFWS, 2011).

Stressor: Disease or predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Predation remains a threat for populations located on sheep grazing land. Most Delphinium species are toxic to cattle but not sheep. Several populations may be threatened by sheep grazing (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Federal Endangered Species Act is the primary Federal law that provides protection for Delphinium luteum since it was considered endangered with the Listing Rule of 2000. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, other laws and regulations have limited ability to protect the species in absence of the Act (USFWS, 2011).

Stressor: Risk of extirpation due to small population sizes (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The small number of individuals in the single Delphinium luteum population increases the threat of extinction of the species as a whole through stochastic demographic and environmental events. Delphinium has been reduced to a few unprotected populations with fluctuating numbers of individuals (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Global climate change is a potential threat to Delphinium luteum. Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2011).

Recovery

Reclassification Criteria:

At present there is no approved draft or final Recovery Plan for Delphinium luteum and therefore no recovery criteria (USFWS, 2011).

Delisting Criteria:
At present there is no approved draft or final Recovery Plan for Delphinium luteum and therefore no recovery criteria (USFWS, 2011).

Recovery Actions:

- Gather information on habitat needs and requirements. Little is known about the habitat needs and requirements for Delphinium luteum. All wild populations grow on north-facing rocky slopes in Sonoma or Marin counties, but the plant is grown easily in horticulture. Research to gather information about soil and moisture requirements, pollination and germination requirements and viability of the seed bank is recommended (USFWS, 2011).
- Continue captive propagation efforts for Delphinium luteum at the University of California Botanical Garden at Berkeley (USFWS, 2011).
- Write a Recovery Plan. The Act requires that all listed species have recovery plans. Delphinium luteum has been listed since 2000, development of a recovery plan would provide guidance to conservation efforts already in progress and provide criteria for successful recovery of the species (USFWS, 2011).
- Pursue communication with landowners for access to survey plants. Some of the CNDDB occurrences are on private property and have not been observed in many years. The Service recommends communicating with landowners to negotiate access to their properties to survey for plants (USFWS, 2011).
- Yearly surveys of plants. Currently there is little knowledge about the numbers of plants and populations of Delphinium luteum. The Service recommends yearly surveys of sites listed in the CNDDB in addition to sites on north-facing rocky slopes that may have unknown populations of D. luteum. With yearly surveys the Service can establish basic knowledge of the population numbers and range of the species, in addition to more information about any changes in habitat, a more comprehensive threats analysis and an estimation of the population trends of the species (declining, stable, or increasing) (USFWS, 2011).
- Find appropriate reintroduction sites. Survey for reintroduction sites on protected property and pursue landowner agreements (USFWS, 2011).
- Not available.

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SPECIES ACCOUNT: *Dicerandra christmanii* (Garrett's mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/21/1989; Southeast Region (R4)

Physical Description

Dicerandra christmanii is a small, fragrant shrub that reaches 50 cm in height (Huck et al. 1989). Both its floriferous and vegetative shoots are stiff and ascend from a ramose (many branched, branching), woody base. Its taproot is branched with extensive, spreading, fibrous roots. The leaves of Garrett's mint are sessile and have rounded apices, cuneate bases, entire margins and glandularpitted upper and lower surfaces (Huck et al. 1989). Leaves found on the determinate, flowering shoots are narrowly ovate to narrowly oblong. Those that subtend the cymes are 2 to 8 mm long and 0.5 to 1.8 mm wide, while those that do not subtend the cymes are approximately 5 to 11 mm long, and 1 to 2.5 mm wide. The leaves of overwintering, vegetative shoots are similarly shaped, but larger. The inflorescence is a verticillaster (Huck et al. 1989), with each cyme containing 1 to 3 flowers. The calyx is 6.5 to 10 mm long, approximately 2 mm wide (at midpoint), and bordered with an indistinct white band. The corolla is funnel shaped and abruptly bent to about 90 degrees. Its tube is 7 to 10 mm long, and its limb (from geniculum to distal edge of upper lobe) is 5 to 10 mm long. The corolla buds yellow, but at maturity, it is a pale cream (eventually fading to white). It has vivid purple-red markings that are often trellise-patterned on the upper lobe, but irregularly spotted on the lower lobe. The upper lobe is a recurving, cleft standard, and the lower lobe is tripartite (three parted) with a recurving middle petal. The flowers have four, paired stamens, which are exerted slightly beyond the lower corolla lip (Huck et al. 1989). The filaments are white, the anther sacs are brilliant yellow, and the connective is widened and may be covered with a few small, reddish and yellow glands at the basal end. The pollen is white and sticky. The pistil is white and has a slender, hirtellous style. The fruit is a schizocarp of four ovoid, brown, smooth nutlets. (USFWS, 1999)

Taxonomy

Specimens of D. christmanii were first collected by Garrett in 1948 east of Sebring and originally identified as D. frutescens by Ward (1979), Wunderlin (1984), and Huck (1987). D. christmanii was named as a distinct species in 1989 (Huck et al. 1989). (USFWS, 1999)

Historical Range

The historic distribution of Garrett's mint was along a 6-km section of an ancient yellow-sand ridge that has only been fragmented within the last 40 to 60 years (Menges et al. 2001). (USFWS, 2009)

Current Range

In Highlands County, Florida, between Lake Jackson and Lake Istokpoga. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers from July to November, primarily in September and October (USFWS, 1999)

Reproduction Narrative

Adult: Dicerandra christmanii flowers from July to November, primarily in September and October (Huck et al. 1989). Like other Dicerandra species, it has spurred anthers which must be triggered by insects for the pollen to be released and dispersed (FWS 1987). This pollination process occurs mainly through bee-flies (Exoprosopa fasciata), and few other insects visit the plant (Huck et al. 1989). (USFWS, 1999)

Habitat Type

Adult: Pine Scrub/Oak-hickory scrub

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: Dicerandra christmanii is found within openings in sclerophyllous oak scrub (Huck et al. 1989). As a "gap" species, it prefers open areas and does not grow vigorously when in shaded conditions. The species occurs on well-to excessively drained yellow sands of Astatula and Tavares soil types and is found where the seasonal high water table is at least 1 to 2 m deep. (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The seeds do not have mechanisms for wind dispersal and generally fall close to the plant (R. Huck, personal communication, 1996). Some Dicerandra species have been shown to use water as a dispersal agent, sometimes having their seeds carried by streams (Huck 1987). However, the limited distributions of D. christmanii, D. frutescens, and D. immaculata indicate that this mechanism is not effective in South Florida. Given this limited dispersal, colonization of a newly disturbed area by D. christmanii depends on whether or not it is present in the seedbank. The lifespan of seeds in the seedbank is unknown. (USFWS, 1999)

Population Information and Trends

Number of Populations:

Four

Population Size:

3,891

Population Narrative:

The loss of scrub on the Lake Wales Ridge habitat was the primary reason for listing Garrett's mint as endangered. Garrett's mint is known from four sites, all occurring in a 6-km (3.7 mi) (north to south) by 3-km (1.9 mi) (east to west) area of Highlands County, Florida (FNAI 2009). The species is poorly represented on conservation land. Only one of the four occurrences is

located within a protected area at the Flamingo Villas unit of the LWRNWR (Service 1999a, FNAI 2009). Three of four occurrences are located on private land. The area in the vicinity of these occurrences has been largely converted to citrus groves and scattered single family residences. Fire suppression continues to be a threat to Garrett's mint populations because the species thrives in the open conditions (gaps between shrubs) created and maintained by fire (Menges et al. 1999; Evans et al. 2004; Menges et al. 2006; Evans et al. 2008). At Flamingo Villas, estimates of the number of plants in the population began in 1994. From 1994 to 1998, the number of plants ranged from 2,266 to 3,507 (Menges and Weekly 1999). In 2009, a complete census of the population located 3,891 plants (Bok Tower Gardens 2010). Work is still required to complete land acquisition, control unauthorized access, remove trash, and restore the scrub vegetation with prescribed fire. Garrett's mint occurs at 'Carter Creek East', also known as 'Sebring Railroad East Scrub', a parcel targeted for acquisition by the Florida Forever program (FDEP 2008). The site is a 40-acre block of scrub located adjacent to a railroad track in a relatively remote area with no nearby public roads (Schultz et al. 1999). A large and thriving population of Garrett's mint was extant on this site as of October 2010 (C. Peterson, Bok Tower Garden, pers. comm. 2010). The occurrence in the vicinity of Moon Ranch Road is in an area lightly developed with single-family residences. Access for surveys was denied in 2009 (Bok Tower Gardens 2010). Remaining nearby scrub habitat may still support Garrett's mint. The occurrence in the vicinity of Snyder Road is extant along the roadside and on parcels that still contain habitat. Plants on the roadside are subjected to occasional mowing. The population consisted of a mere 88 plants in October 2009. Most of the surrounding area is converted to citrus groves and heavily disturbed (Bok Tower Gardens 2010).

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019

Stressor: Lack of adequate fire management
Exposure:

Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of D. christmanii are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the seral stage of xeric oak scrub that supports D. christmanii (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of D. christmanii. Conduct surveys for additional populations of D. christmanii. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Monitor existing populations of D. christmanii. Develop monitoring protocol to assess population trends for D. christmanii. Develop a quantitative description of the population structure of D. christmanii. Monitor re-introduced plants. (USFWS, 1999)
- Provide public information about D. christmanii. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of D. christmanii. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. christmanii and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Secure habitat through acquisition, landowner agreements, and conservation easements. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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SPECIES ACCOUNT: *Dicerandra cornutissima* (Longspurred mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/1/1985; Southeast Region (R4) (USFWS, 2015

Physical Description

A pungently aromatic, low shrub from a woody taproot. Leaves are opposite, needle-like, mostly ascending, with margins that are sometimes slightly wavy. The inflorescence appears as a narrow system of axillary clusters, each with 1-5 flowers. Flower petals are rose-purple, strongly 2-lipped, about 13 mm long. (Based on Kral 1983.) (NatureServe, 2015).

Taxonomy

Distinct species; one of six in Florida (NatureServe, 2015). Dicerandra is a genus of seven species in the mint family (Lamiaceae or Labiatae) (USFWS, 1987).

Historical Range

Originally found in Marion and Sumter Counties (USFWS, 2008).

Current Range

Currently known to occur at four sites in Marion County: CFG, along the l-7S right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision (USFWS, 2008).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1987)

Dependency on Other Individuals or Species

Adult: Apidae spp. (USFWS, 1987)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1987)

Reproduction Narrative

Adult: The three perennial species of Dicerandra are obligate outcrossers that reproduce entirely by seed (Huck 1984). Each has spurred anthers, which must be triggered by insect pollen vectors (usually the Apidae) for pollen to be released and dispersed (Huck 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine-turkey oak scrub/sandhill, slash pine-palmetto scrub (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Scattered in openings (natural or artificial) in longleaf pine-turkey oak scrub/sandhill or on low rises in slash pine-palmetto scrub. (Based on Kral 1983.) (NatureServe, 2015). The habitat occupied by this species needs periodic prescribed fires. D. cornutissima grows well in open, sandy patches usually along roadside edges (USFWS, 2008).; D. cornutissima is endemic to sand pine scrub habitat that can best be described as scrub composed of overstory of older mature sand pine (Pinus clausa), with an open to thick understory of sand live oak (Quercus geminate), Chapman's oak (Q. chapmanii), myrtle oak (Q. myrtifolia), saw palmetto (Serenoa repens), scrub palmetto (Sabal etonia), Florida rosemary (Ceratiola ericoides), and the state listed Garberia heterophylla (Herring 2005). The ground cover component of this habitat is composed of patchy occurrences of lichens (Cladina evansii, Cladina subtenuis, and Cladonia leporine), as well as grasses such as wiregrass (Aristida stricta), arrowfeather threeawn (Aristida purpurescens), and sandy field beaksedge (Rhynchospora megalocarpa). D. cornutissima grows well in open, sandy patches usually along roadside edges. Although D. cornutissima occurs in a fire-adapted habitat, the timing of fires related to the plants survivorship and reproduction is not known (Herring 2005). At CFG, D. cornutissima mostly occurs within sand pinedominated scrub that has a mosaic of sandhill throughout the site (Herring 2005). The overstory is open, consisting of mostly sand pine, but longleaf pines are occasionally found. Fire suppression in the sandhill has led to an invasion of sand pine, but prescribed burning of this area needs to be conducted carefully, since response of D. cornutissima is unknown (Herring 2005). Menges (1992) found that a similar species, D. frutescens, a short-lived perennial is killed by fire and reestablishes vigorously from seed. Weekley (2006) notes its close relative D. christmanii is also killed by fire and reestablishes from seed. There has recently been research (K. Holsinger, University of Connecticut, unpublished data, 2008) to show that longer intervals of fire (more than 12 years) may be optimum for these species. Therefore, research on the similar D. frutescens, which grows in yellow sand scrub at Archbold Biological Station on the Lake Wales Ridge, should be considered to elucidate the effects of fire on Dicerandra species and help refine prescribed burning activities (A. Johnson, FNAI, personal communication, 2008). Further east on the CFG, along the I-75 right-of-way, and Marion Oaks and Ocala Waterway Estates subdivisions, D. cornutissima occurs along roadside edges, its preferred habitat (Herring 2005). Care must be taken along these edges to not move dirt, mow, and establish fire lines with heavy equipment (Herring 2005). There are plans at CFG to manage the scrub habitat using mechanical means to open the habitat and reduce the sand pine. Due to the close proximity of I-75 to this site, prescribed burning is extremely difficult. The OGT recently completed a management plan for CFG that has goals and objectives to protect, enhance, and increase D. cornutissima found on the site (FDEP 2007). (USFWS, 2016)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Not available

Species Trends:
Unknown (USFWS, 2008)

Number of Populations:
6 (USFWS, 2023)

Population Size:
~37,134 to 42,874 (USFWS, 2023)

Adaptability:
Low (inferred from NatureServe, 2015)

Population Narrative:
the species status is unknown; the last comprehensive population survey was completed in 1991. During the 2005 FNAI survey, a total of 731 plants were documented on the FDOT 1-75 right-of-way. Four sites of D. cornutissima are known to occur in Marion county, FL (USFWS, 2008). This species has few individuals and a very restricted range, and is experiencing a reduction in habitat from development pressures (NatureServe, 2015).; D. cornutissima was originally found in Marion and Sumter Counties. Currently D. cornutissima is only known to occur at four sites in Marion County: CFG, along the I-75 right-of-way, Marion Oaks subdivision, and Ocala Waterways Estates subdivision. A survey of the historic locations of D. cornutissima in Sumter County was conducted in 1984 and no plants were found (Wunderlin 1984). Florida Natural Areas Inventory (FNAI) has a record of D. cornutissima south of Marion Oaks along a powerline in Sumter County in 1988. The site along the powerline was discovered after the recovery plan was written in 1987. The recovery plan states that there was no suitable habitat left at the sites surveyed in 1984 in Sumter County, although suitable habitat may still exist between Sumter County and southern Marion County. (USFWS 1987, Wunderlin 1984). Other FNAI records include plants on private lands in Marion County near Rainbow Lakes Estates in 1993 and along State Road 200 (Bahia Oaks development) in 1991. No surveys of these sites have occurred since the early 1990s. Adjacent protected lands (Ross Prairie State Forest, Halpata Tastanaki Preserve, and Potts Preserve) have been surveyed the past five years but no D. cornutissima have been located in suitable habitat at these locations (A. Johnson, FNAI, personnel communication, 2008). (USFWS, 2018). Current distribution includes six extant D. cornutissima populations on public and private lands in Marion and Sumter counties, Florida. Based on the most recent estimates, there may be approximately 37,134 to 42,874 or more individuals in those six populations (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: Habitat destruction remains the greatest threat to D. cornutissima. Populations along the I-75 right-of-way have been impacted by road construction, exotic plant invasion, and other road-related activities. The other two remaining sites are on private property and are susceptible to destruction due to urban development. Without natural caused or prescribed fires, sand pine creates a dense overstory, making the habitat unsuitable for D. cornutissima (USFWS, 2008).

Stressor: Invasive species (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The introduction of cogon grass along the I-75 right-of-way as well as on a few sites in the CFG in areas occupied by D. cornutissima has reduced the amount of suitable habitat for this species (USFWS, 2008).

Stressor: Fire suppression (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: This species occurs mainly along areas that have been naturally maintained with fire. Where fire has been suppressed for long periods, canopy cover increase and understory vegetation increases, reducing open sandy patches. The majority of sites containing D. cornutissima are degraded due t fire exclusion or lack of mechanical vegetative management (USFWS, 2008).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The Florida Administrative Code 5B-40 (Preservation of Native Flora in Florida) provides the Florida Department of Agriculture and Consumer Services with limited authority to protect these plants (primarily from the standpoint of illegal harvest) on state and private lands. Only a few populations of D. cornutissima are located on protected land (CFO) where they are being managed. The FDOT is managing the I-75 right-of-way by controlling exotics however the right-of-way would not be considered protected land. CFO was acquired by the State of Florida in 1991, after Congress de-authorized the Cross Florida Barge Canal construction and transferred all the lands to the State. CFO has an approved unit management plan in place to protect D. cornutissima (FDEP 2007). FDOT currently manages for D. cornutissima along the I-75 right-of-way by working with their contractors that mow this right-of-way to avoid routine mowing outside the highway clear zone (approximately 36 feet from the travel lanes) and to control the cogon grass found on the right-of-way. A monitoring and management program should be established, including experimentation with different regimes of vegetation management outside the clear zone and re-establishment of an extirpated cluster of D. cornutissima that occurred within the southbound rest area before the construction. Two of the populations occur on private lands with little to no protection. The Service's Partners for Fish and Wildlife program could work with these landowners to better manage and protect these populations. (USFWS, 2018)

Recovery

Reclassification Criteria:
Ten separate, self-sustaining populations of the species are established at secure sites in peninsular Florida. This numerical goal is subject to revision as information becomes available on the population biology of each species and as suitable sites are found (USFWS, 1987).

Delisting Criteria:
20 separate, self-sustaining populations are established at secure sites in peninsular Florida (USFWS, 2008).

Recovery Actions:
- Protect and manage existing population (USFWS, 1987).
- Conserve germ plasm (USFWS, 1987).
- Establish and manage new populations (USFWS, 1987).
- 1. Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing and/or eliminating threats to D. cornutissima as well as updated information on the species distribution, biology, and management needs. (USFWS, 2018)
- 2. Support further research on: a) the effects of prescribed burning and other management tools on D. cornutissima. Continue working with public land managers to increase management efforts to benefit D. cornutissirna on their sites. b) Additional life history needs. Additional information is needed on how cogon grass and other invasive plants affect D. cornutissima plants and what the effects of the herbicides used to eradicate cogon grass have on this species. c) The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitat. d) The various pollinators (e.g., Hymenoptera and Lepidoptera), as well as how different ant species assist with seed dispersal. (USFSW, 2018)
- 3. Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program. (USFWS, 2018)
- 4. Complete a rangewide survey to find all known and potential sites occupied by D. cornutissima and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions. (USFWS, 2018)
- 5. Consider reintroduction and monitoring of D. cornutissima on additional publicly owned lands with suitable habitat. Reintroduction of D. cornutissima could help to increase the number of populations on protected sites and augment populations \Vhere needed. (USFWS, 2018)
- Revise the current recovery plan to include more objective and measurable recovery criteria that are related to reducing and/or eliminating threats to D. cornutissima as well as updated information on the species distribution, biology, and management needs (USFWS, 2008).
- Support further research on A. The effects of prescribed burning and other management tools on D. cornutissima. Continue working with public land managers to increase management efforts to benefit D. cornutissima on their sites. B. Additional life history needs. Additional information is needed on how cogon grass and other invasive plants affect D. cornutissima plants and what the effects of the herbicides used to eradicate cogon grass have on this species. C. The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitat. D. The various pollinators (e.g. Hymenoptera and Lepidoptera), as well as how different ant species assist with seed

dispersal (USFWS, 2008).

- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2008).
- Complete a rangewide survey to find all known and potential sites occupied by D. cornutissima and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2008).
- Consider reintroduction and monitoring of D. cornutissima on additional publicly owned lands with suitable habitat. Reintroduction of D. cornutissima could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence wherever additional opportunities present themselves. • Encourage landowners whose populations are under a habitat management plan to monitor occupied habitat for increased data of long-term trends. • Engage Duke Energy Corporation to encourage routine powerline vegetation maintenance activities to benefit species through seasonal timing and education (USFWS, 2023).

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SPECIES ACCOUNT: *Dicerandra frutescens* (Scrub mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/2/1985; Southeast Region (R4)

Physical Description

The scrub mint is a dense or straggly, low-growing shrub (Kral, 1983). It reaches 50 cm in height and grows from a deep, stout, spreading-branching taproot. Its branches are mostly spreading, and sometimes are prostrate. Its shoots have two forms, one which is strictly leafy and overwintering, and another which is flowering and dies back after fruiting. The leaves vary in shape. They can be narrowly oblongelliptic, linear-elliptic, or linear-oblanceolate (Kral 1983). The upper surface of the leaves is dark green, with the midrib slightly impressed. The lower surface is slightly paler, with the midrib slightly raised. They are 1.5 to 2.5 cm long, 2 to 3 mm wide, subsessile, flattish but somewhat fleshy, narrowly or broadly rounded at the apical end, have entire margins, and are not revolute. Scrub mint has an inflorescence that is elongated and interrupted, and, at least half of the flowering shoot is floriferous (Kral 1983). The calyx, at anthesis, is approximately 9 to 10 mm long, nearly erect, proximally and medially green, and distally tinged with red, with a broad white zone around the orifice. The corolla is 1.9 to 2.0 cm long, with an erect tube that is approximately 7 mm long. The external surface of the throat and limb is white or yellowish white. The upper lip is marked internally with a trellis pattern of lines and dots of deep purple, while the lower lip is maculate with larger, concentric spots from lobe bases to base of the lip. The flower has two pairs of stamens, with one pair slightly longer than the other (Kral 1983). The filaments are white, and the anthers are purple. Styles are almost white and bent forward or curved downward (usually above the anthers). (USFWS, 1999)

Taxonomy

Dicerandra frutescens was named by Lloyd Shinners (1962); his circumscription of the species was modified by Huck (1981), who reassigned specimens from Sumter and Marion counties to a new species, Dicerandra cornutissima. Kral (1982), working independently of Huck, came to the same conclusion. (USFWS, 1999)

Historical Range

Historically distributed more or less contiguously along a high yellow-sand ridge that has only been fragmented within the last 40 to 60 years (Menges et al. 2001). (USFWS, 2009)

Current Range

Dicerandra frutescens is endemic to a very limited portion of the Lake Wales Ridge in Highlands County, Florida, and is found at four localities. The mint occurs at Archbold Biological Station; in the Sun 'n' Lakes Estates subdivision east of US highway 27 and southeast of the town of Lake Placid; at YMCA Camp Florida on the west side of Grassy Lake southeast of the town of Lake Placid; and on a sand ridge along the northwest shore of Lake Placid. All four of these areas are native vegetation which are surrounded by agricultural and residential areas. (NatureServe, 2015.)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexually, with outcrossing (USFWS, 1999)

Dependency on Other Individuals or Species

Adult: Needs insects for pollination (USFWS, 1999)

Other Reproductive Information

Adult: Scrub mint is insect pollinated and requires insect visits for seed production (Evans et al. 2004). Exprosopa fasciata (Diptera: Bombyliidae), a bee-fly is the dominant pollinator, accounting for 95 percent of all visits at Archbold Biological Station (ABS) . (USFWS, 2019).

Reproduction Narrative

Adult: Dicerandra frutescens has perfect flowers (Kral 1983) and reproduces sexually, with outcrossing (Huck 1981). It is not capable of spreading clonally (Menges 1992), but has been shown to root easily from cuttings of vegetative growth (FWS 1987). Growth containing flowers or flower buds will also root, but will often flower then die (FWS 1987). Its flowers have spurred anthers, which require triggering by insects to release and disperse pollen (FWS 1987). Though visited by a variety of insects (Huck et al. 1989), the scrub mint is pollinated mainly by bee-flies (Menges 1992). Its flowering occurs from August through winter, and fruit production occurs from September through winter (Wunderlin 1984). (USFWS, 1999)

Habitat Type

Adult: Scrub vegetation

Environmental Specificity

Adult: Dicerandra frutescens is a gap-utilizing species; it inhabits open areas in the vegetation. It does not tolerate shading by other plants. (USFWS, 1999)

Habitat Narrative

Adult: Dicerandra frutescens is mostly restricted to excessively drained, yellow sandy soils of the Astatula and Paola soil types (Menges 1992). However, it has been found on a moderately well-drained, yellow sand of the Orsino type (Menges 1992). In these soil types, scrub mint occurs adjacent to or within disturbed areas in sand pine scrub, oak scrub and sandhill habitats (FWS 1987, Menges 1992). It occupies sites with shallow litter layers that have an incomplete, or non-existent, tree and shrub canopy (Menges 1992). (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The scrub mint's seed dissemination mechanisms are unknown, though they possibly include passive dispersal (E. Menges, Archbold Biological Station, personal communication 1997). It is possible that the seeds are not dispersed far from the parent plant, since seed dispersal in the related Lakela's mint (Dicerandra immaculata) is known to be very limited. Observations of an introduced population of Lakela's mint at Hobe Sound NWR indicate that the

seedlings occur a maximum distance of 2 m from parent plants (Race 1994). Scrub mint's seeds survive in the seed bank for at least 2 years (E. Menges, Archbold Biological Station, personal communication 1997), and if dispersal in scrub mint is similarly limited, then persistence in the seed bank may be an important strategy that this species uses for colonizing newly disturbed areas. (USFWS, 1999)

Population Information and Trends

Number of Populations:

14

Population Size:

~5,000

Population Narrative:

In the most recent FNAI Element Tracking Summary (FNAI 2015), scrub mint was known from 14 occurrences, 7 of which were on managed areas. The other seven occurrences were located on private land and their status was unknown. Based on 2008 aerial images, it appeared that four occurrences were likely extirpated or heavily disturbed and another five were possibly still extant based on remaining habitat in the area where they were previously recorded. Scrub mint populations are dependent on fire for long-term persistence (Menges et al. 2006). There is an inverse relationship between time-since-fire and multiple demographic and reproductive factors, including mortality of adult plants, growth and maturation rates, plant fecundity, number of pollinator visits, and seedling recruitment. Populations begin to decline six years after a fire (Menges et al. 2006; Evans et al. 2008). A population viability analysis (PVA) indicated that population growth rates decline below the replacement level of 1.0 (on average) in populations that remain unburned more than five years (Menges et al. 2006). Most demographic parameters peak at 3 to 5 years post-fire, after which populations experience a long, slow decline (Menges and Weekley 1999). Stochastic simulations using both regular and stochastic fire regimes predicted that fire return intervals of 6 to 12 and 6 to 21 years, respectively, were optimal for minimizing extinction risk. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land

uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Stressor: Drought
Exposure:
Response:
Consequence:
Narrative: Drought exacerbates declines due to lack of fire and prevents strong post-fire recovery of scrub mint populations. Regeneration of populations from seed after fire appears to be lower due to reduced seedling survival when a ‘dry’ year follows a fire. At ABS, a burn in 2006

was followed by a drought period and did not result in a strong population recovery as observed following other fire events. Since 2005, the scrub mint populations at ABS have been declining. Few seedlings were recruited in 2006 and 2007 (E. Menges pers. comm. 2008). Although 188 seedlings recruited early in 2008, less than half (48.4 percent) survived the spring drought (C. Weekley, pers. comm. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:

1. Enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of D. frutescens, are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the seral stage of xeric oak scrub that supports D. frutescens (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support populations of sufficient sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of D. frutescens. Conduct surveys of D. frutescens. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Continue research on life history characteristics of D. frutescens. Although recent work on D. frutescens can be used to infer answers to some life history questions, much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing and reintroduced populations of D. frutescens. (USFWS, 1999)

- Provide public information about D. frutescens. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of D. frutescens. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. frutescens and other rare species require a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-Level Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine the condition of the unprotected occurrences on private land whose status is currently unknown. • Acquire or secure permanent easements on lands with existing populations from willing sellers and restore scrub habitat on these sites, including the implementation of prescribed fire and vegetation thinning by hand. • Advocate for and support the application of prescribed fire to maintain xeric scrub habitat for scrub mint. • Advocate for and support the use of small-scale, hand removal of woody shrubs and tree species around scrub mint populations either in combination with or independent of prescribed fire. • Conduct a taxonomic study of the Dicerandra genus within Central Florida using a multidata approach (e.g., morphology, genetics, geography, ecological factors, etc.). • Continue demographic monitoring and expand to additional occurrences, especially those that are protected. • Evaluate and strengthen ex situ efforts for scrub mint. • Service recovery leads should maintain open lines of communication with State land managers and provide updates as appropriate to ensure proper management of occurrences. (USFWS, 2021)

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SPECIES ACCOUNT: *Dicerandra immaculata* (Lakela's mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015)

Physical Description

Lakela's mint is a small, fragrant shrub that can be differentiated from other Dicerandra by its spotless, lavender-rose colored flower. Lakela's mint reaches 20 inches (in) tall (Kral 1982). Its growth is bushy when in open sun but becomes lax when in shade. It forms small mats or domes of ascending to spreading or sprawling branches. The primary branches arise from a stout, deep, woody-branched taproot, and its numerous innovations arise from spreading or sprawling older growth. The main leaves are spreading (horizontal) or ascending (pointing upward), while those in the inflorescence (flower cluster) are sometimes reflexed (pointing downward) (Kral 1982). All leaves are linear, oblong-linear, linear-elliptic, linear-lanceolate or linear-oblanceolate in shape. They are 0.75–1.2 in long, 0.08-0.16 in wide, smooth, flattened, subsessile, narrowly rounded at the apical end, often slightly emarginate, and entire, though larger leaves can be minutely serrulate at the apical end. The inflorescence is usually 6-10 in long (Kral 1982). Its flowering cymes overlap and each has one, three, or five flowers. The calyx body is 0.28-0.31 in long and is usually purplish, becoming white or roseate toward the orifice. The corolla is about 0.75 in long, immaculate (not spotted), and is a bright lavender-rose. The upper corolla lip is broadly ovate to obovate, about 0.28 in long, apically upswept, and broadly rounded-emarginate. The lower lip is broadly obovate, trilobate, 0.35-0.40 in long, and downswept. The lateral lobes are spreading, oblong, broadly rounded, or oblique-truncate, and the medial lobe is emarginate. The anthers are exserted, and the style is projecting. (USFWS, 2016)

Taxonomy

The color of the corolla, lavender-rose to purplish, and its lack of spots separate Lakela's mint from other species of the Dicerandra genus (Service 1985). A new variety, D. immaculata Lakela var. savannarum, was described from southern St. Lucie County and is separated from D. immaculata var. immaculata by its wider leaves and lax habit (Huck 2001). With the original description of Dicerandra immaculata (Lakela 1963), Lakela briefly described and named a white-flowered form she found in the populations. She named this form D. immaculata forma nivea Lakela. In accordance with 50 CFR Subpart B, section 17.12(g), when we listed Lakela's mint as an endangered species, all lower taxonomic units were considered included as the listed entity. Thus the taxon D. immaculata forma nivea was treated as endangered at the time of listing. Although described as a different, but still lower taxonomic rank than species, the same endangered status applies to the more recently described D. immaculata var. savannarum. (USFWS, 2016)

Historical Range

The historic range of Lakela's mint is extremely small, encompassing an area only one-half mile wide by three miles long in southern Indian River and northern St. Lucie Counties (USFWS,1999).

Current Range

The current range of Lakela's mint is limited to St. Lucie and southern Indian River Counties in Florida, with an additional introduced site in Martin County. (USFWS, 2008)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Seedling recruitment occurs primarily from December through March but can occur at any time of the year (Peterson et al. 2009). Leafing occurs from February to August. Anthesis occurs primarily from September to November and sporadically throughout the year. Fruiting occurs primarily from October to December and sporadically throughout the year (Austin et al. 1980). Mortality rates increase during September through December (Peterson et al. 2009). Plants appear to become reproductive at 1 to 2 years of age (Peterson et al. 2009). However, Lakela's mint has very low germination rates and germination is inconsistent (Peterson et al. 2009). Experimental germination trials seem to indicate that fire may increase germination success (Peterson et al. 2007); however, Huck (in litt. 2008) cautioned that fire does not trigger germination and should be used with care. Lakela's mint only reproduces through seeding and needs insects for pollination. Its flowers have spurred anthers, which require triggering by insect vectors to release and disperse pollen (Service 1987). Not all of the insect species responsible for the pollination of this mint are known, but it is thought that bees may pollinate the plants (Huck 1987). Seed dispersal of Lakela's mint is limited. Introduced colonies at the Hobe Sound National Wildlife Refuge (NWR) have dispersed no more than 6.5 feet from parent plants (Race 1994). In addition, Austin et al. (1980) indicated that areas of disturbed sandy soils within the vicinity of Lakela's mint colonies provided no evidence of recolonization. Oliveira et al. (2007) indicated that closely related taxa occur in close physical proximity to one another, which supports seed dispersal hypotheses; there is a lack of long-distance seed dispersal except by intermittent rainfall events that transported fruits along waterways, by high winds from hurricanes, or by the rise and fall of sea level during the Pleistocene as new habitat formed (Huck and Chambers 1997, Oliveira et al. 2007). It is interesting to note that all of the perennial taxa, including Lakela's mint, have very narrow geographic distributions, whereas the annuals are more widely distributed and none are listed or considered rare.

Habitat Type

Adult: Scrub

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Lakela's mint is found in light shade or clearings in scrub in a limited area along the Atlantic coastal ridge in south Florida (Service 1987). Lakela's mint is a "gap" species. It abounds in open sunlight, but becomes straggly and weak as woody plants and saw palmetto invade open areas (Kral 1982). It occupies sites with varying degrees of litter, from partly covered to bare sand. These bare sands are probably created through a combination of wind action and fires. The mint has been observed growing on both white and yellow sands of the following soil series: Astatula sands, Paola sands, and St. Lucie sands (Service 1985). These soils

are deep, nearly level to sloping, occur on high, dune-like ridges, and are acidic. Intensive site maintenance, including removal of vines, invasive species, grass competitors, and small trees and limbs that over-shade the plants, improves habitat conditions and provides additional capacity to support more individuals (Peterson et al. 2007). However, if not managed as such, overgrowth of the habitat reduces the amount of sunlight available and increases competition from other plants for nutrients and light, rendering long-term proliferation of the species unlikely without fire or other disturbance. Habitat conditions in and around the existing populations of D. immaculata var. savannarum also continue to deteriorate, resulting in population decline (Barry et al. 2007).

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Number of Populations:

14 (5 natural and 9 introduced) (USFWS, 2021)

Population Size:

6,100 - 9,660

Adaptability:

Very sensitive to disturbance and successional canopy closure. (NatureServe, 2015)

Population Narrative:

Like other Dicerandra species, Lakela's mint is protected from insect herbivory by its essential oils (McCormick et al. 1993). Likewise, the variety savannarum also has essential oils, although it contains three compounds that are not present in Lakela's mint (Peterson et al. 2009). The cut leaves of one of its relatives, scrub mint (Dicerandra frutescens), have been shown to repel ants, and only Pyralid moths are known to feed on it (Eisner et al. 1990). Whether Lakela's mint is protected to this degree has not been verified. Though resistant to insect feeding, Lakela's mint populations have been adversely affected by mildew. Mildew grows on the nectary glands and can cause destruction of the fruits, destroying the viability of seeds before dispersal (Austin et al. 1980, Robinson 1981). Because of urban development, the overall distribution of Lakela's mint is significantly reduced. Trends in spatial distribution show increasing fragmentation of Lakela's mint as the coastal ridge has become developed and fire has been suppressed. Spatial distribution of Lakela's mint may be affected by disturbance factors. All Dicerandra mints, including Lakela's mint, in the southeastern United States tend to grow on disturbed sites, such as eroded dunes, sides of scraped dirt roads, fire lanes, unsodded banks, drainage ditches with loose sand, steep river banks, and gopher tortoise holes (Huck 1987, Huck in litt. 2008). On the Hallstrom Farmstead, plants are generally clustered in two areas on the property at tree-line edges next to sand paths or sandy openings (Peterson 2007a). The Service has observed that the distribution of the other remaining large natural population is similar. During fall 2006, 29 private properties in coastal scrub within the vicinity of the Hallstrom Farmstead and south to Indrio Road were surveyed (Peterson 2007b, Peterson et al. 2007). Only one new mint site was identified from this effort, and it contained approximately 10 plants (Peterson et al. 2007). It is

presumed that this colony is part of one of the originally identified Florida Natural Areas Inventory sites (Peterson 2007b, Peterson et al. 2007). Additionally, two other sites containing the mint were brought to our attention (Peterson 2007b, Peterson et al. 2007). These small colonies were estimated to each contain 15-50 individual plants (Peterson 2006). All of these new sites are at risk of being developed and rescue efforts to obtain and preserve genetic material have taken place. At least one of the sites has already been cleared for development (Peterson et al. 2007). The population where it is believed that Dr. O. Lakela first collected the original type specimen for the species 45 years ago has disappeared (Huck in litt. 2008). Additionally, 53 private parcels encompassing over 100 acres along the Atlantic coastal ridge from Midway Road south to County Line Road in St. Lucie County and additional areas in Martin County south to Sewall's Point were surveyed to determine if the variety occurs in other locations, but no new populations were observed (Barry et al. 2007). At least seven sites where Lakela's mint occurred have been extirpated, including one that contained the new variety. In total, there are seven extant sites where populations naturally occur and four introduced populations. However, two of the sites where they occur naturally are slated to be developed. Four of the natural sites are privately-owned and three are on public lands. The four introduced populations (two populations of Lakela's mint and two of the new variety) are all on public lands. Trend data indicate declines in populations of both Lakela's mint and the variety savannarum. The total population of Lakela's mint is estimated to be between 6,100 and 9,660 plants (Peterson et al. 2009). When first discovered in 1995, approximately 200 individuals of the new variety were counted (Huck 2001). Due to drought and over-shading from competing plants, the natural population steadily declined to 89 individuals in 2005 and to nearly zero plants in 2012 (Peterson and Richardson in press). Lakela's mint occupies open areas in scrub, so prescribed burning or equivalent management is necessary to maintain the quality of its habitat. The way this species responds to disturbance and the frequency of disturbance needed are not known. Lakela's mint is a narrow ranging species, historically occurring in just two Florida counties along the Atlantic Coastal Ridge (southern St. Lucie and northern Indian River Counties). Introductions in Martin County and northern Indian River County have increased the species' range from approximately 3 to 59 mi (4.8 to 95 km) long. In 1996, the Savannas mint variety was discovered in southern St. Lucie County (Huck 2001). Introductions of this variety have increased its range from approximately 0.5 to 4 mi (0.8 to 6.4 km) long. There are currently 14 populations (5 natural and 9 introduced) of Lakela's and Savannas mint (Table 1; Peterson et al. 2009; Peterson 2017a, 2018, 2019, 2020, 2021a, 2021b, 2021c; Eastwick 2020). Since the previous status review (Service 2008), three populations have been introduced (one Lakela's mint and two Savannas mint) (Table 1; Peterson 2017a, 2020). However, the last remaining natural population of Savannas mint has been extirpated, portions of two Lakela's mint populations on private sites have been extirpated, and two populations of Lakela's mint entirely on private property are in danger of development and currently for sale (Table 1; Peterson et al. 2009; Peterson 2018, 2019, 2020; Service biologist observations 2020, 2021). Despite recovery efforts and the increase in number of introduced populations, only a few of the Lakela's mint populations are large enough to withstand stochastic events (Service 2019a), and even large populations are observed to decline rapidly in unsuitable habitat and weather conditions (Peterson et al. 2009; Peterson 2020). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2008)
Exposure:

Response:
Consequence:
Narrative: Continued habitat loss, fragmentation, and changes in land use threaten the existence of Lakela's mint. Although a few populations are on sites that are publicly owned, populations on private sites are threatened with destruction or habitat modification due to improper or lack of management.-Just since July 2006, HBS has rescued plants from two sites slated for development that were identified as a result of the survey effort from the Hallstrom Farmstead south to Indrio Road, one containing 2 plants and the other containing 56 (Peterson et al. 2007). The germplasm waSTI) aced in the National Collection, but the sites where these plants naturally occurred have now been lost. One of these sites was near the Hallstrom Farmstead, but because recent surveys in the surrounding area have yielded no positive results it is presumed that all adjacent colonies have been lost to development (Peterson et al. 2007). - Two additional plant rescues have been initiated since July 2006, and HBS is in the process of tagging and removing seeds and cuttings from all individuals on the sites with the hope of removing as many adult plants as possible (Peterson et al. 2007). One site containing 50-100 plants will be cleared to become a retention pond as part of a road project, and a bridge and development will be built through the other property that contained over 500 healthy plants and seedlings (Peterson et al. 2007). The only two locations where the variety is known to occur naturally are on private lands and both are threatened with destruction as a result of lack of management, dumping, or development (Peterson et al. 2007). Because of these threats, some of the plants were rescued, propagated, and introduced onto protected land in 2005, and germplasm was placed in the National Collection for preservation of genetic material (Peterson et al. 2007). However, it is probable that both of these natural populations will be extirpated. - Between 2005 and 2060 Florida's population is projected to double from approximately 18 to 36 million people (Zwick and Can 2006). Assuming a similar pattern of development at current gross urban densities for each county, this translates into the need to convert an additional 7 million acres of undeveloped land into urban land uses (Zwick and Carr 2006). It is projected that the coastal counties of Florida will be almost entirely built out by 2060 (Zwick and Carr 2006). Within the range of Lakela's mint, the model predicts that the human population will grow from just below 130,000 to nearly 285,000 in Indian River County and from 232,000 to over 563,000 in St. Lucie County between 2005 and 2060 (Zwick and Can 2006). Therefore, habitat loss, degradation, and fragmentation continue to threaten the species. (USFWS, 2008)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Generally, managing agencies have limited regulatory tools. The Act provides protection for this species and its habitat through section 7 (interagency cooperation). Lakela's mint is also listed by FDACS as endangered (5B-40.0055 Regulated Plant Index), but this legislation does not provide any direct habitat protection. Existing federal regulations prohibit the removal or destruction of listed plant species on Federal lands. State regulations require both written permission from the owner or legal representative and a permit issued by FDACS to collect or remove plants listed as endangered on the Florida Regulated Plant Index. However, these regulations afford no protection to listed plants on private lands. In some situations, existing regulatory mechanisms do not appear to be adequate, as several private properties with mints have been developed, and the only option for the plants was to rescue them prior to clearing. Because this plant occurs in habitat along the Atlantic coastal ridge, which is desirable

real estate for development due to its elevation, this species remains vulnerable where it occurs on private property. (USFWS, 2008)

Stressor: Land management practices (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Land management practices such as canopy reduction are vitally important to maintaining and working towards recovery of Lakela's mint. Even though some sites are protected from development, habitat degradation may still be a concern at these sites. This species occurs in scrub habitat along the Atlantic coastal ridge, which is typically maintained by fire (Peterson 2007b). On many privately owned scrub sites, fire has historically been suppressed, and habitat has not received regular maintenance. If sites are not regularly maintained, vines tend to overtake the mints, competition for light, water, and nutrients from grasses and invasive species becomes too great, and limbs and small trees limit the amount of available sunlight necessary for survival (Peterson 2007b). Invasive plant species that impact the mints include, but are not limited to, Brazilian pepper (Schinus terehinthifolius), rosary pea (Abrus precatorius), natal grass (Rhynchelytrum repens), and guinea grass (Panicum maximum). (USFWS, 2008)

Stressor: Other natural or manmade factors (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Vegetation restoration and management programs are costly, and the availability of funding is never assured; therefore, habitat modification from inadequate management on protected lands remains an imminent, though moderate, threat. Degradation to habitat can also occur from damage by feral hogs (Sus scrofa), as cited in recent reports that assessed three Florida state parks (Engeman et al. 2003, 2004). Also, the species' limited distribution renders it vulnerable to random natural events, such as hurricanes and drought. (USFWS, 2008)

Recovery

Reclassification Criteria:
Not defined. (USFWS, 1999; USFWS, 2019)

Delisting Criteria:
1. When at least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (Factor A) (USFWS, 2019)

2. When populations (as defined in criterion 1) in coastal sand pine scrub habitat are distributed across the historical range of the species in order to maintain and enhance the species geographic patterns of genetic diversity. (Factor A) (USFWS, 2019)

3. When populations (as defined in criterion 1) must be protected via a conservation mechanism and managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, D, E). (USFWS, 2019)

Recovery Actions:

- 1. Determine current distribution of D. immaculata. A comprehensive survey of D. Immaculata's range was completed in fall 1996. Taxonomic questions still exist with a newly located population at the Martin County border that make a definitive distribution difficult. (USFS, 1999)
- 2. Protect and enhance existing populations. Much of the native xeric uplands on the Atlantic coastal ridge has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- 3. Conduct research on life history characteristics of D. immaculata. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- 4. Monitor existing populations of D. immaculata. Develop monitoring protocol to assess population trends for D. immaculata. Develop a quantitative description of the population structure of D. immaculata. Monitor re-introduced plants. (USFWS, 1999)
- 5. Provide public information about D. immaculata. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society,and private landowners be appropriately informed about this species. However, caution should be taken to avoid revealing specific locality information of D. immaculata. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of D. immaculata and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Both urbanization and fire suppression have decreased the available habitat. To date, there are no protected sites for this species in its historic range. - Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. - Conduct habitat-level research projects. Study the response of D. immaculata to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. - Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, mechanical disturbance, etc., on the habitats where D. immaculata occurs. - Provide public information about xeric vegetative communities and its unique biota. (USFWS, 1999)
- Continue to survey potential habitat and pursue conservation agreements/implement management recommendations and/or acquire land. This is a high priority action, particularly for D. immaculata var. savannarum. • Include D. immaculata var. savannarum in conservation programs to conserve the genetic diversity found in the entire genus (Oliveira et al. 2007) • Write a management plan after acquisition of the portion of property containing the Lakela's mint at the HBOI property. (USFWS, 2008)
- Identify additional reintroduction sites and establish reintroduced populations; population augmentations should also be implemented. • Continue monitoring for both reintroduced and natural populations. • Propagation efforts should continue and clones of the original "parent" should be placed throughout the Halistrom site to augment the population. • Where private sites are being developed, efforts should be continued to rescue individual

plants and use them for propagation or to augment populations on protected sites. (USFWS, 2008)

- Federal, state, and local agencies, botanical gardens, and conservation organizations should convene to evaluate the current status of protection and the level of implementation of management practices at each site and to discuss current levels of support, threats to habitat and individual plants, and any obstacles to management and recovery. (USFWS, 2008)
- Evaluate the effects of climate change on the species, including those that result from precipitation pattern changes and temperature rise. (USFWS, 2008)
- To re-create open soils, managers should consider implementing mechanical disturbance, such as scratching or raking around plants, removing competitive plants in the vicinity of mints, or lightly disking larger areas, after mints flower but before the fruits drop (approximately two months after blooming) (Huck in litt. 2008). • Work with staff at Savannas Preserve State Park to understand habitat requirements of this species. • Conduct research on the response of Lakela's mint to fire and fire prescriptions necessary to benefit the species. • Continue seed germination studies and make efforts to develop additional outplanting techniques, especially those that may alleviate dessication of plants during dry conditions. • Demographic studies such as long-term survival and potential correlations with rainfall cycles and other variables should be examined. (USFWS, 2008)
- Opportunities should be sought where possible to include the media in the first Hallstrom Farmstead augmentation to provide information about this species to the public. • Conduct additional research on the biology, ecology, genetics, and management needs of the species. (USFWS, 2008)
- Partnerships should be promoted to share information, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Continue management actions to include removal of debris and exotics, canopy and vine reduction, controlling public access, re-creation of open areas and loose sands, and the careful reintroduction of prescribed fire into the ecosystem. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Increase land management actions to include removal of hardwoods, debris and exotics, canopy and vine reduction, and reintroduction of prescribed fire into the ecosystem. • Conduct research on the response of Lakela's and Savannas mint to fire and fire prescriptions necessary to benefit the species. • Collaborate with partners and stakeholders on development of long-term habitat improvement and maintenance plans specific to the mints on public lands. • Develop a long-term, regular monitoring program for both reintroduced and natural populations. • Continue long-term spatial seedling recruitment and survival research. • Continue seed predation studies to determine if seed predators are a significant threat to the survival of the species. • Perform further research on pollinator species significance in the recovery and survival of Lakela's mint and Savannas mint. Explore potential connection between lack of pollination to seeds found with fungus. • Continue propagation efforts; clones of the original "parent" should be placed throughout the Hallstrom site to augment the population. • Continue seed germination studies and make efforts to develop additional outplanting techniques, especially those that may alleviate desiccation of plants during dry conditions. • Perform demographic studies such as long-term survival and potential correlations with rainfall cycles and other climate variables. • Continue to survey potential habitat and pursue conservation agreements, implement

management recommendations, and/or acquire land, particularly for D. immaculata var. savannarum (Savannas mint). • Increase outreach efforts to raise awareness of this native species and the natural scrub habitat. • Promote partnerships to share information, seek funding, conduct collaborative research on coastal scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Identify additional reintroduction sites and establish reintroduced populations; implement population augmentations. • Where private sites are being developed, efforts should be continued to rescue individual plants and use them for propagation or to augment populations on protected sites. • Conduct additional research on the biology, ecology, genetics, and management needs of the species. • Conduct a taxonomic study of the Dicerandra genus within Central Florida using a multidata approach (e.g., morphology, genetics, geography, ecological factors, etc.). (USFWS, 2021)

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SPECIES ACCOUNT: *Diplacus vandenbergensis (=Mimulus fremontii var. v.)* (Vandenberg monkeyflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/25/2014; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Vandenberg monkeyflower is a small, annual herbaceous plant that grows from 0.5 to 10 inches (in) (1.2 to 25.4 centimeters (cm)) tall. The stems are glandular and usually green with purplish tinting. Leaves are obovate (narrowly elliptic) and reach 1.2 in (3 cm) in length. Plants produce a single flower or plants are branched producing multiple flowers. The tubular yellow flowers are bilaterally symmetrical, with the distal ends of the petals forming a unique structure that is likened to a face; hence the common name monkeyflower. Seed capsules are ovoid and reach 0.5 in (1.3 cm) in length. The capsule splits open longitudinally from the tip to release approximately 20 to 100 seeds. (USFWS, 2013)

Taxonomy

Vandenberg monkeyflower was first described as Mimulus fremontii (Benth.) A. Gray var. vandenbergensis D.M. Thompson (Thompson 2005, p. 134) as a member of the Scrophulariaceae (figwort family). This is the name and family placement we have previously followed. Molecular systematics studies examining members of the Scrophulariaceae, including Mimulus, determined that this genus and a few others constituted a separate monophyletic group warranting recognition at the family rank as Phrymaceae (Beardsley and Olmstead 2002, pp. 1193-1101; Olmstead 2002, p. 18). Placement of Mimulus in the family Phrymaceae is recognized by species experts, is used in the recent flora of California (Thompson 2012, pp. 988-998), and will be treated as such in the upcoming volume of the Flora of North America. In 2012, Barker et al. (2012) recognized a redefined genus Diplacus that includes 46 taxa previously segregated as Mimulus, including Vandenberg monkeyflower as Diplacus vandenbergensis (D.M. Thompson) Nesom (Barker et al. 2012, p. 29). The citation in Barker et al. (2012, p. 29) attributes the nomenclatural combination at the species rank to Nesom in Phytoneuron 2012-47: 2, which was published electronically on the same day as Barker et al. (2012). The Start Printed Page 64842current citation for Vandenberg monkeyflower is at the species rank as Diplacus vandenbergensis (D.M. Thompson) G.L. Nesom. This combination is accepted by species and genus experts and will be used in the upcoming treatment in the Flora of North America. Accordingly, we will use the correct name (Diplacus vandenbergensis) and family attribution (Phrymaceae) throughout this and subsequent documents. (USFWS, 2013)

Historical Range

Historical locations for Vandenberg monkeyflower are known from Santa Rita Valley, Lower Pine Canyon, Lower Santa Lucia Canyon in Santa Barbara County, California. (USFWS, 2013)

Current Range

Endemic to the eastern portion of Burton Mesa (Wilken 2010 in Elvin 2010) in Santa Barbara County, California. Mimulus fremontii var. vandenbergensis is bounded by Purisima Hills to the north and east, Santa Ynez River to the south, and the mesa edge on the west side of Santa Lucia Canyon, including the tributary canyons to the west (e.g., Lakes, Oak, and Pine Canyons).

The habitat and soils that it grows on are only found in a crescent-shaped area approximately 10.7 km long by 3.0 km wide that comprises less than 6,070 ha or 60.7 square km (Elvin 2010). (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/10/2015.

Legal Description

On August 11, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 10, 2015) for Diplacus vandenbergensis (Vandenberg monkeyflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (80 FR 48142-48170).

Critical Habitat Designation

The critical habitat designation for Diplacus vandenbergensis includes four CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 5,755 acres (ac) (2,329 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 48142-48170).

Unit 1: Vandenberg: Unit 1 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 223 ac (90 ha). Unit 1 is located adjacent to and between two extant occurrences (Oak Canyon and Pine Canyon, which are located on Vandenberg AFB) and is known to support suitable habitat for Vandenberg monkeyflower.

Unit 2: Santa Lucia: Unit 2 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing, is currently occupied by the species, and consists of 1,484 ac (601 ha). This unit includes State lands (96 percent) within the Reserve, relatively small portions of local agency lands (for example, school districts, water districts, community services districts) (less than 1 percent) and private lands (3 percent). Unit 2 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. The eastern boundary of Vandenberg AFB delineates the western boundary of this unit. Unit 2 includes most of the Vandenberg and Santa Lucia Management Units of the Reserve. Unit 2 extends from Purisima Hills at the northern extent through the width of Burton Mesa to the agricultural lands south of the Reserve, and to the eastern boundary of the Vandenberg and Santa Lucia Management Units where these units abut Vandenberg Village.

Unit 3: Encina: Unit 3 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 2,024 ac (819 ha). This unit contains State-owned lands (72 percent), including most of the Encina Management Unit of the Reserve, local agency lands (1.2 percent), and privately owned lands such as areas adjacent to the Clubhouse Estates residential development (27 percent) (see Table 1 above). Unit 3 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. Unit 3 extends from approximately the Purisima Hills to the north, through the Reserve and to the agricultural lands just south of the Reserve boundary, and is between Vandenberg Village and State Route 1 to the east and the residential communities of Mesa Oaks and Mission Hills to the west.

Unit 4: La Purisima: Unit 4 is within the geographical area occupied by Vandenberg monkeyflower at the time of listing and consists of 2,024 ac (819 ha). Unit 4 contains mostly State-owned lands (89 percent) consisting of most of La Purisima Mission SHP and a small portion of the La Purisima Management Unit of the Reserve that is north of La Purisima Mission SHP. This unit also contains private land to the east of La Purisima Mission SHP (11 percent), and a small portion of local agency lands (less than 1 percent) (see Table 1 above). Unit 4 contains the appropriate vegetation structure of contiguous chaparral habitat with canopy gaps (PCE 1) and loose, sandy soils (PCE 2) that support Vandenberg monkeyflower. This unit extends approximately from the Purisima Hills in the north to the southern boundary of La Purisima Mission SHP, and between the residential communities of Mesa Oaks and Mission Hills to the west and to just east of, and outside, the State Park's eastern boundary.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Diplacus vandenbergensis critical habitat consists of two components (80 FR 48142-48170):

(i) Native maritime chaparral communities of Burton Mesa comprising maritime chaparral and maritime chaparral mixed with coastal scrub, oak woodland, and small patches of native grasslands. The mosaic structure of the native plant communities (arranged in a mosaic of dominant vegetation and sandy openings (canopy gaps)) may change spatially as a result of succession, and physical processes such as windblown sand and wildfire.

(ii) Loose sandy soils on Burton Mesa. As mapped by the Natural Resources Conservation Service (NRCS), these could include the following soil series: Arnold Sand, Marina Sand, Narlon Sand, Tangair Sand, Botella Loam, Terrace Escarpments, and Gullied Land.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain physical and biological features that are essential to the conservation of the species and that may require special management considerations or protection. All areas proposed as critical habitat will require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Vandenberg monkeyflower. In all areas, special management is needed to ensure that the habitat is able to provide for the growth and reproduction of the species. The habitat where Vandenberg monkeyflower occurs faces threats from urban development, maintenance of existing utility pipelines, anthropogenic fire, unauthorized recreational activities, and most substantially the expansion of invasive, nonnative plants (see Factors A and E in the proposed listing rule). Management activities that may reduce these threats include, but are not limited to: (1) Protecting from development lands that provide suitable habitat; (2) minimizing habitat fragmentation; (3) minimizing the spread of invasive, nonnative plants; (4) limiting authorized casual recreational use to existing paths and trails (as opposed to off-trail use that can spread invasive species to unaffected areas); (5) controlled burning; and (6) encouraging habitat restoration. These management activities would limit the impact to the physical or biological features for Vandenberg monkeyflower by decreasing the direct loss of habitat, maintaining the appropriate vegetation structure that provides the sandy openings that are necessary components of Vandenberg monkeyflower habitat, and minimizing invasive, nonnative plants spreading to areas where they currently do not exist. Preserving large

areas of contiguous suitable habitat throughout the range of the species should maintain the mosaic structure of the Burton Mesa chaparral that may be present at any given time, and maintain the genetic and demographic diversity of Vandenberg monkeyflower. (USFWS, 2013)

Life History

Food/Nutrient Resources

Competition

Adult: Veldt grass, eucalyptus, and pine groves (USFWS, 2015)

Food/Nutrient Narrative

Adult: The Vandenberg monkeyflower competes with non-native species such as veldt grass, eucalyptus, and pine groves (USFWS, 2015)

Reproductive Strategy

Adult: Mixed mating (USFWS, 2015); seed-banking annual (NatureServe, 2015)

Lifespan

Adult: One year (inferred from USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Pollinators to achieve seed production; namely smaller solitary bees to medium and larger social bees (USFWS, 2015)

Reproduction Narrative

Adult: The Vandenberg monkeyflower is a seed-banking annual plant (NatureServe, 2015). It reproduces with a "mixed mating" strategy and, as an annual plant, lives no more than one year. It is dependent on pollinators to achieve seed production, particularly small to large-sized bees (USFWS, 2015).

Habitat Type

Adult: Coastal scrub, chaparral, and woodlands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevation 30-122 m; restricted to the Burton Mesa region (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Moderately sparse (inferred from USFWS, 2014). Restricted to the Burton Mesa region is andy openings of coastal scrub, chaparral, and woodlands (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Habitat Narrative

Adult: The Vandenberg Monkeyflower inhabits coastal scrup, chaparal, and woodland areas The species is restricted to the Burton Mesa region in sandy openings of coastal scrub, chaparral, and woodlands from 30-122 m in elevation (Elvin 2010). (NatureServe, 2015). Its spatial

arrangement is relatively sparse, and habitat connectivity is named as a key resource needed for habitat (USFWS, 2015).

Dispersal/Migration

Dispersal

Adult: High (inferred from USFWS, 2014)

Dependency on Other Individuals or Species for Dispersal

Adult: Small mammals (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Seeds are primarily dispersed by gravity, along with wind and water over relatively short distances. Long-distance dispersal of seeds occurs in numerous ways, including vertebrate dispersal (e.g. small mammals, by adhesion or ingestion), wind dispersal of seeds (in updrafts and storms, or by secondary dispersal over the substrate), wind dispersal of plants (tumble-plant dispersal), and water dispersal High dispersal is inferred based on discussion and implied relevancy of the surprisingly long flight distances of its pollinators (USFWS, 2014; USFWS, 2015).

Additional Life History Information

Adult: Gravity is also named as a means of dispersal (USFWS, 2015)

Population Information and Trends

Population Trends:

Declining (NatureServe, 2015)

Species Trends:

Not available

Number of Populations:

7 (NatureServe, 2015)

Population Size:

2,000 total individuals observed in 2006; size may vary considerably year to year (NatureServe, 2015)

Additional Population-level Information:

The variety was named in 2005 so it is difficult to assess long term trends (NatureServe, 2015)

Population Narrative:

There are 7 known populations of this species. While species level trends are not available, a decline has been observed at the population level. Total population size was 2,000 individuals in 2006 and estimated to be similar in 2009, but acknowledged to likely vary considerably from year to year due to the species' status as a seed-banking annual. One population was destroyed in 2007 while the remaining populations are vulnerable to multiple stressors, notably invasion of non-native species. Long-term trends have been difficult to assess, in part because the variety was named in 2005 (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat destruction and alteration (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The majority of remaining Burton Mesa chaparral where Vandenberg monkeyflower occurs is within Federal or State-owned lands and is protected from development. Therefore, large-scale future development of remaining Burton Mesa chaparral is not likely to occur and thus is not a significant threat to Vandenberg monkeyflower. However, smaller-scale private property development; access to easements; maintenance of utility, oil, and gas pipelines; fire and fire suppression; and authorized and unauthorized recreational activities may continue to take place throughout Burton Mesa. Some of these activities may occur within Burton Mesa chaparral or adjacent to occurrences of Vandenberg monkeyflower, resulting in the destruction and possible removal of Vandenberg monkeyflower habitat and creating open areas for nonnative plants to invade. Therefore, the direct destruction and alteration of chaparral habitat is likely to continue on a relatively small scale and is thus considered a threat to Vandenberg monkeyflower both currently and in the future. (USFWS, 2014)

Stressor: Utility and pipeline maintenance (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Utility and pipeline structures occur within the Burton Mesa Ecological Reserve (Reserve), and access routes through the Reserve service the Plains Exploration and Production Company oil processing plant, which surrounds the La Purisima Management Unit of the Reserve. Additionally, local land use agencies and public works agencies retain other utilities and pipelines, and easements for access. For example, the Vandenberg Village Community Services District has several structures (including water tanks, a water processing plant, wells, and water lines and sewer lines) located within the Reserve (Gevirtz et al. 2007, p. 63). These existing facilities or structures at times require routine maintenance to ensure proper operation. As a result, vehicles and foot traffic could occur at or adjacent to these structures and potentially result in trampling of habitat and other soil surface disturbance, which in turn could result in ground disturbance that removes Burton Mesa chaparral and creates open areas in the vegetation that act as pathways for nonnative plants to expand or invade. There is no indication that ongoing maintenance activities of existing pipelines and utilities have directly impacted Vandenberg monkeyflower habitat. However, utility maintenance actions could result in ground disturbance that removes Burton Mesa chaparral, creating open areas in the vegetation that act as pathways for nonnative plants to invade. (USFWS, 2014)

Stressor: Invasive, non-natice species (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Invasive, nonnative plants occur and are expanding throughout the Burton Mesa. More specifically, at least one of the four most problematic invasive plants occurs within or adjacent to suitable habitat at each of the nine extant occurrences of Vandenberg monkeyflower

and at one potentially extirpated location. Invasive plants have demonstrated the ability to reduce the diversity of native vegetation and convert the native shrublands into nonnative-dominated vegetation. (USFWS, 2014)

Stressor: Anthropogenic fire (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Because of the human presence and infrastructure on Burton Mesa, the frequency of human-caused wildfires is likely greater than the frequency of historical fires on the mesa. An increased fire frequency in Burton Mesa chaparral would tend to favor the establishment of nonnative vegetation in open areas at the expense of native vegetation. However, the primary threat to Vandenberg monkeyflower and its habitat from fire is the post-fire expansion of invasive, nonnative plants, regardless of the fire frequency. Because an abundance of nonnative plants already occurs on the mesa, and invasive plants rapidly invade open areas, any fire that occurs within or adjacent to Vandenberg monkeyflower habitat is likely to result in an increase of invasive, nonnative vegetation. Likewise, fire suppression activities that include clearing vegetation in fuel breaks or spreading retardant would increase the likelihood of nonnative species invading suitable Vandenberg monkeyflower habitat, as well as enhance the habitat conditions for invasive species expansion. Additionally, because the presence of invasive, nonnative plants creates a positive feedback mechanism, the greater the percent cover of nonnative vegetation, the more likely fires will occur on Burton Mesa. Based on the information presented in this section, the current threat from anthropogenic fire and associated fire suppression activities to Vandenberg monkeyflower habitat described above is expected to continue into the future. (USFWS, 2014)

Stressor: Recreation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Recreation is enumerated among the threats and stressors to this species. Recreational activities that occur throughout Burton Mesa include authorized uses such as hunting, hiking, biking, wildlife observation, and leashed-dog walking. Additionally, off-road vehicle (ORV) use is authorized on Vandenberg AFB (Air Force 2011a, p. 6), but it is not permitted on the Reserve (Gevirtz et al. 2007, p. 70) or La Purisima Mission SHP (California State Parks 1991, p. 109). ORV use and other casual recreational activities may contribute to soil disturbance and increase the potential for invasive, nonnative plants to be introduced and further spread across Burton Mesa, including into locations where Vandenberg monkeyflower and its suitable habitat occurs (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Climate change is enumerated among the threats and stressors to this species. Climate change may have potential impacts on Vandenberg monkeyflower and its habitat, such as increased temperatures and decreased precipitation that would likely reduce suitable habitat. Scientific measurements spanning several decades demonstrate that changes in climate are

occurring, and that the rate of change has increased since the 1950s (FR, 2014).

Recovery

Reclassification Criteria:
Recovery Priority Number of 8

Recovery Actions:

- The Air Force has an approved Integrated Natural Resources Management Plan (INRMP) on Vandenberg Air Force Base in 2011. Included are the following components: (1) Development. The Air Force is not likely to construct new launch facilities within suitable habitat near human-populated areas, and the future siting of community facilities is expected to occur in a manner that capitalizes on existing infrastructure and circulation systems (Air Force 2009a, p. 32). Thus, no specific conservation measures have been proposed to minimize the threat of development to Vandenberg monkeyflower or its habitat on Base. (2) Utility Maintenance and Miscellaneous Activities. Construction of new facilities is not likely to occur within Vandenberg monkeyflower habitat; however, existing utilities will require periodic maintenance. No specific conservation measures were proposed in the addendum to the INRMP (Air Force 2012). The main objective is to avoid any impacts to habitat, when possible, by either confining the work to existing disturbed areas or rerouting the work to avoid suitable habitat completely, and minimize the impact as much as possible (Air Force 2012, p. 2). For Vandenberg monkeyflower, the Air Force would avoid impacting Burton Mesa chaparral as much as possible if utility maintenance is required in suitable habitat. (3) Invasive, Nonnative Plants. The INRMP (Air Force 2011a) includes an Invasive Plant Species Management Plan that identifies the threat of invasive, nonnative plants on Base, and proposes removal methods to limit further spread and assist in restoration of habitat degraded by invasive species. In most cases, the Air Force would utilize chemical application to manage for invasive plants (Air Force 2011a, p. 43). Although the INRMP identified invasive, nonnative plants as a threat and calls for their removal, it did not identify which nonnative species, and which areas on Base, were a priority for treatment. In the 2012 addendum to their INRMP, the Air Force identifies veldt grass as the most problematic invasive, nonnative plant on Base for Vandenberg monkeyflower. As part of this addendum, the Air Force also identified their 10-year funding program, which included more than $500,000 to treat veldt grass, starting in 2009 and continuing through 2019 (Air Force 2012). While the Air Force does not specify precisely where, when, or how much veldt grass will be treated or removed in specific years, they state that a substantial portion of this effort will focus on areas within the range of Vandenberg monkeyflower (Air Force 2012, p. 1). Through 2012, the Air Force has chemically treated approximately 141 acres (57 ha) of invasive, nonnative plants, mostly treating pampas grass within Burton Mesa chaparral but not near extant Vandenberg monkeyflower occurrences (treatment was to benefit Eriodictyon capitatum (Lompoc yerba santa)). Other invasive, nonnative plants treated included veldt grass, iceplant, Eucalyptus spp. (Eucalyptus), and Pinus spp. (Pine)). Only a small proportion of this chemical removal occurred within Burton Mesa chaparral at two locations where Vandenberg monkeyflower occurs (Lake and Pine Canyons) (Lum in litt. 2013). (4) Fire. For fires that would affect Vandenberg monkeyflower and its habitat, the Air Force developed a GIS layer incorporating all potential suitable habitat areas, which has been made available to fire response crews for use during actual fire events. Multiple conservation measures that address the potential threat of fire are included in the

addendum (Air Force 2012, p. 2), including the following: (a) Established roads, both paved and unpaved, would be used to the greatest extent possible as fire lines unless an emergency dictates otherwise. (b) Burned areas would be assessed after a fire for rehabilitation options within 10 days of the area being declared safe for entry. (c) Vandenberg monkeyflower habitat affected by wildfire and rehabilitation projects will be monitored, which would include recommendations for nonnative species control. (d) Following any significant wildfire event within the range of Vandenberg monkeyflower on Base, a Burn Area Emergency Response (BAER) project will be initiated. This generally includes implementation of erosion control, native vegetation restoration, firebreak rehabilitation, and invasive species management. Additionally, the addendum proposes to incorporate portions of Vandenberg monkeyflower habitat in a controlled burn program (Air Force 2012, p. 2). (5) Recreation. No conservation measures have been proposed to address the threat of recreation to Vandenberg monkeyflower. (USFWS, 2013)

- Burton Mesa Ecological Reserve (Reserve): The State Lands Commission signed a 49-year lease of the Burton Mesa Ecological Reserve on January 20, 2000. The purpose of the lease is to manage, operate, and maintain these sovereign lands for the sensitive species and habitats they support . The CDFW developed a management plan for the Reserve that guides management of habitats, species, and programs to achieve the mission of CDFW to protect and enhance wildlife values. Conservation measures are proposed in the management plan, contingent upon available funding and staffing. (1) Development. Because new development would not occur on the Reserve, there are no conservation measures to implement that would minimize this threat to Vandenberg monkeyflower. (2) Utility Maintenance and Miscellaneous Activities. Several public utilities and local governmental agencies provide services to the local community and use the Reserve to accomplish their roles. Within the Reserve, agencies responsible for conducting maintenance activities submit maintenance plans for all scheduled activities to CDFW, who in turn may request conservation measures (such as modifying the size and frequency of actions) to minimize impacts on natural resources (3) Invasive, Nonnative Species. The Reserve's management plan encourages minimizing the impact and presence of invasive, nonnative plants, including monitoring and removing nonnative plants; preventing new introductions by working with public utilities, local governmental agencies, and recreationists that use the Reserve; and restoring disturbed and degraded areas with native species. (4) Fire. The CDFW management plan for the Reserve calls for coordination among the Santa Barbara County Fire Department, enforcement agencies, local governmental agencies, and adjacent small and large landowners to ensure that fire risk is reduced, that new development projects adjacent to the Reserve are reviewed by CDFW staff and address fuel reduction needs and requirements, and that appropriate and efficient post-fire remediation takes place, where needed. Reducing the risk of fire would limit the potential for wildfire to occur within Vandenberg monkeyflower habitat, and thus reduce the impact of fire suppression activities and the impact of invasive, nonnative plants invading the habitat post-fire. No controlled burns within Vandenberg monkeyflower habitat have occurred to date. (5) Recreation. CDFW developed a trails plan that shows existing trails within the Reserve as well as proposed new trail construction; seasonal trail closures or restrictions may occur to protect sensitive resources such as wildlife breeding locations or rare plant assemblages that vary from year to year (Gevirtz et al. 2007, p. 70). This system of trails would reduce the risk of authorized recreational uses directly impacting suitable Vandenberg monkeyflower habitat. The management plan calls for maintaining public access to the Reserve through pedestrian hiking trails by providing a network of trails,

including loop trails, linking interesting areas while protecting resources, and preventing unauthorized uses (Gevirtz et al. 2007, p. 231).

- La Purisima Mission State Historic Park: A general management plan for La Purisima Mission SHP was completed in 1991, and an ecosystem characterization of La Purisima Mission SHP was completed in 2005. Directives specific to La Purisima Mission SHP that concern the habitat where Vandenberg monkeyflower occurs include preserving Burton Mesa chaparral, protecting and managing rare and endangered plants in perpetuity, controlling nonnative plants that have become established, and developing a prescribed-burn plan. Conservation measures are proposed in the general management plan, as outlined below, with implementation contingent upon available funding and staffing. (a) Development. There are multiple existing structures within the park, and any new structures must provide for visitors' needs without competing for attention with historical buildings or the natural setting. All new development must be sensitive to that purpose of providing appropriate visitor facilities without detracting from the historical and natural setting of La Purisima Mission. Burton Mesa chaparral habitat areas are designated as low-intensity use areas. Therefore, any new development is unlikely to impact Vandenberg monkeyflower or its habitat in the park. (b) Invasive, Nonnative Species. California State Parks' resource management programs try to remove or control invasive, nonnative species and reestablish indigenous native species. (c) Fire. In 2007, California State Parks initiated development of a wildfire management plan that would include management strategies to protect the existing infrastructure (buildings) and protect cultural resources and biological resources of the park (which would include Vandenberg monkeyflower habitat), as well as informing fire suppression agencies of the areas with high-value resources and the limits of fire suppression activities in those areas. No prescribed burns currently occur within the park. (d) Recreation. Consideration will be given to designating trails for specific types of uses and constructing new trail segments to avoid conflicts (California State Parks 1991, p. 65). The trail system requires continual brush and erosion control, in which California State Parks often relies on numerous volunteers such as scouts and environmental groups to assist the park each year in various projects, from litter pickup to trail construction. A designated trail system would reduce the risk of authorized recreational uses directly impacting Vandenberg monkeyflower habitat. However, the best available information indicates that recreational activities are currently having minimal to no effect on Vandenberg monkeyflower habitat at La Purisima Mission SHP

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SPECIES ACCOUNT: *Dodecahema leptoceras* (Slender-horned spineflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/28/1987; Pacific Southwest Region (R8) (USFWS, 2015)

Physical Description

An annual plant that has a distinctive basal rosette of leaves ranging from 3 to 8 centimeters (cm) (1.2 to 3.1 inch (in)) in diameter. The leaves frequently become reddish at maturity. The flower stalks are branched and erect 3 to 10 cm (1.2 to 4 in) tall . Flowers are arranged in clusters along the flower stalks and each cluster is surrounded by an involucre (a ring of modified leaves beneath a flower cluster). Characteristic of this species, each of the 6 involucre segments has an awn at its base as well as at its apex. This feature distinguished this genus from the closely related genera Chorizanthe and Centrostegia (Reveal and Hardham 1989, p. 86). The flowers are white to pink, 1.2 to 2 millimeters (mm) (0.5 to 0.8 in) long, each producing a single achene (a dry single-seeded fruit), 1.7 to 2 mm (0.06 to 0.08 in) long (USFWS, 2010).

Taxonomy

In the buckwheat family (Polygonaceae). At the time of listing, the species was classified as Centrostegia leptoceras A. Gray. A reassessment of the distinct morphology of the involucre and relationships to other closely related taxa resulted in a taxonomic revision. The current recognized name for slender horned spineflower is Dodecahema leptoceras (A. Gray) Reveal and Hardham (Reveal and Hardham 1989, p. 85) (USFWS, 2010).

Historical Range

See current range/distribution.

Current Range

Southwestern California, in the foothills of the San Gabriel Mountains in Los Angeles County, the San Bernardino Mountains in San Bernardino County, and the San Jacinto Mountains in western Riverside County (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: The level of gene similarity (or homozygosity) detected in this species indicates that Dodecahema leptoceras has a mixed mating system (e.g., seed is produced both through pollination between flowers on a single plant and between flowers on different plants), but the latter condition, outcrossing, is more prevalent. The level of gene similarity (or homozygosity) detected in this species indicates that Dodecahema leptoceras has a mixed mating system (e.g., seed is produced both through pollination between flowers on a single plant and between

flowers on different plants), but the latter condition, outcrossing, is more prevalent (USFWS, 2010).

Habitat Type

Adult: Terrestrial (USFWS, 2010)

Habitat Vegetation or Surface Water Classification

Adult: Alluvial scrub on sandy and gravelly soils in sandy wash systems (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Elevation range of 656 to 2,296 feet (USFWS, 2010)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2010)

Habitat Narrative

Adult: Species habitat is alluvial scrub on sandy and gravelly soils in sandy wash systems, at elevations ranging from 656 to 2,296 feet, in areas where intermittent, scouring flood events occur (USFWS, 2010). Soils are riverbed alluvium high in silt and low in organic matter (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal may be by small animals or sheet flows during heavy rains (USFWS, 2010).

Population Information and Trends

Population Trends:

Decline of 70-90% (NatureServe, 2015)

Species Trends:

Decline of >50% (NatureServe, 2015)

Number of Populations:

15 occurrences are extant, 13 are presumed extant, 7 are possibly extirpated, and 9 are extirpated (USFWS, 2022)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The alluvial terrace habitat where this species lives has been severely altered, degraded and destroyed over the past 100 years. The long-term trend is a decline of 70-90%; the short-tern trend is a decline of >50%. Thousands of individuals at the San Jacinto River and Temescal Canyon sites. A total of 35 occurrences are known, however, only 19 are non-historic. While several populations are known to be extirpated or historic, between 1/3-2/3 of the story of loss and decline is known. In other words, it is suspected that more decline is occurring than

researchers know about (NatureServe, 2015).. Of the 11 spineflower occurrences in Los Angeles County, 1 is extant, 2 are presumed extant, 3 are possibly extirpated, and 5 are extirpated. of the 17 spineflower occurrences in Riverside County, 8 are extant, 7 are presumed extant, 1 is possibly extirpated, and 1 is extirpated. of the 16 spineflower occurrences in San Bernardino County, 6 are extant, 4 are presumed extant, 3 are possibly extirpated, and 3 are extirpated (Table 2). Two occurrences are new since 2010 (USFWS, 2022). We reviewed data from the CNDDB, CCH2, Habitat Conservation Plans, project-related surveys, and the Forest Service to update spineflower occurrence numbers and status. Our 2010 5-year review identified 36 occurrences of spineflower. Twenty were presumed extant, 3 were possibly extirpated, and 13 were extirpated (Table 1). This 2022 review of new information finds that there are 44 occurrences of spineflower. Eight occurrences that were not considered in the 2010 5-year review have been either (1) discovered since 2010, or (2) were known to others but not included in our last review. Across the range of spineflower in Los Angeles, Riverside, and San Bernardino counties, 15 occurrences are extant, 13 are presumed extant, 7 are possibly extirpated, and 9 are extirpated (Table 1). Since 2010, conservation land acquisition has occurred at or adjacent to three occurrences of spineflower. The spineflower is also a covered species under the draft Upper SAR HCP and the 2020 Wash Plan, which will implement measures to help conserve and manage for the species (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The current threats to habitat are urban and agricultural development, mining, altered hydrology, off-highway vehicle activity, trash dumping, fire, invasive nonnative plants, and other habitat degrading activities (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act is the primary Federal law that has provided protection for this species since its listing as endangered in 1987 (USFWS 1987, pp. 36265-36270). Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act (USFWS, 2010).

Stressor: Climate change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Climate change refers to a shift in the mean or variability in measures of climate (e.g., precipitation or temperature) that persists for an extended period of time, typically a decade or more, due to natural variability, human activity, or both (IPCC 2013, p. 1450). In our 2010 5- year review, we considered climate change a threat to spineflower (Service 2010, pp. 24–25). Since 2010, scientists have used downscaled climate models to project changes in temperature and

precipitation in California under a range of future climate scenarios (Kalansky et al. 2018, entire; Pierce et al. 2018, entire). Temperature has increased throughout Southern California over the past century, and warming is expected to continue (Table 3) (Hall et al. 2018, pp. 10–11). Wet and dry precipitation extremes are projected to increase in the future, although models project small mean changes compared to historical precipitation variability (Hall et al. 2018, p. 13). Models also project increases in the frequency of atmospheric-river storms, which deliver intense precipitation and can cause severe flooding (Dettinger 2011, p. 519). However, droughts are also projected to become more frequent and intense and will be exacerbated by higher temperatures (USFWS, 2022).

Stressor: Dumping and trash (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: In our 2010 5-year review for spineflower, we identified trash dumping as a threat at three spineflower occurrences but noted that the incidence of trash dumping could be higher than reported (Service 2010, p. 16) (USFWS, 2022).

Stressor: Rangewide altered hydrology (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Rangewide altered hydrology and other ongoing threats are still present at spineflower occurrences. Thirty-six percent of occurrences (16 of 44) are extirpated or possibly extirpated due to development and altered hydrology, and 30 percent of occurrences (15 of 44) have not been observed for over 10 years (i.e., are presumed extant) (USFWS, 2022).

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:

- There is no final approved recovery plan for this species (USFWS, 2010).
- Monitor known and historical occurrences as well as suitable habitat to determine presence and condition of Dodecahema leptoceras.
- Identify opportunities to work with private landowners to encourage conservation actions for Dodecahema leptoceras on sites that are not conserved. This could be done through the Partners for Fish and Wildlife Program as well other cooperative programs.
- Determine by experimental means and field studies the extent to which the presence of invasive nonnative plants impacts growth and persistence of Dodecahema leptoceras.
- Identify pollen and seed (fruit) vectors and their habitat requirements. Incorporate these requirements into habitat management considerations for Dodecahema leptoceras.
- Identify the structure and dynamics of the seed bank of Dodecahema leptoceras

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS To recover slender-horned spineflower, we need to conserve additional spineflower habitat and enhance or restore degraded habitat. To accomplish these actions, we also need additional monitoring, surveys, and site assessment across the species' range. We recommend that the following actions be completed over the next 5 years to enhance habitat and manage threats to slender-horned spineflower. We recognize that conservation of this species will require cooperation and coordination with partners. 1. Monitor known and historical occurrences to determine presence and condition of spineflower. Evaluate threats and develop site-specific recommendations to prioritize management actions. 2. Model suitable habitat across the range of spineflower and prioritize areas for further survey. Work with interested landowners to survey suitable habitat where spineflower has not been detected. 3. Collect spineflower seed from occurrences outside the Wash Plan area and conserve seed in an off-site conservation seed bank. 4. Enhance spineflower habitat using the site-specific recommendations developed under action 1. 5. At spineflower occurrences that are not conserved, identify opportunities to work with landowners to acquire lands or encourage conservation actions for spineflower. 6. Over the next 10 years, identify adaptive management and monitoring approaches from the Spineflower Working Group that could be applied range-wide, especially in regard to invasive species management and hydrological conditions (USFWS, 2022).

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SPECIES ACCOUNT: *Dubautia herbstobatae* (Na`ena`e)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

Dubautia herbstobatae is a shrub that can be either upright or sprawling, and has stems reaching to 0.5 m (1.6 ft) in length. Its leaves are opposite, or rarely ternate (three per node), and measure 2 to 5.5 cm (0.8 to 2.1 in) long. The inflorescences are borne on the stem tips and contain 5 to 15 yellowish-orange flower heads. The flower heads contain 4 to 20 disk florets and lack ray florets. The achenes (a type of dry, seed-like fruit) are 4 to 6 mm (0.157 to 0.236 in) long and are tipped by feather-like bristles (Wagner et al 1999) (USFWS, 2016).

Taxonomy

A member of the Asteraceae (sunflower) family (USFWS, 2016). The genus is endemic to hawaiian islands, this species is endemic to waianae mts. of Oahu (NatureServe, 2015).

Historical Range

See current range/distribution

Current Range

Dubautia herbstobatae is endemic to the Hawaiian Islands and is known to occur on the leeward side of the northern Waianae Mountains on only two ridge systems. These ridge systems span a distance of approximately 6 km (4 mi). One system includes Ohikilolo Ridge and the ridges in and around Keaau Valley. The second ridge system includes Kamaileunu, encompassing the Kamaileunu and Waianae Kai population units (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Dubautia herbstobatae (Pauoa) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Dubautia herbstobatae (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Dubautia herbstobatae includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Dubautia herbstobatae includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Dubautia herbstobatae critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Dubautia herbstobatae occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy:

Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Dubautia herbstobatae to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2016)

Lifespan

Adult: < 10 years (USFWS, 2013)

Breeding Season

Adult: May - June (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Flowering usually occurs in May and June. The species is almost certainly pollinated by insects, as are most other yellow-flowered members of the sunflower family, along with those Dubautia species whose mode of pollination has been studied (USFWS, 2016). Dubautia herbstobatae is a short-lived perennial (< 10 years) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist shrublands and forests (NatureServe, 2015); dry to mesic shrubland and forest (USFWS, 2016)

Habitat Narrative

Adult: Moist shrublands and forests on ridgetops, sides of ridges, steep slopes and cliffs (NatureServe, 2015). Dubautia herbstobatae occurs in dry-mesic to mesic areas and is often found on open rocky slopes and cliff faces. These slopes and cliffs are usually more or less north-facing. The vegetation of these habitats is rather sparse shrublands and scrubby forests (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2013)

Number of Populations:

6 (USFWS, 2019)

Population Size:

~838 mature and 37 immature (USFWS, 2019)

Minimum Viable Population Size:

50 mature, reproducing individuals (USFWS, 2016)

Population Narrative:

This species appears to be increasing. Currently, there are approximately 1,188 individuals in the Keaau (70 mature plants), Makaha/Ohikilolo (350 mature plants), Ohikilolo/Makai (358 mature plants), Ohikilolo/Mauka (382 mature and six immature plants), Makaha (36 mature and one immature plant), and Waianae Kai (10 mature and four immature plants) population units (U.S. Army Garrison 2005c). D. herbstobatae is characterized by three populations each with more than 50 mature, reproducing individuals (the recommended number for stabilization populations for this species; Service 1995a, 1998a) in the action area and four populations outside of the action area each with fewer than 50 mature reproducing individuals (USFWS, 2016). The 1,242 mature and immature individuals reported in 2012 represent little change from the 1,237 reported in the last five-year review (USFWS, 2013). Currently, there are approximately 838 mature and 37 immature individuals of Dubautia herbstobatae in six populations in the Wai‘anae mountains of O‘ahu (Army Natural Resources Program-O‘ahu (ANRP) 2018; U.S. Army 2018). Two population units contain over 100 individuals, and one population unit contains over 300 individuals (U.S. Army 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Nonnative plants (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: Alien plants compete with natives for space, light, water, and nutrients (Cuddihy and Stone 1990). The most significant aliens appear to be Schinus terebinthWolius (Christmas berry), Psidium cattleianum (strawberry guava), Melinus minutflora (molasses grass), Clidemia hirta

(Koster's curse), Lantana camara (lantana), Leucaena leucocephala (koa haole), Rubus argutus(prickly Florida blackberry), Grevillea 18robusta (silk oak), Erigeron karvinskianus (daisy fleabane), Myricafaya (firetree), Paspalum conjugatum (Hilo grass), Casuarina equisetifolia (common ironwood), Passflora suberosa (huehue haole), Ageratina adenophora (Maui pamakani), Ageratina riparia (Hamakua pamakani), Kalanchoepinnata (air plant), Tibouchina herbacea (a relative of Koster's curse), and Ardisia elliptica, (shoebutton ardisia). (USFWS 1995, 1 996a, 1 996b) (USFWS, 1998).

Stressor: Stochastic events (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Dubautia herbstobatae are vulnerable to extirpation from naturally occurring events such as landslides, hurricanes, flooding, and/or reduced reproductive vigor due to small population size and limited distribution (61 FR 53108; Service 1995a, 1998a) (USFWS, 2016).

Stressor: Feral ungulates (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: Animals such as pigs, goats, and cattle were introduced by the early Hawaiians (pigs) or more recently by European settlers (goats and cattle) forfood andlor commercial ranching activities. Overthe 200 years following their introduction, their numbers increased and the adverse effects offeral ungulates on native vegetation have become increasingly apparent. Beyond the direct effect oftrampling and grazing native plants, feral ungulates have contributed significantly to dispersal ofintroduced plant species and to the heavy erosion still taking place on most ofthe main Hawaiian Islands (Cuddihy and Stone 1990) (USFWS, 1998).

Stressor: Fire (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: Because Hawaii's native plants have evolved with only infrequent, naturally occurring episodes offire (lava flows, infrequent lightning strikes), most are not adapted to fire and are unable to recover well afterrecurring, human-set fires. Some alien plants are more fire-adapted than the natives and will quickly exploit suitable habitat after a fire (Cuddihy and Stone 1990). Species that grow in dry and mesic vegetation may be susceptible to fires set accidentally or maliciously, especially near areas ofhabitation from which fires could easily spread. Fire threatens plants upslope from Makua Military Reservation and Schofield Barracks, where current military firing exercises could unintentionally ignite fires (USFWS, 1998).

Stressor: Human disturbance (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: On Oahu, habitat disturbance caused by human activities may threaten rare plant populations that grow where military training exercises and ground maneuvers are occasionally conducted. However, because most ofthe taxa grow on moderate to steep slopes, ridges, and

gulches, habitat disturbance is probably restricted to foot and helicopter traffic. Trampling by ground troops associated with training activities and construction, maintenance, and use of helicopter landing zones could affect many recovery plan plant taxa (USFWS 1995, 1996a, 1996b) (USFWS, 1998).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013 (USFWS, 2013).

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Construct strategic fencing to protect populations from feral ungulates (USFWS, 1998).

- Control competing alien plant species in enclosures (USFWS, 1998).
- Maintain adequate genetic stock (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).
- The types of management actions needed will depend on local site characteristics but should include fencing, ungulate control, protection from fire, weed control, maintenance of adequate genetic stock, and outplanting of local genetic material (Service 1998a) (USFWS, 2016).
- The Makua Implementation Team (2003) has developed stabilization protocols for Dubautia herbstobatae which are incorporated in the Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). Dubautia herbstobatae can be successfully propagated from seed, air layers and cuttings. It is represented in several ex situ collections including: 23 cuttings in nurseries (Army Environmental Division, Oahu and Harold L. Lyon Arboretum), 3,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and six seedlings in a nursery (Harold L. Lyon Arboretum) (Service 2005b). Feral ungulate control is being implemented by the Army and State in Makua (U.S. Army Garrison 2005b) (USFWS, 2016).
- Captive propagation for genetic storage and reintroduction - Continue seed collection for genetic storage (USFWS, 2013).
- Fire protection – Develop and implement fire management plans (USFWS, 2013).
- Predator / herbivore control – Control rats and slugs (USFWS, 2013).
- Ungulate exclosures - Complete fencing of last unfenced population (USFWS, 2013).
- Surveys / inventories - Survey for populations in known historical sites and suitable habitat (USFWS, 2013).
- Population biology research: Develop pollination studies.Study populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors and threats (USFWS, 2013).
- Reintroduction / translocation - Reintroduce individuals into suitable habitat within historical range (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year reviews in 2008 and 2013. Thus, the following recommendations for future actions are reiterated for this 5-year review for 2019. • Surveys, inventories, and monitoring—Continue surveys for occurrences in known historical sites and suitable habitat. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of habitat degradation and browsing by feral ungulates. • Ecosystem-altering invasive plant species control—Control nonnative invasive plant species at all populations. • Fire destruction and degradation of habitat—Implement fire management plans. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o Continue to assess genetic variability within the extant populations and implement a plan for conserving the species' genetic diversity in ex situ and reintroduced populations. • Reintroduction and

translocation—Continue to reintroduce and augment populations of Dubautia herbstobatae in areas protected from known threats. • Population biology research— o Develop pollination studies. o Study populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Alliance and partnership development—Continue to work with the U.S. Army, the Honolulu Board of Water Supply, and other land managers to contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)

- New Management Actions: • Captive propagation for genetic storage and reintroduction— o Seed and propagule collections for the larger populations have not been initiated. However, collections have begun for the small populations (ANRP 2018). o The ANRP reports 215 plants in their nursery representing 28 founders from Mākaha and 3 founders from Waianae Kai (U.S. Army 2018). In addition, almost 50 seeds are in storage representing 23 individuals from six smaller subpopulations (Mākaha, Waianae Kai, and ʻŌhikilolo); however, seed set is very low in this species. Approximately 100 individuals are in two ex situ living collections (U.S. Army 2018). • Reintroduction—Out of 56 plants reintroduced in 2016, 18 plants have survived, representing individuals from Waianae Kai and Mākaha (U.S. Army 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Dudleya abramsii ssp. parva* (Conejo dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/28/1997; Pacific Southwest Region (R8)

Physical Description

A succulent dicot, rosette-forming perennial herb with vernal leaves (summer deciduous), an inflorescence stem 5 to 18 centimeters long, and pale yellow-green flowers that often exhibit flecks of red on the keel. The roots are constricted at irregular intervals . (USWS, 2015)

Taxonomy

In the stonecrop family (Crassulaceae). Dudleya parva was recognized as a distinct species by Munz and Keck in 1959 and 1968, Nakai in 1983, and Moran in 1980 (McCabe in litt. 2008a). In 1991, Bartel published a revision treating D. parva as a subspecies of D. abramsii (Bartel 1991) based on similarities between the flowers of D. abramsii and D. parva noted by Reid Moran (1948). However, D. parva and D. abramsii have differing micromorphological leaf surface characters, caudex diameters, and wound responses that appear to clearly separate the two (McCabe in litt. 2008a). The name of this species has been returned to Dudleya parva (from Dudleya abramsii ssp. parva) as of November 2006. (USFWS, 2015)

Historical Range

See current range/distribution.

Current Range

Known locations are in a narrow band of recorded occurrences along a 10-mile stretch of land from the western portion of the Simi Hills, through Mountclef Ridge, to the Conejo Grade in Ventura County, California (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Unknown; up to 24 years in cultivation (USFWS, 2015)

Breeding Season

Adult: Blooms in late spring (May-June) (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Bees and flies for pollination (USFWS, 2015)

Reproduction Narrative

Adult: Blooms in late spring (May - June), and is pollinated by bees and flies. D. parva tends to exhibit a higher degree of auto-fertility and is prone to pollinator unreliability, short and

unpredictable reproductive seasons, small population size, and high population turnover. D. parva will hybridize with some of the other Dudleya species (e.g., D. pulverulenta), which is typical of the Dudleya genus. Seeds sprout in the winter when there is ample precipitation and continue to grow throughout the rainy season. The plants may spread slowly underground by roots or stems, and any stem within 2 to 3 cm (0.8 to 1.2 in) of a centrally established individual may be a clone of that individual (USFWS, 2015).

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Scattered rock outcrops in grassland and cactus dominated coastal sage scrub habitat (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevations ranging from 60 to 450 meters (USFWS, 2015)

Environmental Specificity

Adult: Very narrow (inferred from USFWS, 2015)

Habitat Narrative

Adult: On a broad scale, suitable habitat for Dudleya parva is comprised of coastal sage scrub and valley and foothill grassland with clay or volcanic soils, at elevations ranging from 60 to 450 meters (180 to 1350 ft), and on slopes ranging from 0 to 90 degrees, but most commonly on north-facing slopes of approximately 10 degrees. This species is highly localized in its distribution, occurring exclusively in thin-soiled substrate over rocky outcrops derived from the Miocene Conejo volcanics (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal information is not available (inferred from USFWS, 2015).

Population Information and Trends

Population Trends:

Stable (inferred from USFWS, 2015)

Species Trends:

Stable (inferred from USFWS, 2015)

Number of Populations:

14 (USFWS, 2015)

Population Size:

~150,000 individuals (USFWS, 2015)

Population Narrative:

The population boundaries and numbers for Dudleya parva exhibit some annual fluctuations; however, the species has generally remained in the same suitable habitat areas noted at the time of listing in 1997. Since the time of listing, the number of documented individuals within the noted occurrences of the species has increased in some cases, while decreasing somewhat in others; however, the information gathered from the more recent population surveys seems to show that overall the species has remained at relatively constant levels since the time of listing. While many of the sites occur on private lands and could not be adequately surveyed, the numbers of plants that were seen on public lands have substantially increased in a few areas. Observed increases from different population surveys does not represent an actual increase in the number of plants, but rather is likely a result of the more thorough surveys (USFWS, 2015).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Habitat encroachment from new or existing development, fire suppression activities, human recreational activities (such as hiking, rock climbing, biking, and horseback riding) continue to be a threat (USFWS, 2015).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Due to the accessibility of some of the habitat sites to the public and the appeal of Dudleya species to horticulturalists, collection still constitutes a threat to the species. However, due to the vernal nature of this species (leaves wither and fall off in the summer), it may be slightly less attractive to collectors than non-vernal species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act is the primary Federal law that has provided some level of protection for Dudleya parva since its listing as threatened in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act (USFWS, 2015).

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The low numbers of individuals and limited range of Dudleya parva make it particularly vulnerable to extinction from random human-caused or natural events. Dudleya

parva is potentially threatened by: (1) pre-fire fuel-reduction activities, such as removal of native vegetation and disturbance of soils that can reduce habitat quality; (2) the wildfire itself, in which the intense heat can kill or set back the growth of individuals; and (3) fire suppression activities, including the disturbance of native vegetation and soils during the grubbing of fire lines and the dropping of fire retardants, the latter of which increases soil nitrogen and stimulates the growth of non-native grasses that could compete with D. parva (USFWS, 2015).

Stressor: Climate change effects (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The 2009 5-year review (Service 2009 p.14) introduced climate change as a threat to Dudleya abramsii ssp. parva. Threats resulting from climate change may be complex, and include physical stress, death by erosion, increased competition, and increased likelihood of fire. Expected climate change for the Los Angeles area predicts rising annual and extreme high temperatures (Hall et al. pp. 10-11) and more episodic rainfall with more extreme floods and drier droughts (Hall et al. pp. 11-14, 18). Changes in climate could threaten Dudleya abramsii ssp. parva in several ways. First, although the species is dormant in the dry part of the year, more intensely dry summers with long-term drought could kill plants (Burgess (in litt. 2022). Second, more intense precipitation and erosion could cause slope slippage, destroying plants. Third, with changing climate, non-native annual grasses are expected to increase in dominance both as a result of increased fire frequency (Hall et al. 2018 p. 53) and with increasing annual temperatures (Sandel and Dangremond 2012 entire). The increased annual grass dominance can both promote more fire and may have negative competitive effects on Dudleya abramsii ssp. parva. Because it characteristically occurs in rocky areas with sparse vegetation that does not carry fire well, this may not negatively affect the species. However, if non-native annual grass cover does increase and fires do increase in frequency or intensity at Dudleya abramsii ssp. parva occurrences, the species could be negatively impacted. The threat of climate change on Dudleya abramsii ssp. parva remains (USFWS, 2023).

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
1. All current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity (USFWS, 1999).

2. All current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years (USFWS, 1999).

Recovery Actions:
- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).

- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)
- Recommendation for Future Action from 2015 5-Year Review: Conduct new, up-to-date, extensive population surveys of known occurrences and areas of suitable habitat. - Develop and implement monitoring and adaptive management plans for known existing occurrences. Monitoring should occur at intervals of 3 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. - Update and expand knowledge of the species’ life history and specific habitat requirements (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The recommendations for future actions largely mirror those of the 2015 5-year review (Service pp.22-23): 1. Conduct thorough population surveys of known occurrences and areas of suitable habitat. 2. Develop and implement a monitoring plan for known existing occurrences. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 3. Work with public and private landowners to raise public awareness of the species to support appropriate conservation measures. 4. Update and expand knowledge of the species’ life history and specific habitat requirements. 5. Improve the completeness of coverage of Dudleya abramsii ssp. parva in conservation seed banks, with more occurrences over more years (USFWS, 2023).

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SPECIES ACCOUNT: *Dudleya cymosa ssp. marcescens* (Marcescent dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb that forms a rosette of succulent leaves in the spring, withering in summer. The rosette leaves are 1.5 to 4 centimeters (0.6to 1.6 inches) long, 5 to 12 millimeters (2.0 to 4.7 inches) wide; the caudex (stem) is 2 to 7 centimeters (0.8to 2.8 inches) thick, flowering stems are 4 to 10 centimeters (1.6 to 4 inches) tall and the corolla is bright yellow, to yellow with red markings, to bright red (Munz 1974; Hickman 1993). (USFWS, 1999)

Taxonomy

Dudleya cymosa was described by Charles Antoine Lemaire in 1858 as Echeveria cymosa based on a collection sent to him by horticulturist Louis de Smet of Ledeburg, Belgium; unfortunately, the type locality is unknown and the type specimen has been lost (Moran 1951). Britton and Rose (1903) included this species in their newly described genus Dudleya, as D. cymosa (Moran 1951). Other subspecies of D. cymosa range throughout the Sierra Nevada, the coast ranges, the transverse ranges, and the northern portion ofthe peninsular ranges. Dudleya cymosa ssp. marcescens differs from other subspecies of D. cymosa in that its rosette leaves wither in the summer, but do not fall off (i.e., they are marcescent). (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

Dudleya cymosa ssp. marcescens is endemic to the Santa Monica Mountains in California and is known from a 24-km (15-mi) stretch between Hidden Valley and Malibu Creek State Park (Raven et al. 1986). The total area that encompasses all of the known D. cymosa ssp. marcescens occurrences is approximately 230 square km (88 square mi) (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Dudleya cymosa ssp. marcescens is pollinated by hummingbirds and bees, and produces an abundant amount of small seed. (USFWS, 2009)

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: Flowering generally occurs between May and June and produces fruits with five follicles that split open to release abundant small seeds in late summer or early fall (Skinner and Pavlik 1994, Dorsey 2007). Dudleya cymosa ssp. marcescens is pollinated by hummingbirds and bees, and produces an abundant amount of small seed. Pollination services to D. cymosa ssp. marcescens may be less than for other Dudleya taxa because they grow on rock faces with no other flowering plants to attract pollinators. The seeds of D. cymosa ssp. marcescens range from 0.2 to 1.2 millimeters (0.008 to 0.047 inch) in diameter (Wall 2008). Compared with other rare Dudleya taxa found in the Santa Monica Mountains, D. cymosa ssp. marcescens had a relatively low reproductive output and low seed germination that may put it in greater danger of extinction than other rare Dudleya taxa (Dorsey 2007). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Sheer volcanic cliffs and canyon walls in canyons with perennial streams (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Grows with mosses and lichens in places too step for soil to form (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: Riefner and Bowler (1995) hypothesize that the fog-capturing lichen found in the coastal bluffs and cliffs of California may trap Dudleya seeds, provide nutrients and water, and may protect young plants from snail and slug herbivory. (USFWS, 2009)

Habitat Narrative

Adult: suitable habitat for Dudleya cymosa ssp. marcescens is generally located on the lower reaches of volcanic rock outcrops adjacent to streams, chaparral, and coast live oak (Quercus agrifolia) woodland (CNDDB 2008, NPS 2003). In most locations, the topographic relief has prevented deep soil formation; therefore, this species may be the only flowering plant occurring in a microhabitat that is otherwise dominated by mosses, lichens, and ferns (CNDDB 2008). The mosses and lichens may play a crucial role in trapping D. cymosa ssp. marcescens seeds and allowing them to germinate and establish on the volcanic outcrops (Riefner and Bowler 1995, Riefner and Wishner 2000). (USFWS, 2009)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Animals (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The grouping of the plants along the watershed corridor may indicate a dispersal mechanism that is driven by water or short-distance wind dispersal. The seeds of D. cymosa ssp.

marcescens are very small in size and may be easily transported by water, wind, or animals within and outside of the watershed (Wall 2008). (USFWS, 2009)

Population Information and Trends

Population Trends:
Not available

Number of Populations:
14 (USFWS, 2023)

Population Size:
>6,000 total (USFWS, 2023)

Population Narrative:
According to EO records available through the CNDDB, field surveys from the National Park Service (NPS), and seed collection studies, 13 sites currently or historically supported Dudleya cymosa ssp. marcescens. The most recent surveys, completed in 2003 by NPS and in 2005 by Dorsey, indicate that the total number of individuals of D. cymosa ssp. marcescens throughout its range is approximately 12,000. (USFWS, 2009). At the time of listing in 1997 (Service 1997), there were 7 known occurrences of Dudleya cymosa ssp. marcescens. The number of known occurrences has gradually increased to 14 (Table 1, Service 1999 p. 27, Service 2009 p. 6, Dorsey et al. 2013 pp. 29-41; CNDDB 2023 (last updated 2015), Guilliams and Hasenstab-Lehman 2021 pp. 35-37). Most of these occurrences have been recently confirmed as extant (Guilliams and Hasenstab-Lehman 2021 pp. 35-37). Nine of the occurrences are at least partially on public land, and thirteen of the fourteen occurrences are in the fire footprint of the 2018 Woolsey Fire (Guilliams and Hasenstab-Lehman 2021 p. 27). Unpublished data suggest that several known occurrences of Dudleya cymosa ssp. marcescens are more extensive than currently documented and that there may be several undocumented occurrences (Devlin Gandy pers. comm. 2023). If the undocumented occurrences are verified, the range of the species would extend by 1.5 km (1 mi) to the west and 4.5 km (3 mi) to the east (USFWS, 2023). Twelve of the 14 known occurrences were surveyed in 2020 and a total of 6,148 individuals were found (Table 2, Guilliams and Hasenstab-Lehman 2021 pp. 35-37, 42-43). Two of the occurrences were not surveyed because they could not be located. The study also assessed trends in abundance and concluded that two thirds of the surveyed occurrences were stable and one third were declining over time. No occurrences were considered to be increasing. Some of the occurrences were scored as “stable” despite having fewer individuals over time (EO 7, EO 13), because it was felt they were in the process of recovering from moderate effects of the 2018 Woolsey Fire. In general, declines can be attributed to the effects of the Woolsey Fire, which burned 11 of the 12 occurrences observed during the 2020 surveys (USFWS, 2023).

Threats and Stressors

Stressor: Recreation (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: Dudleya cymosa ssp. marcescens habitat is often used for rock climbing and rappelling (Service 1997). These activities have the potential to destroy the moss substrate that the species depends on and can tear out individual plants. Rock climbing and rappelling may occur on both public and private land where D. cymosa ssp. marcescens occurs. Popular rock climbing areas located in the vicinity of known D. cymosa ssp. marcescens occurrences include Planet of the Apes Wall, Ghetto Wall, Echo Cliffs, and Century Lake Canyon (The Mountain Project 2008, Rockclimbing.com 2008).

Stressor: Vandalism (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: On April 27, 2009 the Service was notified by NPS staff that large swaths of moss that support Dudleya cymosa ssp. marcescens had been damaged at the Seminole Hot Springs occurrence (Sagar 2009). The moss appeared to be scraped away from the rock face to form pictures and initials (Figure 3). An unknown number of individual plants have been damaged or destroyed by the disturbance (Figure 4). The site appears to be used as a local social gathering place, and will likely suffer recurring damage if some type of protective action is not taken (e.g. closing the site to public access, posting signage, etc.).

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In the rule listing the species, we also discussed that occurrences are located on both public and private lands, and that individuals of Dudleya cymosa ssp. marcescens on private lands may be threatened by development. One occurrence on private land, Seminole Hot Springs, is owned by the Mountains Restoration Trust, a non-profit land trust dedicated to preserving natural land in the Santa Monica Mountains. This site is protected from development, but is threatened by recreational activities as demonstrated by the damage to the moss substrate observed in 2009. For the other six occurrences on private lands, local zoning designations can provide some information about the potential for development at each site. Private lands that support D. cymosa ssp. marcescens individuals are primarily zoned for open space or agriculture, with certain parcels in Ventura County falling under the Santa Monica Mountains Overlay Zone, which provides protections for sensitive species including D. cymosa ssp. marcescens. (USFWS, 2009)

Stressor: Overutilization (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing in 1997, we discussed that species of Dudleya are collected by professional horticulturalists as well as amateur collectors and gardeners (Service 1997). We believe that collection still may constitute a threat to the species. Although we do not have specific reports of vandalism for D. cymosa ssp. marcescens, we believe that, due to the accessibility of certain populations to the public, collection still constitutes a threat to the species. (USFWS, 2009)

Stressor: Fire (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing Dudleya cymosa ssp. marcescens in 1997, we discussed that fire can be a natural or human caused factor affecting D. cymosa ssp. marcescens (Service 1997). The ecosystems of the Santa Monica Mountains have evolved with periodic lightning-caused fires that were generally small in size and intensity, but occurred at frequent intervals (NPS 2007b). With the expansion of human settlement, it has been suggested that large fires are the result of effective suppression of small fires (NPS 2007b). Fire has been observed to reduce moss substrate that D. cymosa ssp. marcescens requires (Dedero 1992). Furthermore, it may be assumed that large fires pose a greater threat to D. cymosa ssp. marcescens because large fires may have a greater flame height and burn temperature that may impact the rocky outcrops that might otherwise be unaffected by small fires with lower flame heights and burn temperatures. Large fires may also burn through the entire range of the species whereas small fires would cover less area. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, IPCC 2007). Based on modeling, they predicted that species' distributions will shift in response to climate change, and that species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Dudleya cymosa ssp. marcescens, small-ranged species, such as D. cymosa ssp. marcescens, are generally more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008). Some Dudleya taxa have evolved characteristics such as facultative leaf withering (McCabe et al. in prep. 2008) and switching between CAM and C3 photosynthesis pathways (Thorghton et al. 1977), which allow them to live in water-limited environments and adapt to climate fluctuations. These characteristics may benefit the species in the face of a changing climate. (USFWS, 2009)

Stressor: Climate change effects (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The 2009 5-year review introduced climate change as a threat to Dudleya cymosa ssp. marcescens (Service 2009 p. 13). Effects of climate change for the Los Angeles area include predicted rising annual and extreme high temperatures (Hall et al. pp. 10-11) and increased episodic rainfall with more extreme floods and drier droughts (Hall et al. pp. 11-14, 18). Changes in climate could threaten Dudleya cymosa ssp. marcescens through habitat degradation or migration, mortality through drought or erosion, and increased non-native annual grasses leading to greater competition or fire susceptibility (Service 2009 p. 13). Recently, the current effects of non-natives and erosion were assessed to be low for the taxon (Guilliams and

Hasenstab-Lehman 2021 pp. 42-43). As climate changes and vegetation shifts, optimal habitat for Dudleya cymosa ssp. marcescens may also shift, and the taxon may not be able to disperse far and fast enough to match the vegetation shift. Although the taxon is dormant in the dry part of the year, more intensively dry summers with long-term drought could kill plants. Conversely, more intense precipitation could cause increased erosion on the steep cliff habitat of Dudleya cymosa ssp. marcescens, destroying plants. Non-native annual grasses are expected to increase in dominance because of increased fire frequency (Hall et al. 2018 p. 53) and with increasing annual temperatures (Sandel and Dangremond 2012 entire). The increased annual grass dominance can in turn both promote more fire and may have more negative competitive effects on Dudleya cymosa ssp. marcescens. Because the taxon characteristically occurs on steep cliffs with sparse vegetation that does not carry fire well, this may not negatively affect the taxon. However, if non-native annual grass cover does increase and fires do increase in frequency or intensity at Dudleya cymosa ssp. marcescens occurrences, the taxon could be negatively impacted. The threat of climate change on Dudleya cymosa ssp. marcescens remains (USFWS, 2023).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. All the current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)

2. All the current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

Recovery Actions:
- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)
- Establish a monitoring strategy to understand the population and demographic dynamics of Dudleya cymosa ssp. marcescens. The minimal survey data that is available indicates that many of the populations may be stable or increasing. However, without population data at all sites, abundance trends cannot be determined; without demographic data, population stability cannot be presumed. At a minimum, all known occurrences should be surveyed for abundance and demographics. If survey results indicate that populations are stable or increasing, and all occurrences have multiple age classes, indicating regular recruitment, the species may be considered to be self-sustaining. If survey results indicate that populations are declining or demographics show a single age class, further monitoring will be required to determine population trends. (USFWS, 2009)

- Work with the National Park Service and California Department of Parks and Recreation to identify Dudleya cymosa ssp. marcescens occurrences on public lands that may be degraded by recreational activities such as climbing, and conduct a study to clearly identify impacts to the species caused by recreational activities. If impacts are identified, install fencing, signage, or other mechanisms to eliminate threats to the plants and their habitat. (USFWS, 2009)
- Work with rock climbing leaders, organizations, and websites to make them aware of the sensitive species that may occur in the vicinity of their climbing areas. Explore the possibility of establishing "best climbing practices," such as avoiding vegetation on rock faces, and not establishing new climbing sites on rock faces that are vegetated. (USFWS, 2009)
- Work with the Mountains Restoration Trust and other partners to reduce impacts to the individuals and habitat at Seminole Hot Springs by installing signage, installing fencing, closing the area to visitors, or using other means to eliminate recreational threats. (USFWS, 2009)
- Work with private landowners at locations where zoning may permit development to raise awareness of the species. Cooperation with landowners is crucial to monitoring and protecting Dudleya cymosa ssp. marcescens occurrences on private lands. (USFWS, 2009)
- Work with Ventura County and Los Angeles County to educate them about Dudleya cymosa ssp. marcescens, so that when issuing development permits the counties are able to identify developments that may impact the species and encourage measures that would protect the species. (USFWS, 2009)
- Survey previously uninvestigated areas with potentially suitable habitat within and adjacent to the known range of Dudleya cymosa ssp. marcescens to determine if habitat and individuals are present. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue genetic, common garden, and other analyses to determine if Dudleya cymosa ssp. marcescens is a valid narrow taxon, or part of the range of variation of a more widespread and abundant taxon. 2. Conduct thorough surveys of known occurrences, adjacent areas, and other areas of suitable habitat to potentially increase the extent of known occurrences and document new occurrences. Develop and implement a monitoring plan. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 3. Work with public and private entities to prevent damage to plants and to raise public awareness to support appropriate conservation measures. 4. Update and expand knowledge of the taxon's life history and specific habitat requirements, especially regarding fire. 5. Improve the completeness of coverage of Dudleya cymosa ssp. marcescens in conservation seed banks, with more occurrences over more years (USFWS, 2023).

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SPECIES ACCOUNT: *Dudleya cymosa ssp. ovatifolia* (Santa Monica Mountains dudleyea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb that forms a rosettes of evergreen, succulent leaves. Leaves are 2 to 5 cm (0.8 to 2.0 in long, 1.5 to 2.5 cm (0.6 to 1.0 in wide; floral stems are 4 to 15 cm (1.6 to 6.0 in tall; corollas are pale yellow (Munz 1974). The ovateleaves have a maroon underside. (USFWS, 1999; NatureServe, 2015)

Taxonomy

Dudleya cymosassp. ovatifolja was originally described as Dudleya ovatifolia by Britton (1903) based on a collection made by H.M. Hall in 1902. The type locality is listed as "Sierra Santa Monica," thought to be Topanga Canyon, Los Angeles County (Moran 1951). The species was subsequently recognized as Cotyledon ovatifolia and Echeveria ovatifolia (Fedde 1904 and Berger 1930 respectively, cited in Moran 1951) when different generic concepts were used in the family Crassulaceae. Moran (1957) published the currently accepted combination of Dudleya cyrnosa ssp. ovatifolia. Nakai (1983) considered plants from near Agoura, Los Angeles County to be distinct from Dudleya cyrnosa ssp. ovatifolia. Subsequently, (Nakai 1987) published the new name D. cymosa ssp. agourensis. Nakai distinguished the new subspecies from the other on the basis of number and shape ofrosette leaves, pedicel length, and degree of spreading in petal apices. Nakai (1987) considered D. cymosa ssp. agourensis to differ from D. cymosa ssp. ovatfolia in having a simple- to several-branched caudex and glaucous elliptical basal leaves. Nakai (1987) noted that D. cyrnosa ssp. ovatifolia has an unbranched caudex and green, ovate basal leaves. Bartel (1993) apparently considered these differences consistent, and included D. cyrnosa ssp. agourensis in D. cymosa ssp. ovatifolia in his treatment of the genus Dudleya, for the Jepson Manual. (USFWS, 1999)

Current Range

Currently, there are four populations of what the Service considered to be Dudleya cymosa subsp. ovatifolia at the time of listing in Los Angeles and Orange Counties. This includes two in the Santa Monica Mountains, one in the Santa Ana Mountains, and one in Agoura Hills. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The Dudleya species which have small yellow to orange flowers (including D. cymosa subsp. ovatifolia) are pollinated by bees and flies, while species with larger red flowers are

pollinated mostly by hummingbirds. (USFWS, 2009)

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: The flowering season is from May through June for D. cymosa subsp. agourensis and from March through May for D. cymosa subsp. ovatifolia (Dorsey 2007). The Dudleya species which have small yellow to orange flowers (including D. cymosa subsp. ovatifolia) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds. A study performed on Dudleya cymosa subsp. ovatifolia ex situ found that the average number of fruits produced per individual was 19 and the maximum number of seeds per fruit was 114. (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: North-facing slopes and cliffs in chaparral communities and deep canyon bottoms (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Typically found on sedimentary conglomerate rock; persists in exposed dry habitat (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2009)

Habitat Narrative

Adult: On a broad scale, suitable habitat for Dudleya cymosa subsp. ovatifolia is generally located on sedimentary and conglomerate rock on canyon bottoms and shaded slopes in drainages along the south-facing slope of the Santa Monica Mountains (Dorsey 2007). In the Santa Ana Mountains, it occurs on shaded sandstone cliffs (Roberts 2008). Adjacent plant communities include coastal scrub and chaparral (CNDDB 2008b). In most locations, the topographic relief has prevented deep soil formation; therefore, this species may be the only flowering plant occurring in a microhabitat that otherwise supports mosses, lichens, and clubmoss (Selaginella spp.) (Dorsey 2007, CNDDB 2008b). (USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

4 (USFWS, 2009)

Population Narrative:

Currently, there are four populations of what the Service considers to be Dudleya cymosa subsp. Ovatifolia. (USFWS, 2009)

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The threat of habitat encroachment from new or existing development surrounding several of the known Dudleya cymosa subsp. ovatifolia (and D. cymosa subsp. agourensis) population sites continues to be a threat. Due to an increase in residential and commercial development in the surrounding and adjacent areas (City of Agoura Hills 2009), such fire suppression activities may be an increasing threat to both D. cymosa subsp. ovatifolia and D. cymosa subsp. agourensis (see Appendix 1 and 2) (Halsey 2006, Service 2007, Halsey in litt. 2008). However, because most occurrences are on rocky outcrops with little vegetative cover, we believe the threat is low at this time. (USFWS, 2009)

Stressor: Roadside scraping (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Roadside scraping for weed abatement has modified habitat for D. cymosa subsp. ovatifolia. Since most individuals occur on rocky substrates, the Service believe this threat would be confined to the margins of the populations that are along existing road edges. (USFWS, 2009)

Stressor: Recreation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Recreational activities such as rock climbing and hiking were not discussed at the time of listing as a threat to the species. The Service considers this to be a new threat at certain locations. In Orange County, the Modjeska Peak occurrences (EOs #9 and 12) are located near a dirt road that is used by the public to access the peak, and Soza and Boyd (1999) noted the vulnerability of these occurrences and the presence of trash and footprints at EO #12; however, these occurrences are now thought to be a different Dudleya taxon (Roberts 2008). The Modjeska Canyon occurrence (EO #1) is inaccessible, and no visible signs of disturbance were seen in 1999 (Soza and Boyd 1999). Disturbance from recreational activities is also noted in CNDDB (2009) as a potential threat for the two populations in the Santa Monica Mountains, Los Angeles County. A site visit in 2009 confirmed that the Malibu Canyon population (EO #10) is being impacted by rock climbing activity (Marek in litt. 2009); the extent of recreational impacts on the Topanga Canyon population is unknown at this time. (USFWS, 2009)

Stressor: Collectors (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: Dudleya species were included in the Smithsonian's list of Commercially Exploited Endangered and Threatened Species in the Continental United States, citing private collectors as a threat; although no specific reference to D. cymosa subsp. ovatifolia was made, D. cymosa subsp. marcescens was considered endangered by the authors and thus included (Ayensu and DeFillips 1978). Collection for horticultural purposes by professional horticulturists and amateur collectors and gardeners was identified as a threat to all of the Dudleya taxa including D. cymosa subsp. ovatifolia (inclusive of plants now identified as D. cymosa subsp. agourensis) in the 1997 final listing rule (Service 1997). (USFWS, 2009)

Stressor: Fire suppression and fuel modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Despite efforts to suppress fires in coastal southern California, the present fire frequency of every 15 years or less is substantially higher than it was historically, which, for coastal scrub, is thought to be every 50 to 100 years (Keeley 2006). Over a period of 60 years, most of the area in the Santa Monica Mountains has burned an average of three to five times, with an average interval of every 12.4 to 20.7 years (Radtke et al. 1982). An increase in fire frequency can result in type-conversion of chaparral and coastal sage scrub communities to annual invasive grasses which aggressively compete with native species for resources. However, because the specific sites where Dudleya cymosa subsp. ovatifolia grow are on rocky outcrops and would not support dense stands of chaparral or coastal sage scrub (Christy Brigham, Santa Monica Mountains National Recreation Area, pers. comm. 2009; CNDDB 2008a, b; Marek in litt. 2009), the Service believes that impacts from wildfires on the Dudleya taxa would likely be less severe than on the surrounding native plant communities. The practice of discing for fire prevention and suppression is unlikely to directly affect D. cymosa subsp. ovatifolia because it inhabits rocky outcrops. The spraying of fire retardant has been demonstrated to affect native species in grassland habitats outside California because they facilitate the growth of annual grasses (Larson and Newton 1996, Bell 2003). The impacts from their use on sites where D. cymosa subsp. ovatifolia occurs are unknown at this point in time. (USFWS, 2009)

Stressor: Competition with non-native species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In recent site visits, competition with non-native grasses has not been noted as a concern at any of the sites (Marek in litt. 2009, Roberts in litt. 2009, Soza and Boyd 1999). Jade plant (Crassula argentea), a non-native species from South Africa, was observed growing in Topanga Canyon within EO #2 by McCabe (Sagar in litt. 2008); its impacts on the Dudleya cymosa subsp. ovatifolia population are unknown. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: The Service now considers Dudleya cymosa ssp. ovatifolia to be threatened by stochastic events due to the small size and isolation of the populations. Conservation biology literature commonly notes the vulnerability of taxa known from small populations (Shaffer 1981, 1987; Meffe and Carroll 1997; Primack 1998). It is generally accepted that small populations have higher probabilities of extinction than larger populations because their low numbers make them susceptible to inbreeding, loss of genetic variation, high variability in age and sex ratios, demographic stochasticity, and random naturally occurring events such as wildfires, floods, droughts, or disease epidemics (Menges 1991, Ellstrand and Elam 1993, Shaffer 1981, 1987; Soulé 1987; Meffe and Carroll 1997; Primack 1998). Isolation often acts in concert with small population size to increase the probability of extinction. Isolated populations are more susceptible to long-term/permanent extirpation by accidental or natural catastrophes because the likelihood of recolonization following such events is negatively correlated with the extent of isolation (Wilcox and Murphy 1985, Meffe and Carroll 1997). Human development exacerbates the risk of stochastic extinction because it further isolates and fragments remaining populations as time goes on. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, IPCC 2007). Due to the elevation and coastal location of the Santa Monica Mountains, this area is expected to become one of these potential future refugia and greatly increase in diversity (Loarie et al. 2008). We recognize that climate change is an important issue with potential effects to listed species and their habitats. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect small-ranged species that are restricted to soils of limited distribution, such as Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis, we acknowledge that they are more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008). (USFWS, 2009)

Recovery

Delisting Criteria:
1. All current sites are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)

2. All current sites are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

Recovery Actions:
- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)

- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)
- Develop and implement monitoring and adaptive management plans for known existing occurrences of Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis populations. Monitoring should occur at intervals of 3 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. (USFWS, 2009)
- Work with private landowners and local agencies to protect and manage Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis on private property. If development is proposed or planned near D. cymosa subsp. ovatifolia and D. cymosa subsp. agourensis, recommend measures to protect the species such as creating large buffer zones between development and plants and invasive plant prevention and control. (USFWS, 2009)
- Work with local fire departments to: a) develop or modify fire management plans for when fires occur in or near the habitat of each species and b) prevent or limit discing of soil in fire management zones near Dudleya cymosa subsp. ovatifolia and D. cymosa subsp. agourensis habitat to prevent the spread of invasive, nonnative plants. (USFWS, 2009)
- Once additional information concerning the status of populations and current threats is obtained, consider whether: a) a change in status for Dudleya cymosa subsp. ovatifolia may be warranted and, b) candidate status may be warranted for D. cymosa subsp. agourensis. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Regularly monitor Dudleya cymosa subsp. ovatifolia and Dudleya cymosa subsp. agourensis populations to evaluate population trends. 2. Improve the completeness of coverage of Dudleya cymosa subsp. ovatifolia, Dudleya cymosa subsp. agourensis, and undescribed taxa in conservation seed banks, with more occurrences over more years. 3. Confirm recent taxonomic changes, including the undescribed taxa in the Santa Ana Mountains, and recognize the segregation of the recognized undescribed taxa, Dudleya cymosa subsp. ovatifolia, and Dudleya cymosa subsp. agourensis. 4. Determine with more detail the distribution and status of all taxa in the Santa Ana Mountains that were considered part of Dudleya cymosa subsp. ovatifolia since listing. (USFWS, 2021)

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SPECIES ACCOUNT: *Dudleya setchellii* (Santa Clara Valley dudleya)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/03/1995; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Dudleya setchellii is a low-growing perennial of the stonecrop family (Crassulaceae) with fleshy, glabrous (hairless) leaves. The oblong to triangular, slightly glaucous (covered with a whitish or bluish waxy or powdery film) leaves are 3 to 8 cm (1 to 3 in long and 7 to 15 mm (0.3 to 0.6 in) wide. Two or three flowering stems ascend to heights of 5 to 20 cm (2 to 8 in) in mid to late spring. The pale yellow petals are 8 to 13 mm (0.3 to 0.5 in) long (Hickman 1993). (USFWS, 2013)

Taxonomy

Dudleya setcheliji was variously treated as Cotyledon setcheliji (Fedde 1904), Echeveria setcheliji (Nelson and Macbride 1913), and Echeveria laxa var. setcheliji (Jepson 1936). Reid Moran (1959) combined the material referred to as Dudleya setchellii and Dudleya paniculata in Dudleya cymosa ssp. setcheliji. Kei Nakai (1987) separated the two entities into Dudleya cymosa ssp.paniculata and Dudleya cymosa ssp. setchellit on the basis of leaf shape, inflorescence branching patterns, and pedicel (stalk of individual flower or fruit) length. Bartel's treatment ofDudleya retains Nakai's Dudleya cymosassp. paniculata and resurrects Britton and Rose's Dudleya setchellii for the Santa Clara Valley dudleya (Hickman 1993). (USFWS, 1998)

Historical Range

There are four historic reports of Streptanthus albidus ssp. albidus . One occurrence from 1895 may actually be a different species of Streptanthus. The second historic occurrence documented in 1937 has likely been extirpated because it is located in an area now covered by Anderson Lake. A third occurrence first documented in 1980 at Tulare Hill was extirpated when the plants were covered by fill during construction of a housing development. A fourth occurrence was documented in Gilroy along Llagas Avenue in 1957 and has not 4 been reported since. There is some taxonomic uncertainty about this occurrence (CDFG 1997, Whittal 2011). (USFWS, 2013)

Current Range

Two occurrences are located approximately 5 miles southwest of the previously known southernmost extent of the historic range. One of which is located within the Mount Madonna Santa Clara County Park. (USFWS, 2013)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) (USFWS, 2013)

Lifespan

Adult: ~10 years (USFWS, 1998)

Breeding Season

Adult: May to June (USFWS, 2013)

Reproduction Narrative

Adult: Dudleya setchellii flowers from May to June (Munz and Keck 1959) and producing wind dispersed seeds (McCarten 1993). The species can also reproduce vegetatively by forming rosettes that can separate from the parent plant or remain attached. Individual plants may live for approximately 10 years. (USFWS, 1998; USFWS, 2013)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Grassland/herbaceous (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 120 and 300 m (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Dudleya setchelli are found on rocky outcrops within serpentine grasslands at elevations between 120 and 300 m (NatureServe, 2015). McCarten (in litt., 1998) suggests (1) the narrow distribution of Dudleya setchelli may be associated with the limited number of appropriate rock crevices available and (2) potential habitat for Dudleya setchelli cannot be determined by counting the number of rock outcrops because only some have crevices deep enough to provide habitat. (USFWS, 1998; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dudleya setchellii flowers from May to June (Munz and Keck 1959) and producing wind dispersed seeds (McCarten 1993). (USFWS, 2013)

Population Information and Trends

Population Trends:

Long-term decline of 50-70%; short-term decline of 30-50% (NatureServe, 2015)

Number of Populations:

207 (USFWS, 2013)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Long-term populations trend indicate a decline of 50-70%, while short-term trends suggest a 30-50% decline (NatureServe, 2015). There are currently 207 known occurrences in the entire range (ICF 2012; CNDDB 2009). (USFWS, 2013; NatureServe, 2013)

Threats and Stressors

Stressor: Development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, 11 of the 14 populations were on private land and were subject to various levels of threat due to development. Three in the northernmost portion of its range were threatened by development. One population was threatened by the proposed Cerro Plata Project, consisting of 550 dwelling units and a 164 acre golf course on a 575 acre site. This population contained approximately 20,000 plants, 61 percent of all known plants, of which approximately 2,380 would be directly eliminated by planned construction activities (City of San Jose 1993). All remaining plants would be exposed to human activities during and after construction that could result in significant impacts to the population. These impacts included potentially harmful runoff from and upslope golf course, introduction of weed species during construction, and uncontrolled foot traffic. The second of the northern sites was threatened by the proposed construction of the Valley Christian School and South Valley Christian Church. The construction was thought to eliminate 74 percent of the approximately 1,900 plants found on the site (City of San Jose 1992). In the central part of its range, 2 of the 3 central populations were also threatened with residential development and road construction. The 3rd central population was threatened by off-road motorcycle traffic and unauthorized dumping due to its proximity to an off-road motorcycle park. In the southernmost portion of its range, around Morgan Hill, 3 populations were in an area developing rapidly and had been proposed for development. (USFWS, 2013)

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: After construction of the Ranch on Silver Creek housing development and golf course project, reduction of coyotes occurred on the property. As a result, the ground squirrel population increased to the extent that the squirrels began devouring Dudleya setchellii. This new threat is an indirect effect of the housing and golf course development. At the same site, an expansion of native sagebrush led to an increased rabbit population that in turn reduced Dudleya setchellii (WRA 2010). (USFWS, 2013)

Stressor: Nitrogen deposition (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: A relatively recently identified threat is nitrogen deposition into grasslands from air pollution sources and the resultant increase in productivity of the soils has facilitated increased

invasion of nonnative species (ICF 2012). The main effect for Santa Clara Valley dudleya and Metcalf Canyon jewelflower is their vulnerability to annual grass overgrowth. Nonnative annuals are much less dominant in serpentine areas, although increasing nitrogen deposition from air pollution has increased the productivity of serpentine soils and allowed a greater number of nonnatives to invade (Evens and San 2004; Harrison et al. 2003; Weiss 1999). Santa Clara Valley dudleya (Dudleya setchellii) lives on rock outcrops and is relatively immune from grass invasions except when extremely tall grasses smother small rock outcrops. The species persists on medium to large rock outcrops in ungrazed areas. Metcalf Canyon jewelflower can be a poor competitor against dense annual grasses, and some degree of grazing appears necessary to maintain populations (ICF 2012). Livestock grazing is an important management tool to combat increased invasive nonnative plants in serpentine grasslands due to atmospheric nitrogen deposition (Weiss 1999). (USFWS, 2013)

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: ICF (2012) summarized the potential effects of climate change to serpentine plant species and its relationship to the proposed permitted activities during the Santa Clara Valley Habitat Plan's proposed 50 year permit span. Serpentine plant distribution is restricted to highly specialized and localized habitat requirements that include species-specific microclimate conditions coincident with serpentine soil occurrence. Restriction to serpentine soils limits species range and distribution to this soil type. Climate change could change microclimate conditions so that species can no longer persist within their current range. Increase in favorable microclimate conditions could lead to an expansion of distribution and increase in abundance, both in terms of number of populations and number of plants within each population. Change in timing or intensity of seasonal events could have an effect on pollinator reproductive and plant flowering periods leading to phonological mismatches. (USFWS, 2013)

Recovery

Reclassification Criteria:
1. If 20 populations of Dudleya setchellii within and representing its entire range are (1) fully protected and managed with the primary intention of preserving the populations in perpetuity and (2) shown to be stable or increasing over a minimum of 20 years that include the normal precipitation cycle, the species should be evaluated for downlisting. (USFWS, 2013)

2. Management plans emphasizing Dudleya setchellii and other special status species for all populations and any occupied or unoccupied habitat identified as essential to survival must be developed and implemented. (USFWS, 2013)

3. Population monitoring in specified recovery areas must show stable or increasing for a period of 20 years that include the normal precipitation cycle. (USFWS, 2013)

Delisting Criteria:
1. Dudleya setchellii should not be considered for delisting unless 30 populations distributed throughout its entire range. (USFWS, 2013)

2. Management plans emphasizing Dudleya setchellii and other special status species for all populations and any occupied or unoccupied habitat identified as essential to survival must be developed and implemented. (USFWS, 2013)

3. Once downlisted, there must not be a decline after downlisting to consider delisting for this criteria; if declining, determine cause and reverse trend prior to considering delisting. (USFWS, 2013)

Recovery Actions:

- Populations on private land should be protected by land acquisition, conservation easements, or other means. Protection should, at least, involve securing the populations themselves as well as a 150-meter (500-foot) buffer around each population, where possible, to reduce external influences and allow expansion of populations. (USFWS, 1998)
- Management plans emphasizing Dudleya setchellii and other special status species in these locations must be developed and implemented. The plans should include provisions for standardized monitoring of Dudleya setchelli populations every 3 years to determine demographic trends. (USFWS, 1998)
- Also of value in recovery efforts for Dudleya setchelli is collection and banking of seed in Center for Plant Conservation certified botanic gardens. (USFWS, 1998)
- In addition to protection of known populations and seed collection of Dudleya setchellii, other suitable serpentine habitat should be surveyed to determine whether undiscovered populations exist. (USFWS, 1998)
- Certain types of research are also high priority recovery activities for Dudleya setchellii. In particular, because Dudleya setchellii co-occurs in a number of locations with bay checkerspot butterfly and because bay checkerspot butterfly habitat benefits from vegetation management, the effect of various vegetation management techniques on Dudleya setchellii needs to be evaluated. (USFWS, 1998)
- Preserve, protect, manage, and monitor Dudleya setchellii CNDDB occurrence number 43. Occurrence number 43 was found in the year 2005, subsequent to listing of the species and the Recovery Plan. The occurrence represents the most southwesterly extent of its current known range.
- Confirm if the historic and current westernmost and southernmost occurrences for Streptanthus albidus ssp. albidus are valid. Perform additional surveys in suitable habitat around CNDDB number 6 and 21 to confirm if the range of the species is smaller than previously understood.
- Conservation measures should include focus on preserving, monitoring, and managing pollinator fauna as it appears to be essential for any significant fruit set in Streptanthus albidus ssp. albidus.
- Streptanthus albidus ssp. albidus plant numbers can fluctuate drastically from year to year (Whittall 2011). Reliable methods should be developed to evaluate when a population should be considered as stable and viable. The methods should include ways to measure and evaluate natural and human influenced variables.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Santa Clara Valley dudleya. Some of these recommendations have already been discussed in previous recovery

documents (Service 2013) and remain valid. 1. Genetic and Demographic Studies. Genetic testing across rock outcrops should be conducted in order to develop an understanding of genetic populations of Santa Clara Valley dudleya. This may change or solidify how an occurrence is defined, leading to more consistent surveys and clarifying the recovery effort which is dependent on population trends. 2. Standardized Surveys. A standard way of determining populations as well as regular monitoring of known populations should be done in the future to get a better understanding of how the species is doing across its range. Surveys should utilize a standardized methodology to determine trends in population/occurrence abundance and should include an in-depth analysis of threats and management actions at each occupied location. 3. Dispersal Studies. Research into pollinators and seed dispersal may help determine why Santa Clara Valley dudleya occur at certain rocky outcrops and not others that also seem suitable. Along with genetic testing it could clear up uncertainties with the species' local distribution and clarify recovery efforts. 4. Habitat Acquisition, Management, and Restoration. Additional sites with Santa Clara Valley dudleya present should be protected, managed, and monitored to address recovery goals. Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and unprotected areas currently occupied by a large occurrence should be given the highest priority. Protected lands must also be adequately managed or restored based on the best available science. (USFWS, 2021)

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USFWS. 2021. 5-YEAR REVIEW Santa Clara Valley Dudleya (Dudleya setchellii). 9 pp.

SPECIES ACCOUNT: *Dudleya stolonifera* (Laguna Beach liveforever)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A succulent perennial herb with basal rosettes of flattened, bright green, purple-tinged leaves. Reddish flowering stems, mostly 8-20 cm tall, are topped with yellow-green flowers during May, June, and July. This species branches by stolons, forming lateral vegetative branches that arise from the basal rosette. (NatureServe, 2015)

Taxonomy

Two hybrids of Dudleya stolonifera occur in Aliso Canyon (Thomson 1993, pp. 208, 210). This canyon is the only location where D. stolonifera and D. edulis co-occur, resulting in reported hybrids and apparent backcrosses that appear morphologically similar to one of the parent types. Results from genetic analysis reveal no irregularity of meiosis in D. stolonifera x D. edulis hybrids (Moran 1949, p. 112). Aliso Canyon also supports D. lanceolata x D. stolonifera hybrids, which represent the former presumed parent in the leaf rosette shape and the latter in shorter, thicker leaves with maroon undersides (Thomson 1993, p. 210). (USFWS, 2010)

Historical Range

See current range/distribution.

Current Range

Dudleya stolonifera was historically found only in Orange County, California. At listing, the species was found in six occurrences near Laguna Beach (USFWS 1998, p. 54939). Historical occurrences were restricted between Laguna Canyon to the north and Aliso Canyon to the south, an area of approximately 10 sq. km (3.9 sq. mi). Since listing, no new occurrences have been reported. All six of the historical occurrences are considered extant. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (self-fertilization (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Bees in the genera Bombus and Anthophora have been identified as important pollinators of other Dudleya (Moldenke 1976). Niebla ceruchoides is a saxicolous (lives among rocks) lichen also found in abundance in fog zones near the Pacific coast in Orange County (Riefner and Bowler 1995, p. 82). This fruticose (shrubby) lichen may benefit D. stolonifera by capturing seeds. The body of the lichen also provides the seed adequate moisture and a nutrient-rich soil bed. (USFWS, 2010)

Breeding Season

Adult: May to July (USFWS, 2010)

Reproduction Narrative

Adult: During late spring and early summer (May to July), a flowering stalk grows up to 20 cm (8 in) tall. The tubular yellow flowers found in D. stolonifera are similar to the flowers of other Dudleya species that are known to be self-fertilizing. This similarity suggests some degree of self-pollination may occur in D. stolonifera. Bees in the genera Bombus and Anthophora have been identified as important pollinators of other Dudleya (Moldenke 1976). Niebla ceruchoides is a saxicolous (lives among rocks) lichen also found in abundance in fog zones near the Pacific coast in Orange County (Riefner and Bowler 1995, p. 82). This fruticose (shrubby) lichen may benefit D. stolonifera by capturing seeds. The body of the lichen also provides the seed adequate moisture and a nutrient-rich soil bed. (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations up to 300 m (1000 ft) (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist

Dependency on Other Individuals or Species for Habitat

Adult: Dudleya stolonifera almost always co-occurs with mosses and lichens in a very thin layer of soil, often less than 1 cm (0.4 in) deep (Moran 1977, p. 1). Dudleya stolonifera may have a positive association with a co-occurring lichen species, Niebla ceruchoides (angel-hair sea fog lichen) (Riefner and Bowler 1995, p. 81). (USFWS, 2013)

Habitat Narrative

Adult: Distribution of Dudleya stolonifera is restricted to shaded north-facing Miocene sandstone and San Onofre breccia rock outcrops, slopes, and canyon walls primarily in coastal sage scrub ecotypes (Moran, 1977, p. 1; Roberts 1997, p. 1). The taxon is also found in chaparral, cismontane woodlands, and valley and foothill grasslands at elevations up to 300 meters (1000 feet) (CDFG 1987, p. 1). Dudleya stolonifera almost always co-occurs with mosses and lichens in a very thin layer of soil, often less than 1 cm (0.4 in) deep (Moran 1977, p. 1). Dudleya stolonifera may have a positive association with a co-occurring lichen species, Niebla ceruchoides (angel-hair sea fog lichen) (Riefner and Bowler 1995, p. 81). Niebla ceruchoides is a saxicolous (lives among rocks) lichen also found in abundance in fog zones near the Pacific coast in Orange County (Riefner and Bowler 1995, p. 82). This fruticose (shrubby) lichen may benefit D. stolonifera by capturing seeds. The body of the lichen also provides the seed adequate moisture and a nutrient-rich soil bed. (USFWS, 2013)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

6 (USFWS, 2010)

Population Size:

~30,000 (USFWS, 2010)

Population Narrative:

At listing, six known occurrences of Dudleya stolonifera were reported to support up to approximately 8,000 to 10,000 individual standing plants (USFWS 1998, p. 54946). Since listing, we discovered that the Mathis Canyon (EO 7) count made in 1992 by Karlin Marsh reported 20,000 individuals (CNDDB 2010a, p. 7). This count was unknown to the Service at listing and increases the known abundance of Dudleya stolonifera to approximately 30,000 standing plants. (USFWS, 2010)

Threats and Stressors

Stressor: Urbanization (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Since listing, none of the known occurrences has been directly impacted by development related activities. The steep and rugged nature of Dudleya stolonifera habitat makes the remaining occurrences on private property undesirable for development. Nevertheless, adverse development effects are a potential threat to the two occurrences on private lands, Aliso Canyon and Canyon Acres (EO 2, 5), as pressure to develop private lands is not curbed by regulatory measures in the densely urbanized coastal portion of Orange County. (USFWS, 2010)

Stressor: Proposed development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Aliso Canyon (EO 2) is the occurrence most adversely affected by past development activities. The portion of this occurrence that was lost prior to listing is commercially developed. The remaining portion of this occurrence is threatened by expanded development as a result of the Aliso Canyon Redevelopment Plan (S. Drapkin, Senior Planner, City of Laguna Beach, pers. comm. 2010). This plan could result in the rebuilding of the Aliso Canyon Inn, but is delayed indefinitely as of 2008 (Drapkin, pers. comm. 2010). (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The listing rule discussed the vulnerabilities associated with few occurrences of small population sizes for Dudleya stolonifera. These vulnerabilities included susceptibility to stochastic events such as flood, fire, or drought and inbreeding depression (USFWS 1998, p. 54950). Stochastic, or unexpected, events represent a significant threat to small occurrences. In the case of Dudleya stolonifera, two of the six occurrences (Canyon Acres (EO 5) and Lateral Canyon B (EO 6)) can be considered small, each represented by less than 100 standing plants. Stochastic events that could destroy these smaller occurrences include flood, fire, or drought. Given the impact these events could have on a third of the known populations of D. stolonifera, they represent a potential threat to the species as a whole. There is also a potential for small populations to suffer from inbreeding depression. Inbreeding depression is the reduced fitness resulting from breeding of related individuals, most often in small populations, by highlighting deleterious genetic traits. In order to avoid inbreeding depression, it is important to maintain genetic diversity, especially for rare alleles (different forms of a gene). The likelihood of maintaining this diversity decreases in smaller populations (Barrett and Kohn 1991, pp. 9, 10, and 13). (USFWS, 2010)

Stressor: Nonnative plant competition (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At listing, nonnative plant competition was considered a threat to Dudleya stolonifera, though severity and specific occurrence information were not provided (USFWS 1998, p. 54950). Since listing, direct competition to D. stolonifera by nonnative plant species has remained a threat at two occurrences, Aliso Canyon (EO 2) and Mathis Canyon (EO 7). This threat is most prevalent in Aliso Canyon (EO 2) where Tropaeolum majus (nasturtium), Aeonium haworthii (pinwheel) (Roberts, pers. comm. 2009b), Myoporum laetum (myoporum) (Roberts 1995, p. 2), Echium spp., and Echeveria spp. (Marsh 1992, p. 65) have been found within habitat occupied by D. stolonifera. These nonnative species thrive among rocks and compete directly with D. stolonifera for limited resources (e.g., soil moisture, space, light). In particular, A. haworthii is accelerating its competition with D. stolonifera and is displacing the taxon from the western end of the Aliso Canyon occurrence (EO 2) (Roberts, pers. comm. 2009b). (USFWS, 2010)

Stressor: Fuels modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Threats associated with fuels modification (thinning vegetation, fire breaks, disking, and mowing) for fire prevention and damage reduction were mentioned but not discussed at listing. Fires burned four of the six Dudleya stolonifera occurrences in the last 30 years (CDFFP 2003). Though no direct effects to D. stolonifera due to fuels modification practices have been documented since listing, the potential hazard of wildfire has prompted the clearing of edge vegetation surrounding the Top of the World subdivision near the Mathis Canyon occurrence (EO 7) (Roberts, pers. comm. 2009b). Proactive measures should be taken to avoid adverse effects while fighting active fires and to ensure that fuels modification activities avoid the taxon to the

maximum extent practicable. The Orange County Central-Coastal NCCP/HCP prescribes criteria for fuels modification to limit the encroachment of invasive species and precludes them within reserve boundaries (Orange County 2006, p. II338). However, the plan allows fuels modification to occur in proximity to some of the known occurrences of D. stolonifera. Fuels modification related activities remain a potential threat to the Mathis Canyon (EO 7) and Big Bend (EO 1) occurrences of D. stolonifera, which are near the Top of the World subdivision. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Since listing, it has become apparent that potential threats exist to biota of the United States from ongoing, accelerated climate change (IPCC 2007). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying are predicted for the foreseeable future (Field et al. 1999; Cayan et al. 2005; IPCC 2007). Significant temperature increases create a stressor for endemic species. This stressor enhances pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must somehow adapt to these pressures in situ (in place) or shift their geographic range (Cayan et al 2009, p. 45). Such a shift in range for narrow endemic species such as Dudleya stolonifera could exceed the tolerance of the species. Additionally, there is very little available habitat in coastal Orange County to assist this species with a range shift. Though we know little of the adaptive ability of D. stolonifera, climate change could potentially pose a significant range-wide threat to the species. (USFWS, 2010)

Stressor: Hybridization
Exposure:
Response:
Consequence:
Narrative: Species within the genus Dudleya are known to hybridize with other co-occurring Dudleya species. In particular, D. stolonifera is documented to hybridize with D. edulis (ladyfingers) and was identified as a threat by California Department of Fish and Wildlife (CNDDB 2021, unpaginated). The potential for hybridization is on-going in occurrences where both species occur such as Aliso Canyon. However, hybridization has not been confirmed. (USFWS, 2021)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Recovery actions are not available.
- Work with partners to help conserve Dudleya stolonifera occurrences on private property at Big Bend (EO 1), Aliso Canyon (EO 2), and Canyon Acres (EO 5). Identify opportunities

through the Service's Partners Program to conduct potential research, conduct surveys, and develop monitoring protocols. (USFWS, 2010)

- Identify opportunities for conservation or preservation for Dudleya stolonifera occurrences on private lands. Property easements or purchases of these parcels could be made through the Act's section 6 funding and other programs. (USFWS, 2010)
- Develop plan to monitor and document the number of standing plants and threats at all occurrences in coordination with subsequent 5-year reviews. Mathis Canyon (EO 7) is currently the only occurrence with an established monitoring program. (USFWS, 2010)
- Research Dudleya stolonifera reproductive strategies and pollinator requirements. (USFWS, 2010)
- Determine if genetic distinctness exists across occurrences in the two watersheds that comprise the existing range. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Dudleya stolonifera and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid with future restoration efforts. 1. Create and implement a protocol for range wide surveys and monitoring to track the status and trend of the species. Collect voucher specimens at all unvouchered populations. 2. Preserve and restore occupied habitat on private lands (Aliso Canyon-EO 2, and Canyon Acres-EO 5). 3. Develop a strategy to manage nonnative plants, particularly Aeonium haworthii should the species continue to spread in Aliso Canyon (Aliso Canyon-EO 2 and Laguna Laurel Canyon-EO 4). 4. Educate homeowners regarding the threat of invasive plants, particularly Aeonium haworthii, at the Aliso Canyon occurrence. 5. Research Dudleya stolonifera reproductive strategies and pollinator requirements to determine if reduced pollination is contributing to declines in recruitment. 6. Conduct a genetic study to determine if there is gene flow between populations and assess genetic variability to determine if threats associated with small population size are realized. A genetic study could also help evaluate the degree of hybridization. (USFWS, 2021)

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SPECIES ACCOUNT: *Dudleya traskiae* (Santa Barbara Island liveforever)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Dudleya traskiae is a small, perennial herb with five-parted flowers; five petals and carpels, and ten stamens (Service 1985). The flowering stems rise from the axils of basal rosettes. Clusters of 20 to 100 rosettes per plant are typically found, with 25 to 35 leaves per rosette (Service 1985). Rosette leaves range up to 15 cm (5.9 in) long and up to 4 cm (1.6 in) wide. The foliage of D. traskiae is glaucous gray or non-glaucous green while the flowers are usually bright yellow with red veins (Moran 1951). The plant blooms mid spring, usually from April to May (Moran 1978), but sometimes extends to July (Service 1985, CNPS 2001). The flowers are acute at the tip, with floral stems standing 20-30cm tall. Reduced triangular-ovate cauline leaves attached to the floral stems decrease in size as they progress from the rosettes to the flowers (Service 1985). (USFWS, 2012)

Taxonomy

Dudleya traskiae was described by Rose in Britton and Rose in 1903. Although Moran (1942) placed the species within Dudleya and the subgenus Stylophyllum, he stated that the flowers of the Santa Barbara Island liveforever are intermediate between the subgenera Dudleya and Stylophyllum. Moran (1951 and 1978) speculated that because Dudleya traskiae is a tetraploid, it may have originated as an amphidiploid between species of the subgenera Dudleya and Stylophyllum. Accordingly, Munz (1959 and 1974) in his later floras concurred that D. traskiae was a distinct species and Philbrick (1972) felt that it was the most distinctive endemic of Santa Barbara Island. (USFWS, 1985)

Historical Range

See current range/distribution.

Current Range

This species has always been restricted to Santa Barbara Island (USFWS, 2012)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: May to July (USFWS, 2012)

Reproduction Narrative

Adult: The plant blooms mid spring, usually from April to May (Moran 1978), but sometimes extends to July (Service 1985, CNPS 2001). (USFWS, 2012)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 15 to 110 m (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 2012)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: High (inferred from USFWS, 2012)

Habitat Narrative

Adult: Dudleya traskiae are found among the cliffs and exposed rocky slopes on Santa Barbara Island. Dudleya traskiae is generally found in soil pockets on the rocky cliffs and marine terraces that measure 15-110 m (49-360 ft) in height that surround Santa Barbara Island. The largest colony of these plants resides in close proximity to Signal Peak, the highest point of the island with an elevation of 193 m (635 ft). The island supports roughly 11 colonies of D. traskiae, with an estimated 1000 individuals in existence. (USFWS, 2012)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seed dispersal may be naturally limited in this species of Dudleya as it is for others in the genus (Moran in Clark 1989), and may be a factor in maintaining the small, localized colonies that give rise to the high degree of endemism displayed by the genus. Seed caching by deer mice may result in herbivory of some seed, but aid in dispersal of the unconsumed portion of seed (Sieg 1987). The Graveyard Canyon colony of D. traskiae (NPS#5) is particularly limited by seed dispersal because the colony resides on the edge of a cliff where seeds, which are most likely dispersed by water splash, fall into the ocean below (Chaney et al. pers. obs. 2011). (USFWS, 2012)

Population Information and Trends

Population Trends:

Not available

Number of Populations:
14 (USFWS, 2021)

Population Size:
2,353 (USFWS, 2021)

Adaptability:
Low (inferred from USFWS, 2012)

Population Narrative:
CIES recognizes 14 colonies, which they have georeferenced. This is an increase of 3 colonies (colonies 11, 13, and 14) compared to the number of CINP colonies of the 2012 5-year review; however, one of the 14 colonies (colony 14) is a failed outplanting attempt. There is uncertainty about the identity of the colonies in Middle Canyon, because previous location descriptions do not match with maps within other documents, and previous maps and location descriptions do not correspond well with the way colonies are currently mapped. It may be impossible to accurately apply individual colony data across studies within Middle Canyon; however, past data from Middle Canyon colonies can be pooled for analysis. The most recent plant counts of Dudleya traskiae were completed by CIES in 2020 (Parker et al. 2021), as a combination of ground surveys and analysis of photos taken from a helicopter (Table 2). Most colonies were surveyed using only one method, but three colonies were surveyed using both, and numbers of plants were similar between the two methods. A total of 2,353 plants were counted. Most plants on the island were found with the helicopter survey of colony 11, which was considered extirpated in the 2012 5-year review (Service 2012 p. 8). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Though habitat alteration on a landscape scale has ceased with the establishment of the Park (originally designated a National Monument in 1938), residual impacts remain. Specifically, nonnative plant taxa whose spread was favored by the previous disturbances are still present. In areas with steep slopes, another residual impact is soil erosion caused by previous disturbances and high clay composition (Halvorson et al 1988) restoring slope stability may take decades, if not longer (McEachern 2004). (USFWS, 2012)

Stressor: Pelican habitat expansion (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: In 2004, during surveys, Park staff observed that the federally endangered (at the time) brown pelicans had expanded their roosting habitat onto Santa Barbara Island. By early 2006, pelican roosting activity had expanded greatly, and the Park closed access to the eastern portion of the island (National Park Service 2006). According to Laurie Harvey (NPS Seabird Biologist), the pelican colony on Santa Barbara Island reached a historic maximum in 2006 with

an estimated 4,000 nests (Gress and Harvey in prep) (See Figure 3). Since 2006, pelican populations have been much smaller on the island. As a result, short-term effects from pelicans on Dudleya traskiae and the surrounding habitat may vary depending on the abundance and locations of pelican nests. Long term effects on the habitat, however, may linger despite the fluctuations in yearly pelican population sizes. Droppings from pelicans tend to be high in nitrates, which can burn D. traskiae and act as fertilizer for nonnative plants thereby increasing numbers of nonnative grasses which may outcompete D. traskiae (Rodriguez in litt. 2011). In addition, destabilization of slopes result from nesting and roosting pelicans due to the birds' size and weight. A continuous impact from pelican presence can often lead to erosion of soils from canyon slopes and cliff sides, which is where D. traskiae are usually found. (USFWS, 2012)

Stressor: Predation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: At least by 1979, biologists from the Santa Barbara Museum of Natural History observed that the native deer mice (Peromyscus maniculatus subsp. exilis) were feeding on Dudleya traskiae (Collins et al. 1979). Park staff also observed deer mice feeding on D. traskiae, and noted that 30 to 40 percent of their fruiting stalks were gnawed through and broken (Drost 1983 in Service 1985). Moreover, caches of D. traskiae fruits and fruit debris were observed at the openings of deer mouse burrows (Clark 1989). Herbivory thus could reduce the vigor of individuals through reduction in leaf tissue, and also reduce the amount of seed available to contribute to the seed bank. However, seed caching associated with herbivory may also serve to disperse seed to potentially suitable habitat. It has been documented that mice populations have a positive correlation with the abundance of nonnative grasses. When nonnative grasses increase, mice populations, which rely on grasses and seeds as other major food sources, also increase in number. Thus, overall effects on D. traskiae from mice vary over time. Owl moth larva predation has not been observed recently, and so is not considered a major threat for this 5-year review (Blazek pers. obs. 2011). (USFWS, 2012)

Stressor: Low reproduction (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Recruitment rates may not keep pace with rates of mortality. Although good recruitment rates under greenhouse conditions have been achieved, recruitment rates observed in the wild appear to be extremely low and episodic. Small colonies may be even more vulnerable to reduced viability because the seed they produce have lower germination rates than those produced by larger colonies (Clark 1989, Chaney 2007). (USFWS, 2012)

Stressor: Trampling (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: In Factor A, we discussed impacts to Dudleya traskiae habitat from pelican nesting and roosting activity. Here in Factor E, we discuss impacts to individual plants. Pelican nesting and roosting results in trampling of rosettes, breakage of floral stems, destabilization of slopes which cause plants to become dislodged, and loss of substrate which precludes new seedlings from

becoming established. In 2006, an assessment of pelican impacts on D. traskiae colonies was conducted. Seven of the 11 colonies of D. traskiae were characterized as having sustained impacts or were immediately vulnerable to impacts from pelican activities (Chaney 2007). Of these, five colonies were characterized as being at extreme or high risk of extirpation from these impacts (Chaney 2007). (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). In addition, an increase in the rate of sea level rise has been predicted for the coast of California (California Coastal Commission (CCC) 2001, California Climate Change Center 2006). In particular, ocean bluffs along the coast will likely be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). We lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as limited geographical distribution, will affect federally listed species; however, small-ranged species such as Dudleya traskiae are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). Wilken (1996) noted that because most colonies of D. traskiae occur on cliff sides in close proximity to the ocean, the species is subject to a wide range of climatic conditions, such as occasional salt spray, which may directly affect the soils and plants at Signal Peak. (USFWS, 2012)

Stressor: Cliff failure (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The largest colony at Signal Peak, which is located on the face of a sea cliff, is vulnerable to cliff failure. The combination of threats associated with erosion, shoreline retreat, limited habitat range, and existence of only a few small colonies of Dudleya traskiae may make this species particularly vulnerable to the effects of climate change. (USFWS, 2012)

Stressor: Stochastic extinction (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Stochastic extirpation of colonies and extinction of the species also pose a potential threat to the species and are exacerbated by low recruitment rates. Those colonies with low numbers of individuals are particularly vulnerable to extirpation from stochastic events because, due to their tendency to be clumped into colonies, the stochastic event is likely to affect the entire population (Meffe and Carroll 1997). At the time of listing, we noted that, due to the limited number of individuals and geographic range of Dudleya traskiae, this species was at risk of extinction from naturally occurring events, such as fire, drought, disease, or landslides (Service 1985). We believe that, since the majority of D. traskiae reside in one location (near Signal Peak) and on a cliff side, this places the species at risk of extinction from stochastic events. In addition, as a result of its limited range, the resilience of D. traskiae to human caused or natural disasters may be greatly reduced (Menges 1991). (USFWS, 2012)

Recovery

Reclassification Criteria:
1. Secure all 11 colonies of the species in a vigorous, self-sustaining condition. (USFWS, 2012)

2. Expand the distribution of the plant to include 50 percent of the suitable potential habitat. (USFWS, 2012)

Delisting Criteria:
1. Expand the distribution of the plant to include 95 percent of the suitable potential habitat. (USFWS, 2012)

Recovery Actions:
- Protect the Santa Barbara Island liveforever and its habitat from physical disturbance. (USFWS, 1985)
- Enhance the liveforever and its habitat. (USFWS, 1985)
- Protect the liveforever from collection. (USFWS, 1985)
- Develop and implement an educational/information program to facilitate recovery of the liveforever. (USFWS, 1985)
- Continue assessing the threat to Dudleya traskiae colonies from pelican nesting, roosting, and flight activity. Undertake actions to protect those colonies found to be at-risk, as appropriate. For example, cages and netting could be placed over individual plants during pelican nesting season. (USFWS, 2012)
- Continue efforts to expand existing colonies and establish new colonies of Dudleya traskiae. These efforts should include sufficient logistical support to maximize the success of the efforts (e.g., sufficient staff, funding, and logistical support to carry out and monitor the program). In 2011, Chaney suggested salvaging the surviving D. traskiae colony at Arch Canyon (NPS #10), which has been in decline as documented by past surveys, and relocate the colony closer to the Park visitor center where it can be better managed and observed (Chaney et al. pers. obs. 2011). (USFWS, 2012)
- Bank seed from any colonies that are not yet represented in seedbank collections. In addition to maintaining collections at the Park, a portion of the seed banks should be maintained by a facility within the Center for Plant Conservation network (likely Santa Barbara Botanic Garden or Rancho Santa Ana Botanic Garden). (USFWS, 2012)
- Due to the lack of recent surveys and monitoring, particularly on the largest Dudleya traskiae colony at Signal Peak, it is recommended that new assessments be made to evaluate the status of D. traskiae. New information may clarify the extent of various threats and more effective recovery initiatives. (USFWS, 2012)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Establish a robust and permanent identification system for colonies. 2. Develop a regular monitoring schedule so that meaningful comparisons can be made between monitoring events. 3. Continue helicopter surveys to assess colonies not easily seen with ground-based surveys. 4. Establish conservation seed banks for each element occurrence at Center for Plant Conservation approved facilities. 5. Document the effects of deer mice on seedlings, outplantings, and established plants. Develop strategies to overcome detrimental effects.

6. Monitoring the effects of pelican nesting on the Dudleya traskiae colonies. Develop strategies to overcome detrimental effects. 7. Define habitat requirements for Dudleya traskiae and map potential suitable habitat. 8. Continue outplanting efforts to augment existing colonies and establish new colonies to bridge gaps between existing colonies. (USFWS, 2021)

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SPECIES ACCOUNT: *Dudleya verityi* (Verity's dudleya)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/29/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

A perennial herb that forms a rosette of succulent leaves. Flowering stems are 5-15 cm tall, bearing lemon-yellow flowers. This plant forms colonies of up to 100 rosettes. (NatureServe, 2015)

Taxonomy

Dudleya verityi (Verity's dudleya) was described by Kei Nakai (1983) based on a collection he made in 1978 in Long Grade Canyon, Santa Monica Mountains, Ventura County. Raven and Thompson (1966) had assumed these plants to represent a southern extension of D. farinosa. During preparation ofthe 1977 revision ofthe flora, Dave Verity recognized these plants as representing a distinct species, and he subsequently encouraged Kei Nakai to review the taxonomy ofthe species. (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

All known occurrences are within eastern Ventura County, California, along north-facing volcanic rock outcrops on the lower slopes of the west end of the Santa Monica Mountains in coastal sage scrub. The entire distribution of the species is scattered over a 6.4-km (4-mi) stretch of land along the northern slope of Conejo Mountain and on north-facing volcanic outcrops in the vicinity of the California State University Channel Islands campus. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: The cushion lichen, Niebla ceruchoides, appears to provide a nursery habitat for seed capture and germination for D. verityi (Riefner 1992) (see cover photo). The Dudleya species which have small yellow to orange flowers (including D. verityi) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds (Levin and Mulroy 1985, Aigner 2004). (USFWS, 2009)

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: Dudleya verityi blooms in late spring (May-June) (California Native Plant Society (CNPS) 2008) and has floral stalks 5 to 15 cm (2.0 to 5.9 in) tall with lemon-yellow corollas and petal tips recurved to 90 degrees (Service 1999). The cushion lichen, Niebla ceruchoides, appears to provide a nursery habitat for seed capture and germination for D. verityi (Riefner 1992). The Dudleya species which have small yellow to orange flowers (including D. verityi) are pollinated by bees and flies, while species with larger red flowers are pollinated mostly by hummingbirds (Levin and Mulroy 1985, Aigner 2004). (USFWS, 2009)

Habitat Type

Adult: Terrestrial (USFWS, 2009)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Hardwood

Geographic or Habitat Restraints or Barriers

Adult: Based on CNDDB (2008) records and recently mapped coordinates onto Google Earth (2008), known occurrences of Dudleya verityi prefer elevations ranging from 60 to 350 m (200 to 1150 ft) Dudleya verityi prefers slopes ranging from 20 to 90 degrees, and most commonly with north-facing exposures (CNDDB 2008, Sagar 2008). (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2009)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 2009)

Dependency on Other Individuals or Species for Habitat

Adult: There is evidence that mosses and lichens aid in seed recruitment and germination by providing nutrients, moisture, substrate, and protection against snails and slugs (Riefner and Bowler 1995, Riefner et al. 2003). (USFWS, 2009)

Habitat Narrative

Adult: In general, Dudleya taxa typically inhabit ocean bluffs, sheer cliffs, and rock outcrops including open habitat soils that have nutrient poor substrates and little vegetation (Riefner et al. 2003). This species is highly localized in its distribution, occurring exclusively in thin-soiled substrate over rocky outcrops derived from the Miocene Conejo volcanics (Service 1999). Based on CNDDB (2008) records and recently mapped coordinates onto Google Earth (2008), known occurrences of Dudleya verityi prefer elevations ranging from 60 to 350 meters (200 to 1150 feet). Dudleya verityi prefers slopes ranging from 20 to 90 degrees, and most commonly with north-facing exposures (CNDDB 2008, Sagar 2008). The entire distribution of the species is scattered over a 6.4-km (4-mi) stretch of land along the northern slope of Conejo Mountain and on north-facing volcanic outcrops in the vicinity of the California State University Channel Islands campus. (USFWS, 2009)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Long term trends indicate a decline of <50% to relatively stable, while short-term trends suggest declines of 10-30% (NatureServe, 2015)

Number of Populations:

8 (USFWS, 2023)

Population Size:

Thousands (USFWS, 2023)

Adaptability:

Low (inferred from USFWS, 2009)

Population Narrative:

As a result of 2003 surveys (Sagar 2008) which reported an additional six occurrences, the number of occurrences is now currently at nine (CNDDB 2008, Sagar 2008). Due to its location in a highly developable area and a very narrow distribution short-term trends indicate a decline of 10-30% and long term trends of relatively stable to declines less than 50% (NatureServe, 2015). (USFWS, 2009; NatureServe, 2015). At the time of listing in 1997 (Service 1997), there were 3 known occurrences of D. verityi. This number is now increased to a total of 8 CNDDB Element Occurrences ([EO] Table 1, CDFW 2023), and one possible unassigned occurrence (Dorsey et al. 2013, p. 61). An EO is a group of plants separated by at least 400 meters (1/4 mi) from the closest group of plants of the same species. The increase in the number of occurrences since listing was recognized in the Service 2009 5- year review and in Dorsey et al. 2013, but at the time of these publications CNDDB EO numbers had not yet been assigned to all of them. This resulted in different identification numbers being used for the same occurrences among the publications that differ somewhat from the current CNDDB EO numbers. We cross-walked the identification numbers in Table 1 above. Eight of nine occurrences are known since at least 2003, and it is unlikely that additional occurrences will be found beyond the small, known geographic range of the species. We presume that all the occurrences are currently extant (CDFW 2023). More than half of the occurrences are partially or fully on private land, with limited or no access for surveys. Several of the occurrences are relatively close to adjacent occurrences and may be merged in the future, particularly EO# 1 and EO# 4, and EO# 3 and the unassigned occurrence also on Conejo Mountain. The areas between these occurrences are on private land and not available for survey. EO# 1 has a range of hybrids between D. verityi and D. lanceolata as well as pure D. verityi (Guilliams and Hasenstab-Lehman 2020, pp. 34-36). EO# 5 may contain only hybrid plants between the two species (Dorsey et al. 2013, pp. 58 and 65), but no genetic analysis of the EO# 5 occurrence has been conducted. We discuss hybridization further in the threats section below (USFWS, 2023). Abundance: Information about total population size for D. verityi was not given when we listed the species (Service 1997). Most of the occurrences and individuals are at least partially on private land, and have limited or no accessibility for surveys. Botanists surveyed at least parts of most of the occurrences in 2003,

and estimated that the species had a total of approximately 15,000 individuals (Table 2). This is the most comprehensive data regarding D. verityi abundance available. Three occurrences (EO# 1, EO# 2, and EO# 6) had population surveys in the same three years2003, 2010, and 2021. It is unknown how similar survey efforts were between years. Each of these occurrences had decreasing numbers of plants from 2003 to 2010, with total numbers of 13,450 in 2003 and 3,479 in 2010 (Table 2). These occurrences were also visited immediately after the 2013 Springs Fire burned over all occurrences of the species, causing severe mortality estimated at over 90% of the known individuals of the species (CNDDB 2023). The 2013 postfire count was described as a "brief visit", and there was a total of only about 10 plants visible among these three occurrences (Dorsey et al. 2013, p. 66). Numbers of plants were not given for each separate occurrence, and CNDDB (2023, not included in Table 2 below) reports this total only as 11-50 plants for EO# 2, without giving numbers for EO# 1 or EO# 6. It is likely that at that time there were individuals which had the leaves burned off and were still alive but undetected. Botanists conducted a 2021 survey of the same three occurrences (EO# 1, EO# 2, and EO# 6), and found a total of 1,016 plants. Because of the decrease in numbers between 2003 and 2010 and the continued effects of the Springs Fire, all occurrences are characterized by CNDDB as decreasing (USFWS, 2023).

Threats and Stressors

Stressor: Rock quarry (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Historically, the lower slopes of Conejo Mountain near occurrence number 2 have been the site for quarrying of construction-grade rock. This land is zoned by the County of Ventura for mineral extraction and there are abandoned, active, and proposed quarry operations within the distribution of Dudleya verityi (Service 1997, 1999). However, the quarrying near occurrence number 2 remains as the only current quarry operation within the distribution of D. verityi, and even though we are not aware of any individuals of D. verityi that have been affected by these actions, the current quarry operation has violated some of their county permit requirements and has mined beyond the permit boundaries (C. Danko, Ventura County Planning Division, pers. comm. 2009). In addition, the quarry operation, once back in compliance with county requirements, may request to expand its operation. Therefore, the activities and the effects of this quarry to D. verityi or its habitat remain unclear and therefore continue to be a threat. (USFWS, 2009)

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the current time, habitat encroachment from new or existing development activities surrounding several of the known Dudleya verityi occurrences continues to be a threat to the species and its habitat. For the most part, D. verityi and associated habitat is located in areas where impacts from development itself may not directly affect the species or its habitat. However, the associated human impacts to the land (e.g., hiking, mountain biking) in these areas adjacent to new or existing developments could result in D. verityi and associated lichen communities to be trampled and/or dislodged. Additionally, erosion from such activities may

cause changes in the substrate which may change the microhabitat necessary for the lichen communities to persist. (USFWS, 2009)

Stressor: Collection (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: An incident of vandalism of chalk dudleya (Dudleya pulverulenta) occurred near a public access location in Topanga Canyon, California in 1999, illustrating that collection of Dudleya species continues to be a threat to members of this genus (Farris 1999). Even though we are unaware of any collection of Dudleya verityi, occurrence number 1, 5, and 7 are especially prone to collection given the ease of accessibility and proximity to existing development and roads. (USFWS, 2009)

Stressor: Caterpillar predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Damage from caterpillars eating the inside of the stems of plants within the Dudleya genus has been reported in many locations. These hollow roots and stems were first noticed in some Dudleya individuals as early as 1990 and have been reported as far south as the considerably isolated Isla Zapato in Mexico, leading to speculation that it is a native caterpillar that is responsible for the damage (McCabe 2008b). (USFWS, 2009)

Stressor: Air quality (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Air pollution impacts to coastal sage scrub have been documented in the Santa Monica Mountains as a threat to the viability and functioning of the habitat (O'Leary 1990). The diverse lichen flora associated with D. verityi contains species that are considered rare and disappearing from southern California (Riefner 1992). The cushion lichen (Niebla ceruchoides) appears to provide a nursery habitat for seed capture and germination for D. verityi (Riefner 1992). The population of Niebla on Conejo Mountain is the largest on the mainland (it is also known from the California Channel Islands). Lichens are sensitive to air pollutants and have been eliminated from many areas during the past century (Hale 1983). Studies in California have shown a strong correlation between the increases in smog and the loss of the regional lichen flora (Sigal and Nash 1982). With Ventura County's improvements in air quality, air pollution is not the threat it was at the time of listing. However, until studies have been performed to determine the levels of smog that would impair the ability for the cushion lichen, Niebla ceruchoides, to persist, air quality may continue to be a threat to D. verityi. (USFWS, 2009)

Stressor: Fire suppression, fuel modification, wildfire survivability, and invasive species (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: At the time of listing in 1997, we discussed general threats to several species within the Dudleya genus, including the effects of fire (Service 1997). Natural fire regimes of these areas have been affected, consequently having drastic effects on the grassland, coastal sage scrub, chaparral, and oak woodland ecosystems and the species that reside there (Keeley et al. 1999). In some cases, D. verityi is threatened by direct removal during fuel modification and fire-break efforts that occur in the vicinity of the habitat for this species due to the large number of residences and buildings that exist in close proximity to the existing distribution of this species (Service 1997, 1999; Sagar 2008). Additionally, fire that reduces or eliminates the lichen community could dramatically reduce the extent and number of populations of D. verityi. Lichens grow very slowly and persist for long periods of time (Hale 1983). The population structure of D. verityi depends on mature lichen individuals (Service 1999). Therefore, an extremely hot fire could remove the necessary substrate for the species to germinate and would modify D. verityi habitat for an uncertain period of time. Although the plants probably have the ability to survive small, low-intensity fire, there is a high probability that the plants may not survive a larger, high intensity fire. Increased fire suppression over the last century in a large portion of southern California increases the chance of having these larger, more intense fires (Keeley et al. 1999) and thus high intensity fires may pose a threat to the species. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, we noted that due to the limited number of individuals and the restricted range of Dudleya verityi, this species is under threat of extinction from naturally occurring events, such as fire, drought, disease, or rock slides (Service 1997). As a result of the number of individuals and range of D. verityi, the genetic viability and thus resilience of the species to human-caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). The Santa Monica Mountains and Simi Hills are expected to increase in diversity becoming potential future refugia for some species (Loarie et al. 2008). Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors, such as low numbers of individuals, will affect Dudleya verityi, small ranged species such as D. verityi are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. All the current sites (including seedbanks) are fully protected and managed with the primary intention of preserving the populations in perpetuity. (USFWS, 2009)

2. All the current sites (including seedbanks) are shown to be self-sustaining over a minimum of 10 years. (USFWS, 2009)

Recovery Actions:
- Protect and secure all current sites of these plant species (including seedbanks). (USFWS, 1999)
- Manage and monitor protected areas where plants occur. (USFWS, 1999)
- Survey historic locations and other potential habitat where the six plant species may occur. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies, population dynamics, and to guide recovery/conservation efforts. (USFWS, 1999)
- Develop public outreach plans to enhance the public's understanding of conservation needs of these endangered and threatened plant species. (USFWS, 1999)
- Conduct new, up-to-date extensive population survey of existing and potential habitat sites. Potential partners include the National Park Service (Santa Monica Mountains Recreation Area), California State Parks, and California State University, Channel Islands. (USFWS, 2009)
- Develop and implement monitoring and adaptive management plans for known existing occurrences. Monitoring should follow Sahatjian's (2008) monitoring methodology. Update and expand knowledge of species life history and specific habitat requirements. (USFWS, 2009)
- Work on public outreach and education with private land owners in the area; develop incentives aimed at conservation of the species. Seek input from public and other stakeholders on the management and preservation of the species. Cooperative agreements and coordinated planning and management efforts could assist in conservation efforts. (USFWS, 2009)
- Work closely with agencies to implement a species monitoring and public outreach program, in addition to implementing new conservation measures for the species (e.g., fencing off certain areas, etc.) and preserving additional potential habitat for the species. (USFWS, 2009)
- Work with county planning departments to develop a species conservation plan; if development does occur, onsite protection should be required. (USFWS, 2009)
- Investigate air quality impacts on cushion lichen, Niebla ceruchoides. (USFWS, 2009)
- Investigate Dudleya verityi (and suspected hybrids) growing and reproducing on the clay tile roofs at California State University Channel Islands campus near occurrence number 5 to determine whether these plants are in fact D. verityi, and not hybrids. (USFWS, 2009)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue genetic and morphometric analyses to determine the extent of hybridization with other Dudleya species, and deposit voucher specimens of the variation at all occurrences in herbaria. 2. Conduct thorough surveys within all known

occurrences and areas of suitable habitat. 3. Conduct surveys to determine if there are additional plants in areas between the currently mapped occurrences, and if occurrences can be merged. 4. Develop and implement a monitoring plan for all occurrences. Monitoring should include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 5. Work with public and private entities to gain access to occurrences, prevent damage to plants, and raise public awareness to support appropriate conservation measures. 6. Update and expand knowledge of the species' life history and specific habitat requirements, especially the relationship to lichens that are important for recruitment. Continue the work to enhance lichen abundance that is currently being performed so that successful outplanting to the field can occur, which would help increase overall population abundance and resiliency against severe wildfires. 7. Continue the recovery actions of supplemental watering and lichen transplantation until the pre-Springs Fire lichen habitat is reestablished. 8. Increase the number of D. verityi accessions in conservation seed banks, so that all known occurrences are represented in the collections. (USFWS, 2023).

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SPECIES ACCOUNT: *Echinacea laevigata* (Smooth coneflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/8/1992; Southeast Region (R4) (USFWS, 2015)

Physical Description

A rhizomatous perennial herb, which grows to a height of about 1.5 m, with smooth stems, few leaves and pink to purplish flowers. This species flowers from May to mid-July and fruits from late June to September (Gaddy 1991) (NatureServe, 2015).

Taxonomy

It belongs to the aster family (Asteraceae) was first described in 1903, under the name Brauneria, by Boynton and Beadle from material collected in South Carolina in 1888; it was transferred to the genus Echinacea in 1929 (Small 1933, McGregor 1968) (USFWS, 1995).

Historical Range

The reported historical range of smooth coneflower included Pennsylvania, Maryland, Virginia, North Carolina, South Carolina. Georgia, Alabama. and Arkansas (USFWS, 1995).

Current Range

Current range: Georgia, South Carolina, North Carolina, Virginia. Reports from Alabama and Arkansas are believed to have been misidentifications (Gaddy 1991); also an apparent false report from Maryland (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 1995)

Breeding Season

Adult: May through July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators; bare soil that is rich in magnesium and/or calcium; disturbance (USFWS, 1995)

Reproduction Narrative

Adult: Flowering occurs May through July; fruiting occurs June to October. Seldom produces viable seeds. Rhizomatous/Cormophyte (NatureServe, 2015). Gaddy (1991) stated that reproduction was apparently only by sexual means and that no vegetative reproduction had been observed. However, vegetative reproduction has been reported from the Chattahoochee National Forest in Georgia (Robert Joslin, U.S. Forest Service, personal communication, 1994)

and from the Sumter National Forest in South Carolina (Lonnette Edwards, U.S. Forest Service, personal communication. 1995). Pollinators for this species are unknown; however, Edwards and Madsen (1993) have documented preliminary list of insect visitors to South Carolina populations of smooth coneflower (see Appendix A). Smooth coneflower appears to need bare soil that is rich in magnesium and/or calcium for seedling germination and growth. Some form of disturbance (such as fire) is also essential (USFWS, 1995)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Prairie, oak-savannas, cedar barrens, limestone bluffs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full or partial sun (NatureServe, 2015); periodic fire (USFWS, 1995)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Formerly, a plant of prairie-like habitats or oak-savannas maintained by natural or Native American-set fires. Now, primarily occurs in openings in woods, such as cedar barrens and clear cuts, along roadsides and utility line rights-of-way, and on dry limestone bluffs. Usually found in areas with magnesium and calcium-rich soils. Requires full or partial sun. Associated species include: Juniperus virginiana and Eryngium yuccifolium. This species is disturbance dependent (NatureServe, 2015). Smooth coneflower occurs in community types described by Schafale and Weakley (1990) as xeric hardpan forests and diabase glades or in Virginia dolomite woodlands or glades as described by Rawinski (1994). Optimal sites for smooth coneflower are characterized by abundant sunlight and little competition in the herbaceous layer (Gaddy 1991). Natural fires, as well as large herbivores, are part of the history of the vegetation in this species' range (USFWS, 1995).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are probably dispersed by seed-eating birds or small mammals (USFWS, 1995).

Population Information and Trends

Population Trends:

Decline of 30-70% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2011)

Number of Populations:

68 (USFWS, 2011)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Remaining populations appear to be small in numbers which may result in low genetic diversity. Since the species' discovery, more than 2/3rds of the historical populations have been lost. Known from 61 populations in 8 states. However, when it was listed, it was known from fewer than 25 sites in 4 states. This species has experienced a long-term decline of 30-70%. A site in North Carolina is probably the largest, with an estimated 2000 individuals. Total estimated population size is 2,500 - 100,000 individuals. Species is limited to 4 states, 10 counties and about 20 populations in a narrow band from Georgia through the Carolinas to Virginia. There are a few restored populations in Georgia and South Carolina. (NatureServe, 2015). Based on survey information gathered at individual populations throughout the range of the species, it appears that the Echinacea laevigata is stable. Peters et al. (2009) found that the species displays a relatively high level of diversity based on analyses across the range of populations. A total of 68 populations are considered extant while 32 populations are believed to be extirpated or historical (USFWS, 2011).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Echinacea laevigata is threatened range-wide by the suppression of fire and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis. Echinacea laevigata also is threatened by timber operations. Sites located within utility rights of-way are threatened by herbicide use and/or mowing during critical growth periods. The destruction of habitat, resulting from development or land conversion also threatens this species, but to a lesser degree than the factors listed above. The invasive plant, Pueraria lobata (kudzu), occurs at one Echinacea laevigata population in SC. Lespedeza cuneata (Sericea lespedeza) is problematic at some roadside locations in NC (USFWS, 2011).

Stressor: Longhorn beetle (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The non-native longhorn beetle (Hemierana marginata) has been identified at some Echinacea laevigata populations in NC. This beetle chews into the flowering stems causing flowers to die before they produce viable seeds. The insect also may burrow into the base of the plant killing the plant (Laura Gadd, NC Plant Conservation Program, Raleigh, NC, pers. comm.) (USFWS, 2011).

Recovery

Reclassification Criteria:

1. 12 geographically distinct, self-sustaining populations are protected across the species' range, including some populations in at least two counties in VA, two counties in NC and two counties in SC and one county in GA (USFWS, 2011).

2. Managers have been designated for each population (USFWS, 2011).

3. Management plans have been developed and implemented (USFWS, 2011).

4. Populations have been maintained at stable or increasing levels for five years (USFWS, 2011).

Delisting Criteria:
1. At least 15 geographically distinct, self-sustaining populations are protected in at least two counties in VA, two counties in NC, two counties in SC and one county in Georgia (GA) (USFWS, 2011).

2. Management plans have been developed and implemented for each site (USFWS, 2011).

3. Populations (as measured by number of adult plants) have been stable or increasing for 10 years (USFWS, 2011).

4. Permanent conservation ownership and management of at least 10 populations are assured by legally binding instruments (USFWS, 2011).

Recovery Actions:
- Maintain cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1995).
- Implement protective management for extant populations (USFWS, 1995).
- Survey suitable habitat for additional populations and potential reintroduction sites; reestablish populations within the species' historic range (USFWS, 1995).
- Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.) (USFWS, 1995).
- Monitor existing populations (USFWS, 1995).
- Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurs (USFWS, 1995).
- Revisit known populations that have not been visited in the past three years in order to monitor the population size, habitat conditions and to document any potential threats to the viability of each site; discuss conservation options with landowners and managers where appropriate; report findings to the appropriate NHP (USFWS, 2011).
- Search for additional populations in appropriate habitat (USFWS, 2011).
- Identify those populations/subpopulations that will contribute toward long term recovery and determine their status (increasing, stable or decreasing) (USFWS, 2011).
- Prioritize protection of unprotected sites that are critical for recovery and protect them (USFWS, 2011).
- Develop conservation agreements with applicable landowners to ensure recovery objectives are met (USFWS, 2011).
- Determine which sites have management plans and how they are being implemented and develop and implement management plans for the remaining sites that are deemed to be

critical to the recovery of the species (USFWS, 2011).

- Develop monitoring protocols and initiate long-term population monitoring that will demonstrate if a site is stable or not (USFWS, 2011).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2011).
- Conduct further genetic analysis of populations not included in the research by Peters, et al (2009) (USFWS, 2011).
- Organize a meeting of land managers, researchers and other interested parties to discuss the recovery of this species (USFWS, 2011).
- Collect seeds and develop propagation protocols according to Center for Plant Conservation guidelines (USFWS, 2011).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2011).
- Secure funding to accomplish the actions listed above (USFWS, 2011).

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SPECIES ACCOUNT: *Echinocactus horizonthalonius var. nicholii* (Nichol's Turk's head cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: NTHC

Listing Status: Endangered; 11/28/1979; Southwest Region (R2)

Physical Description

The NTHC is a small, blue-green to gray-green, barrel cactus that is globose, becoming more columnar as it grows. Large individuals range in height from 41 to 51 cm (16 to 20 inches) tall and range in diameter from 13 to 20 cm (5 to 8 inches) wide. Individuals are single-stemmed with 8 ribs that spiral around the base to the apex. Each areole has three central spines, one black that curves downwards and two red or basally gray that curve upwards, and 5 radial spines that tend to be black or partially gray. Flowers are 4 to 7 cm (1.5 to 2.7 inches) in diameter when fully opened (Chamberland 1995; Turner et al. 1995). One to five bright pink fruits are produced in May and June (Benson 1982) and are covered with wooly, white hairs at the apex of the stem, becoming dry with maturity. (USFWS, 2009)

Taxonomy

Baker (2007, 2009) is conducting a multivariate analysis to compare the degree of morphological variation of stem characters within populations of variety nicholii to populations within E. horizonthalonius throughout its known range to determine if these characters are significantly different to the full suite of characters. Baker's results suggest that there are three distinct varieties within the species E. horizonthalonius: variety nicholii in the Sonoran Desert population, variety horizonthalonius in the Chihuahuan Desert, and an unnamed variety in San Luis Potosí, Mexico. However, more populations need to be measured in order for the results to be conclusive (M. Baker, pers. comm. 2009) (USFWS, 2009).

Historical Range

It is endemic to the Sonoran Desert (Pima and Pinal Counties, , Arizona, and Sonora, Mexico). (USFWS, 2009)

Current Range

Populations occur in the Waterman Mountains and Koht Kohl Hills in Pima County, Arizona; the Vekol Mountains including those near the vicinity of the Vekol Mine in Pinal County, Arizona; and a population in the Sierra del Viejo Mountains in Sonora, Mexico (USFWS, 2009). The NTHC occurs in isolated mountain ranges that extend from southcentral Arizona in Pima and Pinal Counties to a disjunct location in Sonora, Mexico. The plant is found almost entirely on Horquilla limestone. (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Extremely slow-growing; takes 10 years to reach a height of 2 inches (NatureServe, 2015).

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2009)

Lifespan

Adult: 35 - 95 years (USFWS, 2009).

Breeding Season

Adult: April - July (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Soil seed bank (USFWS, 2009)

Reproduction Narrative

Adult: Flowering occurs during mid-April to July, with 90 percent of blooms occurring in June (USFWS 1986). One to five bright pink fruits are produced in May and June (Benson 1982). The NTHC is self-incompatible, requiring pollen from another plant for pollination. Individual lifespan is estimated between 35 and 95 years (USFWS 1986; Schmalzel and Francisco 2000). Each fruit generally contain less than 100 seeds (K. Rice, pers. comm. 2008). The Schmalzel and Francisco (2000) study found that individuals reach maturity (i.e. bloom for the first time) at 2 cm (0.78 inches) tall and 8 cm (3.2 inches) wide. Preliminary studies examining population age-structure suggest that an immature cactus takes 11 to 13 years to reach a diameter of 2 cm (0.78 inches). Seeds are incorporated into a soil seed bank until favorable conditions for germination are present (Ecker 1991; Rojas-Aréchiga and Vázquez-Yanes 2000; Godinez-Alvarez et al. 2003; notes from S. Brack, Mesa Garden, courtesy of Desert Botanical Garden files) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sonoran desert scrub (USFWS, 2009; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 730 - 1,250 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2009; see dispersal/migration narrative)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in Sonoran desert scrub on dissected alluvial fans at the foot of limestone mountains, and on inclined terraces and saddles on limestone mountain sides at 730 -1,250 m. It

has been found to grow almost exclusively on Pennsylvania-aged Horquilla limestone (USFWS 2009; NatureServe, 2015). The environmental specificity is narrow (specialist or community with key requirements common) (NatureServe, 2015). It occurs on 0 - 30 percent slopes with a north, west, and south-facing exposure. Grows in open areas and partially to shaded areas underneath the canopy of shrubs and trees, or shouldered next to rocks on steep slopes and within limestone outcrops. Occurs in Parkinsonia microphylla scrub with Ambrosia deltoidea, Carnegiea gigantea, Cylindropuntia acanthocarpa, Encelia farinosa, Fouquieria splendens, Krameria grayi, and Opuntia phaeacantha (Baker 2007). Other dominant associated plant species include Larrea tridentata, Ambrosia deltoidea, Krameria grayi, and Opuntia sp. (USFWS 1986; NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2009)

Dispersal/Migration Narrative

Adult: Seedlings often establish around the base of the "mother" plant and can give the appearance of small clumps (USFWS, 2009).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

4-5 (USFWS, 2021)

Population Size:

<1,300 (USFWS, 2021)

Population Narrative:

As of 2020, there are thought to be fewer than 1,300 total individuals (an estimated 1,024 live and 288 dead), most of which occur in the Waterman Mountains of Pima County Arizona. The status of NTHC on the Tohono O'odham Nation is uncertain. Despite surveys since the 1980s and continuing periodically through 2020, no new populations have been located outside of the four historical areas (the Waterman Mountains and Koht Kohl Hills in Pima County, Arizona; the Vekol Mountains in Pinal County, Arizona; and the Sierra del Viejo Mountains in Sonora, Mexico). A potential fifth population of 83 plants that morphologically resemble the NTHC occur in central Sonora (Van Devender and Reina-Guerrero 2012, entire). Their taxonomic status remains uncertain and until verified, the population is not considered the listed entity (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2019)
Exposure:
Response:

Consequence:
Narrative: Habitat desctruction to the Waterman Mountains population is no longer adversely affecting var. nicholii. As of 2018, the BLM has completed most of the recovery actions from the Recovery Plan. The establishment of IFNM with the signing of the Presidential Proclamation, permanently protects natural resources within the 906.5 ha (2,240 ac) encompassing var. nicholii's habitat. In accordance with the proclamation, IFNM is withdrawn from all forms of mineral extraction and recreational off-road vehicles (Service 2009, BLM 2011, 2013). In implementing recovery actions, BLM has acquired 148.9 ha (368 ac) out of 222.5 ha (550 ac) of patented land held by a private owner within occupied habitat and continues to pursue acquisition of remaining private acreages (BLM 2011; D. Tersey BLM, pers. comm. 2018). (USFWS, 2019)

Stressor: Herbivory (USFWs, 2019)
Exposure:
Response:
Consequence:
Narrative: The Recovery Plan stated that moderate levels of grazing did not appear to affect the var. nicholii because cows seem to avoid stepping on the plants (Service 1986). Moderate grazing continues throughout var. nicholii's habitat (Service 2012). During the summer months, cattle may congregate under large trees for shade in dense patches of var. nicholii and disturb its habitat (K. Robertson, FWS, pers. obs., 2018). We have little evidence (observed or documented) of cows stepping on the cactus or damaging its tissue. BLM manages the Agua Dulce Grazing Allotment to promote var. nicholii conservation. Livestock waters are currently located next to existing roads, but BLM will move or replace those that cause habitat impacts. BLM will place any future water developments in locations to move cattle outside of occupied areas with the intent to reduce or minimize any impacts (BLM 2013; Service 2012). However, any potential effects from livestock grazing, as well as bighorn sheep and other small mammals have not been fully evaluated and should be considered in a thorough threats assessment. (USFWS, 2019)

Stressor: Climate change (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change is considered a threat to var. nicholii due to effects from hotter temperatures and increased aridity (Service 2009). Climate change has resulted in some species shifting their range to higher elevation or higher latitude (Hannah et al., 2005; Chen et al., 2011). For southwestern plants, scientists are finding migration may occur in all directions depending on the species' ability to adapt, and having available, connected habitat (Stills et al., 2015; Krause and Pennington 2012; Notaro et al., 2012). Variety nicholii grows on mountain slopes that could presumably support more plants in the future if they remain cooler and soils retain more moisture than those on the valley floor. Alternatively, as temperatures and aridity increase, these exposed areas may become hotter, drier and ultimately unsuitable in the future. With the limiting presence of Horquilla limestone on a few mountain ranges, changes in the suitability and amount of available habitat for the taxon could cause dramatic reductions in its range. Gaining a better understanding of its adaptive capacity and conserving the distinct geographic areas where it occurs will allow opportunities for the taxon to endure into the future. (USFWS, 2019)

Stressor: Invasive plant species (USFWS, 2019)

Exposure:
Response:
Consequence:
Narrative: In the 5-year Status Review, we identified the spread of invasive grass, Cenchrus ciliaris as a significant threat to var. nicholii habitat. Cenchrus ciliaris had expanded into a 7.2 ha (18 ac) area on the north side of Waterman Mountains, including a location near hundreds of var. nicholii increasing the fire risk (Service 2009). There have been recurrent efforts to control Cenchrus ciliaris by manual removal through various volunteer organizations (2005-2009) and BLM contracted annual herbicide sprayings (2008-2009). In 2010, the BLM organized a mechanical reshaping and contouring of the area that was followed by restoration efforts through 2012 (J. Scheuring, Friends of Ironwood Forest, pers. comm., 2013). Cenchrus ciliaris has been effectively brought under control through continued removal and spot treatment which eliminated its threat to nearby var. nicholii. In 2016, several var. nicholii seedlings were found growing in the restoration area. (USFWS, 2019)

Recovery

Reclassification Criteria:
The criterion for downlisting to threatened status is permanent protection of 75 percent of the known habitat according to the steps outlined in the Recovery Plan. (USFWS, 1986)

Delisting Criteria:
1. Conserve and protect all existing var. nicholii individuals and habitat for their pollinators (approximately a 600 meter (0.37 mi) radius around each plant) in three or more extant populations through land protection, land management actions, and restoration techniques (i.e., actions that enhance habitat quality, support increased germination, and establishment). Each var. nicholii population must have available habitat of sufficient quality and size for natural population dynamics and long-term expansion, to support a viable seed bank, as well as, habitat for pollinators, allowing pollen exchange within populations. Variety nicholii habitat is defined as areas that contain the appropriate geology, elevation, soil type, Sonoran Desert native plants and trees, native pollinators, with minimal ground disturbance and limited non-native invasive grass species. (USFWS, 2019)

2. Each var. nicholii population must be self-sustaining, with annual recruitment exceeding mortality over any 20 years of a 30-year period. Long-term monitoring every 3–5 years demonstrates that the annual total estimated population size among three or more extant populations is maintained at or greater than 3,700 individuals for a minimum of 20 years over a 30-year survey period. Threats must be managed so that populations can be maintained at target levels (a minimum of 3,700 total individuals) for a minimum of 20 years over the 30year period. Expected yearly fluctuations in plant abundance due to changes in precipitation, fire, or other causes, may result in two monitoring events during the time period that does not meet these targets. (USFWS, 2019)

3. Develop a long-term ex-situ (off-site) var. nicholii conservation program that includes maintenance of seeds for conservation and recovery at seed storage facilities, captive propagation, germination trials, guidelines for supplementing natural populations, and postintroduction monitoring that demonstrates the introduced var. nicholii are fully functioning in their environment, including flowering, seed production, and survival. (USFWS, 2019)

Recovery Actions:

- Maintain, protect, and enhance natural populations. It is important and crucial to the preservation of the Nichol Turk's head cactus to protect populations in the wild. To do this, a continuing program of law enforcement, monitoring, and management must be implemented and coordinated among Federal agencies, the State of Arizona, and private individuals or organizations. (USFWS, 1986)
- Study populations in their natural habitat at existing sites. An in-depth knowledge of the plant's ecology and biology is needed to understand its habitat requirements. With this information, sound management decisions can be made and implemented to sustain healthy, natural populations. The use of a well documented and accessible living collection could provide a source of material for these types of studies. (USFWS, 1986)
- Develop a comprehensive trade management plan (CTMP) for all cacti. Prior to development of trade management strategies, studies are necessary to determine what species are in the trade, the overall trend of trade in listed cacti, the feasibility of reducing the collecting pressure on the wild populations by promoting a commercial artificial propagation program, and to determine strategies for effective implementation of law enforcement responsibilities of ESA, CITES, Lacey Act, and State laws. These studies should be national in scope and address all cacti. Completion of subtasks 31 through 34 will result in development of an FWS policy on the cactus trade problem and will allow the drafting of a CTMP. (USFWS, 1986)
- Develop public awareness, appreciation, and support for the preservation of the Nichol Turk's head cactus. Education of the public is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of the foregoing recovery measures. Public interest groups, especially local ones such as botanical gardens native plant societies, cactus societies, and The Nature Conservancy chapters need to be involved. The visibility of their support can be instrumental in shaping public opinion. Specific strategies would include lectures, pamphlets, letters, etc., concerning conservation of threatened and endangered plant species. (USFWS, 1986)
- Recommended Action from 2009 5-Year Review: The 1986 NTHC Recovery Plan should be revised to incorporate new information that has been gathered since it was finalized. The recovery criteria should be revised to address newly identified threats to the subspecies. Criteria for delisting should be established. Threats should be discussed relative to the five-factor analysis regarding their impact to the subspecies and its habitat (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Establish a systematic monitoring protocol to more effectively evaluate the status of the subspecies across its known range. Expand the area being monitored to include a larger sample size that is more representative of the Waterman Mountains population. Monitoring should be designed to establish long-term population trends and investigate effects of climate change (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Studies should be conducted to obtain the quantified data in order to support the recovery criteria using the best scientific and commercial data available. Studies should focus on: ecological factors that influence distribution, density-dependence issues, resource requirements for survival, seedling establishment and dispersal, pollination, demographic trends, population biology, and the amount and condition of suitable habitat (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: Evaluate the genetics of this subspecies to better understand its evolutionary history and relationship to E. horizonthalonius, and to

assess genetic variation within and between the populations. This information would provide a better understanding of its historical range and taxonomic classification (USFWS, 2009).

- Recommended Action from 2009 5-Year Review: Establish a cooperative partnership with OVIS and develop a conservation agreement to survey and (if found) study the cactus in the Sierra del Viejo Mountains in Sonora, Mexico (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: The USFWS should coordinate cooperative agreements with the Tohono O'odham Nation and ensure that partnerships continue to help protect and conserve the cactus on Tribal land (USFWS, 2009).
- Recommended Action from 2009 5-Year Review: The USFWS should coordinate and establish cooperative partnerships with private landowners to implement conservation of the cactus on their land (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Our recommended future actions from the 2009 5-year Status Review remain relevant, and we provide those below with some modifications. We also recommend additional actions to improve our understanding of climatic changes on the status of the NTHC and address data needs to improve long-term species management decisions. 1. Understand trends in survival and mortality of individuals and populations. Cactus species are known to have recruitment events following sufficient precipitation; however, long-term monitoring of the NTHC demonstrates that its response to precipitation and higher temperatures are not as straightforward. With the persistent drought, it is important to continue to investigate demographic trends in order to tease out how mortality rates increase with variable climate patterns. 2. Expand the monitoring area to include a larger sample size that is representative of all populations. Locate demographic plots at sites differing in aspect and slope, and better reflect the representation and redundancy of the cactus. Explore other types of sampling methods (distant sampling transects) to compare information about demographics and changes in habitat. 3. Examine habitat suitability, including the taxon's ability to persist in all populations. Results would guide management decisions on important areas for enhancement or future recovery actions for the cactus' persistence in the future. 4. Conduct germination studies and captive propagation to support future re-establishment of plants in their native habitat, in the event we need to supplement the population or create refugia populations. 5. Evaluate the genetics of this subspecies to better understand its evolutionary history and relationship to E. horizonthalonius, and to assess genetic variation within and between the populations. This information would provide a better understanding of its historical range and taxonomic classification. 6. Invest and support studies examining other potential stressors (invasive grasses, herbivory, disease, and habitat disturbance) to the cactus. For example, placement of cameras and / or fencing could improve our understanding of the roll of herbivores in cactus decline. 7. The Service should continue to enhance and maintain our partnership with the Tohono O'odham Nation to cooperatively achieve long-term conservation of the NTHC on Tribal land. 8. Establish a cooperative partnership with private landowners in Sonora, Mexico that enables information exchange and advances conservation efforts to document, study, and protect the cactus. (USFWS, 2021)

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SPECIES ACCOUNT: *Echinocereus chisoensis var. chisoensis* (Chisos Mountain hedgehog Cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/31/1988; Southwest Region (R2)

Physical Description

Echinocereus chisoensis var. chisoensis is a relatively low— growing (to 10-12 in., 25—30 cm), cylindrical cactus, reddish— maroon, becoming greener in summer. The stems are most often singular, though they also form clumps composed of multiple stems with age or injury. The stems have 11-16 vertical or slightly spiraled ribs, which have distinctly separate tuberoles separated by broad valleys. The areoles are less than 0.13 in. (3.2 mm) long and about 0.25 in. (6.4 mm) apart, circular and distinctly wooly when young, but becoming elliptic and bare with age. The spines are relatively sparse and do not completely obscure the stem. The outer (radial) spines number 10-16, and are notably whitish, or ashy to pinkish gray, with brown to maroon tips. The radial spines are slender and irregular in length, the uppermost 0.06—0.13 in. (1.6-3.2 mm) long and bristle-like, the laterals to 0.37 in. (9.5 mm) long and the lowermost to 0.75 in. (19.1 mm) long. The central spines, numbering 1—6, are more slender than the radials, and dark brown to black with whitish bases. The largest central spine, 0.63 in. (15.9 mm) long, is the lowermost and is held nearly perpendicular to the stem. The other central spines are 0.25—0.50 in. (6.4— 12.7 mm) and spreading. The flowers are quite distinctive and appear from March to July. They are funnelform, 2.52-3.75 in. (6.4-9.5 cm) long, 0.50 in. (1.3 cm) in diameter, and do not open very widely. The greenish floral tube has a striking woolliness with clusters of bristly or hairy brown-tipped spines. Even more notable are the petals, 2 in. (5.1 cm) long and 0.50 in. (1.3 cm) wide with pointed tips, upright, and having distinctive internal coloration. Internally, the tips of the petals are pinkish to magenta, the throat is white, and the base of the petal is dark crimson. Stamen filaments are white to pink with yellow anthers. The pistil extends about 0.13-0.17 in. (3.2-4.3 mm) above the stamens and has a dark green 10—parted stigma. The fruits are club-shaped, 1.0—1.4 in. (2.5—3.5 cm) long, and 0.5 in. (1.3 cm) wide. They are greenish—red to red, with white semi—dry flesh, and wooly areoles with bristly or hairlike spines. The fruits split open with age. The seeds are oval, less than 0.06 in. (1.6 mm) in diameter, black, and warty (adapted from Benson 1982, Weniger 1984, Taylor 1985, Evans 1986, and Poole and Riskind 1987). The stems are very inconspicuous and the species frequently occurs in the shade and protection of another plant. The best field recognition characters are the distinctive, showy flowers. When encountered without flowers the best recognition characters are the reddish—maroon to dark green stem color, ribs with distinct, separate tubercles, contrasting whiteness of the spine mass, brown or maroon tipped outer spines, and cottony wool around the young areoles (Benson 1982, Heil and Anderson 1982a). (USFWS, 1993)

Taxonomy

It was described as a new species, Echinocereus chisoensis by W.T. Marshall (1940). Lyman Benson (1969) reduced the taxon to a variety of Echinocereus reichenbachii. The plant was generally known as Echinocereus reichenbachii var. chisoensis until the publication of Nigel Taylor's monograph of the genus in 1985. He considered it sufficiently distinct that he returned it to species status and named two varieties, Echinocereus chiscensis var. chisoensis endemic to Big Bend National Park, and Echinocereus chisoensis var. fobeanus of Coahuila and northeastern

Durango, Mexico (also very rare) (USFWS, 1993).

Historical Range

It was first collected in 1939, reportedly in the Chisos Mountains of Texas (USFWS, 1993).

Current Range

This variety's range is limited to a very small area on the southeastern side of Big Bend National Park in Brewster County, Texas. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 1993)

Breeding Season

Adult: March - June (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Pollinators - unknown (USFWS, 1993)

Reproduction Narrative

Adult: The status report by Heil and Anderson (1982a) noted that plants may have multiple stems from the same root system, flower from March to June, and fruit from May to August. Plants are known to outcross readily, but the effective pollinator has not been established (Heil and Anderson 1982a) (USFWS, 1993).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chihuahuan Desert grasslands or xeromorphic shrublands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,950 - 2,250 ft. elevation (USFWS, 1993)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 1993)

Habitat Narrative

Adult: Inhabits Chihuahuan Desert grasslands or open, xeromorphic shrublands on unconsolidated gravelly fan and terrace deposits at moderate elevations (NatureServe, 2015). This variety is found on alluvial flats. These flats are unconsolidated Quaternary fan and terrace deposits at elevations of 1,950—2,250 ft. (650—750 m) (Heil, Brack, and Porter 1985). The soils

are Aridisols eroded to rocky desert pavement (Heil and Anderson 1982a and 1982b) (USFWS, 1993).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are unknown (USFWS, 1993).

Population Information and Trends

Population Trends:

Declining (USFWS, 1993)

Number of Populations:

12 (USFWS, 2018)

Population Size:

approximately 1,500 invidiuals (USFWS, 2018)

Population Narrative:

In March, 2016, personnel of BIBE and USFWS collected data from Chisos hedgehog cactus in 3 monitoring plots. The populations within these plots had declined substantially since 2011 (2011 and 2012 were years of exceptional drought at this site), and had not recovered. However, these plots were not representative samples of the entire population. The population decline on the plots is alarming, but it is not possible to extrapolate the plot data to determine an overall demographic trend. Schmidt (2017) reported a total of 1,500 individual Chisos hedgehog cactuses, including 1,490 individuals detected in a 2010 census, and 10 new individuals she found during her field work. Thus, it might appear that the total population had increased more than 50 percent since the time of Heil and Anderson's status report (1982a). However, the earlier figure was only an approximate figure rather than an actual count. the most recent information confirms that Chisos hedgehog cactus is extant in the same areas where it was known when it was listed as threatened. Populations may have declined during recent exceptional droughts, but we have insufficient information to detect any general demographic trends during this 30-year span. (USFWS, 2018)

Threats and Stressors

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Overgrazing in the early 20thCentury depleted the native grass cover and the seedling establishment substrate (Heil and Anderson 1982a), and may have increased soil erosion and shrub encroachment (U.S. Fish and Wildlife Service 1993). Three quarters of a century after the park was established and livestock were removed, there appears to be little regeneration of native grass cover within the known populations of Chisos hedgehog cactus. This modification of habitat, including soil erosion, continues to threaten the species. We have no information on the

current trend of shrub encroachment. Schmidt (2017) documented the encroachment of the introduced invasive buffelgrass (Pennisetum ciliare) near an area of occupied habitat. Buffelgrass threatens to outcompete Chisos hedgehog and its host plants, and also increases the risk of wildfire. Buffelgrass disperses rapidly in the disturbed soils along roads and trails before spreading into adjacent intact habitats; 39.0 km (24.2 mi) of roads and trails pass through the occupied habitats of Chisos hedgehog cactus (U.S. Fish and Wildlife Service 2015, p. 8). (USFWS, 2018)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Heil and Anderson (1982a) stated that Chisos hedgehog cactus is sold commercially and is probably collected illegally from BIBE. An incidence of poaching occurred in 1990 (U.S. Fish and Wildlife Service 1993, p. 11). Personnel at BIBE do not know the current extent of illegal collection (Schmidt 2017, p. 16); listing as a threatened subspecies has stimulated greater public awareness of the conservation need, and federal protection has probably reduced the incidence of poaching. Nevertheless, poaching will continue to be a potential threat as long as there are avid cactus collectors who seek specimens dug from wild populations. Portions of the population that are nearest roads and trails are at greater risk of poaching. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The recovery plan (U.S. Fish and Wildlife Service 1993, p. 11) reported that jackrabbits (Lepus sp.) or rodents damage Chisos hedgehog cactus plants during periods of dry weather. Personnel of BIBE and USFWS also observed mortality of Chisos hedgehog cactus individuals from herbivory at monitoring sites in March, 2016, following several years of exceptional drought. Thus, herbivory is not only brought on by drought, but exacerbates mortality from other causes during drought. If droughts become more frequent as a result of climate changes, the impact of herbivory may also increase. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The ESA does provide some legal protection for federally listed plants on land under federal jurisdiction, including the entire known range of Chisos hedgehog cactus at BIBE. Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south and west Texas. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the ESA, in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (U.S. Department of Homeland Security 2008). Additional border wall construction has been proposed

by the current Administration. If implemented, the border wall and related infrastructure may affect populations and habitats of Chisos hedgehog cactus that occur along the Rio Grande/Bravo. Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally listed with these statuses. Chisos hedgehog cactus was listed as endangered by the State of Texas on December 30, 1988. The State prohibits taking and/or possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands without a TPWD permit. (USFWS, 2018)

Stressor: Population genetics (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The federal listing states, “Any further reduction in plant numbers could reduce the reproductive capabilities and genetic potential of this cactus.” (53 FR 38455). Small, isolated plant populations are vulnerable to genetic drift, loss of genetic diversity, and inbreeding depression. However, the population genetics of Chisos hedgehog cactus have not been investigated; we have no evidence of the extent of the actual impacts of these potential threats. (USFWS, 2018)

Stressor: Climate change (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The federal listing also states, “Long or short term climatic changes may be creating drier conditions in the area, possibly contributing to a population decline.” We do not know whether the climate changes that have already occurred have affected the populations or distribution of Chisos hedgehog cactus, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, it is unlikely that this species could migrate, without facilitation, fast enough to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species’ fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could reduce mortality from freezing. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, Chisos hedgehog cactus might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete with it. Conversely, extended drought followed by extreme rainfall could damage habitats through erosion. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of Chisos hedgehog cactus populations and habitat. Therefore, we will adapt our recovery and management strategies when necessary to address the changing conditions; however, our ability to make sound decisions will depend on periodic, verifiable monitoring of the species’ status.

Recovery

Reclassification Criteria:
Not applicable. (USFWS, 1993)

Delisting Criteria:
Preliminary delisting criteria are as follows: (USFWS, 1993)

1. When 50 distinct populations are established, each consisting of a minimum of 100 reproductive individuals dispersered over a minimum area of 10 -20 acres. (USFWS, 1993)

2. It should be demonstrated that the populations are demographically stable and reproductively successful, as demonstrated by monitoring the species over at least 10 years. (USFWS, 1993)

Recovery Actions:

- 1. Protect known and newly discovered Echinocereus chisoensis var. chisoensis populations from existing and future threats and develop management plans. Prospects for the protection of Echinocereus chisoensis var. chisoensis are excellent. Its occurrence on National Park Service (NPS) land gives the variety the protection of the NPS mandate to protect and preserve its natural features. It also gets the added protection associated with special requirements of Federal agencies under section 7(a)(1) and 7(a)(2) of the Endangered Species Act. Well—planned management actions are needed to ensure the protection of these populations. Because population numbers and sizes are so small, inappropriate land management practices could result in significant loss or damage. Illegal collection is a continuing problem and any collection represents a significant threat to the variety. (USFWS, 1993)
- 2. Establish a reserve germ bank/cultivated population with responsible agencies/institutions. Preservation of Echinocereus chisoensis var. chisoensis in its natural environment is absolutely of first priority. However, natural populations appear to be at critically low levels and occur over a restricted geographical area (Heil and Anderson 1982a, 1982b, Poole 1987). To prevent total loss of the variety through some catastrophic event, a seed bank and cultivated population is advised. If initial investigations indicate that seed can be successfully stored, a seed bank would be the most cost—effective way to maintain the genomic reserve. A cultivated collection operating in cooperation with the seed bank program can provide needed support for periodic testing and replenishment operations. Cultivated plants should also serve as a non—destructive source of material for research, restoration, education, and possible horticultural development. It is essential that this cultivation program proceed responsibly and in a manner that does not threaten the reproductive capacity of existing populations. While promising cultivation work has been initiated with Sul Ross State University and the Chihuahuan Desert Research Institute, this work should be expanded. (USFWS, 1993)
- 3. Conduct studies necessary to provide a basis for designing and evaluating protective management and restoration plans. A basic lack of scientific information about the critical parameters of habitat, growth, and reproduction for Echinocereus chisoensis var. chisoensis is limiting the ability of conservation agencies to evaluate the limiting factors and to prescribe management activities. Most information available to date is based on qualitative observation; more quantitative research is needed on these and other specific aspects of the life history. (USFWS, 1993)

- 4. Search areas with potential habitat for additional populations and potential reintroduction sites. As more information about the habitat and biology of Echinocereus chisoensis var. chisoensis becomes available, predictive abilities for determining areas capable of supporting the variety should improve. Additional surveys should be done for new populations in the U.S. and in Mexico. Potential 33 reintroduction sites in the U.S. should be noted. Knowledgeable NPS employees working in the area may be helpful in recognizing new populations of the variety. (USFWS, 1993)
- 5. Assess restoration feasibility. An evaluation of the need and potential for reintroduction of the variety can be made when more information is available about the possibility of overlooked populations, genetic vitality, population stability, habitat availability, long—term management requirements of the community, and success of cultivation. In the event that this additional information indicates that reintroduction is feasible and advisable, the following recovery actions (tasks 51-53) should be implemented. (USFWS, 1993)
- 6. Develop and implement a reintroduction plan, if feasible. If reintroduction is determined to be feasible based on the 34 assessment of the pilot program, a reintroduction plan should be developed and implemented. The reintroduction plan should provide for all phases including plant multiplication, site selection, site preparation, introduction, establishment (to independent living), monitoring, and short- and long-term management strategies. (USFWS, 1993)
- 7. Develop public concern and support for the preservation and study of Echinocereus chisoensis var. chisoensis. A broad-based awareness of the variety and support for efforts to recover it need to be developed. However, cacti have natural appeal to collectors, and greater awareness is expected to increase demand and therefore increase collection pressures. Public education efforts should proceed only after a provision to meet horticultural demand is in place. (USFWS, 1993)
- 8. Develop a post-recovery monitoring plan. If recovery is determined to be feasible, a monitoring plan should be developed that will track the condition of natural and introduced populations for at least 5 years after delisting, as required by the 1988 amendments to the Endangered Species Act. Responsibilities for implementation and reporting should be clear. This plan should specify types and levels of decline that should trigger intervention. (USFWS, 1993)
- Recommended Actions from the 2018 5-Year Review: The most important recovery actions during the next five years include, but are not limited to, the following: - Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria that clarify the delineation of populations; the use of a minimum viable population level as a recovery criterion may be more practically applied to metapopulation. The ten-year monitoring period is not long enough to detect demographic trends. -The best-justified taxonomic classification is Echinocereus chisoensis subspecies chisoensis. -The best-justified common name is Chisos hedgehog cactus. - Continue to improve the potential habitat model as we learn more about the ecological requirements. Conduct expanded surveys based on this model, using representative sampling and appropriate statistical methods to determine reliable estimates of the total population size. Design an efficient sampling protocol that can be repeated at intervals to determine demographic trends. -Establish a controlled propagation and reintroduction plan; collect seeds, following Center for Plant Conservation Guidelines, representing the range of the subspecies' ecological and genetic diversity; develop propagation methods; and reintroduce the propagated Chisos hedgehog cactus plants into other portions of the potential habitat range

to create redundant populations. - Investigate the population genetics to determine the genetic structure, genetic diversity and extent of inbreeding, evidence of gene flow, and other parameters that will be useful in the conservation and recovery of Chisos hedgehog cactus. (USFWS, 2018)

- Protection and conservation at Big Bend National Park (BIBE): The entire known global population of Chisos hedgehog cactus lies within BIBE. The National Park Service manages all species on their lands in accordance with the National Park Service Organic Act of 1916. Since the park is federally owned land, it is a violation of the Endangered Species Act (ESA) to remove and reduce to possession its threatened and endangered plant species. Federally funded or regulated actions that may affect Chisos hedgehog cactus, including the National Park Services' operations and management of the park, are subject to consultation with USFWS under section 7 of the ESA.BIBE monitors populations of Chisos hedgehog cactus, and its law enforcement officers discourage illegal collection. (USFWS, 2018)
- Section 7 consultations: BIBE consulted with USFWS under section 7 of the ESA in the development of its Exotic Plant Management Plan (2012). We concurred that the actions described in the plan are not likely to jeopardize the continued existence of Chisos hedgehog cactus (U.S. Fish and Wildlife Service 2015). To the contrary, these actions will benefit Chisos hedgehog cactus and other listed threatened cactus species by reducing competition from buffelgrass and King Ranch bluestem (Bothriochloa ischaemum) and by preventing the trampling of cactus by feral livestock. (USFWS, 2018)
- Section 6-funded grants: "The Cooperative Endangered Species Conservation Fund (section 6 of the ESA) provides grants to States and Territories to participate in a wide array of voluntary conservation projects for candidate, proposed, and listed species. The program provides funding to States and Territories for species and habitat conservation actions on non-Federal lands" (USFWS 2009). (USFWS, 2018)

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SPECIES ACCOUNT: *Echinocereus fendleri var. kuenzleri* (Kuenzler hedgehog cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: EFK

Listing Status: Reclassified to Threatened effective 6/11/2018; originally classified as Endangered effective 11/28/1979); Southwest Region (R2)(USFWS, 2018)

Physical Description

EFK grows as solitary stems or 1 to 4 in a cluster, rarely as many as 8 stems; mature stems are conical to short cylindroid, 10–15 centimeters (cm) (4–6 inches [in]) tall, rarely to 30.5 cm (12 in) tall, and 5.1–10.2 cm (2–4 in) in diameter; ribs 9 to 12, usually 10; tubercles conspicuous; spines sharply pointed, angular in cross section, bulbous and fused together at base, central spine usually absent, sometimes one, light to dark brown or dull black 2.2–2.9 cm (0.87–1.14 in) long; radial spines 2–6, mostly 4–5 stout, mostly curved, 0.6–2.2 cm (0.25–0.87 in) long, typically contorted, white and chalky textured; flowers apical 5.7–10 cm (2.25–4.0 in) in length and diameter, tepals are magenta, usually with bands of green and darker color near center, usually pointed (Castetter et al. 1976: 77–78; Ferguson and McDonald 2006: 2). Baker (2007: 25) did not find fusion of the radial spines in the specimens he studied. The few contorted, white, chalky-textured spines and large, magenta flowers separate the EFK from other cacti within the range. Other hedgehog cacti (Echinocereus spp.) either have red flowers or multiple central spines present that are gray to black (Benson 1981: 120–121; Weniger 1984: 10–15). Echinocereus triglochidiatus var. triglochidiatus, a common cactus in the area, can be differentiated by its red flower and lack of stripes on the larger spines, and large fuzzier, white areoles (Zimmerman 1995: 1). (USFWS, 2017a)

Taxonomy

In 1976, EFK, in its New Mexico and Mexico locations, was proposed as endangered under the name Echinocereus hempelii (Service 1976: 24,536). Later in 1976, Echinocereus kuenzleri was described as a new species specifically for the New Mexico population of what had previously been called E. hempelii (Castetter et al. 1976: 77). Echinocereus hempelii, presently referred to as E. fendleri var. hempelii (also taxonomically uncertain at this time), is known only from a few locations in Chihuahua, Mexico (Felix et al. 2014: 65). EFK was originally listed in 1979 as Echinocereus kuenzleri (Service 1979: 61,524). Benson (1982: 631) subsequently reduced it to infraspecific rank as E. fendleri var. kuenzleri. Based on this nomenclatural change we accepted the variety E. fendleri var. kuenzleri and officially changed the name on the list of Endangered and Threatened Wildlife and Plants in 1984 (Service 1984: 21). Anderson (2001: 236) was uncertain whether this variety should be recognized taxonomically. Felix et al. (2014: 105) elevated EFK to subspecies rank. The taxonomic standing of a named variety depends upon a consensus of opinion and the informed judgment of those taxonomists who publish their opinions. Zimmerman (1995: 1) believed the variety kuenzleri was very closely related to typical E. fendleri, such that it's just barely a valid taxon and postulated that variety kuenzleri is simply a neotenous form of E. fendleri that retains juvenile stem and spination characteristics into adulthood. Zimmerman and Parfitt (2003: 157) reduced variety kuenzleri to a synonym of the common and widespread E. fendleri var. fendleri because of its neotenous features. Baker

(2007: entire) examined the morphological variation in the varieties of Echinocereus fendleri, and assigned kuenzleri as a separate variety based on stem rib morphology and spine length and shape. Felix et al. (2014: entire) published a morphological study of Echinocereus fendleri where they found that the structure, texture, and conformation of the spines were unique in kuenzleri, warranting subspecies status. Echinocereus fendleri var. kuenzleri could be classified as 1) an infraspecific taxon representing a discrete geographic lineage worthy of nomenclatural recognition; 2) the same variety as E. fendleri var. fendleri; or 3) a trivial variant that should not have taxonomic status within the broader suite of unnamed varieties and falls under the species E. fendleri (Service 1979: 61,924; Zimmerman and Parfitt 2003: 164). Echinocereus fendleri var. fendleri exhibits variation throughout its range and occurs in scattered populations that are widespread but not abundant. It is known throughout the western portion of New Mexico, into Arizona, Colorado, and Texas, and in northern Mexico (Chihuahua, Sonora) (Zimmermann and Parfitt 2003: 164; Felix et al. 2014: 65). There does not appear to be any overlap between E. fendleri var. fendleri and E. fendleri var. kuenzleri though intermediate forms have been found in the Vera Cruz area (Northern Sacramento Mountains population) (Marron and Associates, Inc. 2000: 4.14–4.15) and along US 54 north of Carrizozo (west side of Sacramento Mountains (Blue Earth Ecological Consultants, Inc. [BEEC] 2002: 28–32). Based on this information, the Service maintains E. fendleri var. kuenzleri as a variety until further work can be done on the genetics of the taxon. (USFWS, 2017a)

Historical Range

See Current Range.

Current Range

Kuenzler hedgehog cactus was federally listed as endangered in 1979 (USFWS 1979; 44 FR 61924) as Echinocereus kuenzleri and downlisted to threatened in 2018 (USFWS 2018; (83 FR 21928). No critical habitat was designated due to threat of collection. This endemic cactus is known to range in New Mexico from the northwest side of the Sacramento Mountains in Lincoln County to the middle of the Guadalupe Mountains in Eddy County. Distinct management areas within the species' range include the northern Sacramento population, southern Sacramento population, and Guadalupe Mountains population (Figure 1). Populations, or element occurrences (EOs), are further divided into subpopulations, or sub-element occurrences (SubEOs), which are groups of individuals in discrete areas that are in close proximity (NatureServe 2002: 12). Subpopulations may be scattered individuals or core sites that contain the majority of known individuals within a geographic area. (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2017a)

Lifespan

Adult: Potentially decades; annual mortality of 10 percent (USFWS, 2017a)

Dependency on Other Individuals or Species

Adult: Pollinators (USFWS, 2017a)

Breeding Season

Adult: Budding occurs in April and flowering normally occurs during the first half of May into early June. Fruit forms in August. (USFWS, 2017a)

Other Reproductive Information

Adult: Plants reach a diameter of 0.3, 0.9, and 1.8 cm (0.1, 0.4, and 0.7 in) at 1, 2, and 3 years of age, respectively (NMEMNRD 1989: 97). Growth averaged over all age classes was estimated at 1.4 cm (0.55 in) per year (NMEMNRD 1989: 100). By year 4 plants can exceed 4.0 cm (1.6 in) in diameter (NMEMNRD 1989: 97). Maximum diameter is about 10 cm (3.9 in) (NMEMNRD 1989: 97). The size class distribution indicates the population is dominated by 4+ year old plants with limited recruitment. (USFWS, 2017a)

Reproduction Narrative

Adult: Budding occurs in April and flowering normally occurs during the first half of May into early June. Warm years can initiate earlier flowering and cool springs may delay flowering until early June (BEEC 2002: 27). Flowers are large for the size of the plant. Fruits form in August and average 3-6 per plant (NMEMNRD 1989: 106). Fruits are bright red when mature, ovoid to cylindrical, may be over 5 cm (2 in) long, and are spiny with miniature versions of the stem spines. Each fruit can have as many as 1,050 seeds (NMEMNRD 1989: 106). Seeds are black and pitted. Greenhouse studies at Mesa Gardens in Belen, New Mexico, indicate EFK requires 21 degree Celsius (°C)(70 degree Fahrenheit [°F]) soil temperature and sufficient moisture for germination (NMEMNRD 1989: 106). Seeds have over 90 percent viability and can survive in the soil for at least 5 years (NMEMNRD 1989: 106). There is no known dormancy requirement. (USFWS, 2017a)

Habitat Type

Adult: Terrestrial (USFWS, 2017a)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper savannah (USFWS, 2017a)

Dependencies on Specific Environmental Elements

Adult: about 1,560 to 2,130 m (5,100 to 6,990 ft) elevation (USFWS, 2017a)

Spatial Arrangements of the Population

Adult: Small, scattered populations (USFWS, 2017a)

Habitat Narrative

Adult: Typical EFK habitat is the lower fringes of the pinyon-juniper woodland from about 1,560 to 2,130 m (5,100 to 6,990 ft) elevation. Occupied habitat consists of flat to gentle slopes (mean slope range 0 to 50 degrees) or benches with gravelly to rocky soils and southern, eastern, and western exposures. Soils may be derived from limestone or intrusive rocks of the Sacramento or Capitan uplifts. EFK also occurs on unconsolidated, gravel hills in the Fort Stanton area (BEEC 2002: 27). EFK distribution does not appear to be random, but restricted to discontinuous

microsites. Distribution within the occupied microsites is clumped. It has been suggested that biotic factors such as the proximity of a microsite is to another microsite may increase the probability of pollination and thus effective reproduction or seed dispersal vectors. (USFWS, 2017a)

Dispersal/Migration

Dispersal

Adult: Rodents, wind, water (USFWS, 2017a)

Dispersal/Migration Narrative

Adult: Seed dispersal occurs during September and October by rodents, wind, and water (BEEC 2002: 27). Seed dispersal may be dependent on summer rainfall, average to above-average summer rainfall results in abundant fruit production, which prolongs good seed dispersal. Dry summers result in low fruit abundance, which are intensively consumed by rodents as soon as fruits mature. Only seeds that are not consumed are likely to survive to germinate (BEEC 2002: 27). The size class distribution of the population suggests that successful germination and growth into juvenile plants is rare (USFWS, 2017a)

Population Information and Trends

Population Trends:

Half the populations are stable to increasing (USFWS, 2017a)

Species Trends:

Stable to increasing (USFWS, 2017a)

Resiliency:

Resilience and Redundancy: Resilience refers to the population size necessary to endure stochastic environmental variation (Shaffer and Stein 2000: 308–310). Redundancy refers to the number and geographic distribution of populations or sites necessary to endure catastrophic events (Shaffer and Stein 2000: 308–310). EFK distribution and abundance have been variable over time. Currently, surveyed areas appear to be stable. The primary cause of the declines in habitat quantity and population numbers is stochastic events including wildfire and prolonged drought. Both the larger and smaller populations face stressors from these stochastic events. These stressors, alone or in combination, could result in the further decline of one or more of the three populations, further reducing the overall redundancy and representation of the species. Northern Sacramento – This population has the highest number of plants and highest density, mostly occurring on BLM and Forest Service managed lands; however they continue to be threatened by wildfire which increases mortality, insect damage reducing reproduction, and climate change. The removal of livestock grazing from a significant portion of this population habitat has increased the level of fine fuels, which increases the risk of catastrophic uncontrolled wildfire. It is projected that climate change may result in increased periods of drought, increased average temperatures, decreased annual rainfall, and milder winters; however EFK has demonstrated adaptability to variations in environmental conditions. Large numbers, plus high connectivity and density in this population, increases the risk of insect infestation. Assuming the parasitic insects are not newly-introduced species, EFK has been coevolving with them and is able to persist. This population appears to have sufficient floral

resources, pollinator availability, and high connectivity between colonies. Therefore, we predict that over time, conditions will likely continue supporting a robust and stable population with a complex of dense colonies, able to withstand stochastic events. Southern Sacramento population – This population represents roughly a quarter of the current EFK numbers and is currently stable. It continues to be threatened by a moderate risk of wildfire, insect damage, and climate change. It is projected that climate change may result increased periods of drought, increased average temperatures, decreased annual rainfall, and milder winters; however EFK has demonstrated adaptability to variations in environmental conditions. This moderately sized population appears to have moderate floral resources, moderate pollinator efficiency, and moderate connectivity between patches. We predict that over time, overall conditions will likely remain moderate, supporting a stable population and a complex of colonies with a moderate risk of a stochastic event impacting the population. Guadalupe population – The smallest of the known populations, it is likely that this population would be significantly impacted by stochastic events. Due to its low numbers and spatial distribution, the probability of insect infestation causing mortality is relatively low; however, inability to recover from wildfire and to adapt climate variations places this population at relatively high risk. This small population appears to have limited floral resources, limited pollinator efficiency, and low connectivity between colonies, reducing the ability to successfully reproduce and therefore recover from threats. We predict that due to small population size and limited connectivity, overall condition of this population will remain poor, with low resiliency. As discussed in Section IV.1.10, the projected climate changes forecast by the range of models and emissions scenarios will affect EFK survival in highly complex ways. And we do not know what the net result of beneficial and detrimental effects will be. However, we predict that EFK will be impacted minimally until a climatic severity threshold has been crossed. If this threshold is crossed, we predict the results would be decreased flowering and reproduction, causing a substantial population reduction. The Recovery Plan (Service 1985: iii) established a recovery criterion of maintaining a stable protected population with at least 5,000 individuals, for 5 consecutive years, but did not show how this level was determined. However, we now understand that wildfire is able to devastate large, dense populations. We conclude that few large populations are much more vulnerable than many small populations, and that this recovery criterion should be amended. The resilience of EFK derives not merely from the size of colonies, but also their density. Colonies that are too small or too isolated may incur loss of genetic diversity and inbreeding. Inversely, vulnerability to insect parasitism and rodent herbivory increases when colonies become too dense, or too large. Therefore, we believe that there must be some optimal range of meta-population density and colony size, although we do not currently know what those optima are. These concepts of colony size and density depend on how colony boundaries are delimited. The EO concept is a good starting point, but may have to be revised for EFK considering its specific population dynamics. We can speculate that the population densities found on the small number of areas that have been quantitatively surveyed are representative of the entire global distribution of this subspecies. Based on all available evidence, we provisionally estimate that the global population size is about 20,000 individuals (Appendix B). Regardless of how this number is divided into colonies, we believe that it is likely that EFK has multiple, resilient populations (USFWS, 2017a).

Representation:

Considering difference in habitat conditions, and variations among populations, EFK demonstrates its diversity and ability to adapt to environmental conditions. However, due to the EFK densities, gene flow among them may be easily disrupted. Therefore, maintaining the

continuity of potential habitat throughout the subspecies range should have a high conservation priority. We recognize the need and recommend that genetic studies be conducted to determine the variation among populations, viability monitoring should be continued long enough to determine population dynamics and demographic trends at the colony and subspecies levels. Requirements, factors affecting survival and current conditions are summarized in Table 8. We believe that the three populations have a sufficient number of individuals, distributed across their ranges, with adequate connectivity to, provide for the representation needed to decrease the risk of extinction (USFWS, 2017a).

Redundancy:

Resilience and Redundancy: Resilience refers to the population size necessary to endure stochastic environmental variation (Shaffer and Stein 2000: 308–310). Redundancy refers to the number and geographic distribution of populations or sites necessary to endure catastrophic events (Shaffer and Stein 2000: 308–310). EFK distribution and abundance have been variable over time. Currently, surveyed areas appear to be stable. The primary cause of the declines in habitat quantity and population numbers is stochastic events including wildfire and prolonged drought. Both the larger and smaller populations face stressors from these stochastic events. These stressors, alone or in combination, could result in the further decline of one or more of the three populations, further reducing the overall redundancy and representation of the species. Northern Sacramento – This population has the highest number of plants and highest density, mostly occurring on BLM and Forest Service managed lands; however they continue to be threatened by wildfire which increases mortality, insect damage reducing reproduction, and climate change. The removal of livestock grazing from a significant portion of this population habitat has increased the level of fine fuels, which increases the risk of catastrophic uncontrolled wildfire. It is projected that climate change may result in increased periods of drought, increased average temperatures, decreased annual rainfall, and milder winters; however EFK has demonstrated adaptability to variations in environmental conditions. Large numbers, plus high connectivity and density in this population, increases the risk of insect infestation. Assuming the parasitic insects are not newly-introduced species, EFK has been coevolving with them and is able to persist. This population appears to have sufficient floral resources, pollinator availability, and high connectivity between colonies. Therefore, we predict that over time, conditions will likely continue supporting a robust and stable population with a complex of dense colonies, able to withstand stochastic events. Southern Sacramento population – This population represents roughly a quarter of the current EFK numbers and is currently stable. It continues to be threatened by a moderate risk of wildfire, insect damage, and climate change. It is projected that climate change may result increased periods of drought, increased average temperatures, decreased annual rainfall, and milder winters; however EFK has demonstrated adaptability to variations in environmental conditions. This moderately sized population appears to have moderate floral resources, moderate pollinator efficiency, and moderate connectivity between patches. We predict that over time, overall conditions will likely remain moderate, supporting a stable population and a complex of colonies with a moderate risk of a stochastic event impacting the population. Guadalupe population – The smallest of the known populations, it is likely that this population would be significantly impacted by stochastic events. Due to its low numbers and spatial distribution, the probability of insect infestation causing mortality is relatively low; however, inability to recover from wildfire and to adapt climate variations places this population at relatively high risk. This small population appears to have limited floral resources, limited pollinator efficiency, and low connectivity between colonies, reducing the ability to successfully reproduce and therefore recover from threats. We

predict that due to small population size and limited connectivity, overall condition of this population will remain poor, with low resiliency. As discussed in Section IV.1.10, the projected climate changes forecast by the range of models and emissions scenarios will affect EFK survival in highly complex ways. And we do not know what the net result of beneficial and detrimental effects will be. However, we predict that EFK will be impacted minimally until a climatic severity threshold has been crossed. If this threshold is crossed, we predict the results would be decreased flowering and reproduction, causing a substantial population reduction. The Recovery Plan (Service 1985: iii) established a recovery criterion of maintaining a stable protected population with at least 5,000 individuals, for 5 consecutive years, but did not show how this level was determined. However, we now understand that wildfire is able to devastate large, dense populations. We conclude that few large populations are much more vulnerable than many small populations, and that this recovery criterion should be amended. The resilience of EFK derives not merely from the size of colonies, but also their density. Colonies that are too small or too isolated may incur loss of genetic diversity and inbreeding. Inversely, vulnerability to insect parasitism and rodent herbivory increases when colonies become too dense, or too large. Therefore, we believe that there must be some optimal range of meta-population density and colony size, although we do not currently know what those optima are. These concepts of colony size and density depend on how colony boundaries are delimited. The EO concept is a good starting point, but may have to be revised for EFK considering its specific population dynamics. We can speculate that the population densities found on the small number of areas that have been quantitatively surveyed are representative of the entire global distribution of this subspecies. Based on all available evidence, we provisionally estimate that the global population size is about 20,000 individuals (Appendix B). Regardless of how this number is divided into colonies, we believe that it is likely that EFK has multiple, resilient populations (USFWS, 2017a).

Number of Populations:

11 (USFWS, 2017a)

Population Size:

> 4,330 (USFWS, 2021)

Additional Population-level Information:

For a population in high (good) overall condition, we estimate that the probability of persistence over the next 50 years would be 90 percent or higher (in other words a 10 percent or less probability of extirpation. For a population in moderate condition, we estimate that the probability of persistence over approximately the next 50 years would be 66 to 90 percent (10 to 33 percent probability of extirpation), and for one in low (poor) condition, a probability of persistence of 0 to 66 percent over 50 years (33 to 100 percent chance of extirpation. (USFWS, 2017a)

Population Narrative:

It was considered to be near extinction in the early 1980s, with population estimates below 500 plants (Fletcher, 1985), but later Chauvin (2001) estimated the population size to be over 2500 plants, and USFWS (2005) counted 3300 plants estimating total population size of 6600 to 13200 individuals. Currently, over half of the suitable habitat has been surveyed and the variety is more extensive than previously thought. This species has experienced a long term population trend of < 50% decline to relatively stable. The population is currently relatively stable.

Approximately 3,300 plants have been counted. It may be reasonable to estimate total population size of 6,600 to 13,200 individuals. May et al. (2008) found 2,449 cacti on 21 hillsides at the Fort Stanton Special Area of Environmental Concern in Lincoln Co. (none in Eddy Co.), New Mexico (outnumbering a previous survey of the same locations 10 to 1) also noting several additional sites between the surveyed area and Eddy Co. in subsequent years with the species present; indicating numbers are likely much larger and habitat much broader than previously thought. Eleven population centers are known; two in the Guadalupe Mountains, eight in the Sacramento Range, and one in low hills between the Guadalupe Mountains and the Sacramento Range. May et al. (2008) found 2449 cacti on 21 hillsides at the Fort Stanton Special Area of Environmental Concern in Lincoln Co. (none in Eddy Co.), New Mexico; also noting several additional sites between the surveyed area and Eddy Co. in subsequent years with the species present (USFWS, 2005; NatureServe, 2015). The species status is stable; there have been no recent reports of extirpations or serious population declines (USFWS, 2005). At the time of listing, fewer than 200 individuals had been documented at 2 locations. Biologists and botanists have since found at least 4,330 individual plants through inventories conducted from 1976 to 2015. Occurrences of Kuenzler hedgehog cactus are primarily on federal lands, including lands managed by the Bureau of Land Management (BLM) Roswell and Carlsbad Field Offices and in the U.S. Forest Service (USFS) Lincoln National Forest's Smokey Bear and Guadalupe Ranger Districts. (USFWS, 2021)

Threats and Stressors

Stressor: Land Management (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction by road construction and home building has affected a very small part of the areas occupied by EFK cactus. At the present time, there are no significant mining or oil and gas production activities within the habitat of this cactus. Most of the known occupied habitats occur in relatively remote areas, which are unlikely to be converted to land uses other than open range for livestock grazing (Service 2005: 12). A significant portion of EFK modeled suitable habitat is managed by Forest Service and BLM for multiple uses (i.e., recreation and livestock grazing). Long-term conservation of EFK is achieved through protections and management on Federal lands. However, the ESA does not prohibit or control the take of EFK on private, tribal, or State lands unless the taking is a consequence of an activity that spends Federal funds, requires a Federal permit, or is in violation of State law, or is for commercial, interstate sale. The New Mexico threatened and endangered plant regulations also do not protect EFK or its habitats on private lands, with the exception of plant collection not authorized by the landowner. Government agencies and conservation organizations collaborate and contribute resources to conserve EFK and its habitat. Development and management projects are evaluated and modified, if necessary, to avoid detriment to EFK and its habitat. Threat due to changing land management is considered low. (USFWS, 2017a)

Stressor: Fire (USFWS, 2017a)
Exposure:
Response:
Consequence:

Narrative: EFK probably does not require fire for germination, or establishment. However, periodic fire is likely to be necessary for population persistence to reduce juniper encroachment into suitable habitat and reduce fuel loads. Wilkinson (1997: 83), and Brown et al. (2001: 121), reported that the Sacramento Mountains, pinyon-juniper stands had a historical fire interval of 25–30 years. This fire interval maintained savanna-like conditions in moderate to high productivity pinyon-juniper woodlands by thinning young non-fire resistant trees, before the introduction of grazing and fire suppression. The diverse shrub and forb vegetation that sustains healthy pollinator pollinations is maintained by periodic wildfire; without fire, dense juniper groves frequently displace these shrubs and forbs. Hence, if the native plant diversity of entire landscapes surrounding EFK populations succumbs to juniper encroachment, pollinator populations will likely decline, and reproduction and gene flow between its colonies may be reduced. Sivinski (2007: 93) found that wildfire can cause high mortality in EFK, and that EFK was slow to recover. This led to studying the effect of prescribed burns as a means of reducing wildfire risk. Wester and Britton (2007: 11) found no evidence that the species was negatively affected by prescribed fire. However, impacts are relative to adjacent high fuel loads and the resulting heat intensity during fire events did increase mortality. Fuel reduction projects and vegetation treatments have been proven as a means of mitigating wildfire hazards, to lessen catastrophic fire. This suggests that prescribed burns or mechanical fuel reduction in EFK habitat could be designed to remove fuel loads without causing direct mortality associated with wildfire (May 2006: 44). Livestock grazing has had a significant effect on the frequency of natural fire within EFK habitats. Removal of fine fuels by grazing animals reduces the ability of a fire to start and carry through the landscape. Land managers have in the past followed an aggressive wildfire suppression program. The result is a disruption of the natural fire regime and an increase of woody vegetation in grassland and savanna habitats. Land managers presently see the need to reintroduce fire into these habitats for the purpose of restoring grasslands and increasing forage for livestock production (Service 2017: 1,682). We believe that uncontrolled wildfire to be a significant threat to EFK. Wildfire is capable of devastating or potentially eliminating small populations of EFK. However, prescribed fire or mechanical fuel reduction used to manage fuel loads would be important to reduce the risk of catastrophic wildfire. Therefore, wildfire is considered a moderate threat to EFK. (USFWS, 2017a)

Stressor: Livestock grazing (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: The Recovery Plan lists grazing as a significant threat (Service 1985: 8). A 2-year study (1984- 1985) by The Nature Conservancy found that during a year of cattle grazing with 65 percent forage utilization, 21 out of 172 individual cacti were found dead outside the fenced exclosure while there was zero mortality inside the exclosure where no grazing had occurred (Bates 1985: 2). One cause of mortality to individuals is trampling by livestock. Concentrating livestock by placing feed, salt, or watering points near cactus clusters can increase the likelihood of cactus Kuenzler's Hedgehog Cactus Species Status Assessment – Final 18 being trampled. Livestock grazing also removes grass cover, which can reduce the suitability of sites for seed germination and seedling establishment and can expose adult plants (Service 1985: 10; Service 2005: 12). The direct or indirect impacts due to grazing, such as trampling, and removal of vegetative cover are minor due to effective grazing management by land management agencies that allows the plant to persist in active allotments. We believe conservative livestock grazing managed responsibly can be used as a management tool to help reduce fuel loads and reduce

the risk of wildfire. Therefore, the threats associated with livestock grazing are considered low. (USFWS, 2017a)

Stressor: Illicit collection (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: Many rare cactus populations have been depleted by collectors. The Recovery Plan lists illegal collection as a threat to the species (Service 1985: 9). Evidence of illegal collection has been observed recently (Baggao 2017: 1). Although illicit collection has not significantly impacted the species, the wild populations openly accessed by the public remain vulnerable. In small populations, removal of individuals could have detrimental impacts to the small populations, and even more so on individual colonies due to reduced genetic diversity, and limited mature individuals for reproduction. Illicit collection is considered a moderate threat to EFK. (USFWS, 2017a)

Stressor: Parasitic Insects (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: Observations have noted apparent direct impacts on individual EFK cacti resulting from the coreid bug (Chelinidea vittiger) (Alexander 2017a: 1). These insects increase the probability of the introduction of pathogenic bacteria and fungi. Damage associated with these insects are known to induce floral abortions in cactus (Miller et al. 2008: 145). Alexander (2017a: 1) also suggested that coreid bug damage may be interfering with flower development, noting that 26 EFK showed signs of failed flower development. Periodic outbreaks of insect parasitism seems to occur when cactus populations become very dense (DeBruin 1996: 8). In large, dense populations of EFK the threat of parasitic insects is high. In the less dense, smaller populations the risk is lower. Parasitic insect infestation in any EFK population has the ability to significantly reduce reproduction, and reduce population numbers. Therefore, the threat parasitic insect's pose to EFK is considered moderate. (USFWS, 2017a)

Stressor: Herbivory (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: Rodents can act as both predators and dispersers of seeds. Rodent herbivory damage has been observed and is known to increase mortality in EFK (Forest Service 1989a: 4; Forest Service 1989b: 20; Marron and Associates 2004: 3–4). However, seed dispersal can be facilitated by rodents (BEEC 2002: 27). The threat of herbivory is considered low. (USFWS, 2017a)

Stressor: Small population size and density (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000: 308–310), such as fluctuations in recruitment (demographic stochasticity), variations in rainfall (environmental stochasticity), or changes in the

frequency of wildfires. EFK has an out-crossing breeding system. The probability of successful fertilization between unrelated individuals is reduced in small, isolated populations. The remaining plants would produce fewer viable seeds, further reducing population recruitment and engendering a downward spiral toward extirpation. The demographic consequences of small population size are compounded by genetic consequences, since reduced out-crossing corresponds to increased inbreeding. In addition to population size, it is likely that population density also influences population viability; density must be high enough for gene flow within meta-populations, but low enough to minimize parasite infestations. Small, reproductively isolated populations are susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding. The loss of genetic diversity may reduce the ability of a species or population to resist pathogens and parasites, to adapt to changing environmental conditions, or to colonize new habitat. Conversely, populations that pass through a "genetic bottleneck" may subsequently benefit through the elimination of harmful alleles. Nevertheless, the net result of loss of the genetic diversity is likely to be a loss of fitness and lower chance of survival of populations and of the taxon. Genetic drift is a change in the frequencies of alleles in a population over time. Genetic drift can arise from random differences in founder populations and the random loss of rare alleles in small isolated populations. Genetic drift may have a neutral effect on fitness, but is also a cause of the loss of genetic diversity in small populations. Genetic drift may also result in the adaptation of an isolated population to the climates and soils of specific sites, leading to the development of distinct ecotypes and to speciation. Because small populations are more susceptible to stochastic events, and loss of genetic diversity reduces EFK's ability to adapt to environmental changes, the threats associated with small population size is moderate. (USFWS, 2017a)

Stressor: Climate change (USFWS, 2017a)
Exposure:
Response:
Consequence:
Narrative: Climate predictions for the cactus area include a 5 to 6 percent increase in maximum temperature (up to 4 ºC [7.2 ºF]), 11 percent decrease in precipitation, and a 25 percent increase in evaporative deficit over the next 25 years (National Climate Change Viewer, Four County Data, accessed May 15, 2017). EFK has experienced rebounds from periods of drought in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. However, without sufficient monitoring in place to assess trends, the severity of this threat can only be surmised based on other cacti and drought research. Therefore, the threat of climate change may result in impacts on EFK and habitat. We believe the threat of climate change is moderate. (USFWS, 2017a)

Recovery

Reclassification Criteria:
Not applicable; reclassified with "Threatened" status in 2018. (USFWS, 2018)

Delisting Criteria:
1. Demonstrate a stable or increasing trend in abundance for the Fort Stanton, Elk, and Texas Hills subpopulations over a 20-year period. (USFWS, 2019)

2. Maintain a minimum of three geographically separated core sites over a 20-year period. (USFWS, 2019)

3a. Maintain genetic diversity within all core sites as measured by the fixation indices inbreeding coefficient (FIS) at or within one standard deviation of the FIS of a closely related species with similar reproductive strategies and demonstrated acceptable viability. (USFWS, 2019)

3b. Maintain presence in 80 percent of all existing subpopulations (Element Occurrences) outside of the core sites over a 20-year period, with any subpopulation extirpations compensated by a newly identified or colonized subpopulation. (USFWS, 2019)

Recovery Actions:

- 1. Survey for additional subpopulations and populations and monitor all known populations in order to apply conservation measures as needed and to determine trends, threats, and progress towards recovery. (USFWS, 2021)
- 2. Conduct research to resolve information gaps related to species' needs, habitat suitability thresholds, species' and ecosystem responses to significant stressors and management practices, and how the distribution and dynamics of populations function to maintain genetic diversity and adaptive capacity through time. (USFWS, 2021)
- 3. Protect and conserve known extant Kuenzler hedgehog cactus populations and habitat (USFWS, 2021)
- 4. Promote communication by encouraging and creating dialog regarding the species between managing and regulatory agencies, academia, landowners, developers, and the public in order to raise awareness and aid recovery. (USFWS, 2021)
- 5. Coordinate and work with stakeholders to achieve recovery. (USFWS, 2021)
- 6. Develop a Habitat Management Plan. (USFWS, 2021)

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SPECIES ACCOUNT: *Echinocereus reichenbachii var. albertii* (Black lace cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: BLC

Listing Status: Endangered; 11/28/1979; Southwest Region (Region 2)

Physical Description

A spin succulent with solitary stems (or sometimes 5-12), the larger green, cylindroid, 7.5 - 15 cm long, 2.5 - 5 cm diam.; ribs about 12 to 18; areoles narrowly elliptic, 1.5 mm long vertically, typically 2 - 4.5 mm apart; central spines none or 1, 2 - 3 mm long, very dark purple, much smaller than the radials, but otherwise similar to them, straight (plants from Kleberg County were found that have well developed central spines, while they are weakly developed or absent in specimens from Jim Wells and Refugio Counties); radial spines white with dark purple tips, 14 - 16 per areole, closely pectinate, 3 - 4 (6) mm long, 0.2 - 0.35 mm diam., circular in cross section; flower 5 - 7.5 cm diam., 2 - 6 cm long; areoles of floral tube with conspicuous fine wool and weak spines; sepaloids with green midribs and pink margins; petaloids pink to light purple, largest oblanceolate, 2.5 - 3.5 cm long, + 9 mm broad, short acuminate, entire; filaments pale yellow or pink, + 9 mm long; anthers yellow, 1.5 mm long, oblong; style pink, 20 - 30 mm long, 1 - 2 mm greatest diam.; stigmas 16 - 20, green + 6 mm long, broad; ovary in anthesis + 9 mm long; fruit green (with pink tinge?) with short spines and soft conspicuous, deciduous, long wool in areoles, + 15 mm long, 9 mm diam.; seeds strongly tuberculate, asymmetrical, 1.5 mm long, 1 mm broad, 0.7 mm thick (Benson, 1982) (USFWS, 1986)

Taxonomy

The scientific name for BLC is Echinocereus reichenbachii (Terscheck) F. Haage var. albertii L.D. Benson. This variety was described from a specimen collected in 1965 in Jim Wells County (USFWS 1987). Some disagreement exists about the taxonomy of the group of Echinocereus with large pink flowers, and there are several synonyms for BLC, including E. melanocentrus (Lowry) and E. fitchii (Britton and Rose) subspecies albertii (L. D. Benson) W. Blum and Mich. Lange (Poole et al. 2007) (Table 2). Some cacti specialists lumped the BLC variety albertii with a very similar counterpart, E. reichenbachii var. fitchii. Blum et al (1998) recognized the taxon albertii but placed it within the species fitchii as a subspecies (E. fitchii ssp albertii). Others have called it a separate subspecies (Poole et al. 2007). There are distinct morphological differences between E. reichenbachii var. albertii and E. reichenbachii var. fitchii. Echinocereus reichenbachii var. fitchii has 4-7 central spines of a brownish-red color while the variety albertii (BLC) has 0-1 central spines (except the Refugio County population that lacks a central spine) and appears more blackish in coloration (Poole et al. 2007). These two varieties are also geographically disjunct, with E. reichenbachii var. fitchii occurring in thorn shrublands atop limestone soils, calcareous sandy loams, or saline clays in Jim Hogg, Starr, Zapata, and Webb Counties, and in Mexico, while E. reichenbachii var. albertii grows on sandy soils in Refugio, Jim Wells, and Kleberg Counties (Poole et al. 2007). Even with these distinctions, Zimmerman and Parfitt (2003) did not recognize any varieties of E. reichenbachii, in part due to the interfertile nature of the taxa, and also due to pure populations not existing sympatrically (Poole et al. 2007). Poole et al. (2007) pointed out that many geographically isolated taxa have not

developed genetic barriers and therefore, when placed in contact with cacti of the same origin, can cross freely. (USFWS, 2009)

Historical Range

The historic range extends from east-central Jim Wells County on the most southwestern edge of the range to northeastern Kleberg County near Ricardo at the most southeastern point, and up to southern Refugio County at the most northern extent. This range encompasses parts of Jim Wells, Kleberg, Nueces, San Patricio, and Refugio Counties in south Texas (USFWS, 2009).

Current Range

Current range is Atascosa, Jim Wells, Kleberg, McMulen, and Refugio Counties in south Texas (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (USFWS, 2009)

Breeding Season

Adult: Flowers from March through June, with peak in mid-April to early May (USFWS, 2009).

Key Resources Needed for Breeding

Adult: Bees and wasps have been observed visiting flowers (USFWS, 2009).

Reproduction Narrative

Adult: Although pollinators have not been researched, bees and wasps have been observed visiting flowers (USFWS, 2009). Species is self-incompatible (USFWS, 1986).

Habitat Type

Adult: Terrestrial (USFWS, 1986)

Habitat Vegetation or Surface Water Classification

Adult: Openings in mesquite brush occurring along streams of the coastal plain (USFWS, 1986).

Dependencies on Specific Environmental Elements

Adult: Sandy loam or silt soil (USFWS, 1986)

Geographic or Habitat Restraints or Barriers

Adult: Elevation of 50 meters or less (USFWS, 1986)

Environmental Specificity

Adult: Very Narrow (USFWS, 1986)

Habitat Narrative

Adult: Terrestrial species; habitat is described as openings in mesquite brush occurring along streams of the coastal plain at 50 meters or less in elevation, in sandy loam or silt soil and in both level and poorly drained or sloped and well drained (USFWS, 1986).

Dispersal/Migration

Motility/Mobility

Adult: N/A

Dispersal/Migration Narrative

Adult: Seeds fall to the ground or are washed down by rainfall as the seed decomposes. Seed dispersal mechanisms are thought to be unspecialized, but native ants have been observed mining BLC seeds, carrying them back to their mounds, an discarding the seeds outside of the colony. Other seed-dispersal mechanisms may include fur-bearing mammals inadvertently picking up seeds in disperse seeds through their rooting activities (USFWS, 2009).

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Species Trends:

Declining (USFWS, 2019)

Number of Populations:

6 natural, 1 introduced (USFWS, 2019)

Population Size:

Uncertain (USFWS, 2019)

Population Narrative:

The 5-year review (USFWS 2009) indicates that six populations of black lace cactus have been found from east-central Jim Wells County to north-east Kleberg County to Refugio County (pp. 11–13). By 2009, only two extant populations were known, in Kleberg and Refugio counties. The status of the Jim Wells population, last observed in 1989, was unknown (p. 5). All extant and historic populations occurred on privately owned land (p. 4). At the Kleberg site, 43,441 individuals were reported in 1983 and 19,250 in 1985. A large portion of the site was cleared in 1986. Since then, 13,250 individuals were reported in 1987, 1,160 in 2001, and 824 in 2002. Similarly, 82,500 individuals were reported from the Refugio site in 1987 and 1,527 in 2004. The Jim Wells population had about 16,000 individuals in one sub-population in 1985; a second subpopulation was cleared, but about 48 individuals survived. Although these population censuses did not use consistent methods, and the relative numbers of juveniles and reproductive adults was not reported, all populations have apparently declined. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction (USFWS, 1986)

Exposure:
Response:
Consequence:
Narrative: It is common practice in the region to clear brush tracts for cultivation for improved pasture with the planting of coastal Bermuda grass. Brush clearing has partly or completely destroyed three known populations and has recently occurred near several others. Land owners of presently known populations are apparently unaware of the cactus, so land improvements could destroy present populations without the land owners even knowing it (USFWS, 1986).

Stressor: Grazing by cattle (USFWS, 1986)
Exposure:
Response:
Consequence:
Narrative: Grazing of natural brush tracts has a negative impact on populations. For the grazed population in Jim Wells County, it was observed that cattle trample plants in open ground with few plants surviving to maturity. The only cacti present were those protected by other vegetation (USFWS, 1986).

Stressor: Collection (USFWS, 1986)
Exposure:
Response:
Consequence:
Narrative: Collecting is always a serious threat to any small desirable species of cactus, particularly when combined with large showy flowers as found in this species (USFWS, 1986).

Stressor: Predation or trampling (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Individual BLC plants have been uprooted by feral hogs and kicked over by cattle. However, no other severe disturbances caused by these mammals or other animals have been noted with the exception of the presence of red imported fire ants (RIFA). Some BLC individuals at the Refugio County site have been noted to be partially or entirely covered by mounds of RIFA. There is potential that these non-native ants could pose threats to the base or quite possibly the root system of the cacti. Also, RIFA may out-compete native ant species and potentially interfere with the role these natives play in seed dispersal. The level of threat to the continued existence of BLC due to feral hog rooting and cattle trampling is unknown, although observations at the Refugio County population site indicate that this type of impact occurs in a scattered manner (USFWS, 2009).

Stressor: Pesticide use to control insects (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Chemical eradication techniques used for the RIFA might also negatively affect natural pollinators of the species and/or native ants and could potentially contribute to an overall decrease in any treated BLC population (USFWS, 2009).

Recovery

Reclassification Criteria:
1. Black lace cactus is documented in 10 or more protected, viable populations, with at least three viable populations in each of three recovery units. Populations and metapopulations are delineated by unpopulated gaps of at least 1 km (0.6 mi). However, as described in Section III.a., viable populations that expand and merge with other populations may be counted as separate populations for the purpose of meeting this criterion. (USFWS, 2019)

2. Viable populations have 1,100 or more mature individuals. Mature individuals have flowered at least once or are judged capable of flowering. Population censuses should be conducted during the peak of flowering and fruiting, from mid-April through May. (USFWS, 2019)

3. Protected populations occur on lands that are legally protected and managed to conserve the region's native flora and fauna, including black lace cactus and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, publicly owned land managed for conservation purposes, and legally binding long-term management agreements with private landowners. (USFWS, 2019)

Delisting Criteria:
Periodic monitoring indicates that the downlisting criteria have been met and that demographic trends have subsequently remained stable or have increased over a period of 25 years. (USFWS, 2019)

Recovery Actions:
- Remove threats to Echinocereus reichenbachii var. albertii populations by enforcement of existing regulations and management of the habitat for protection of the variety. Because of the rarity of this variety, it should be protected from collecting by enforcement of existing regulations and its habitat should be managed to ensure the continued existence of self-sustaining populations. (USFWS, 1986)
- Initiate studies on the ecology and population biology of the black lace cactus. In-depth knowledge of the population biology and ecology of the black lace cactus is needed. Some of this information may be critical to future management of the variety. (USFWS, 1986)
- Determine the genetic relationships among the three populations and between Echinocereus reichenbachii var. albertii and other closely related taxa. Knowing the level of classification of E. reichenbachii var. albertii is not so important as understanding its relationship to its closest relatives. Reliable characteristics that can be used to identify flowering or sterile specimens are essential for enforcement of trade regulations. Determination of the distinctness of the taxon is also imperative since considerable expenditures may be necessary to protect and maintain it in perpetuity. Genetic studies using isozymes and/or flavanoids combined with a thorough morphological analysis can provide evidence on the distinctness or indistinctness of the gene pool within or among the populations under study, and with populations of closely related taxa. (USFWS, 1986)
- Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial, artificial propagation program. These studies should be national in scope and address all

cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. (USFWS, 1986)

- Develop cultivated stocks for commercial distribution. Cultivated stocks can be developed by authorized, responsible and/or licensed agencies, e.g., botanical gardens, universities, etc., for sale to licensed commercial distributors if information from the trade study indicates this is a practical method of reducing collecting pressure. Such trade will be subject to applicable Federal or State permits and reporting requirements. (USFWS, 1986)
- Determine delisting criteria. Before the variety can be downlisted to threatened, at least two of the three known populations should be established as safe sites. Criteria for delisting will be established only after the success of management at permanently protected populations can be evaluated and a search for additional populations has been conducted. (USFWS, 1986)
- Develop public awareness, appreciation, and support for preservation of the black lace cactus. The full recovery of the black lace cactus, and of other endangered species, depends on the attitude and support of the public. Educational materials and presentations should be used to gain public appreciation of the endan- gered species, and support for the program to save it. (USFWS, 1986)
- Recommended Action from 2009 5-Year Review: Thorough, systematic searches for new BLC populations are needed throughout the species' range. Potential habitat should be identified and surveyed, once landowner permission has been granted. Although saline soils underlie all three BLC sites, more indepth soils investigation at the known populations may help to further characterize specific soils and geologic properties that would aid in identifying areas in which to concentrate future population searches. In light of taxonomic controversy regarding the E. reichenbachii-fitchii complex, a thorough systematic review, including genetic studies of the species complex, should be conducted. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: Collaborative studies should be done to investigate life history requirements, including reproductive biology, and propagation techniques. Experimental studies need to address current and potential threats including impacts of insecticide on cacti pollinators and native seed dispersers such as ants and direct threats to BLC from non-native red imported fire ants, as well as from native insects. Feral hog activity levels within BLC populations should be monitored to ascertain the level of damage that occurs from uprooting of, and potentially from foraging on, BLC caused by these animals. In addition, the role of fire in the management of the species should be examined. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: All known populations of BLC exist on private lands. The Service and TPWD should pursue development of conservation plans with current landowners, along with investigating potential for permanent conservation easements. The assessment of appropriate conservation/management measures should be collaborative between landowners, resource agencies, and researchers. Evaluation of the species' status, degree of threats, and level of protection at known population sites is needed on a more frequent and regular basis. Landowners should be informed of new management strategies. (USFWS, 2009)
- Recommended Action from 2009 5-Year Review: Public education should be implemented to educate others about this endangered species and to protect the species from becoming a target of illegal take and distribution. Information about the regulations governing take and propagation of wild and nursery species for trade should be distributed to appropriate

partners. Refugia specimens should be grown and maintained to further aid in propagation studies and to enhance the ability of nurseries, botanical gardens, and the general public to identify the species, if encountered. (USFWS, 2009)

- Recommended Action from 2009 5-Year Review: The recovery plan for the species needs to be revised to incorporate all new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria for down- and delisting of the species should be developed which also address all listing factors relevant to the species. (USFWS, 2009)

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SPECIES ACCOUNT: *Echinocereus triglochidiatus var. arizonicus* (Arizona hedgehog cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/26/1979; Southwest Region (R2) (USFWS, 2016)

Physical Description

A spiny succulent with a few cylindrical stems, 2.25-4 dm tall. Flowers and fruit are deep red in color (NatureServe, 2015). Stems are few in number but as many as 60 in one clump have been reported. Average stem length is 21.6 cm and average stem diameter ranges from 14.4 to 24 cm. Stem ribs number about 10 and are tuberculate. Spines are dark gray, up to 3.6 cm long, straight to slightly curved, not angled. There are 1 to 3 central spines, the largest deflexed, up to 1.8 mm in diameter at the base. Radial spines number 5 to 11. They are often slightly corved, are pinkish-tan and shorter than the centrals. The flowers are bright rerd, road, about 4.8 cm in diameter and 6 cm long (USFWS, 1984).

Taxonomy

The plant was first named as Echinocereus arizonicus by J. N. Rose in 1926. In his first edition of The Cacti of Arizona in 1940, Lyman Benson placed JE. arizonicus in synonymy with Echinocereus polycanthus which he treated as a variety of E. triglochidiatus in the book's 1950 second edition. In his third edition of The Cacti of Arizona published in 1969, Benson resurrected the taxon as E. triglochidiatus var. arizonicus (Phillips et. al., 1979). The taxonomic status of this entity has not been completely resolved (USFWS, 1984). Synonyms include E. coccineus var. arizonicus and E. arizonicus ssp. Arizonicus (NatureServe, 2015).

Historical Range

Echinocereus triglochidiatus var. arizonicus was first collected by Charles Russell Orcutt in the vicinity of the highway between the Arizona towns of Miami and Superior in July, 1922 (USFWS, 1984).

Current Range

So far as is known the present and historic range are the same (USFWS, 1984). It occurs in the mountainous area near the border of Gila and Pina counties in Arizona (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: May - June (USFWS, 1984)

Reproduction Narrative

Adult: Echinocereus triqlochidiatus var. arizonicus flowers annually from late April to mid-May. Fruit is set in May and June (USFWS, 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Interior Chaparral and Madrean Evergreen woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,150 - 1,600 m elevation (USFWS, 1984)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (USFWS, 1984)

Habitat Narrative

Adult: It is found in oak woodlands and chaparral at 1050-1410 m (possibly 1150-1600 m), annual precipitation 48 cm, in a mixture of Interior Chaparral and Madrean Evergreen woodland. It usually grows in clumps among granite boulders with a dense shrub overstory on open slopes or the understory of a more open canopy. The terrain throughout its range is rugged with steep-walled canyons, and boulder-pile ridges and slopes. Cacti are found scattered about on open slopes, in narrow cracks between boulders, and in the understory of shrubs (USFWS 1984). It is normally found on Orthoclase-rich granite of late Cretaceous age; other parent materials in the area include volcanic tuff, mid-Tertiary age dacite and perhaps rhyolite (pH about 6) (NatureServe, 2015). Elevation of the preferred habitat ranges from near 1,150 to about 1,600 m (USFWS, 1984).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: While there is a paucity of species-specific information on seed dispersal, it is known within the genus of Echinocereus that mammals do eat and disperse their seeds. Ringtails, and gray foxes are known to eat the fruits of cacti species in Echinocereus (Willson 1993) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Population Size:

~5,998 (USFWS, 2023)

Population Narrative:

Spotty distribution and varying population sizes makes estimating the total number of plants difficult. According to surveys conducted by Fletcher the number of individuals would be as low as 1,500 or over 14,000 (USFWS, 1984). An estimated population size was not described at the time of listing. Fletcher (1984) approximated 1,500 to over 14,000 individuals based on surveys he completed. NatureServe listed the range-wide population between 250 to 1,000 individuals but did not reference a source for the estimate. According to the HDMS, surveyors observed 1,302 cacti between 1979 and 2009 on the Tonto National Forest. Some of those records were anecdotal, overgeneralized, or were believed accurate at the time but are now confirmed to be for a different red-flowered hedgehog cacti, the Santa Rita hedgehog cactus (Echinocereus santaritensis), that overlaps in habitat with the Arizona hedgehog cactus. The majority of Arizona hedgehog cactus occurrence data is reported by WestLand Resources, Inc. (WestLand) who conducted numerous surveys for compliance with the ESA on behalf of the Tonto National Forest and Resolution Copper for the Resolution Copper Mine project. Surveys occurred in 2004, 2007, 2008, 2010, 2012, 2015, 2017, and 2019 and were located on the Globe Ranger District and focused along U.S. Forest Service (Forest Service) roads, proposed project areas including drill pad locations, and proposed corridors on federal, state, and private land. WestLand recorded a total of 165 Arizona hedgehog cacti from project-related surveys within the proposed project footprint area. An additional 1,962 individuals were located outside the project footprint but within the action area. In 2021 and 2022, the Service worked with AZGFD to re-examine the Arizona hedgehog cactus data records. Baker's 2013 data was re-examined and any datum errors, non-listed, red-flowered cacti, and data lacking attributes were removed. The data removed from the 2021-2022 re-examination included the approximately 2,300 points that were included in WestLands Access database and in Baker's 2013 data set (HDMS 2022). These points are included in the dataset for Arizona hedgehog cactus but are not included in the abundance estimate. HDMS had several scattered points that were considered outliers because of their location beyond the species known elevation range. These points were located north of Globe near Apache Peak, Timber Camp, and turned out to be Santa Rita hedgehog cacti. In some cases, data points submitted by the Tonto National Forest for other surveyed Forest Service species were included and named as Arizona hedgehog cactus data. Given the more recent re-assessment of existing data, the population estimate for the Arizona hedgehog cactus through 2020 is approximately 5,998 individuals (HDMS 2022). As described above, additional plants that may occur within the range of the species, but their locations in the field need verification. As of 2022, we believe that there are less than 5,998 individuals due to the Telegraph Fire in 2021 that burned across Arizona hedgehog cactus habitat south of US 60 adversely affecting many plants. This fire eventually merged with the Mescal Fire at El Capitan where several hundred Arizona hedgehog cacti were previously documented. A full survey post-fire of occupied areas that were previously surveyed including the population at El Capitan has not been completed. See Section 2.1.2 (Factor A) below for a discussion on wildfires. Based on the survey history of the species, it will be necessary to continue to verify or reconcile existing records to get a clearer picture of the Arizona hedgehog cactus population pre-Telegraph fire. It is also important to reiterate that most formal surveys conducted for the cactus were required for compliance with the ESA for projects involving actions that were permitted, funded, or carried out by the federal government. Therefore, it will be critical to expand survey efforts beyond these action areas throughout its range to better understand baseline conditions for the species (USFWS, 2023).

Threats and Stressors

Stressor: Collection (USFWS, 1984)

Exposure:
Response:
Consequence:
Narrative: Comparison of isolated and roadside populations shows evidence of diminished population levels in readily accessible portions of the range of this cactus and tends to support reported collection pressures. The effect of collection on long-term survival is not presently known and individuals in accessible populations need to be tracked to record effects of collection (USFWS, 1984).

Stressor: Habitat modification (USFWS, 1984)
Exposure:
Response:
Consequence:
Narrative: Construction of Highway 60 and its later realignment destroyed some suitable habitat and undoubtedly a few plants. Likewise, construction of the transmission line that crosses Highway 60 probably displaced some plants and habitat. Six plants were removed and transplanted to Boyce Thompson Arboretum in 1978 to permit construction of the Silver King substation for the Salt River project. Most of the remaining ground disturbance activities relate to mining. The Globe-Miami Superior area is one of concentrated mining activity. Numerous mines occur within and at the periphery of the range of this cactus. It is not known how many plants have been destroyed by mining, but in general the cactus does not prefer the habitats of mineralized areas. A greater threat is mining exploration. Most roads have been constructed to provide exploration access. A few of these have been routed through occupied habitat (USFWS, 1984).

Stressor: Predation / Herbivory (USFWS, 1984)
Exposure:
Response:
Consequence:
Narrative: The effect of livestock on seedling survival is not known. Exclosure studies are needed in order to address potential trampling and cover removal conflicts. Javelina feed extensively on cacti in some areas. The possibility of javelina taking the Arizona hedgehog has not been investigated, but the javelina population should be monitored closely. Insect damage has been noted but no studies have been conducted on its extent or effect on seed production or plant survival (USFWS, 1984).

Stressor: Freeze Loss (USFWS, 1984)
Exposure:
Response:
Consequence:
Narrative: Freeze damage occasionally reduces populations in more exposed sites. In April 1981 four plants in a population of 15 had apparently died from freezing. No studies have been conducted on the extent of loss or damage by freezing. Freeze loss has the capacity to affect management and recovery. If there is a relationship between ground cover and freeze loss, allowable use of grasses by livestock may have to be reduced (USFWS, 1984).

Stressor: Wildfire and Invasive species (USFWS, 2023)
Exposure:

Response:
Consequence:
Narrative: At the time of listing, wildfire was of limited concern and was not well-studied enough to be considered a primary threat to the species (Phillips et al. 1979, Fletcher 1984, Cedar Creek Associates, Inc. 1996, Baker 2013). However, current fire regimes are drastically different from historical patterns, and climate change and increased fire suppression over the past 100 years have driven the Southwest into a fire deficit compared to historic fire levels (Yocom et al. 2022). Current wildfire ignition and habitat alteration trends as well as existing wildfire history within the current range for the Arizona hedgehog cactus indicate that wildfire poses a considerable threat to its recovery. The state of Arizona has been in some stage of drought since 1994 (Arizona Department of Water Resources 2023). However, record low precipitation in northeast Arizona from June through September 2020 resulted in extreme drought from 2020 to 2021 (Hoell et al. 2022), resulting in turn with recordbreaking wildfire years. In years of infrequent summer rains, the resulting dry thunderstorms can contribute to an extended, widespread summer wildfire season, when vegetation is most flammable and strong winds drive fire spread (Schmid and Rogers 1988, Arizpe et al. 2020). The remoteness of lightningdriven wildfires, especially within Arizona hedgehog cactus habitat, may render them inaccessible and lessen the possibility of a rapid discovery resulting in more expansive fires (Schmid and Rogers 1988). Human ignited wildfires are also on the rise in the United States, with one study indicating that between 1992 and 2012, human-ignited fires accounted for 84% of all fires and 44% of total area burned, and resulted in fire seasons three times longer than lightningignited fire seasons (USFWS, 2023).

Stressor: Climate change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The impact of climate change in the desert southwest has been evident for several decades. Declines in vegetative cover including cacti in desert habitats are predicted due to climate change (Munson et al. 2013). One study documented high mortality of desert plants, including one species in the genus Echinocereus, in the Grand Canyon over a 100-year period, with mortality and recruitment attributed to drought and unusual precipitation, respectively (Bowers et al. 1995). Still et al. (2015) noted that several species in the genus Echinocereus are likely vulnerable to such effects. We therefore conclude that increased severity and frequency of drought associated with climate change predictions will likely reduce the long-term survivorship of the Arizona hedgehog cactus (USFWS, 2023).

Recovery

Reclassification Criteria:
Three primary goals set as requirements before downlising can be considered: (1) providing 5,000 plants into the commerical pipeline each year for 5 years; (2) attaining a wild population level fo 10,000 plants; and (3) establishing a safe area of suitable habitat withdrawn from mineral entry. The size of the withdrawal is to be determined by future survey but should contain sufficient habitat to house the majority of the 10,000 wild plants (USFWS, 1984).

Delisting Criteria:
A long-term goal of delisting is dependent upon removal of collection pressures and other threats and a requirement of continued favorable management considerationby land managers

after delisting (USFWS, 1984).

Recovery Actions:

- Remove existing and potential threats to E. triglochidiatus var. arizonicus by enforcement of existing regulations and management for protection (USFWS, 1984).
- Provide data enabling management decisions to attain and maintain healthy populations in their natural habitat (USFWS, 1984).
- Use results of No. 2 above to protect populations on all lands (USFWS, 1984).
- Propagate E. triglochidiatus var. arizonicus greenhouse stock (USFWS, 1984).
- Develop public awareness, appreciation, and support for recovery of E. triglochidiatus var. arizonicus (USFWS, 1984).
- Not available

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Based on recent discussions with conservation partners, we recommend the following future actions: Conservation Planning • Continue to verify or reconcile existing records to better determine the Arizona hedgehog cactus population pre-Telegraph Fire. • Aggregate verifiable records from HDMS, conservation partners, and action agencies into one database to clarify existing spatial and temporal trends to track naturally occurring populations and recovery actions over time. • When workloads permit, conduct a Species Status Assessment to guide the development of a finalized recovery plan. • Work with partners to improve species census data across identified suitable habitat using standardized protocols. Continue to update range map as more information becomes available. • When feasible utilize novel survey techniques such as drone surveys during flowering season. • Work with Tonto National Forest and other partners to create a habitat suitability model for Arizona hedgehog cactus based on elevation, vegetation type, and geology. • Work with Tonto National Forest botanists and biologists to create a protected botanical area that limits habitat disturbance in perpetuity. Restoration • Work with conservation partners to improve and restore Arizona hedgehog cactus habitat at transplant sites and, if resources are available, in select areas that have been previously impacted by unnatural disturbance (wildfire, construction, mining, etc.). • Continue to monitor and maintain transplanted Arizona hedgehog cactus populations for up to five years, including monitoring of parent plant populations (plants from which transplants were cut) to determine whether the removal of cuttings negatively impacts parent plants. Based on monitoring outcomes, work with partners to adjust extraction, harvest, and transplantation protocols accordingly. • Support partners and researchers investigating the viability of seed collection, banking, and propagation for future restoration plantings. Fire Monitoring and Management • Support Tonto National Forest and Desert Botanical Garden with post-wildfire monitoring of Arizona hedgehog cactus populations and their habitat. • Support Tonto National Forest and other land management practitioners with invasive species and other wildfire fuels treatment and reduction in Arizona hedgehog cactus habitat to reduce the risk of unnaturally large and intense wildfires. This would likely include increasing native plant diversity at restoration sites and monitoring the effects of both prescribed and wildfires for adaptive management of occupied habitat (USFWS, 2023).

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SPECIES ACCOUNT: *Echinocereus viridiflorus var. davisii* (Davis' green pitaya)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/07/1979; Southwest Region (R2) (USFWS, 2016)

Physical Description

E. v. davisii has rounded, usually solitary stems from 1.0 to 3.5 centimeters (cm) (0.4 to 1.4 inch [in]) tall, 6 to 10 ribs, from 8 to 15 radial spines per areole and infrequently a single central spine. The faintly lemon-scented flowers have a yellowish-green perianth from 1.5 to 2.7 cm (0.6 to 1.1 in) in diameter. The reddish-green to purplish-brown oval fruits are 5.5 to 11 mm (0.2 to 0.4 in) long by 4 to 8 mm (0.2 to 0.3 in) wide, bearing black, warty seeds up to 1.1 mm (0.04 in) long. (USFWS, 2012)

Taxonomy

First reported by Houghton (1931). There is debate over the systematics of the cactus family. Recognized scientific names for this species include: Echinocereus davisii A.D. Houghton (Houghton 1931; Poole et al. 2007; Zimmerman and Parfitt 2011a; Tropicos 2011a; University of Texas 2011); Echinocereus subinermis var. aculeatus (Houghton) (G. Unger Unger 1941, as cited in Tropicos 2011a); Echinocereus viridiflorus subsp. davisii (A.D. Houghton) N.P. Taylor (Taylor 1997; Anderson 2001); and Echinocereus viridiflorus Engelm. var. davisii (A.D. Houghton) W.T. Marsh (Marshall and Bock 1941; Benson 1982; Integrated Taxonomic Information System 2011a; Natural Resources Conservation Service 2011a; U.S. Fish and Wildlife Service 2011a.) Common names used for Echinocereus viridiflorus var. davisii include: Davis' dwarf hedgehog cactus (Poole et al. 2007); Davis' green pitaya (Poole et al. 2007; Center for Plant Conservation 2011a; U.S. Fish and Wildlife Service 2011a); Davis's green pitaya (Anderson 2001); Davis' hedge cactus (Poole et al. 2007); Davis' hedgehog cactus (Poole et al. 2007; Natural Resources Conservation Service 2011a); Davis's hedgehog cactus (Zimmerman and Parfitt 2011a); and dwarf hedgehog cactus (Poole et al. 2007). The Service will continue to classify Davis's green pitaya as E. viridiflorus var. davisii. Further systematic revisions are expected in the E. viridiflorus complex, particularly as genetic studies provide new tools to reveal the phylogeny of the cactus family. (USFWS, 2012)

Historical Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Current Range

Near Marathon, in Brewster County, Texas (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination - based on closely related species (USFWS, 2012)

Breeding Season

Adult: May - August (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Insect pollinators; halictid bees - based on closely related species (USFWS, 2012)

Reproduction Narrative

Adult: Weniger (1979a, 1979b) observed E. v. davisii flowering from May to August and fruits ripening in the summer and fall. He found that it is insect pollinated and reproduces entirely by sexually-produced seeds. It begins flowering at three to four years of age. E. v. davisii plants produce from 85 to 340 seeds per year. Leuck and Miller (1982) found that all taxa within the Echinocereus viridiflorus complex are xenogamous and self-incompatible. Solitary halictid bees pollinate the flowers within the first two hours after anthesis (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chihuahuan Desert scrub or grassland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,200 to 1,350 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 2012)

Habitat Narrative

Adult: Inhabits rock crevices on novaculite outcrops (a hard, fine-grained, silica-rich rock), in full sun, among sparse Chihuahuan Desert scrub or grassland. Usually immersed in mats of spikemoss at approximately 1,200 to 1,350 m. (Loflin and Loflin, 2009). It grows underneath the moss in the crevices of limestone ledges on a select few limestone summits (Weniger, 1970) (NatureServe, 2015). It is endemic to outcrops of Caballos novaculite (USFWS, 2012).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seeds apparently fall near the parent plants as fruits decompose and are dispersed by the surface flow of rain water (USFWS, 2012).

Population Information and Trends

Population Trends:

Not available

Number of Populations:
2 (NatureServe, 2015)

Population Size:
~ 20,000 (USFWS, 2012)

Minimum Viable Population Size:
1,300 or more mature individuals (USFWS, 2019)

Population Narrative:
It is nearly confined to 1 protected ranch area. There are 2 known sites (NatureServe, 2015). The recovery plan estimates a total population of approximately 20,000 individuals. The reported populations occupied an area of 89 ha (220 ac) (USFWS, 2012).

Threats and Stressors

Stressor: Collection (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The evidence of the threat of illicit and unscrupulous collection to both E. v. davisii is clear; the species has been extirpated from their type locations on a publicly-accessible highway ROW – a site well-known to cactus collectors for decades. This cactus species is offered for sale over the internet (B & T World Seeds 2011a, 2011b; High Country Gardens 2011a, 2011b), presumably cultivated legally and ethically from propagated seed or tissue culture rather than seeds or plants collected from the wild. There is no information on the current extent of illicit collection from the remaining wild populations (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Weniger (1979a, 1979b) found no evidence of disease or predation in the wild populations of E. v. davisii, however herbivory by insects, rodents, and perhaps other animals constitutes a potential threat to E. v. davisii (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: While many species have adapted to previous climate changes by migrating in latitude or elevation, this cactus species is endemic to a unique geologic formation where there is very little variation in the range of latitude or elevation. Changes in temperature and rainfall amounts and patterns could alter the species competitive advantages in the unique micro-habitats it occupies. Regardless of how these changes may affect its autecology, the altered synecology may be far more significant. For example, this species might benefit from higher winter temperatures

that extend its growing season. Conversely, it might face new threats from a migration of tropical cactus parasites and pathogens into their habitat (USFWS, 2012).

Recovery

Reclassification Criteria:
We will consider reclassifying Davis's green pitaya to threatened status when: (USFWS, 2019)

1. Ten or more viable metapopulations are legally protected and managed for the purpose of conserving Davis's green pitaya and its habitats. Examples include, but are not limited to, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with private landowners. (USFWS, 2019)

2. The 10 or more protected metapopulations described in the previous criterion must have a minimum viable population size of 1,300 or more mature individuals. (USFWS, 2019)

Delisting Criteria:
1. Periodic monitoring indicates that the minimum viable population levels of 1,300 mature individuals within each of 10 protected metapopulations (the criteria for downlisting to threatened) have remained stable or have increased over a period of 25 years. Monitoring (censuses) of each protected metapopulation must be conducted at least once every five years. (USFWS, 2019)

Recovery Actions:
- Remove threats to Echinocereus viridiflorus var. davisii by enforcement of existing regulations for protection. Because of the rarity of Davis' green pitaya cactus, the population should be protected by the enforcement of existing international, Federal, and State regulations including management of the threats to the species. (USFWS, 1984)
- Obtain management rights for existing populations of E. viridiflorus var. davisii. Develop cooperative agreements with private landowners for the protection and management of the Davis' green pitaya cactus populations and habitat Develop and implement habitat management plans for all existing Davis' green pitaya cactus habitat. Protect occupied suitable habitat presently in private ownership. (USFWS, 1984)
- Initiate and support studies on the population biology and ecology of Davis' green pitaya cactus. Due to the rarity of the Davis' green pitaya cactus, the only known population must be sustained in a healthy and vigorous state. An indepth knowledge of the plant's population biology and ecology is needed to understand its habitat requirements. Growth requirements and limiting factors need to be studied in detail. The knowledge gained can be used to help sustain and manage the natural population. (USFWS, 1984)
- Develop a comprehensive trade management plan for all cacti. Prior to development of trade strategies, studies are necessary to determine what species are in the trade, the overall trend of trade in listed cacti, the feasibility of reducing the collecting pressure on the wild populatons by promoting a commercial artificial propagation program, and to determine strategies for effective, implementation of law enforcement responsibility of ESA, CITES, Lacey Act, and State laws. These studies should be national in scope and address all the cacti. (USFWS, 1984)

- Develop public awareness, appreciation, and support for the preservation of Davis' green pitaya cactus. Education of the public is a vital part of this recovery process. The cooperation of the public is essential for the ultimate success of the foregoing recovery measures. An appreciation of Davis' green pitaya cactus and its role in the environment needs to be developed. This can be initiated with educational programs such as pamphlets, talk programs, and slide shows. (USFWS, 1984)
- Recommended Action from 2012 5-Year Review: Revise the recovery plans and recovery criteria for both species to incorporate the most recent recovery planning guidance (National Marine Fisheries Service 2007). Treat both species in a single recovery plan, and include recovery criteria that are specific, measurable, attainable, realistic, and time-referenced (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Explore means to monitor the species and their habitats that are acceptable to landowners in the Marathon Basin as well as scientifically verifiable. Specific objectives should include a more complete determination of the species' ranges, distributions, population sizes, demographic trends, and threats (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6-funded grants, cooperative efforts with Natural Resources Conservation Service, or non-governmental partners. Establish a private landowner support group for conservation of the Caballos novaculite rare plants, similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus) (USFWS, 2012).
- Recommended Action from 2012 5-Year Review: Support continued research on the population dynamics, reproductive biology, and genetic structure of the wild populations (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The 2012 5-year review recommended revising the recovery plan to establish both downlisting and delisting criteria that comply with updated recovery planning guidance. We have now amended the recovery plan and recovery criteria (USFWS 2019). The other recommendations from the 2012 5-year review have not been accomplished, and are continued here: • Explore means to monitor the species and its habitats that are acceptable to landowners in the Marathon Basin as well as scientifically verifiable. Specific objectives should include a more complete determination of the species' ranges, distributions, population sizes, demographic trends, and threats. • Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6-funded grants, cooperative efforts with Natural Resources Conservation Service, or non-governmental partners. Establish a private landowner support group for conservation of the Caballos novaculite rare plants, similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus). • Support continued research on the population dynamics, reproductive biology, and genetic structure of the wild populations. (USFWS, 2020)

References

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SPECIES ACCOUNT: *Echinomastus erectocentrus var. acunensis* (Acuna Cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southwest Region (R2); 10-31-2013

Physical Description

The acuña cactus is a small, spherical cactus, usually single-stemmed, that can be up to 40 centimeters (cm) (16 inches (in)) tall and 9 cm (3.5 in) wide. The acuña cactus has 11 to 15 radial spines up to 2.5 cm (1.0 in) long and 3 to 4 mauve-colored, up-turned central spines up to 3.5 cm (1.4 in) long . Rose, pink, or lavender flowers 3.6 to 6 by 4 to 9 cm (1.4 to 2.3 by 1.6 to 3.5 in) are produced in March. The fruits, which are held in place by a tight mesh of spines, are pale green, are 1.25 cm (0.5 in) long, and contain small, nearly black seeds. The fruits ripen in April and as they dry, they split longitudinally, exposing the seeds. (USFWS, 2013)

Taxonomy

This species was originally described in 1953 by W.T. Marshall as Echinomastus acunensis. It is known by many synonyms, including Sclerocactus erectocentrus var. acunensis (Coulter) Taylor and Neolloydia erectocentra (W.T. Marshall) var. acunensis L. Benson. The Cactaceae treatment in the Flora of North America recognizes the entity as E. erectocentrus var. acunensis. The other variety, E. erectocentrus var. erectocentrus (needle-spine cactus), is also recognized as a valid taxon in the Flora of North America. The two varieties are generally considered to be morphologically distinct and geographically isolated, but there have been questions regarding the morphology of some individuals. To address those concerns, the Service funded a project to analyze the morphological distinctness of the two varieties, which was completed in January 2007. The results of this study suggest that there are four distinct taxonomic groups, including the separation of variety acunensis and variety erectocentrus. Baker recommended nomenclatural changes, based on the International Rules of Botanical nomenclature, but formal name changes were not proposed in his study. Since that time, Baker collected additional morphology data from other Echinomastus populations and concluded in his 2012 Intermountain Flora Echinomastus treatment, that all varieties of Echinomastus be combined into a single species E. johnsonii. In this treatment, however, Baker notes that further study is needed in order to determine if separating the species into varieties may be warranted . To date, there are no peer-reviewed publications stating that E. erectocentrus var. acunensis should not be considered as a valid taxon. Therefore, the Services accept Baker's 2007 work and the Flora of North America, which separate the acuña cactus from the needle-spine cactus as valid and distinct taxa separated morphologically and geographically (USFWS, 2013). Additional genetics work by Fehlberg at Willis in 2019 concluded that three distinct taxa are recognized: E. erectocentrus var. acunensis, E. erectocentrus var. erectocentrus, and E. johnsonii (Fehlberg and Willis, 2019).

Historical Range

Available information indicates that the historical range of this species does not differ from the current range, with the exception that the current Ajo populations likely had been part of a larger population that occurred before mining activity began there. However, there are no survey records for this species in the area prior to mining activity. (USFWS, 2013)

Current Range

The acuña cactus populations are known from Maricopa, Pima, and Pinal Counties in Arizona and from Sonora, Mexico. In western Pima County, plants are known from the Puerto Blanco Mountains and adjacent Aguajita Wash on National Park Service (NPS) lands within OPCNM; from the Sauceda Mountains on Bureau of Land Management (BLM) and Tohono O'odham Nation lands; from Department of Defense military lands on the Barry M. Goldwater Gunnery Range (BMGR); and from private lands near Ajo. In Maricopa County, the acuña cactus is known from the Sand Tank Mountains on BLM lands within the Sonoran Desert National Monument. In Pinal County, plants are known from Mineral Mountain on BLM, State, and private lands. In Sonora, Mexico, the acuña cactus occurs on Reserva de la Biosfera El Pinacate y Gran Desierto de Altar (Pinacate Biosphere Reserve), communal ejido lands, and private ranches. (USFWS, 2013)

Critical Habitat Designated

Yes; 9/19/2016.

Legal Description

On August 18, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 19, 2016) for Echinomastus erectocentrus var. acunensis (Acuña cactus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Arizona (81 FR 55266 - 55313).

Critical Habitat Designation

The critical habitat designation for Echinomastus erectocentrus var. acunensis (Acuña cactus) includes six CHUs in Maricopa, Pima, and Pinal Counties, Arizona. This species' critical habitat encompasses approximately 18,535 acres (ac) (7,501 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (81 FR 55266 - 55313).

Unit 1: Organ Pipe Cactus National Monument: The unit consists of 2,416 ha (5,971 ac) within OPCNM in southwestern Pima County, Arizona. The unit is on federally owned land administered by the National Park Service.

Unit 2: Ajo: Unit 2 is located in and near the town of Ajo in southwestern Pima County, Arizona. The unit consists of two subunits totaling 666 ha (1,645 ac). This unit contains 195 ha (483 ac) of federally owned land and 470 ha (1,162 ac) of private land. The Federal land is administered by the BLM.

Unit 3: Sauceda Mountains: Unit 3 is located in the Sauceda Mountains of northwestern Pima and southwestern Maricopa Counties, Arizona. We are excluding approximately 156 ha (385 ac) of Tohono O'odham land and exempting 378 ha (935 ac) of BMGR land from this unit, leaving 1,102 ha (2,724 ac) of federally owned land administered by the BLM (refer to the Exclusions and Exemptions sections of the preamble to this rule).

Unit 4: Sand Tank Mountains: Unit 4 consists of 549 ha (1,355 ac) within the Sonoran Desert National Monument of southwestern Maricopa County, Arizona. The unit is on federally owned land administered by the BLM.

Unit 5: Mineral Mountain: Unit 5 consists of 787 ha (1,945 ac) on Mineral Mountain of north-central Pinal County, Arizona. This unit contains 570 ha (1,408 ac) of federally owned land and 217 ha (537 ac) of State-owned land. The Federal land is administered by the BLM (569 ha (1,406 ac)) and the Bureau of Reclamation (1 ha (2 ac)).

Unit 6: Box O Wash: Unit 6 is located near Box O Wash of north-central Pinal County, Arizona. This unit consists of two subunits totaling 1,981 ha (4,895 ac). This unit contains 4 ha (9 ac) of federally owned land, 1,506 ha (3,722 ac) of State-owned land, and 471 ha (1,164 ac) of privately owned land. The Federal land is administered by the BLM.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Echinomastus erectocentrus var. acunensis critical habitat consists of the following components (81 FR 55266--55313):

(i) Native vegetation within the Paloverde-Cacti-Mixed-Scrub Series of the Arizona Upland Subdivision of the Sonoran Desert-scrub at elevations between 365 to 1,150 m (1,198 to 3,773 ft). This vegetation must contain predominantly native plant species that: (A) Provide protection to the acuña cactus (Examples of such plants are creosote bush, ironwood, and palo verde.); (B) Provide for pollinator habitat with a radius of 900 m (2,953 ft) around each individual reproducing acuña cactus; (C) Allow for seed dispersal through the presence of bare soils immediately adjacent to and within 10 m (33 ft) of individual acuña cactus.

(ii) Soils overlying rhyolite, andesite, tuff, granite, granodiorite, diorite, or Cornelia quartz monzonite bedrock that are in valley bottoms, on small knolls, or on ridgetops, and are generally on slopes of less than 30 percent.

Special Management Considerations or Protections

When designating critical habitat, the Service assesses whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat may require some level of management to address the current and future threats to the physical or biological features essential to the conservation of the acuña cactus. In all of the described units, special management may be required to ensure that the primary constituent elements for the cactus are conserved and the habitat provides for the biological needs of the cactus. Some of the management activities that could ameliorate these threats include, but are not limited to, those discussed below. -- (1) Practice livestock grazing in a manner that maintains, improves, and expands the quantity and quality of Sonoran desertscrub habitat. Special management considerations or protection may include the following: manage livestock grazing sustainably with the natural landscape by determining appropriate areas, seasons, and use consistent within the carrying capacity of rangeland in response to current and future drought and warming trends; improve monitoring and documentation of grazing practices; manage cattle and feral hoofed mammals (ungulates) (e.g., burros) to reduce the risk of plants trampled and soil compaction; and manage for other small mammal species to restore desired processes to increase habitat quality and quantity. -- (2) Minimize construction of new border control facilities, roads, towers, or fences. Special management considerations or protections may

include the following: protect lands that support suitable habitat such that destruction of individual plants and their habitat is minimized and habitat is preserved. -- (3) Manage or protect native Sonoran desertscrub vegetation communities from recreational impacts. Special management considerations or protection may include the following: manage trails, campsites, and off-road vehicles (ORVs); reduce the likelihood of wildfires affecting the acuña cactus populations and nearby plant communities. -- (4) Protect suitable habitat from mineral development and associated infrastructure (new access roads). These activities could result in direct plant and habitat loss, or alteration by removing or degrading soils to such an extent that the soils would no longer support the growth of the acuña cactus. Special management considerations or protection may include the following: protect lands that support suitable habitat such that destruction is minimized and habitat is preserved. -- (5) Manage for nonnative, invasive species, such as buffelgrass, by minimizing conditions that may promote or encourage encroachment or establishment of nonnative, invasive species and restore or reestablish conditions that allow native plants to thrive. Within the range of the acuña cactus, the establishment and success of nonnative, invasive species has been a result of historic land use and management practices such as grazing, wildfire suppression actions, mining, and ORV use. Actions have been taken by some land management agencies to reduce the spread of invasive species and reduce the risk of wildfire they pose from creating fine fuel loads. Nonnative, invasive species occur near acuña cactus populations and may pose a threat through competition for resources or increase the risk of fire. Special management considerations or protection may include the following: Prevent or restrict establishment of nonnative, invasive species; minimize ground-disturbing activities that may facilitate their spread; conduct post-disturbance restoration activities such as native plant propagation; practice active removal of nonnative, invasive plant species and targeted herbicide application (provided herbicides can be shown not to negatively impact the acuña cactus or the native pollinators); and improve monitoring and documentation on a site-by-site basis where nonnative, invasive species are present in occupied habitat to assess any effect (beneficial or negative) they pose of the cactus. -- These management activities will protect the physical or biological features essential to the conservation of the acuña cactus by reducing the direct and indirect effects of habitat loss, alteration, or fragmentation; preserving the geology and soils that form the basis of its habitat; and maintaining the native vegetation communities and pollinators. -- In summary, the primary constituent elements of the acuña cactus habitat may be impacted by livestock grazing; U.S.-Mexico border activities; recreational impacts; mineral development and associated transportation infrastructure; and nonnative, invasive species. Currently some of these threats are not identified to occur at a level that threatens populations with extirpation; however, without management of these threats, they could rise to this level. The units designated as critical habitat within the geographical area occupied by the species at the time of listing contain the physical or biological features essential to the conservation of the acuña cactus. Special management considerations or protection may be required to eliminate, or reduce to a negligible level, the threats affecting each unit or subunit and to preserve and maintain the essential features that the critical habitat units and subunits provide to the cactus.

Life History

Food/Nutrient Resources

Competition

Adult: Non-native plant species

Food/Nutrient Narrative

Adult: Non-native plant species reduce native biodiversity through direct competition and alteration of nutrient and disturbance regimes.

Reproductive Strategy

Adult: Seeds and dispersal through pollinators

Lifespan

Adult: At least 35 years

Dependency on Other Individuals or Species

Adult: The leafcutter bee (Megachile palmensis) and cactus bee (Diadasia rinconis) are thought to be the primary pollinators.

Breeding Season

Adult: Flowers in March; fruits ripen in April.

Key Resources Needed for Breeding

Adult: Non-drought years.

Other Reproductive Information

Adult: Recruitment and adult survivorship are impacted by drought, with recruitment not keeping up with mortality.

Reproduction Narrative

Adult: The acuña cactus relies solely on the production of seeds for reproduction and genetic diversity, with pollination highly linked to survival, as the species cannot fertilize itself. Acuña cacti are pollinated by a suite of bees from the Andrenidae, Anthophoridae, Anthophorinae, Halictidae, and Megachilidae families; however, the leafcutter bee (Megachile palmensis) and cactus bee (Diadasia rinconis) are thought to be the primary pollinators. Flowers are pink or purple and up to 5 cm and appear in late March and April. Fruits ripen in April and are pale green when young, tan when dry. Seeds are black and rugose (wrinkled or creased). Recruitment and adult survivorship are impacted by drought, with recruitment not keeping up with mortality. Although we do not know the lifespan of acuña cacti, there are individual plants that have been tracked at Organ Pipe Cactus National Monument (OPCNM) since 1977, and are still alive in 2012 (Holm 2012a, pers. comm.). The lifespan of seeds in the seedbank is unknown; however, in independent greenhouse tests of 6 and 4 year-old seed collected from two discrete populations, less than 19 percent and zero percent germination resulted, respectfully (Rutman 2007, p. 7). In tests of 1 and 2 year-old seed, germination ranged from 64 to 100 percent, and tests of seed collected 19 days previously resulted in 82 percent germination (Rutman 2007, p. 7). It is unknown if seed in its natural environment has the same short lifespan as has been demonstrated in these germination trials. Dispersal is likely through fruit predation by rabbits and rodents.

Habitat Type

Adult: Palo-Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran desertscrub

Habitat Vegetation or Surface Water Classification

Adult: Sonoran desertscrub

Dependencies on Specific Environmental Elements

Adult: Non-drought

Environmental Specificity

Adult: Broad (inferred from USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: 365 to 1,150 m (1,198 to 3,773 ft) elevation

Dependency on Other Individuals or Species for Habitat

Adult: Associated plant species include Larrea tridentata var. tridentata (creosote bush), Olneya tesota (ironwood), Cercidium microphyllum (palo verde), Ambrosia deltoidea (triangle-leaf bursage), and Acacia greggii (catclaw). The acuña cactus is often noted growing under the protective canopy of these or other associated species (Phillips et al. 1982, p. 6; Butterwick 1982–1992, entire; Felger 2000, p. 208; Service 2011a, p. 1; Service 2011b, p. 3), which may act as nurse plants, thereby sheltering seedlings from extreme temperatures and providing some protection from mechanical disturbance (Nobel 1984, p. 316; Suzan et al. 1996, p. 635).

Habitat Narrative

Adult: The acuña cactus occurs in valleys and on small knolls and gravel ridges of up to 30 percent slope in the Palo- Verde-Saguaro Association of the Arizona Upland subdivision of the Sonoran Desert scrub at 365 to 1,150 m (1,198 to 3,773 ft) in elevation (Phillips et al. 1982, p. 4; Arizona Rare Plant Guide Committee 2001, unpaginated; AGFD 2011, entire). This species grows on soil overlying various bedrock types including extrusive felsic volcanic rocks of rhyolite, andesite, and tuff, and intrusive igneous rocks composed of granite, granodiorite, diorite, and Cornelia quartz monzonite; Locomotive fanglomerate (sedimentary rock present (Rutman 2007, pp. 1–2; Anderson 2012a, pers. comm.). Mineralogy of these rocks is varied, with felsic or mafic phenocrysts present, depending on bedrock type (Rutman 2007, pp. 1–2; Anderson 2012a, pers. comm.). Soil texture in these locations varies between bedrock and both coarse and fine-textured substrates (Rutman 2007, pp. 1–2). Associated plant species include Larrea tridentata var. tridentata (creosote bush), Olneya tesota (ironwood), Cercidium microphyllum (palo verde), Ambrosia deltoidea (triangle-leaf bursage), and Acacia greggii (catclaw). The acuña cactus is often noted growing under the protective canopy of these or other associated species (Phillips et al. 1982, p. 6; Butterwick 1982–1992, entire; Felger 2000, p. 208; Service 2011a, p. 1; Service 2011b, p. 3), which may act as nurse plants, thereby sheltering seedlings from extreme temperatures and providing some protection from mechanical disturbance (Nobel 1984, p. 316; Suzan et al. 1996, p. 635).

Dispersal/Migration

Motility/Mobility

Adult: None

Dispersal

Adult: Fruits dispersed by rodents and rabbits

Dependency on Other Individuals or Species for Dispersal

Adult: Rabbits and rodents for dispersal

Dispersal/Migration Narrative

Adult: Dispersal is likely through predation of fruit by rabbits and rodents.

Population Information and Trends

Population Trends:

Unknown, but likely declining

Species Trends:

Unknown, but likely declining

Population Growth Rate:

Low

Number of Populations:

Eight population areas have been identified in the U.S. and one in Mexico.

Population Size:

Box-O-Wash on State and private land has 21 individuals; Mineral Mountains on BLM, private, and State land has 44 individuals; Sand Tank Mountains on BLM has 300 individuals; Coffeepot Mountain on BMGR, BLM, and TON land has 554 individuals; Ajo North on provate has 24 individuals; Ajo South on BLM has 25 individuals; ORPI on NPS has 2,154 individuals; Dripping Spring on NPS is considered extirpated; Sonoita MX on Pinacate Biosphere Reserve and private has 659 individuals.

Minimum Viable Population Size:

Unknown

Resistance to Disease:

Unknown

Adaptability:

Unknown, but likely low.

Population Narrative:

There are a total of 3,781 known living acuna cacti across their range in both the United States and Mexico. Notable trends are the large amount of mortality within the populations that have been visited more than once and the low numbers of juvenile plants in the populations.

Threats and Stressors

Stressor: Drought and insect predation
Exposure: See narrative.

Response: See narrative.
Consequence: See narrative.
Narrative: Uprooting and depredation of acuña cacti have been ongoing for at least several decades at OPCNM, at Coffeepot Mountain, and in all other populations. The pronounced decline in the acuña cactus numbers over the last three decades documented throughout the species' range on BLM, State, private, and lands in Sonora, Mexico, is of serious concern. It appears that the combination of drought stress and insect attack have reduced adult plant numbers and that warmer winters may be increasing insect numbers attacking acuña cacti. Most, if not all, of the populations are significantly impacted by predation; predation, in the form of insect attacks, occurs throughout the range of the acuña cactus. We also believe that the extent to which this threat affects the acuña cactus populations is interactive with the occurrence of drought and other climatic variables such as warmer winters. The ability of the acuña cactus populations to recover from insect attacks depends on the successful germination and survival of seedlings. However, these populations are also experiencing decreased reproduction, which may render the populations unable to recover as they continue to lose mature individuals, with low levels of seedling recruitment and survival.

Stressor: Cross-border activities
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Cross-border violators and associated CBP and LE off-road activities may be affecting individual acuña cactus plants and their habitat. If there is an increase in off-road activities in or near acuña cactus populations or habitat, the likelihood of loss of individuals or loss or modification of habitat also increases. The two areas containing the largest number of living acuna cactus (84 percent of the known living acuna cactus individuals) occur along the U.S.-Mexico border (in OPCNM and Sonora, Mexico). Within populations, acuna cacti are typically spaced within 3 m of each other, and vehicle traffic through any population could potentially impact many individuals. This area is heavily impacted by crossborder violators, CBP, and law enforcement activity, as evidenced by the tremendous increase in illegal roads and trails documented by agencies along the border.

Stressor: Inadequacy of existing regulatory mechanisms to control cross-border activities
Exposure: See narrative.
Response: See narrative.
Consequence: See narrative.
Narrative: Regulations designed to protect the species and its habitat will be generally of little impact to alleviate the threats caused by activities of cross-border violators. The interdiction efforts of the U.S. Border Patrol (USBP), including patrols, electronic surveillance and fence construction have contributed to a significant reduction in cross-border violator off-road traffic that has benefited the cactus and other species. However, we do not find regulatory mechanisms to be adequate to directly address this threat due to the difficulty and ever-changing status of border issues, compliance with agreements has been difficult. The cross-border violator activities are, by their very nature, in violation of the law and regulations.

Stressor: Climate change
Exposure: See narrative.
Response: See narrative.

Consequence: See narrative.
Narrative: In the acuña cactus, water and heat stress reduce flower and seed production, and seedling survival is dependent on summer precipitation and soil moisture. Warmer and drier winters combined with increased insect attack, negatively impacts the survivorship of reproductive adults. Of the remaining living individuals across the species' range, a large portion were found in various stages of deteriorating health, primarily blackening from the base upward, when visited by a botanist in 2011. Across populations, minimal or no recruitment has been seen in recent years. Throughout the species' range, rainfall has been declining, and drought conditions have been dominant for several decades; climate change is anticipated to increase drought periods and warming winters. This combination is expected to continue the documented trend of mortality exceeding recruitment across all populations. When mortality exceeds recruitment in a population, the result is often a declining population.

Stressor: Nonnative plant invasion
Exposure:
Response:
Consequence:
Narrative: Throughout the Sonoran Desert ecosystem, invasions of the introduced have altered nutrient regimes; species composition and structure through competition for open space; microclimates; and fire frequency, duration, intensity, and magnitude. Invasion by nonnative plants will continue in the Sonoran Desert ecosystem in the future, reducing native biodiversity through direct competition and alteration of nutrient and disturbance regimes (USFWS, 2013).

Recovery

Reclassification Criteria:
Recovery Priority Number: 6

1. A minimum of 10 acuña cactus populations must occur throughout the species' range, including at least five of the already existing populations including the Coffeepot, Sand Tank Mountains, OPCNM, and Sonoyta Mexico Populations from the West Representation Area and either Box-O-Wash or Mineral Mountain Populations from the East Representation Area. These 10 populations will include newly established populations in strategic sites, such as areas with greater annual precipitation or habitat protections in place. (USFWS, 2022)

2. All of the populations referenced in #1 above must have documented natural recruitment that is greater than or equal to documented plant loss during two or more monitoring events (every 3 years) within the last 10 years of the 25-year period (USFWS, 2022).

3. A collection of seed representing the geographical, morphological, and genetic diversity of acuña cactus is established within 10 years of the finalization of this recovery plan and maintained in at least one Center for Plant Conservation partner botanical or seed storage institution for conservation purposes (USFWS, 2022).

4. A living collection of plants representing the geographical, morphological, and genetic diversity of acuña cactus is established within 10 years of the finalization of this recovery plan and is maintained in perpetuity in at least one botanical institution for educational and conservation purposes. Each of the eight extant acuña cactus populations is represented within

these living collections (USFWS, 2022).

5. The land within a 1,000-meter radius surrounding at least four populations is protected in perpetuity through a conservation easement, monument status, habitat conservation plan, or other conservation mechanism appropriate to the land status. The 1,000-meter radius area supports acuña cactus pollinators and acuña cactus population expansion (USFWS, 2022).

6. In fulfillment of #5 above, conservation and management programs and plans address the threat of Sonoran Desert habitat loss and degradation and the direct threats to acuña cactus and their pollinators to ensure continued existence of acuña cactus; specifically, the following must be met: a. Within the 1,000-m radius area surrounding acuña cactus populations, site-specific plans are developed and partially implemented, such that: i. there is a reduction in the impacts to habitat and acuña cactus plants by illegal cross border activity and resulting law enforcement response as measured during regular monitoring efforts (Factor A and E), ii. there is a reduction in the impacts to habitat and acuña cactus plants by mining and urban development activities as measured by regular monitoring efforts (Factor A), iii. there is a reduction in impacts to habitat and acuña cactus plants from trespass livestock as measured by regular monitoring efforts and improved management of livestock in locations where they are permitted (Factor A), iv. there is a reduction in nonnative vegetation and promotion of a natural fire regime as measured by regular monitoring efforts (Factor A), v. there is a reduction in acuña cactus predation, herbivory, and uprooting as measured by regular monitoring efforts (Factor C), vi. there is a reduction in illegal acuña cactus collection as measured by regular monitoring efforts (Factor B), and vii. there is habitat restoration using locally sourced native plants and seed on lands impacted by border activity, mining activity, urban development activity, livestock activities, nonnative plant invasion, or other impacts (Factor A and E); and b. Data on the conservation and management of acuña cactus is collected and shared among land managers and researchers (USFWS, 2022).

Delisting Criteria:

1. A minimum of 10 acuña cactus populations must occur throughout the species' range, including at least five of the already existing populations including Coffeepot, Sand Tank Mountains, OPCNM, and Sonoyta Mexico Populations from the West Representation Area and either Box-O-Wash or Mineral Mountain Populations from the East Representation Area. These 10 populations will include newly established populations in strategic sites, such as areas with greater annual precipitation or habitat protections in place (USFWS, 2022).

2. All populations must have documented natural recruitment that is greater than documented plant loss during two or more monitoring events (every 3 years) within the last 10 years of the 35-year period (USFWS, 2022).

3. A collection of seed representing the geographical, morphological, and genetic diversity of acuña cactus is established and maintained in multiple Center for Plant Conservation partner botanical or seed storage institutions for conservation purposes (USFWS, 2022).

4. A living collection of plants representing the geographical, morphological, and genetic diversity of acuña cactus is established within 10 years of finalization of this recovery plan and is maintained in perpetuity in multiple botanical institutions for educational and conservation purposes. Each of the eight extant acuña cactus populations is represented within these living

collections (USFWS, 2022).

5. The land within a 1,000-meter radius surrounding at least five populations is protected in perpetuity through a conservation easement, monument status, habitat conservation plan, or other conservation mechanism appropriate to the land status (USFWS, 2022).

6. In fulfillment of #5 above, conservation and management programs and plans address the threat of Sonoran Desert habitat loss and degradation and the direct threats to acuña cactus and their pollinators to ensure continued existence of acuña cactus, specifically the following must be met: a. Within the 1,000-m radius area surrounding acuña cactus populations, site-specific plans are developed and fully implemented, such that: i. there is a reduction in the impacts to habitat and acuña cactus plants by illegal cross border activity and resulting law enforcement response as measured during regular monitoring efforts (Factor A and E), ii. there is a reduction in the impacts to habitat and acuña cactus plants by mining and urban development activities as measured during regular monitoring efforts (Factor A), iii. there is a reduction in impacts to habitat and acuña cactus plants from trespass livestock as measured by regular monitoring efforts and improved management of livestock in locations where they are permitted (Factor A), iv. there is a reduction in nonnative vegetation and promotion of a natural fire regime as measured by regular monitoring efforts (Factor A), v. there is a reduction in acuña cactus predation, herbivory, and uprooting as measured by regular monitoring efforts (Factor C), vi. there is a reduction in illegal acuña cactus collection as measured by regular monitoring efforts (Factor B), and vii. there is habitat restoration using locally sourced native plants and seed on lands impacted by border activity, mining activity, urban development activity, livestock activity, nonnative plant invasion, or other impacts (Factor A and E); and b. Data on threats, including trends, are collected using standardized methods, and information on the conservation and management of acuña cactus is shared between land managers and researchers (USFWS, 2022).

Recovery Actions:

- Objective 1. Increase the size and number of populations (i.e., improve resiliency and redundancy) through acuña cactus propagation, augmentation of existing populations, and establishment of new populations. Survey for and locate potential sites for introduction with appropriate habitat. Work with landowners, managers, and researchers to complete all necessary compliance, permits, and approvals for augmentation and introduction. Augment existing acuña cactus populations and establish new acuña cactus populations in strategic sites using appropriate genetic and geographic stock appropriate to the representation area to increase the redundancy (number of populations) and resiliency (size of populations) of the taxon (USFWS, 2022).
- Objective 2. Ensure long-term acuña cactus conservation through the establishment of ex-situ plant and seed collections housed at multiple Center for Plant Conservation approved botanical institutions and seed banks. 2a: Develop methods for sexual propagation of acuña cactus. 2b: Determine if there is a mycorrhizal fungus species associated with or nurse species required for acuña cactus. 2c: Grow out acuña cactus propagules from appropriate genetic and geographic stock. 2d: Regularly collect acuña cactus seed representing the geographical, morphological, and genetic diversity of the species using Center for Plant Conservation guidelines. 2e: Conserve the seed in Center for Plant Conservation approved facilities and periodically test acuña cactus seed to estimate the rate of viability loss during seed storage. 2f: Maintain acuña cactus plants in captivity at botanical gardens and other

USFWS approved facilities for educational purposes, seed amplification, and introduction (USFWS, 2022).

- Objective 3. Improve our understanding of current conditions, trends, and outcomes of management actions through monitoring of existing, newly discovered, and established acuña cactus populations and their habitats. 3a: Monitor natural and augmented acuña cactus populations every one to three years. 3b: Monitor nonnative plant invasion and response to treatments. 3c: Monitor impacts to acuña cactus plants and their habitat from urban development, mining, livestock grazing, border activity, and other factors. 3d: Review the status of acuña cactus periodically (USFWS, 2022).
- Objective 4. Protect, restore, and properly manage the quantity and quality of Sonoran Desert habitat within existing, newly discovered, and established acuña cactus populations for the long-term survival of acuña cactus and its pollinators. 4a: Protect through acquisition, conservation easement, or other conservation mechanism appropriate to the land status, areas supporting acuña cactus populations, as well as sites supporting suitable Sonoran Desert habitat where acuña cactus could be introduced. 4b: Restore Sonoran Desert habitat impacted by urban development activity, mining activity, livestock activity, border activity, or other causes using locally sourced native plants and seeds. 4c: Work with land managers, owners, and planners to develop and implement land management programs and plans to protect acuña cactus populations, their habitat, and their pollinators (USFWS, 2022).
- Objective 5. Reduce or mitigate threats (e.g., drought and climate change, border activity, mining activity, urban development activity, livestock activity, and nonnative plant invasion and fire regime alteration, uprooting, herbivory and predation, and illegal collection) to acuña cactus and its habitat within existing, newly discovered, and established acuña cactus populations. 5a: Actively survey for, treat, and monitor nonnative plants. Replant with locally sourced native plants and seed, as appropriate. 5b: Reduce impacts from illegal cross border activity and resulting law enforcement response. 5c: Actively remove trespass livestock and build and repair wildlife-friendly fences where needed to promote the conservation of acuña cactus. 5d: Where livestock are permitted, ensure proper management to promote the conservation of acuña cactus, their habitat, and their pollinators. 5e: Reduce illegal collection of plants through increased law enforcement presence and information dissemination campaigns. 5f: Monitor herbivory, predation, and uprooting and control as needed with approved methods.. 5g: Reduce other threats that are identified through research (USFWS, 2022)
- Objective 6. Improve our understanding of acuña cactus geography, ecology, biology, viability, genetics, threats, compatible land uses, and habitat restoration, through scientific research, thereby enabling better management of acuña cactus. 6a: Identify research needs and conduct scientific studies on the geography, ecology, biology, viability, and genetics of the species and share results among land managers and researchers. 6b: Identify research needs and conduct scientific studies on threats, compatible land uses, and habitat restoration not identified above, and share results among land managers and researchers (USFWS, 2022).

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USFWS. 2022. 2022. Acuña Cactus (Echinomastus erectocentrus var. acunensis) Final Recovery Plan. Southwest Region, Albuquerque, NM, USA. 30 pp.

SPECIES ACCOUNT: *Echinomastus mariposensis* (Lloyd's Mariposa cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 12/06/1979; Southwest Region (R2)

Physical Description

A small succulent. The stems of Neolloydia mariposensis are ovoid—cylindroid, up to 10 cm (3.9 inches) tall, and 4 to 6 cm (1.6 to 2.4 inches) in diameter. The 4 to 7 central spines per areole are white, gray, or pale yellow toward the base with light brown or bluish-gray tips. The upper 3 to 6 central spines spread upward and are often somewhat appressed against the upper radial spines. The upper central spines are 1.3 to 2.0 cm (0.5 to 0.8 inch) long; the lower central spine is porrect (directed outward and forward) or curves downward and is 0.5 to 1.3 cm (0.2 to 0.5 inch) long. The 25 to 36 radial spines per areole are white to gray, sometimes tipped with light brown, and 0.5 to 1.1 cm (0.2 to 0.4 inch) long. The flowers are white, or pinkish fading to white with age, up to 3 cm (1.2 inches) long and of about equal diameter. Fruits are yellowish—green, globose or oblong, and up to 1 cm (0.24 inch) long. Seeds are black, ovate, and slightly over 1.5 mm (0.6 inch) long (Weniger 1970). (USFWS, 1989)

Taxonomy

The Lloyd's Mariposa cactus was first collected by Mr. J. Pinckney Hester at the Mariposa Mine in southwestern Texas and was described by him as Eschinomastus mariposensis (Hester 1945). In 1969, Dr. Lyman Benson placed the Lloyd's Mariposa cactus into the genus Neolloydia (Benson 1969) (USFWS, 1989). An unpublished phylogenetic analysis indicates that the Coahuilan, Mexico, populations should not be included in S. mariposensis. (USFWS, 2018)

Historical Range

This species is known from the Big Bend Region of southwestern Texas (Brewster and Presidio Counties) and from adjacent Coahuila, Mexico (USFWS, 1989).

Current Range

Known from Presidio and Brewster Counties in Texas. (USFWS, 2018)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2018)

Breeding Season

Adult: February - March (USFWS, 1989)

Key Resources Needed for Breeding

Adult: Rocks (USFWS, 1989)

Reproduction Narrative

Adult: Lloyd's mariposa cactuses reproduce sexually, but the pollinators, breeding system (mating system), and seed dispersal were unknown. Flowering occurs mainly from March to April. Flowers open in the afternoon and remain open for 3 to 4 days. The fruits mature about 1 month later; from 5 to 10 fruits per individual produce 20 to 30 seeds each. The abundance of juvenile individuals in the known populations is evidence of recruitment. Individuals reach sexual maturity in 4 to 5 years. (USFWS, 2018)

Habitat Type

Adult: Terrestrial

Habitat Vegetation or Surface Water Classification

Adult: Sotol-lechuguilla shrublands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sunlight (USFWS, 2018)

Geographic or Habitat Restraints or Barriers

Adult: 750-1050 m (2,460-3,445 ft) elevation (USFWS, 2018)

Spatial Arrangements of the Population

Adult: Scattered individuals, sometime dense colonies (USFWS, 2018)

Habitat Narrative

Adult: Populations of Lloyd's mariposa cactus consist of scattered individuals growing in cracks and fragments of highly fractured, crumbling limestone in Chihuahuan Desert scrubland; elevations range from 750-1050 m (2,460-3,445 ft), and mean annual precipitation ranges from 25-35 cm (10-14 in). Geological substrates include some Quaternary deposits, the Tertiary Chisos Formation, and Cretaceous limestones of the Santa Elena, Sue Peaks, Del Carmen, Telephone Canyon, Boquillas, Glen Rose, Del Rio Clay, Aguja, and Pen formations. Soils are alkaline, very rocky, crumbling limestone gravels of the Chambarino, Lajitas, Lozier, Mariscal, Pantera, Solis, Tornillo, and Upton-Nickel series. The habitats are very open, and most individuals are exposed to full sunlight and reflected light from the white limestone. We provisionally estimate that about 220,000 ha (543,000 ac) of potential habitat occur in Brewster and Presidio counties; potential habitats and populations very likely also extend into Terrell County, but we do not have verifiable records of occurrences there. (USFWS, 2018)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Unknown (USFWS, 2018)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

U.S.: 12 (USFWS, 2018)

Minimum Viable Population Size:

Estimated to be in the intermediate range (roughly 1,500 to 2,000 individuals (USFWS, 2018)

Population Narrative:

Demographic studies on two plots observed the following: The populations fluctuated widely, but returned to initial levels after 15 years; estimates of first reproductive age ranged from 5 to 33 years; as much as 95 percent of the youngest class of plants do not reach reproductive maturity; mature plants produced fairly typical numbers of seeds (for a small cactus), but the largest plants also had higher mortality rates; favorable years for recruitment may occur about once every 5 years; and the appearance and growth of juvenile plants indicates that populations are resilient. Anecdotal observations of several experts indicate that the species is much more abundant and widespread than previously known; large populations occur on two protected sites, BIBE and BGWMA; and the most significant threat, the large-scale commercial collection of this species from the wild, appears to have subsided significantly, but will probably continue indefinitely. Several experts suggest that the species could be delisted. However, censuses at BIBE and BGWMA documented only 1,094 and 208 individuals, respectively, and the data from 4 small plots cannot be extrapolated to represent the size and trends of entire populations. (USFWS, 2018)

Threats and Stressors

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: McKinney (1998, p. 7) stated that habitats that were destroyed in the Terlingua-Lajitas area by past as well as current uses, such as development and off-road vehicles (ORVs), may never recover. Other protected habitats, such as BBNP, BGWMA, and large ranches that do not allow trespass, are secure. Some ranches do graze livestock, but due to the harsh terrain the threat of trampling is negligible. Porter and Prince (2011, p. 179) include commercial and residential development in the Lajitas-Terlingua area as potential threats, but the impacts of development on Lloyd's mariposa cactus have not been assessed. A possible consequence of development is increased use of ORVs, which can cause significant damage to habitats and populations in a single pass. This threat is likely to be limited to habitats closer to developed areas, and is of a limited extent. Livestock grazing may be a moderate threat in the northeast portion of the range, both from trampling and habitat degradation resulting from overgrazing (p. 180). Pesticides could affect individuals along highway ROWs as well as the species' pollinators. However, most Lloyd's mariposa cactus populations are far from areas of pesticide use, which is at most a moderate threat. (USFWS, 2018)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2018)

Exposure:
Response:
Consequence:
Narrative: McKinney (1998, pp. 6-7) has observed thousands of small Lloyd's mariposa cactus that were dug by poachers and left to die in the sun. However, the threat of collection has now diminished, and the plants are actively protected at BBNP and BGWMA. Populations on large ranches that do not allow trespass are also relatively secure. Porter and Prince (2011, p. 179) noted recent incidents involving the take of Lloyd's mariposa cactus from a protected area along a highway ROW. They conclude that the species will remain vulnerable to a persistent, low-grade threat of illegal collection. (USFWS, 2018)

Stressor: Disease or predation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Porter and Prince (2011, pp. 180-181) noted that black-tailed jackrabbits (Lepus californicus) and desert cottontails (Sylvilagus auduboni) may browse the tops of Lloyd's mariposa cactuses, exposing the soft inner tissues to opportunistic attack by snails or insects. Some herbarium specimens were infested with moth larvae or other parasites. Although parasitism of Lloyd's mariposa cactus by the cactus longhorn beetle (Moneilema armata) has not been documented, it is possible, but the degree of this threat cannot currently be assessed. Personnel of Big Bend National Park and USFWS observed increased mortality of Chisos hedgehog cactus (Echinocereus chisoensis ssp. chisoensis) individuals from herbivory at monitoring sites in March, 2016, following several years of exceptional drought (USFWS 2018, p.15). Both species occur at Big Bend National Park and are affected by the same climate and herbivore populations; therefore, we assume that herbivory of Lloyd's mariposa cactus also increases during drought. If droughts become more frequent as a result of climate changes, the impact of herbivory may also increase. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The ESA does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the populations of Lloyd's mariposa cactus at Big Bend National Park. Beginning in 2007, USFWS and the U.S. Department of Homeland Security (DHS) interacted extensively regarding the proposed construction of a border wall along the Rio Grande in south and west Texas. A provision of the REAL ID Act of 2005 gives the Secretary of Homeland Security authority to waive other federal laws, including the ESA, in order to expedite construction of border barriers. Hence, the border wall project was exempt from consultation with USFWS under section 7 of the ESA. Nevertheless, DHS and USFWS have coordinated to establish best management practices for the federally listed plants and animals in the project impact area (U.S. Department of Homeland Security 2008). Additional border wall construction has been proposed by the current Administration. If implemented, the border wall and related infrastructure may affect populations and habitats of Lloyd's mariposa cactus that occur along the Rio Grande. - Chapter 88 of the Texas Parks and Wildlife Code lists plant species as state-threatened or endangered once they are federally-listed with these statuses. Lloyd's mariposa cactus was listed as threatened by the State of Texas on April 29, 1983. The State prohibits taking and/or

possession for commercial sale of all or any part of an endangered, threatened, or protected plant from public land. TPWD requires permits for the commercial use of listed plants collected from private land. Scientific permits are required for collection of endangered plants or plant parts from public lands for scientific or educational purposes. In addition to State endangered species regulations, other State laws may apply. State law prohibits the destruction or removal of any plant species from State lands, including BGWMA, without a TPWD permit. (USFWS, 2018)

Stressor: Demographic and genetic consequences of small population sizes (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The federal listing states, "Low total population levels intensify the adverse effects of threats to the two plants [Lloyd's mariposa cactus and bunched cory cactus] and their habitats." (44 FR 64249). To assess this threat, Porter and Prince (2011, pp. 182-183) considered the scattered distribution, the range of population sizes, and the limited geographic range of Lloyd's mariposa cactus. They note that smaller populations are vulnerable to extirpation from natural and human disturbance and random events, while large, remote populations are less vulnerable. Nevertheless, climate changes could affect the species throughout its range. Since individuals reach sexual maturity slowly, the species could not recovery quickly following losses. They concluded, "At the present time it is questionable whether population size represents a vulnerability for this species," (pp. 182-183). Small, isolated plant populations are also vulnerable to genetic drift, loss of genetic diversity, and inbreeding depression. However, the population genetics of Lloyd's mariposa cactus has not been investigated; we have no evidence of the extent of the actual impacts of these potential threats. (USFWS, 2018)

Stressor: Climate change (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: We do not know whether the climate changes that have already occurred have affected the populations or distribution of Lloyd's mariposa cactus, nor can we predict how the species might be affected by the type and degree of climate changes forecast by the range of models. While many species have adapted to previous climate changes by migrating in latitude or elevation, it is unlikely that this species could migrate, without facilitation, fast enough to match the projected rate of climate change. Changes in temperature and rainfall amounts and patterns could have multiple effects that alter the species' fitness in opposing ways. For example, hotter summers could increase mortality from drought, but warmer winters could reduce mortality from freezing. Regardless of how these changes may affect its autecology, the altered synecology may be more significant. For example, Lloyd's mariposa cactus might benefit from more frequent or more severe droughts if it tolerates extended drought better than other plants that compete with it. Conversely, extended drought could reduce pollinator populations, resulting in pollen limitation and reduced reproductive output. At present, we cannot predict how the infinitely complex aggregation of climate changes will affect the synecology of Lloyd's mariposa cactus populations and habitat. Therefore, we will continue to monitor the species' status and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2018)

Recovery

Reclassification Criteria:
Not applicable. (USFWS, 1989)

Delisting Criteria:
1. Identify at least three sites where the species can be protected and then carry out protective management measures. One site should be on private land in northeastern Brewster County, one site should be in Big Bend National Park, and one site should be in Mexico. Each site should initially contain at least 1,000 plants, and should have enough available habitat to permit population expansion and growth. (USFWS, 1989)

2. Conduct management measures that are determined to be necessary for continued protection of the three sites and for the general protection of the species and its habitat. (USFWS, 1989)

3. Demonstrate long-term stability or increase in population levels and habitat through monitoring and habitat surveys. A total of 20,000 plants at protected and managed sites must be sustained. This figure is higher than might otherwise be needed because of the degree of collecting threat to this species. (USFWS, 1989)

Recovery Actions:
- 1. Remove threats to Neolloydia mariposensis by enforcement of existing regulations and management for protection. Because of the rarity of the Lloyd's Mariposa cactus, the populations must be protected by the enforcement of existing Federal and State regulations and by management to remove threats to the species. (USFWS, 1989)
- 2. Gather information for use in management. A thorough understanding of the population biology and ecology of Lloyd's Mariposa cactus is needed to help manage healthy natural populations. (USFWS, 1989)
- 3. Develop a comprehensive trade management plan for all cacti. Studies are needed to determine which species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial program for artificial propagation. (USFWS, 1989).
- 4. Refine propagation techniques to provide nursery stocks and seeds, thereby reducing collecting pressure. The collecting pressure on natural populations could possibly be reduced by making plants commercially available through commercial propagation techniques. This task will be undertaken only if findings from the trade management plan indicate that increased commercial propagation is an advisable means of reducing collecting pressure on natural populations. (USFWS, 1989)
- 5. Establish populations at the botanical gardens of research institutions Even though plants in botanical gardens cannot substitute for healthy populations in natural habitats, a living collection could still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent, well documented, and accessible living collection, together with appropriate seed banking, could provide an important source of material for non-destructive research, maintenance of wild populations, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1989)

- 6. Develop public awareness, appreciation, and support for preservation of the Lloyd's Mariposa cactus. Public education is a vital part of the recovery process. The cooperation of the public is essential for the ultimate success of many recovery measures. (USFWS, 1989).
- Recommendations for Future Actions from 2018 5-Year Review: To ascertain the degree to which the recovery criteria of Lloyd's mariposa cactus have been met, we recommend the following: - Develop efficient, quantitative, verifiable methods to estimate population sizes and trends using representative samples of potential habitats and valid statistical analyses. - Resolve the phylogenetic identity of the Coahuilan populations that were previously included in Sclerocactus mariposensis. (USFWS, 2018)
- Recommendations for Future Actions from 2018 5-Year Review: The most important recovery actions during the next five years include, but are not limited to, the following: - Revise the recovery plan and recovery criteria to incorporate updated guidance and specific, measurable recovery criteria, including the length of the monitoring period needed to detect demographic trends. Revise the population size criterion to the provisional minimum viable population level of 1,500 to 2,000 mature, reproductive individuals per metapopulation. - Continue to improve the potential habitat model as we learn more about the ecological requirements. - Explore the potential to conserve populations of Lloyd's mariposa cactus on private lands in Presidio, Brewster, and Terrell counties, Texas through private landowner agreements or other appropriate measures. - If at least some populations in Coahuila, Mexico are determined to be S. mariposensis (or Echinomastus mariposensis), communicate with Mexican agencies, non-profit conservation organizations, and academic institutions to promote their conservation and management. - Investigate the population genetics to determine the genetic structure, genetic diversity and extent of inbreeding, evidence of gene flow, and other parameters that will be useful in the conservation and recovery of Lloyd's mariposa cactus. (USFWS, 2018)
- Neolloydia mariposensis is on the Texas State protected plant list. Under Texas law, a scientific collecting permit is required for plant collection on State lands; permits are issued only for scientific or educational activities that benefit the species. Collection from private lands for commercial purposes requires written permission from the landowner and a State commercial collecting permit. Each field collected plant must be tagged and the tag must stay attached until the plant reaches its ultimate destination (USFWS, 1989).

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SPECIES ACCOUNT: *Enceliopsis nudicaulis var. corrugata* (Ash Meadows sunray)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Enceliopsis nudicaulis var. corrugata is a perennial plant in Asteraceae (sunflower family) that forms clumps 3.9 to 15.7 inches (in) (10 to 40 centimeters (cm)) high that rise from a stout, woody root-stock (Mozingo and Williams 1980, p. 21). The varietal name corrugata refers to leaf margins that are strongly ruffled-corrugate, especially towards the margins (Cronquist 1972, p. 246; Mozingo and Williams 1980, p. 21). The ray flowers are yellow and number 11 to 23. (USFWS, 2011)

Historical Range

See current range/distribution.

Current Range

Enceliopsis nudicaulis var. corrugata is endemic to the Ash Meadows area of Nye County, Nevada. The range of E. nudicaulis var. corrugata encompasses the Ash Meadows National Wildlife Refuge (Refuge) and adjacent Bureau of Land Management's (BLM) Ash Meadows Area of Critical Environmental Concern (ACEC) and private lands. (USFWS, 2011)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Enceliopsis nudicaulis var. corrugata (Ash Meadows sunray) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat units (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Enceliopsis nudicaulis var. corrugata includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Enceliopsis nudicaulis var. corrugata critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include dry washes or whitish saline soil associated with outcrops of pale whitish limestone.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Enceliopsis nudicaulis var. corrugata flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). (USFWS, 2011)

Breeding Season

Adult: March to May (USFWS, 2011)

Reproduction Narrative

Adult: Inflorescence buds begin developing in February and flowers open from late March to late May (Mozingo and Williams 1980, p.21; Pavlik and Moore 2010, p. 51). Enceliopsis nudicaulis var. corrugata flowers attract at least 21 floral visitors, 19 which are bee taxa (BIO-WEST 2009, pp. 2-5). In 2008, the average E. nudicaulis var. corrugata plant output was 12.7 inflorescences and 11.5 infructescences; while in 2009, plant output averaged 18.5 inflorescences and 15.5 infructescences (Pavlik and Moore 2010, p. 52). Inflorescences that developed earlier in the season produced significantly more seeds than those developing later (Pavlik and Moore 2010, p. 52). Plants approximately produced 17.4 mature seeds per bud (Pavlik and Moore 2010, p. 88, Table 16). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alkali shrub-scrub, salt desert scrub, desert pavement, pale limestone outcrops, dry washes, spring and seep areas (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 617 to 719 m (2,200 to 2,360 ft) (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Enceliopsis nudicaulis var. corrugata occurs between 2,200 and 2,360 feet (ft) (671 and 719 meters (m)) above mean sea level and occurs across a broad range of Refuge habitats including occasionally moist alkaline soils, spring and seep areas, and dry desert washes (Morefield 2001, p. 1; BIO-WEST 2011, p. 113). Enceliopsis nudicaulis var. corrugata most often occupies intermittently flooded to upland mesic Alkali Shrub-Scrub habitat in alkali-clay soil and is occasionally a component of Salt Desert Scrub and Desert Pavement (embedded, tightly packed gravel) habitats (BIO-WEST 2011, p. 113). (USFWS, 2011)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Not available

Number of Populations:
30 (USFWS, 2011)

Population Size:
79,508 (USFWS, 2011)

Adaptability:
Low (inferred from USFWS, 2011)

Population Narrative:
Results from the 2008-2010 Refuge wide survey (BIO-WEST 2011, p. 114) estimate that 79,508 individuals are present on the Refuge in 30 minimum scale occurrences (0.1 mi (0.16 km) distance) or 1 maximum scale occurrence (0.6 mi (1 km) distance). (USFWS, 2011)

Threats and Stressors

Stressor: Groundwater withdrawal (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Refuge encompasses over 23,000 ac (9,172 ha) of spring-fed wetlands and alkaline, desert uplands. More than 50 seeps and springs occur on the Refuge. At the time of listing, groundwater withdrawal was a major threat to the entire Ash Meadows ecosystem. Local groundwater pumping at Ash Meadows (prior to the establishment of the Refuge) was responsible for the destruction of many populations of plants and animals and their wetland habitats. Enceliopsis nudicaulis var. corrugata depends on near-surface water for its survival; therefore, it is reasonable to conclude that additional declines in groundwater levels in the Ash Meadows area (e.g., due to groundwater pumping) would negatively affect populations of this species. A number of measures have been implemented since the 1970's that, in part, have reduced the risk of groundwater level declines at the Refuge. The significance of the remaining threat posed by groundwater pumping will be evaluated below with respect to each of these measures. (USFWS, 2011)

Stressor: Road construction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, Enceliopsis nudicaulis var. corrugata population numbers had been reduced by the loss of habitat from road construction. Since listing, the Service has ceased road construction and maintains only defined Refuge roads that allow for administrative, visitor, and private landowner access. Truckers often use Refuge roads to avoid the need to obtain permits required to transport loads through California (Service and DOT 2011, p. 27). A

transportation study is being completed by the Refuge to identify transportation improvements and management strategies, improve safety, reduce operations and maintenance costs, ensure accessibility, and address traffic circulation needs (Service and Department of Transportation (DOT) 2011, pp. 1-98). Due to ceased road construction and initiation of a transportation study, road construction is no longer a threat to Enceliopsis nudicaulis var. corrugata. (USFWS, 2011)

Stressor: Off-highway vehicle (OHV) activity (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Prior to listing, OHV activity was a threat to Enceliopsis nudicaulis var. corrugata. OHV races were permitted on BLM land in the Ash Meadows area. Since listing, OHV activity is prohibited on the Refuge and has been limited by the construction of fencing around the perimeter of the Refuge in 1995 (Service 2006, pp. 9, 103). Periodically, illegal OHV activity, likely due to downed sections of fencing and fence cutting, occurs on the Refuge (Baldino, pers. comm. 2010). Within the BLM ACEC, OHV activity is confined to existing roads, trails, and dry washes (BLM 1998a, Chapter 2 p. 2-32; Map 2-10). Signs and fences are not present to designate the BLM ACEC from the other bordering BLM land, making it unclear to the public that the BLM land surrounding the Refuge has a special ACEC designation (Baldino, pers. comm. 2010). Due to the periodic illegal OHV activity on the Refuge and undefined ACEC designation, OHV activity is still a threat to Enceliopsis nudicaulis var. corrugata. (USFWS, 2011)

Stressor: Trampling by resident wild and free-roaming horses (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The final listing rule described trampling by wild and free-roaming horses as a threat to Enceliopsis nudicaulis var. corrugata. Since then, in 1995, a fence was constructed around the perimeter of the Refuge (Service 2006, pp. 9, 103). As a result, wild horse activity on the Refuge was stopped. In 1998, the BLM established the Ash Meadows ACEC that surrounds the Refuge and established the appropriate management level (AML) for wild horses as zero (BLM 1998b, p. 7 Table 2-5). Fences are not present to keep horses out of the designated ACEC and they have been seen infrequently near the area (Baldino, pers. comm., 2011). Thus, inspection and maintenance of the exclusionary fence on the Refuge is necessary to prevent re-invasion (Service 2006, p. 99). Due to these positive management practices, trampling by wild and freeroaming horses is no longer a threat to E. nudicaulis var. corrugata on the Refuge, but occasionally may be a threat to E. nudicaulis var. corrugata within the BLM ACEC. (USFWS, 2011)

Stressor: Non-native plant species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Since listing, non-native plants species have been identified as a threat to Enceliopsis nudicaulis var. corrugata. An estimated 42 percent of all species listed under the Act are considered to be at risk primarily due to non-native species (Pimental et al. 2005, p.1). Non-native plants directly compete with native plants for water, nutrients, and sunlight and indirectly by altering ecosystem processes such as hydrology, productivity, nutrient cycling, and fire regime (D'Antonio and Vitousek 1992, pp.63-87; Levine et al. 2003, pp. 775-781; Brooks et al. 2004,

pp.677-688). Approximately 100 non-native species occur on the Refuge; 66 of them non-native plant species (Service, 2006, p. 7, pp. 52-53). Of these Tamarix ramosissima Ledeb. (saltcedar), Acroptilon repens (L.) DC. (Russian knapweed), Bassia hyssopifolia (Pall.) Kuntz (fivehorn smotherweed), Centaurea melitensis L. (Malta starthistle), and Bromus rubens L. (red brome) could potentially threaten E. nudicaulis var. corrugata. (USFWS, 2011)

Stressor: Wildfire (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Since listing, nine wildfires have burned on the Refuge (Sunderman and Weisburg 2011, p. 3). The three largest wildfires (Fairbank fire in 2000 which was 744 ac (301 ha); Longstreet fire in 2004 which was 1,401 ac (567 ha); and Meadows fire in 2005 which was 267 ac (108 ha) were all partially in Enceliopsis nudicaulis var. corrugata habitat and burned prior to initiation of weed treatments in non-native plant species patches of Tamarix ramosissima. Non-native plant species alter ecosystem dynamics such as fire regimes. For example, on the Refuge, Bromus rubens is an annual, nonnative grass, that could increase its dominance on the landscape under climate change predictions. In turn, this would increase the density of fine fuels and create an environment more susceptible to fire (Chambers and Pellant 2008, p. 31). With the exhaustion of SNPLMA funding for non-native plant species treatments and opportunity for them to re-invade, wildfire frequency may increase through alteration of the fire regime. In addition, non-native plant species such as Bromus rubens could invade sparsely vegetated Enceliopsis nudicaulis var. corrugata habitat, thus providing a vector to carry fire into a habitat that may have less tendency to burn. The threat of wildfire is not easily accessed and is dependent on many other factors, thus we conclude that it is a potential threat to E. nudicaulis var. corrugata. (USFWS, 2011)

Stressor: Surface mining (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Refuge is located in the Ash Meadows mining district (Tingley 1998, p. 20), which has the largest clay production of any district in Nevada (BLM 1998a, p. 3-75). At the time of listing, surface mining was identified as a threat to two other listed plant species, Grindelia fraxinopratensis and Astragalus phoenix. Surface mining also poses a threat to Enceliopsis nudicaulis var. corrugata which co-occurs in many places with A. phoenix. Currently, only mining for clay minerals occurs in the Ash Meadows area. The playa sediments covering much of the Refuge contain clays and other minerals that could be classified as locatable minerals under the Mining Law of 1872, as amended (BLM and Service 2000, p. 3-1). Under the Mining Act of 1872, surface disturbance and impacts to rare species that do not have Federal protection are permissible as long as operations comply with all pertinent Federal and State laws. New mineral claims and mining could cause direct loss of E. nudicaulis var. corrugata habitat as well as indirect impacts due to diverting or draining water from occupied habitat. (USFWS, 2011)

Stressor: Solar development (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Since listing, solar development has been identified as a threat to Enceliopsis nudicaulis var. corrugata, specifically due to impacts from groundwater withdrawal. The Amargosa Valley has been selected as a Solar Energy Zone (SEZ) to be evaluated for its environmental and resource sustainability for larger-scale solar energy production (Department of Interior (DOI), 2009, p. 1). The Refuge is located about 20 mi (32 km) southeast of the SEZ (DOE/EIS 2010, pp. 11.1-21). The SEZ is a proposed area of 31,625 acres (12,798 ha) and maximum solar development of this area is assumed to be 80 percent over a period of 20 years on 25,300 ac (10,239 ha) (DOE/EIS 2010, pp. 11.1-1 to 11.1-3). In November 2010, the BLM approved the construction of the first solar project in the SEZ: Solar Millennium, LCC on Amargosa Farm Road. This project is on 6,320 ac (2,558 ha) of land and will use dry-cooled technology. Total annual operational water usage is 400 ac-ft (493,393 m3) per year, but will require 600 ac-ft (740,089 m3) a year during construction (BLM 2010b, p.4; Service 2010a, p. 4). Application 79699 is an application for a change in the manner of use and place of use of 400 afy under existing Permit 15893 (Certificate 5717). Changing the use of 400 ac-ft (493,393 m3) per year of water from irrigation to industrial use for this solar project and the solar projects that will follow is likely to have an impact on the groundwater supply. Agricultural water use allows some water to percolate back into the groundwater system (return flow). Water used for industrial utility-scale solar energy production likely will evaporate and not recharge to the aquifer. Additionally, no significant return flow is anticipated from solar mirror washing operations or other water uses given the average low humidity and high temperatures in the Mojave Desert. Small declines in spring discharge, changes in water temperature, and adjustments in soil or water chemistry resulting from solar projects groundwater withdrawals in the basin would negatively affect Enceliopsis nudicaulis var. corrugata. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Pavlik and Moore (2010, pp. 38, 52) noted that both jackrabbit (Lepus californicus) and insect herbivory had a dramatic effect on E. nudicaulis var. corrugata. 6.7 percent of marked E. nudicaulis var. corrugata plants in 2008 and 51.7 percent of marked E. nudicaulis var. corrugata plants in 2009 had inflorescences removed by jackrabbits, as evidenced by droppings around affected plants (Pavlik and Moore 2010, p. 52). In addition, insect achene predators severely damaged 91.7 percent of infructescences in 2008 and 78.3 percent of infructescences in 2009 (Pavlik and Moore 2010, p. 52). (USFWS. 2011)

Stressor: Stochastic events (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Small, endemic populations with limited geographic distribution like Enceliopsis nudicaulis var. corrugata have a higher risk of extinction due to demographic and environmental uncertainty and natural catastrophes (Shaffer 1987, pp. 69-75; Lande 1993, pp. 911-927). Enceliopsis nudicaulis var. corrugata is known only from the Ash Meadows area. All mapped occurrences of E. nudicaulis var. corrugata are restricted to the Refuge. Drought and wildfire are the most likely stochastic events that could adversely affect E. nudicaulis var. corrugata, as this species is dependent on groundwater and moisture retained in the soil and susceptible to being destroyed by a single, large fire. We conclude that stochastic events are a threat to E. nudicaulis

var. corrugata. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Enceliopsis nudicaulis var. corrugata is dependent on the springs and seeps of the Refuge. The potential effects of climate change on the regional aquifer system that supports E.nudicaulis var. corrugata are unclear. Current climatic models are predicting warmer air temperatures due to elevated levels of atmospheric carbon dioxide and increased drought and flood frequency (Intergovernmental Panel on Climate Change (IPCC) 2007, pp. 2-3). Other effects of climate change include, but are not limited to, changes in types of precipitation (Knowles et al. 2006, p. 4557), earlier spring run-off (Stewart et al. 2005, p. 1152), longer and more intense fire seasons (Chambers and Pellant 2008, pp. 31-32), increases in exotic species invasions (Hawkins et al. 2008, p. 37; Bradley et al. 2010, pp. 310-318), and more frequent extreme weather events (IPCC 2007, p. 13). The springs and surface streams that support Enceliopsis nudicaulis var. corrugata are perennial and originate from a regional aquifer that includes runoff from the Spring Mountains approximately 100 mi (161 km) northeast (USGS 2003, pp. 7-9). As a result of warming, more winter precipitation is falling as rain, and has altered spring stream flow. Snowmelt driven stream flow in spring is about 10 to 15 days earlier than 50 years ago, which increases the frequency of drought by decreasing groundwater recharge and summer water reserves (IPCC 2007; Chambers and Pellant 2008, p. 30). Increasing temperatures and drought frequency could adversely affect Enceliopsis nudicaulis var. corrugata by causing physiological stress, altering phenology, reducing recruitment events and seedling establishment, and altering fire frequencies. At this time, it is difficult to predict local climate change impacts to E. nudicaulis var. corrugata; thus, while the information indicates that climate change has the potential to affect and threaten its ecosystem in the long-term, there is much uncertainty regarding the attributes that could be affected and their timing, magnitude, and rate of change. (USFWS, 2011)

Recovery

Reclassification Criteria:
1. All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar, and Russian olive. (USFWS, 2011)

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devil's Hole is maintained at a minimum level of 1.4 feet below the copper washer. (USFWS, 2011)

3. The essential habitat must be secure from detrimental human disturbances including mining, OHVs, and introduction of non-native species. (USFWS, 2011)

Delisting Criteria:
1. Criteria shown above for downlisting from endangered to threatened. (USFWS, 2011)

2. Secure, protect, and maintain in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of listed plants within the essential habitat. (USFWS, 2011)

3. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats. (USFWS, 2011)

4. All of the listed plant species and the four candidate plants species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population. (USFWS, 2011)

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem. (USFWS, 1990)
- Conduct research on the biology of the species. (USFWS, 1990)
- Conduct management activities within essential habitat. (USFWS, 1990)
- Reestablish populations/monitor new & existing populations. (USFWS, 1990)
- Determine/verify recovery objectives. (USFWS, 1990)
- The Recovery Plan should be updated using the most recent and best scientific management information available. (USFWS, 2011)
- Surveys for Ash Meadows threatened and endangered plant species, including Enceliopsis nudicaulis var. corrugata, should be performed in the BLM ACEC to determine species occurrences and habitat locations. In addition, habitat surveys around roads, trails, and dry washes will verify the impact OHV activity has on this species population. (USFWS, 2011)
- Research on the life history strategies of Enceliopsis nudicaulis var. corrugata should be prioritized. Research should focus on demography, recruitment events, and seed longevity in the seed bank. (USFWS, 2011)
- Seed from all listed plant species, including Enceliopsis nudicaulis var. corrugata, on the Refuge should be collected and stored for ex situ conservation. Ex situ studies of seed and seedling biology should be conducted to enhance germination and propagation techniques. (USFWS, 2011)
- Additional research is needed on the sensitivity and requirements of the species on groundwater and soil moisture throughout the growing season. (USFWS, 2011)
- The Refuge is implementing many restoration projects that could benefit Enceliopsis nudicaulis var. corrugata; however minimal monitoring specific to listed plants is conducted. To document recovery of listed plants, these projects should include pre and post site sampling to verify and quantify the restoration actions as benefiting the species. (USFWS, 2011)
- Environmental analyses on new solar projects in Amargosa Valley should include detailed assessments of the potential effects on the springs and groundwater table within the Refuge. The Service should participate in the review of these documents to ensure that they adequately disclose all potential impacts to Enceliopsis nudicaulis var. corrugata and the Ash Meadows ecosystem. (USFWS, 2011)
- Long-term funding should be secured for long-term non-native plant species treatments on the Refuge. (USFWS, 2011)
- Mineral rights should be purchased or transferred for perpetuity to the Service or a program needs to be established to renew the mineral withdrawal every 20 years. In addition,

existing mining claims should be acquired whenever possible. (USFWS, 2011)
- Property and rights, such as conservation easements, should be acquired on private property that likely contains listed plant species. (USFWS, 2011)
- Research and develop a jackrabbit exclusion study to determine the impacts jackrabbits are having on reproduction of Enceliopsis nudicaulis var. corrugata. If a significant affect to E. nudicaulis var. corrugata is found, a jackrabbit control plan should be established. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: (optional, but may be helpful to identify priorities for management actions and information needs for next 5-year review) 1. Monitor compliance with the January 12, 2018 Nevada Revised Statute Order 1197A, Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, to ensure groundwater levels in Devils Hole can support the population. Order 1197 is no longer in effect. Water levels in Devils Hole are affected by pumping centers in Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020); 2. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service, 2020); 3. Support Ash Meadows sunray (Enceliopsis nudicaulis var. corrugata) research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and 4. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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SPECIES ACCOUNT: *Eremalche kernensis* (Kern mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Annual herb, with erect stem about two to four inches high; white to rose-pink or lavender hollyhock-like flowers (Fish and Wildlife Service 1990). (NatureServe, 2015)

Taxonomy

Treated as Eremalche kernensis by some, including the USFWS. The distinctiveness of this taxon is in question (Roxanne Bittman, California Natural Diversity Database, June 2000). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

California endemic, occurring only in Kern County (Skinner 1997). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits chenopod scrub, valley and foothill grassland; 70-1000 m (Skinner 1997). (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Narrative:

Known from fewer than twenty occurrences (Skinner 1997). (NatureServe, 2015)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Climate change is a potential threat to E. kernensis. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2013).

Stressor: Effects of nitrogen deposition (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Nitrogen is considered a limiting factor in the soils of many terrestrial ecosystems. Nitrogen deposition "hotspots" have been identified downwind of large and expanding metropolitan centers and large agricultural operations in California. Increased soil nitrogen from anthropogenic sources such as automobile exhaust, can lead to increased plant productivity in Nlimited soils. In areas where non-native nitrophilic (i.e., nitrogen-loving) plants have been introduced (such as Bromus madritensis ssp. rubens or red brome), this increased productivity can result in competitive exclusion, whereby the faster growing nitrophilic species out-compete the native vegetation. Smaller-statured forbs (like E. kernensis) can be particularly vulnerable. The increased productivity of non-native annual grasses can also lead to increased fire frequency due to the build-up of fuel. The habitats in which Eremalche kernensis occurs are not fire-adapted, and the native vegetation does not recover quickly after burning (USFWS, 2013).

Stressor: Grazing and competition (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Grazing and competition from non-native plant species are threats to the species, although grazing, when done appropriately, may be an important tool in eliminating competition from both non-native and native competitors of Eremalche kernensis(USFWS, 2013).

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Threats to habitat of Eremalche kernensis include conversion to agriculture (including grazing) and urbanization (on privately owned lands); the occurrences on public lands are protected from direct effects of urbanization and agricultural land conversion, but in some areas are still subject to other threats including oil and gas exploration and conveyance, solar power developments, off-road vehicle use and mineral exploration and extraction (USFWS, 2013).

Stressor: Potential loss of pollinators (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: While it is unknown whether honeybees specifically function as pollinators of E. kernensis, if the causes of colony collapse disorder result in a decline in any E. kernensis pollinators, the species' genetic diversity could be further reduced (USFWS, 2013).

Recovery

Reclassification Criteria:
1. Secure and protect specified recovery areas from incompatible uses: a. 95% of occupied habitat on public lands; b. 75% of population and 75% of occupied habitat in Lokern. 2. Management Plan approved and implemented for recovery areas in the Lokern Area that include survival of the species as an objective. 3. Population monitoring in specified recovery areas shows stable or increasing populations through a precipitation cycle. (USFWS, 2020)

Delisting Criteria:
1. Secure and protect specified recovery areas from incompatible uses: a. 90% or more each of population and occupied habitat in Lokern; b. Two or more distinct populations outside the Lokern Natural Area. 2. Management Plan approved and implemented for all protected areas that include survival of the species as an objective. 3. Population monitoring in specified recovery areas shows no decline after downlisting. If declining, determine cause and reverse trend. (USFWS, 2020)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2013 five-year review, scientific literature, and as a result of discussions with species experts. 1. Conduct more robust genetic testing to determine the distinction between Kern mallow (Eremalche parryi ssp. kernensis) and the closely-related Parry's mallow (Eremalche parryi ssp. parryi). 2. A comprehensive evaluation should be completed for all known occurrences (both extant and extirpated). The site-specific evaluation should include, at minimum, whether the species is present, estimated population/occurrence extent, extent of suitable habitat, and an in-depth analysis of threats at that location. Field surveys for the evaluation should be timed for favorable conditions, such as in the first wet year following a drought. 3. Conduct yearly surveys utilizing a standardized methodology to determine trends in the range-wide status of the species as well as population/occurrence abundance. 4. Monitor known populations of Kern mallow during multiple precipitation/drought cycles to gain a better understanding of the ecology of the species and how it interacts with grazing and with other species (both native and non-native). (USFWS, 2020)

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SPECIES ACCOUNT: *Eriastrum densifolium ssp. sanctorum* (Santa Ana River woolly-star)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/28/1987; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Eriastrum densifolium subsp. Sanctorum is a subshrub occasionally reaching 1 m (3.3 ft) in height. Plants have gray-green stems and leaves. The light gray-green leaves generally curve upward. The leaves are irregularly divided to the midrib in 2 to 6 narrow lobes and are up to 50 mm (2 in) long (Patterson 1993, p. 826). The bright blue funnel-shaped flowers are usually longer than 25 mm (1.0 in), but may be up to 30 mm (1.4 in) long or occasionally as short as 20 mm (0.8 in). The petals of the flowers (corolla) are lavender-blue becoming pinkish-purple with age (Munoz 1991). The congested inflorescences (flower stalks) contain 20 flowers each. The seeds are contained in capsules. (USFWS, 2010)

Taxonomy

Four other subspecies of Eriastrum densifolium have been recognized. A key feature that distinguishes E. d. subsp. Sanctorum from other subspecies is the length of the tube forming the base of the corolla that is up to 30 mm (1.2 in); corolla tube lengths in the other subspecies do not exceed 20 mm (0.8 in) (Patterson, 1993). (USFWS, 2010)

Historical Range

Historically, E. d. subsp. sanctorum occupied about 110 km (60 mi) of habitat along the Santa Ana River from elevations of about 150 m (500 ft) in the vicinity of Santa Ana Canyon in Orange County up to about 600 m (2,000 ft) at the base of the San Bernardino Mountains, through Riverside County (USFWS 1987, p. 36266). Eriastrum densifolium subsp. sanctorum may have occupied alluvial fan sage scrub habitats in Orange County as far downstream as Santiago Canyon (Craig 1934, p. 390; Mason 1945, p. 75; Zembal and Kramer 1984, p. 2). The subspecies is considered extirpated from Orange County and Riverside County (Zembal and Kramer 1985, p. 3; USFWS 1987, p. 36268). At listing, Eriastrum densifolium subsp. sanctorum occurred in isolated stands along the Santa Ana River in San Bernardino County between 360 and 600 m (1,200 and 2,000 ft) in elevation. (USFWS, 2010)

Current Range

Eriastrum densifolium subsp. sanctorum is endemic to the Santa Ana River drainage of southern California. Since listing, 12 new occurrences were detected, and Eriastrum densifolium subsp. sanctorum was also rediscovered within Riverside County just downstream of the border with San Bernardino County. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (self-incompatible) (USFWS, 2010)

Lifespan

Adult: 5 to 10 years (USFWS, 2010)

Dependency on Other Individuals or Species

Adult: Many species of insects and birds visit Eriastrum densifolium subsp. sanctorum flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (Micranthophora flavocincta), giant flower-loving fly (Rhaphiomidas acton subsp. acton), California bumblebee (Bombus californicus), white-lined sphinx moth (Hyles lineata), black-chinned hummingbird (Arhilochus alexandri), and Anna's hummingbird (Calypte anna) (Muñoz 1991, p. 59). (USFWS, 2010)

Breeding Season

Adult: May to August (USFWS, 2010)

Reproduction Narrative

Adult: Eriastrum densifolium subsp. sanctorum flowers between May and August but most heavily in June (Muñoz 1991, p. 22). In artificial crossing experiments, self-pollination produced negligible fruit or seed set, indicating that E. d. subsp. sanctorum is self-incompatible (Muñoz 1991, p. 9; Brunell 1999, p. 250). Many species of insects and birds visit Eriastrum densifolium subsp. sanctorum flowers, but pollination is effected by comparably few of these. The primary pollinators include the solitary digger bee (Micranthophora flavocincta), giant flower-loving fly (Rhaphiomidas acton subsp. acton), California bumblebee (Bombus californicus), white-lined sphinx moth (Hyles lineata), black-chinned hummingbird (Arhilochus alexandri), and Anna's hummingbird (Calypte anna) (Muñoz 1991, p. 59). Eriastrum densifolium subsp. sanctorum plants have an average life span of approximately 5 years with some plants surviving at least 10 years (Burk et al. 1998, p. 21). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, coastal scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Flooding provides habitat and seed dispersal (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Prefers low annual cover, well-lighted areas with slight surface disturbance; found at elevations below 600 m (2,000 ft) (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 2010)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Eriastrum densifolium subsp. Sanctorum thrives in open, well-lighted areas of sand alluvial terraces, where shrublands persist between infrequent flood events (Zembal and Kramer 1984, p. 8; Wheeler 1988, p. 3; Burk et al. 1998, p. 20). The perennial vegetative cover is relative low (seldcom over 50%); annual cover is also fairly low (Zembal and Kramer 1984, p. 4). This species is found in disjunct stands within this habitat and tends to occupy areas with slight disturbance (Zembal and Kramer 1984, p. 4). Eriastrum densifolium subsp. sanctorum is known to occur patchily on the higher floodplain terraces. E. d. ssp. sanctorum colonizes washed sand deposits created by sporadic stream flow action and its habitat is maintained by periodic flooding, scouring, and sediment deposition (Wheeler 1998, p. 16). It thrives in nutrient poor sands of early seral stage habitat that have more than 97% sand particles. Eriastrum densifolium subsp. austromontanum occurs at elevations from 1,200 to 1,800 m (4,000 to 8,000 ft). Most commonly associated perennial plants include Eriogonum fasciculatum, Eriodictyon trichocalyx, Croton californicus, and Lepidospartum squamatum (Zembal and Kramer 1985). (USFWS, 2010)

Dispersal/Migration

Dispersal

Adult: Typically low, but may be high during flooding events (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Dispersal of Eriastrum densifolium subsp. sanctorum seed is limited in the absence of flooding. The majority of seeds fall within 0.3 m (1 ft) of the parent plant and the wetted seed coat forms a mucilaginous mass that readily attaches the seed to the surrounding soil particles (Burk et al. 1989, p. 21). Those seeds not immediately shed from the fruits are retained within capsules that may remain on the plant for several seasons (Wheeler 1991, p. 116). In times of flooding, seeds or capsules may be transported down the floodplain for some distance, thereby facilitating some gene flow between populations. (USFWS, 2010)

Population Information and Trends

Population Trends:

Long-term trends indicate a rapid decline of 70 to 90%, while short-term trends suggest a decline of 50 to 70% (NatureServe, 2015)

Number of Populations:

23 occurrences (USFWS, 2010)

Population Narrative:

There are currently 23 extant or presumed extant occurrences of Eriastrum densifolium subsp. sanctorum, 2 more than documented in the 2010 5-Year Review (Figure 1; Appendix A). Several occurrences are in need of monitoring as there are no survey records for decades, making it hard to accurately determine the occupancy at these occurrences. (USFWS, 2023)

Threats and Stressors

Stressor: Floodplain development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At listing, urban and agricultural development was identified as a threat impacting habitat occupied by Eriastrum densifolium subsp. sanctorum (USFWS 1987, p. 36269). Prior to listing, the Devore occurrence (EO 15) was extirpated by agricultural development and discing (CNDDB 2010a, p. 9). Since listing, additional mainstem and tributary occurrences across the species distribution in San Bernardino, Riverside, and Orange Counties have been directly impacted or extirpated by development related activities: Verdemont (EO 18) in Cajon Creek Wash may have been eliminated when disced in 2005; Highland Avenue (EO 3) in Lytle Creek Wash was extirpated by construction of California Freeway 210 (Foothill Freeway); Jensen Quarry (EO 27) in Sunnyslope was extirpated by construction of the Oak Quarry Golf Club; and the sole Orange County occurrence, Weir Canyon Road (EO 2), may have been extirpated by construction of a nearby subdivision (CNDDB 2010a, p. 220). Adverse effects from development continue to be a threat to E. d. subsp. sanctorum occurrences, and impacts from current and planned development projects in the Santa Ana River floodplain habitat. These developments within the floodplain impact the species by displacing it from limited suitable habitat. Floodplain development projects also affecting the hydrological regime. (USFWS, 2010)

Stressor: Aggregate mining (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At listing, aggregate mining was identified as a threat impacting habitat occupied by Eriastrum densifolium subsp. sanctorum (USFWS 1987, p. 36268). Aggregate mining activities directly eliminate habitat and can degrade or fragment suitable habitat. Mining operations were quite active at the time of listing and impacted over 1,500 acres (ac) (600 hectares (ha)) of the Santa Ana River wash according to accounts shortly after listing (USFWS 1998, p. 3837). Since listing, threats associated with aggregate mining remain a threat at many mainstem and tributary occurrences. There are mining activities indicated as threats near 4 of the 21 occurrences: Institution Road North (EO 33), Institution Road South (EO 4), and Line Avenue (EO 20) in Cajon Creek Wash, and Santa Ana Wash (EO 5) on the Santa Ana River mainstem (CNDDB 2010). Though no new aggregate mining is currently planned for the Santa Ana River mainstem, the level of impact to Eriastrum densifolium subsp. sanctorum associated with ongoing aggregate mining is unknown. (USFWS, 2010)

Stressor: Alteration of hydrology (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At listing, it was predicted that Seven Oaks Dam would greatly reduce peak flow volumes and sediment loads that would drastically reduce the frequency of scouring and depositional events in the floodplain and allow most of the alluvial fan sage scrub communities on the Santa Ana River Wash to succeed to a uniform mature phase, reducing the seedling establishment of Eriastrum densifolium subsp. sanctorum in downstream habitats (USFWS 2008, p. 3). Absence of these scouring and depositional events could preclude all but the mature seral stages in the alluvial fan sage scrub. Since listing, this subspecies continues to be threatened

rangewide by floodplain modifications that alter hydrology, which directly and indirectly eliminate or impair habitat function. The habitat of the Santa Ana River and its tributaries receives little natural disturbance. Sheet flood flows probably occur once every 100 to 200 years and the scouring of such flows appear to maintain the alluvial fan scrub vegetation (USFWS 1986, p. 12181). Flood events are now confined to trenches and channels in Lytle Creek and the Santa Ana River, replacing the alluvial floodplain and the associated alluvial terraces. Constructed flood control channels prevent water from flowing out onto adjacent banks, providing the scouring and redeposition needed by Eriastrum densifolium subsp. sanctorum. The deeper water in these channels serves to increase the flow velocity and increases channel incision with less alluvial deposition. Flood control channels serve to promote mature successional stages of alluvial fan sage scrub, which provides poor establishment potential for E. d. subsp. sanctorum (Wheeler 1991, p. 56). Six occurrences are affected by grading for flood control: Line Avenue (EO 20), Santa Ana Wash (EO 5), Riverside Avenue (EO 21), Alamo Street (EO 22), Fairmont Park Golf Course (EO 24), and Weir Canyon Road (EO 2). Additionally, the construction of Seven Oaks Dam has removed much of the fluvial dynamics from the mainstem of the Santa Ana River and precludes natural scouring and deposition in the future. As discussed in the Habitat section above, the inhibition of flooding events allows for the seral maturation of the alluvial fan sage scrub. This mature scrub then inhibits the establishment of E. d. subsp. sanctorum seedlings, which could ultimately lead to local extirpations. All 14 occurrences on the Santa Ana River are adversely impacted by altered hydrology resulting from the Seven Oaks Dam. In all, 15 of the 21 extant occurrences are threatened by alterations of hydrology. (USFWS, 2010)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: OHV use directly damages plant communities and the soil horizon of Eriastrum densifolium subsp. sanctorum occurrences, thereby degrading habitat. Large flat expanses of alluvial fan sage scrub habitat that support E. d. subsp. sanctorum are also attractive to recreationists for OHV use. Impacts from OHV use is known to occur throughout the species' range and specifically at 11 of the 21 occurrences in Cajon Creek Wash (EOs 33, 4), Lytle Creek Wash (EO 19), and the Santa Ana River mainstem (EOs 5, 1, 25, 29, 21, 22, 24, and 31) (CNDDB 2010). Unauthorized OHV use continues to degrade alluvial fan sage scrub habitat areas within Cajon Creek Wash, Lytle Creek Wash, and the mainstem of the Santa Ana River. Control of these activities rests with local landowners and jurisdictions. Three occurrences are conserved and afforded protection under the Western Riverside County Multiple Species Habitat Conservation Plan (Western Riverside County MSHCP) (EOs 22, 24, and 31). We anticipate that some impacts from OHVs will be ameliorated through active management with future implementation of the Woolly-Star Preserve Area Multiple Species Habitat Management Plan (WSPA). (USFWS, 2010)

Stressor: Hybridization (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Hybridization was not discussed in the listing rule as a threat to Eriastrum densifolium subsp. sanctorum. Though hybridization, or the occurrence morphological intermediates (with E. d. subsp. elongatum or E. d. subsp. austromontanum) had been suspected since the 1930s, genetic verification did not occur until the occurrences in Lytle Creek were compared to those in

the Santa Ana River utilizing enzyme electrophoresis (Brunell and Rieseberg 1993). Similarly, hybridization was thought to occur with E. d. subsp. elongatum near the confluence of Lytle Creek and Cajon Creek (Verdemont (EO 18), Institution Road North (EO 33), and Institution Road South (EO 4)) (Craig 1934, p. 390; Burk et al. 1989, p. 20). The upper reaches of those washes seem to support E. d. subsp. elongatum while the listed entity is found downstream toward the Santa Ana River. Eriastrum densifolium subsp. austromontanum has also been thought to hybridize with E. d. subsp. sanctorum at La Cadeña Dr. and Lytle Creek (La Cadeña Drive (EO 29) and La Loma Hills (EO 30)) (DeGroot 2008, p. 1; Brunell and Whitkus 1997, p. 545). Though gene flow between E. d. subsp. sanctorum populations in the Santa Ana River and intermediates of Lytle Creek Wash likely took place in the recent past (150 years), they now appear isolated (Brunell and Rieseberg 1993, p. 5). The extent of threat from hybridization remains unknown. Hybrids have been confined to lower Lytle Creek Wash and the Santa Ana River at its confluence with Lytle Creek. Hybridization is a potential threat at 7 of the 21 occurrences. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Global climate change was not addressed as a threat in the final listing rule for the Eriastrum densifolium subsp. sanctorum. Since listing, it has become apparent that potential threats exist to biota of the United States from ongoing, accelerated climate change (IPCC 2007). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying are predicted for the foreseeable future (Field et al. 1999, pp. 1–63; Cayan et al. 2005, pp. 1–47; IPCC 2007). Significant temperature increases create a stressor for endemic species. This stressor enhances pressures from competitors, nonnative species, habitat change, low water supply, and disease. Species must somehow adapt to these pressures in situ (in place) or shift their geographic range (Cayan et al. 2009, p. 45). Such a shift in range for narrow endemic species such as Eriastrum densifolium subsp. sanctorum could exceed the tolerance of the subspecies. Additionally, there is very little available alluvial fan sage scrub habitat in the Santa Ana River basin to assist this subspecies with a range shift. Though we know little of the adaptive ability of E. d. subsp. sanctorum, climate change could potentially pose a significant rangewide threat to the subspecies. (USFWS, 2010)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Recovery actions are not available.
- Work with partners, such as the Service's Partners for Fish and Wildlife Program to identify opportunities for conservation or preservation for Eriastrum densifolium subsp. sanctorum occurrences on private lands. Property easements or purchases of parcels could also be made through the Act's section 6 funding and other programs. (USFWS, 2010)

- Ensure natural recruitment of Eriastrum densifolium subsp. sanctorum is sufficiently documented following extreme fluvial events (i.e., floods) to assure long-term sustainability. (USFWS, 2010)
- Determine occurrences where genetic distinctness exists between occurrences in Cajon Creek, Lytle Creek, and the Santa Ana River mainstem that comprise the range of known hybrid of Eriastrum densifolium subsp. sanctorum. (USFWS, 2010)
- Develop a final recovery outline for Eriastrum densifolium subsp. sanctorum. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years. The actions are intended to reduce threats to Eriastrum densifolium subsp. sanctorum and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this subspecies will require cooperation and coordination with partners to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. 1. Work with partners to identify opportunities for conservation or preservation of E. d. subsp. sanctorum occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire suitable habitat. 2. Conduct rangewide surveys for E. d. subsp. sanctorum to help update the distribution and current baseline conditions. 3. Identify seed accessions within the California Botanical Garden (formerly Rancho Santa Ana Botanical Garden) seed bank and complete seed collection and viability testing. 4. Conduct small-scale E. d. subsp. sanctorum plant seeding experiments. 5. Determine extent of genetic differences between E. d. subsp. sanctorum populations. 6. Conduct experiments to determine how to restore Riversidean Alluvial Fan Sage Scrub habitat to help facilitate recolonization of E. d. subsp. sanctorum to alluvial benches (USFWS, 2023).

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SPECIES ACCOUNT: *Erigeron decumbens* (Willamette daisy)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/24/2000; Pacific Region (R1)

Physical Description

The Willamette daisy is a taprooted perennial herb. It grows 1.5 to 6 cm (0.6 to 2.4 inches) tall, with erect to sometimes prostrate stems at the base. The basal leaves often wither prior to flowering and are mostly linear, 5 to 12 cm (2 to 5 inches) long and 3 to 4 mm (0.1 to 0.2 inches) wide. Flowering stems produce two to five heads, each of which is daisy-like, with pinkish to pale blue ray flowers and yellow disk flowers. The morphologically similar Eaton's fleabane (E. eatonii) occurs east of the Cascade Mountains, while the sympatric species Hall's aster (Aster hallii) flowers later in the summer. In its vegetative state, the Willamette daisy can be confused with Hall's aster, but close examination reveals the reddish stems of Hall's aster in contrast to the green stems of the Willamette daisy (Clark et al.1993) (USFWS, 2016).

Taxonomy

In the sunflower or daisy family (Asteraceae). Thomas Nuttall (1840) described Erigeron decumbens based on a specimen he collected in the summer of 1835. The autonym E. decumbens var. decumbens was automatically established by Cronquist (1947) when he described E. decumbens var. robustior. Recent revisions of the Erigeron genus (Strother and Ferlatte 1988, Nesom 1989) treat the plant as a variety, E. decumbens var. decumbens. According to Strother and Ferlatte (1988), E. decumbens var. decumbens is geographically limited to the Willamette Valley and the morphologically similar E. decumbens var. robustior is restricted to Humboldt and western Trinity Counties, California. (USFWS, 2010).

Historical Range

See current range/distribution.

Current Range

Occurs only in the southern end of the Willamette Valley, Oregon. Historically had ranged further north near Portland. Generalized range of 7400 sq. km. (USFWS, 2016)

Critical Habitat Designated

Yes; 11/30/2006.

Legal Description

On October 31, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 30, 2006) for Erigeron decumbens var. decumbens (Willamette daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes nine critical habitat units (CHUs), in Oregon and Washington (71 FR 63862-63977).

Critical Habitat Designation

The critical habitat designation for Erigeron decumbens var. decumbens includes nine CHUs in Benton, Lane, Linn, Marion, and Polk Counties, Oregon. This species critical habitat encompasses approximately 718 ac (291 ha). Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule (71 FR 63862-63977; USFWS, 2006).

Units WD–1A and 1B encompass approximately 41.2 ac (16.7 ha) of Federal land occurring in northern Polk County. This unit is located adjacent to Highway 22, approximately 5.6 mi (9 km) northeast of the City of Dallas.

Unit 2 for Erigeron decumbens var. decumbens (Unit WD–2) Unit WD–2 encompasses approximately 12.2 ac (4.9 ha) of private land occurring in southern Marion County. This unit occurs south of SE Triumph Road and east of SE Boedigheimer Road.

Unit WD–3 encompasses approximately 58.3 ac (23.6 ha) of private land occurring within northern Linn County. This site is located north of SE Kingston Lyons Drive and on both the east and west sides of Huntly Road, and is primarily owned by TNC.

Unit WD–4 encompasses approximately 9.3 ac (3.8 ha) of private and City of Corvallis land occurring in Benton County. This unit is located north of SW Reservoir Avenue and south of NW Oak Creek Drive. Approximately half of the habitat within this unit is located on City of Corvallis land and half on private land.

Unit WD–5 consists of approximately 38.5 ac (15.6 ha) of private land, south of Corvallis, in Benton County. This unit is located along Muddy Creek, just to the west of Cutler Lane.

Unit WD–6 encompasses approximately 85.4 ac (34.6 ha) of critical habitat, with an estimated 89 percent on Federal land and 11 percent occurring on private land. This unit is located in Eugene, along Ken Neilsen Road and West 11th Avenue. The federally owned land includes both BLM and Army Corp of Engineers lands.

Unit WD–7A consists of approximately 22.3 ac (9 ha) of critical habitat, primarily on Federal land, with 2 percent occurring on private land. WD–7A is located to the west of Green Hill Road and to the north of West 11th Avenue, and is managed by the Army Corp of Engineers.

Subunits WD–8A and 8B consist of approximately 135.9 ac (55 ha) of Federal and private lands in West Eugene, Oregon. These subunits are located near the intersection of Willow Creek and West 18th Avenue. An estimated 45 percent of this area occurs on private land with approximately 55 percent occurring on BLM land.

Subunit WD–9A encompasses an estimated 90 ac (36.4 ha) of private land and is located approximately 1.2 mi (2 km) east of the intersection of Pine Grove Road and Crow Road.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Erigeron decumbens var. decumbens critical habitat consists of one component (71 FR 63862-63977):

(i) Early seral upland prairie, wet prairie, or oak savanna habitat with a mosaic of low-growing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils.

Special Management Considerations or Protections

Because Erigeron decumbens var. decumbens does not tolerate the presence of woody vegetation, habitat management will be required for the long-term persistence of this species. Further investigation is needed to determine the most appropriate techniques for managing available habitat. Also, due to the low reproductive capability of the species, conservation of the E. decumbens var. decumbens will likely depend on artificially augmenting populations in areas where woody vegetation has been removed (Clark 2000, pp. 9-10). (USFWS, 2006)

Expanding Erigeron decumbens var. decumbens populations will require more investigation into the roles of sexual and vegetative reproduction of this species. If sexual reproduction proves to be most important for population recruitment, mangers will need to focus on strategies that promote flowering, seed production, and seedling establishment (Clark 2000, p. 9). However, if vegetative regeneration is predominant, managers will need to focus on activities that promote ramet (refers to individual plants in a clump, each portion of which is identical with the original parent plant) production (Clark 2000, p. 9). Clark et al. (1995b, pp. 22-23) found that vegetative propagation is a viable technique for E. decumbens var. decumbens; populations may also be increased by sowing seeds under appropriate conditions, although this technique appeared to be less effective than vegetative propagation. (USFWS, 2006)

Erigeron decumbens var. decumbens is at risk of inbreeding depression and site extirpation across their respective ranges because populations are small and isolated from one another. This species will benefit from reestablishing prairie plant patches in proximity to core populations. (USFWS, 2006)

Many remaining populations of Erigeron decumbens var. decumbens populations occur in road rights of ways and are adversely affected by maintenance activities such as mowing or spraying of herbicides at the wrong time of year. (USFWS, 2006)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: The Willamette daisy typically flowers throughout June and July (USFWS, 2016)

Reproduction Narrative

Adult: The Willamette daisy typically flowers throughout June and July with pollination carried out by syphrid flies and solitary bees (Clark et al.1995). The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August. The seeds of the daisy are achenes, like those of other Erigeron species, and have a number of small capillary bristles (the pappus) attached to the top, which allow them to be distributed by the wind. Due to the small size and number of these bristles, the seeds do not fly well in the wind, so seed distribution is quite restricted. The Willamette daisy is capable of spreading vegetatively through rhizomes over very short distances of less than 10 cm (4 inches) and is commonly found in large clumps scattered throughout a site (Clark et al.1993). Willamette daisy responds positively to late spring and early summer rains. Studies conducted at the Willow Creek Preserve indicate that

not all individuals of the Willamette daisy bloom every year, and that some individuals may remain dormant for an entire growing season (Kagan and Yamamoto 1987) (USFWS, 2016).

Habitat Type

Adult: Vally Prairie (USFWS, 2016)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (Natureserve, 2015)

Habitat Narrative

Adult: The Willamette daisy is typically occurs where woody cover is nearly absent and where herbaceous vegetation is low in stature (Clark et al.1993; USFWS 2010a). It occurs in both wet prairie grasslands and drier upland prairie sites. The wet prairie grassland community, which was historically maintained by periodic flooding and fires, is characterized by the dominance of tufted-hairgrass, California oatgrass, and a number of Willamette Valley endemic forbs. It is a flat, open, seasonally wet prairie with bare soil between the pedestals created by the bunching Deschampsia cespitosa (Kagan and Yamamoto 1987). On drier upland prairie sites, associated species commonly include Symphotrichum hallii, Festuca idahoensis ssp. roemeri and Toxicodendron diversilobum (Meinke 1982, Clark et al.1993). Willamette daisy prefers heavier soils, and has been found on the following soil associations: Bashaw, Briedwell, Chehulpum, Dayton, Dixonville, Dupee, Hazelair, Marcola, Natroy, Nekia, Pengra, Philomath, Salkum, Saturn, Stayton, and Witzel (USFWS, 2016).

Dispersal/Migration

Dispersal

Adult: Wind dispersed (USFWS, 2016)

Dispersal/Migration Narrative

Adult: The daisy produces and subsequently disperses large quantities of wind-dispersed seed in July and August (USFWS, 2016).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015; USFWS, 2016)

Number of Populations:

17 (USFWS, 2016)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The Willamette daisy is endemic to the Willamette Valley of western Oregon. Herbarium specimens show a historical distribution of Willamette daisy throughout the Willamette Valley; frequent collections were made in the period between 1881 and 1934, yet no collections or observations were recorded from 1934 to 1980 (Clark et al.1993). The species was rediscovered

in 1980 in Lane County, Oregon. At the time of listing, 28 occurrences of Willamette daisy were recognized with a total of 286 acres of occupied habitat (USFWS 2000). In 2010, the total acreage considered to be occupied was 233 at 39 sites (USFWS 2010a). In 2010, Willamette daisy was believed to be extant at 37 sites that comprise 17 populations (USFWS 2010b). Of these, 3 populations had been augmented and Willamette daisy had been introduced to 5 new sites since the time of listing. Three of the extant populations are the direct result of recent introductions, and 5 natural populations have been discovered since the time of listing. Willamette daisy is believed to be extirpated or the status is unknown at 11 sites where it was previously documented. Of these sites, 8 were known at the time of listing, including 5 that represented individual populations and 3 that likely contributed to larger populations. Current population estimates are based on available information from 2004 to 2010 (USFWS 2010b). For most sites, long-term data needed to detect population trends is not available. In some cases, documentation of the number of plants at a site is not available. Where sites are within 3 km (2 miles) of each other, they are generally considered to be subpopulations that comprise a larger population (i.e., metapopulation) based on pollinator travel distance (USFWS 2010a). Of the 17 currently known populations, only 2 include protected sites that support relatively large subpopulations (i.e., with over 2,000 plants) known to have been stable for 8 years or more (USFWS 2010b). Trend data is not available for most sites, and many sites are not formally protected. Recovery criteria outlined for downlisting have not been met in any of the recovery zones. Almost all previously identified threats to the species still remain. Significant progress has been made to store genetic material, and efforts to collect and store seed will likely continue. Population size may fluctuate substantially from year to year. Monitoring at the Oxbow West site, near Eugene, found 2,299 Willamette daisy plants in 1999, 2,912 plants in 2000, and only 1,079 plants in 2001 (Kaye and Brandt 2005). The population at Baskett Butte declined to 48% of the original measured population between 1993 and 1999 (Clark 2000; Clark et al.1995). Detecting trends in Willamette daisy populations is complicated by the biology and phenology of the species. For instance, Kagan and Yamamoto (1987) found it difficult to determine survival and mortality between years because of irregular emergence and sporadic flowering from year to year. They suggested that some plants probably lie dormant during some years, as indicated by the sudden appearance of large plants where they were not previously recorded, and the disappearance and later re-emergence of large plants within monitoring plots. In addition, Clark et al.(1993) stated that non-reproductive individuals can be very difficult to find and monitor due to their inconspicuous nature, and that the definition of individuals can be complicated when flowering clumps overlap (USFWS, 2016).

Threats and Stressors

Stressor: Development (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Like many native species endemic to Willamette Valley prairies, the Willamette daisy is threatened by habitat loss due to urban and agricultural development (USFWS, 2016).

Stressor: Encroachment/woody succession (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Secondary successional encroachment of habitat by trees and brush is a threat to this species (USFWS, 2016).

Stressor: Competition (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition with non-native weeds is listed as a threat to this species (USFWS, 2016).

Stressor: Small populations (USFWS, 2016)
Exposure:
Response:
Consequence: Extinction/lack of genetic diversity
Narrative: Small population sizes (Kagan and Yamamoto 1987, Clark et al.1993) are listed as a threat to this species (USFWS, 2016).

Stressor: Private land (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Service (USFWS 2000) estimated that habitat loss is occurring at 80% of remaining 84 remnants of native prairies occupied by Willamette daisy and Kincaid's lupine. The Service (USFWS 2000) also stated that 24 of the 28 extant Willamette daisy populations occur on private lands and, "without further action, are expected to be lost in the near future."

Recovery

Reclassification Criteria:
1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. Subpopulations contributing to larger interacting populations should be within pollinator flight distance (3 kilometers [2 miles]) of each other. See Table IV-3 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 10 years. The term "stable" in this context does not mean that the population size is static over time; over a period of 10 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1 above must meet these criteria: (a) Prairie quality. Sites supporting populations of the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (e.g., nest sites and food plants) for native pollinators. See Appendix D of the Recovery Plan for suggested criteria for evaluating prairie quality and diversity. (b) Security of habitat. For each

listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species. (c) Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with Sidalcea nelsoniana or Lupinus sulphureus ssp. kincaidii should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species. (USFWS, 2010)

Delisting Criteria:
Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-3 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 2 above must meet these criteria: (a) Prairie quality. Same as Downlisting Criterion 1. (b) Security of habitat. Same as Downlisting Criterion 1. (c) Management, monitoring, and control of threats. Same as Downlisting Criterion 1. (USFWS, 2010)

4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

Recovery Actions:

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)
- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)
- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)
- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish

and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans, data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)

- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)
- Recommendation for Future Action from 2019 5-Year Review: Action 1: Survey and Monitor: • Maintain information about what is currently known about the locations of extant and extirpated sites. •Maintain map with historical and extant populations and potential introduction sites. •Survey known and potential extant populations where status of populations or possible extirpation is unknown; identify and assess factors that appear to be driving population trends at occupied sites. • Monitor key populations and identify factors that may be driving population trends at occupied sites. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 2: Habitat Protection, Management and Restoration: • Select populations and lands on which to focus protection, management and restoration recovery actions. • Work with landowners to restore, manage and reduce threats to significant sites. • Work with partners to explore and develop opportunities to protect key populations on private lands. • Work to secure significant unprotected sites. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 3: Seed Collection, Propagation and Banking: • Continue on-going seed collection efforts for propagation and banking. • Identify sites for additional seed collection. • Increase seed availability through cultivation and propagation at facilities that can manage genetic diversity and any necessary isolation. (USFWS, 2019)

- Recommendation for Future Action from 2019 5-Year Review: Action 4: Research: • Conduct demographic studies to determine how Willamette daisy responds to restoration and management treatments. •Research genetic and reproductive biology questions related to progeny fitness, demographic trends and the breeding system for use in developing seed transfer and augmentation guidelines, and to evaluate inbreeding depression concerns. •Research effects of climate change and voles on Willamette daisy populations and develop recommendations for responses to these threats. (USFWS, 2019)
- Recommendation for Future Action from 2019 5-Year Review: Action 5: Augment Small Populations and Reintroduce Willamette Daisy to Suitable Habitats: • Identify protected populations that would be likely to benefit from augmentation and suitable habitats in strategic locations between secure populations that could be used as reintroduction sites. • Implement augmentation projects; develop management plans with landowners, as needed. • Implement (re)introduction projects; develop management plans with landowners, as needed. (USFWS, 2019)

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SPECIES ACCOUNT: *Erigeron parishii* (Parish's daisy)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/24/1994; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Parish's daisy is a small perennial herb in the aster family (Asteraceae) that reaches 4 to 12 inches (10 to 30 centimeters) in height (Nesom 1993, p. 260). The leaves are 1 to 2 inches (2 to 5 centimeters) long, simple, linear and covered with soft, silvery hairs (Nesom 1993, p. 260). Flower heads are solitary and borne at the tips of leafy stems, with bluish to pink or white ray flowers and yellow disk flowers. Grayish-green glandular bracts surround each flower head (USFWS 2002, p. 78571). Parish's daisy generally flowers between May and June (CNPS 2001). (USFWS, 2009)

Historical Range

Historical collections of this plant were made from Rattlesnake Canyon south of Old Woman Springs, and from Long Canyon in the Little San Bernardino Mountains in Joshua Tree National Park (USFWS 1994, p. 43653). (USFWS, 2009)

Current Range

Since the most recent 5-year review (Service 2009, entire), our knowledge of Erigeron parishii distribution has grown. Previously, we described the range of E. parishii as spanning approximately 35 miles (mi) [56 kilometers (km)] (Service 1994, p. 43653; 2009, p. 3). However, the range of the species is now known to span approximately 50 mi [80 kilometers (km)], including into northern Riverside County, California (Figure 1). The 50-mi (80 km) range extends from the northern edge of the San Bernardino Mountains (north and east of Big Bear Lake), southeast to Quail Mountain in the Little San Bernardino Mountains, Joshua Tree National Park, California (USFWS, 2022).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Erigeron parishii (Parish's daisy) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for Erigeron parishii includes one CHU (25 subunits) in San Bernardino County, California (67 FR 78570-78610).

Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin, Big Bear City, and Onyx Peak, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Erigeron parishii critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from upstream or upslope limestone, dolomite, or quartz monzonite parent materials that occur on dry, rocky hillsides, shallow drainages, or outwash plains at elevations between 1,171 and 1,950 m (3,842 and 6,400 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Breeding Season

Adult: May to June (USFWS, 2009)

Reproduction Narrative

Adult: Parish’s daisy generally flowers between May and June (CNPS 2001).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 1,171 to 1,950 m (3,842 to 6,400 ft); prefers open canopy cover (USFWS, 2009)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Soils Erigeron parishii occurs primarily on carbonate soils in the San Bernardino Mountains. At the time of the 2009 5-year review, we were only aware of two locations where E. parishii grew on soils that are not associated with limestone (Service 2009, p. 5). At the Burns Pinyon Ridge Reserve (EO 22) and an adjacent occurrence near Pioneertown (EO 27), the species occurs on quartz monzonite with no apparent limestone alluvium (Neel 2000, p. 84). Since 2009, E. parishii has been discovered at several new locations that are farther east and southeast of their range in carbonate soils of the San Bernardino National Forest and adjacent areas (CDFW 2022, dataset). Many of the newly discovered E. parishii occurrences are in soils derived from gneiss, granodiorite, or monzogranite (Fraga et al. 2014, pp. 13, 36). A detailed soil analysis was conducted for the Quail Mountain occurrence (EO 47), the largest population of Erigeron parishii in Joshua Tree National Park (Rindfleisch 2009, entire). The analysis determined that preferred habitat for E. parishii includes areas with very shallow to shallow soils (Rindfleisch 2009, p. 72). In some cases, individual plants grew directly out of cracks in the bedrock or directly next to, or under, outcrops of granitic or gneissic bedrock (Rindfleisch 2009, p. 72). In most cases, soils were dominantly sandy loams with moderate amounts of coarse fragments (Rindfleisch 2009, p. 72). Habitat New information has become available about Erigeron parishii habitat in Joshua Tree National Park. In addition to the soil type information in the section above, E. parishii in the Quail Mountain occurrence (EO 47) grow exclusively on rocky northern aspects, primarily on low hills with slopes up to 35 percent (Rindfleisch 2009, p. 72). This population of E. parishii grows in a variety of microhabitats that can be generally described as either (1) steep slopes with gneiss outcrops and loose loamy soil or (2) among granitic boulders along the canyons and washes, often growing from rock crevices (La Doux 2022, p. 1). For comparison, the typical description of occurrences in the western part of the species' range is that E. parishii often grow on alluvium in washes in canyon bottoms (USFWS, 2022).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Long-term trends indicate a decline of 50 to 70%, while a short-term trends suggest a decline of 10 to 30% (NatureServe, 2015)

Number of Populations:

51 occurrences (USFWS, 2022)

Population Size:

>20,000 (USFWS, 2022)

Population Narrative:

Long term trends indicate a population decline of 50 to 70%, while short-term trends suggest a decline of 10 to 30%. According to the final listing rule, Parish's daisy was known from fewer than 25 occurrences with a total population size of about 16,000 individuals (USFWS 1994, p. 43653). There are 32 known occurrences and 2 are historic. (NatureServe, 2015). The Western Group, primarily in San Bernardino National Forest, includes the majority of occupied habitat and designated critical habitat. The Eastern Group includes a cluster of locations at the eastern edge of San Bernardino National Forest and all locations in the Bighorns Mountains. The Southeastern Group contains all locations in the Little San Bernardino Mountains, including the locations near Pioneertown and in Joshua Tree National Park. Nineteen new occurrences have been documented since the 2009 5-year review, all of which are Element Occurrences2 (EO) in the CNDDB. Of the 19 new occurrences, 4 are in the San Bernardino National Forest, 11 are on BLM land, and 4 are in Joshua Tree National Park. All of the new occurrences are in the Eastern and Southeastern geographic groups. Currently, we consider there to be 51 Erigeron parishii EOs in the CNDDB (CDFW 2022, dataset; Table 1). While the CNDDB dataset includes 52 EOs, the location of 1 of the occurrences (EO 64, directly north of Lake Arrowhead in the western San Bernardino Mountains) is likely erroneous. The actual location of the 2017 observation is likely in carbonate habitat west of the Mitsubishi plant in San Bernardino National Forest, where the observer recorded another plant on the same date (Crawford 2022, pers. comm.). Of the 51 occurrences, 26 are extant (i.e., the species was observed during the past 10 years), 24 are presumed extant (i.e., the species was not observed during the past 10 years, but suitable habitat is present), and 1 has an unknown status because the occurrence is unconfirmed (CDFW 2022, dataset; Table 1). At the time of the listing rule in 1994, the total population of Erigeron parishii was estimated at 16,000 individuals among fewer than 25 occurrences (Service 1994, p. 43653). Twenty years later in 2014, the number of known occurrences had increased to 41 and the total population of E. parishii was estimated at just over 20,000 individuals (Fraga et al. 2014, p. 17). Fraga et al. (2014, p. 17) noted that the most abundant occurrences are in the San Bernardino Mountains and population size is thought be decreasing in at least five occurrences, including in the largest population (EO 14). We consider the current total population of Erigeron parishii in 2022 to be similar to the 2014 estimate of just over 20,000 individuals (Fraga et al. 2014, p. 17). Although 10 new occurrences have been documented since the 2014 estimate, none are reported to be abundant or extensive. Reports for these 10 occurrences range from an observation of a single vegetative individual to an observation of 50–100 plants (CDFW 2022, dataset). With the exception of the occurrence with 50–100 plants, all numerical observations were of 15 plants or fewer. In summary, Erigeron parishii survey efforts have detected numerous additional locations, bringing the number of total occurrences to 51, more than twice as many occurrences as were known at the time of listing. Of the 51 known occurrences, 19 were discovered (or reported) for the first time since the 2009 5-year review. With the newly discovered occurrences, our understanding of E. parishii distribution has improved. We now consider the species' range to span approximately 50 mi (80 km), primarily in San Bernardino County but also extending into northern Riverside County. Considering the larger range and increased number of known occurrences, the rangewide abundance of E. parishii may be greater than previous estimates (i.e., 16,000 in the listing rule and just over 20,000 in a 2014 Conservation Assessment). However, an increase in the number of E. parishii occurrences does not suggest a commensurate increase in total population abundance. Population size in some occurrences may be decreasing (Fraga et al. 2014, p. 17) and most of the occurrences discovered since 1994 are small in comparison to the long-known occurrences in the western

part of the range (CDFW 2022, dataset (USFWS, 2022).

Threats and Stressors

Stressor: Mining (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Mining activity remains the primary threat for Parish's daisy (USFWS 2005a, p. 246). Mining can impact habitat through the removal of mined materials, disposal of overburden, and road construction (USFWS 1997, pp. 17–18). (USFWS, 2009)

Stressor: Dust (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Dust can affect Parish's daisy by altering soil chemistry and light penetration into seedbanks (USFWS 1997, p. 17–18). (USFWS, 2009)

Stressor: Artificial lighting (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Artificial lighting may affect Parish's daisy's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18). (USFWS, 2009)

Stressor: Off-road vehicle (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The final listing rule indicated off-road vehicle use and energy development projects were a threat to Parish's daisy. Such activities could impact the species' habitat through ground disturbance or dust creation. About 6 acres (2 hectares) of occupied habitat and 20 acres (8 hectares) of designated critical habitat for Parish's daisy overlap with roads and motorized vehicle trails (USFWS 2005a, p. 256). The San Bernardino National Forest has closed road 3N77 and placed signs and barriers for the other roads (USFWS 2001, p. 18), which should help limit impacts due to off-road vehicle use. Additionally, road 3N11A is proposed for decommissioning and roads 3N03D, 3N54, 3N88, and 3N88B are proposed for reclassification as administrative use only (USFWS 2009, p. 2), which should reduce vehicle activity in the area and further reduce the threat to the species. We are unaware of any energy development or off-highway vehicle projects occurring since listing that affect Parish's daisy. (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities have been identified since listing (USFWS 2001, pp. 4-11). These activities can result in trampling of Parish's daisy and impact its habitat through ground disturbance or dust creation. In addition, fire suppression activities can result in ground disturbance through fire line construction, retardant and water drops, and establishment of fire camps. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The threat of predation from burro grazing was identified after listing (USFWS 2001). However, burros are expected to have minimal effects to Parish's daisy due to the low numbers of burros present (about 60), the dispersal of the burros across a large area, the burros preference for wetter habitats, and the short stature and scarce nature of carbonate plants, which makes foraging on them unlikely (USFWS 2001, p. 39). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Climate change is a threat that was not mentioned in the final listing rule for Parish's daisy. This issue was also raised in a letter received by the Service on May 6, 2008 (Potter, in litt. 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (IPCC 2007; Cayan et al. 2005; Field et al. 1999). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. Parish's daisy is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains and near Pioneertown to the east. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. There will be no suitable habitat when the elevational range exceeds the species' maximum elevation. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The potential for stochastic extinction is enhanced by habitat loss and fragmentation and drought. Habitat fragmentation can result in areas too limited and isolated to support pollinators or other seed dispersal agents (USFWS 1997, p. 16). (USFWS, 2009)

Stressor: Climate change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Climate change refers to a shift in the mean or variability in measures of climate (e.g., precipitation or temperature) that persists for an extended period, typically a decade or more,

due to natural variability, human activity, or both (IPCC 2013, p. 1450). A recent climate change vulnerability assessment of Mojave Desert region plants classified Erigeron parishii as "moderately vulnerable" to climate change, meaning that the species' abundance and/or range extent are likely to decrease by 2050 (Wilkening et al. 2021, pp. 7, 11, Table 2, Table 3). The key factors contributing to E. parishii vulnerability in the assessment were natural barriers that restrict movement in response to changing climatic conditions, dispersal ability, and physical habitat (dependence upon a particular uncommon landscape or geological feature) (Wilkening et al. 2021, pp. 11–12, Table 3). The 2009 5-year review described climate change as a threat to Erigeron parishii, but regionspecific projections of future climatic conditions were uncertain (Service 2009, p. 12). Since then, downscaled projections under multiple future climate scenarios have become available for California and its sub-regions, including the range of E. parishii. The following sub-sections describe projections for changes in temperature and precipitation within the range of E. parishii based on recent downscaled climate models (USFWS, 2022).

Stressor: Grazing (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: The threat of grazing by burros was discussed in the 2009 5-year review but the potential effects to Erigeron parishii from burro grazing are considered minimal (Service 2009, p. 9). Cattle grazing was not described as a threat to E. parishii in the final listing rule (Service 1994, entire) or the previous 5-year review (Service 2009, entire). However, cattle grazing has been reported as a threat to 10 occurrences of E. parishii in the eastern San Bernardino Mountains and Bighorn Mountains (CDFW 2022, dataset). Effects to E. parishii from cattle could include predation (Factor C) or trampling and ground disturbance (USFWS, 2022)

Recovery

Reclassification Criteria:
1. The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to: 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000 hectares (5,000 acres) based on known areas occupied by the plants and should include protection for the threatened species, Erigeron parishii (which is discussed separately under the delisting objective and criteria). (USFWS, 2009)

2. Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 1,860 hectares (4,600 acres), including lands to meet Delisting Criterion #2 for Erigeron parishii. (USFWS, 2009)

Recovery Priority Number: 8C

Delisting Criteria:
1. Consistent with Downlisting Criterion #1, essential extant populations of Erigeron parishii are conserved on public lands specified in Downlisting Criterion #1 for the endangered carbonate

plants, plus lands where Erigeron parishii is the only listed plant, in order to represent the southeastern portion of Erigeron's range, with connections to other populations and reserves. Priority of protection will be determined by the ranking factors in Downlisting Criterion #1 for the four other carbonate plants (excepting the need for Erigeron parishii sites to represent the southeastern portion of its range). (USFWS, 2009)

2. Any additional lands necessary to connect otherwise isolated reserve areas, provide strategic buffer zones and potential population reintroduction expansion areas are protected. This criterion may be fulfilled in conjunction with Downlisting Criterion #2 [for the endangered carbonate plants]. (USFWS, 2009)

3. Early detection of problems in the reserve system is assured through adaptive population monitoring/adaptive management programs. Protocols for responding to problems are in place. Ecological restoration of human-disturbed sites (closed OHV [off-highway vehicle] roads, abandoned quarries, etc.) that formerly affected Erigeron parishii habitat is in progress. (USFWS, 2009)

Recovery Actions:

- Identify, design, and establish endemic plant species reserves encompassing the extant populations. (USFWS, 1997)
- Identify and conserve additional habitat needed to recover the species. (USFWS, 1997)
- Answer ecological and management questions described in Downlisting Criterion 2. (USFWS, 1997)
- Identify monitoring programs needed to support adaptive management and initiate them. (USFWS, 1997)
- Evaluate recovery efforts and implement corrective measures. (USFWS, 1997)
- Begin to establish a public constituency for the endangered taxa by developing and implementing a public education program. (USFWS, 1997)
- Prepare a new threats-based recovery plan specific to Parish's daisy that identifies a recovery strategy, objectives, and criteria for delisting. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Parish's daisy. (USFWS, 2009)
- Work with the San Bernardino National Forest to conduct systematic monitoring of Parish's daisy throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change. (USFWS, 2009)
- Work with partners, such as the San Bernardino National Forest, to help conserve Parish's daisy by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Parish's daisy from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Parish's daisy habitat. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to

Erigeron parishii and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Continue implementation of the Carbonate Habitat Management Strategy, particularly additions of E. parishii habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value. 2. Research E. parishii populations' susceptibility to climate change by determining climate tolerances (e.g., temperature, drought duration) for reproduction and survival of different age or size classes. Identify areas of climate refugia to protect in different populations across the range. 3. Determine appropriate monitoring frequency for E. parishii and implement a range-wide monitoring strategy that provides useful information about occupancy and population health. 4. Conduct a species status assessment to assess viability given climate change projections, conservation, and progress in threat reduction. The assessment may be used to revise recovery criteria or to inform a reclassification decision. 5. Continue managing the threat of roads, off-road vehicle activity, or other recreational activities to carbonate habitat. This may be achieved through road decommissioning, installation and maintenance of signs and barriers, or other management. 6. Research the efficacy of restoring E. parishii populations on reclaimed lands that have been restored after mining. 7. Finalize the establishment of the proposed Blackhawk Research Natural Area. 8. Collect additional E. parishii seeds, as needed, to maintain a viable and genetically diverse conservation seed bank (USFWS, 2022).

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SPECIES ACCOUNT: *Erigeron rhizomatus* (Zuni fleabane)

Species Taxonomic and Listing Information

Listing Status: Threatened; 04/26/1985; Southwest Region (R2) (USFWS, 2016)

Physical Description

A perennial herb that produces clumps of stems, about 3 dm in diameter and 2.5-4.5 dm tall. Solitary white (sometimes tinged blue-violet) flower heads bloom at the tops of the stems during May and June (NatureServe, 2015).

Taxonomy

The two species Erigeron rhizomatus and Erigeron lepidopodus (of Chihuahua and Durango, Mexico) have been sectionally consolidated as Erigeron sect. Geronpternix Nesom & Noyes. Section Geronpternix is the most primitive phylogenetic element of the genus Erigeron (Nesom and Noyes 1999). This sectional reclassification indicates the great phylogenetic age of Zuni fleabane and its basal position in the evolution of this large genus (USFWS, 2007).

Historical Range

Zuni fleabane was discovered on the Navajo Nation in 1999 by botanist, Arnold Clifford, in the Chuska Mountains on the New Mexico/Arizona border in northwestern New Mexico and northeastern Arizona (USFWS, 2007).

Current Range

Occurs in the Datil and Sawtooth Mountains in northern New Mexico. McKinley and Catron counties in the Cibola National Forest, and some on Bureau of Land Management public land in Catron County. Also found in Arizona on the east side of the Chuska Mountains in June 1999 (Sue Schuetze pers. comm. to Eric Nielsen 6/2000) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual (USFWS, 2007)

Lifespan

Adult: 2+ years (inferred from NatureServe, 2015)

Breeding Season

Adult: May - June (USFWS, 1988)

Reproduction Narrative

Adult: It is a perennial species (NatureServe, 2015). Most propagation of Zuni fleabane probably occurs asexually by the spread of rhizomes (Knight 1988). Within populations, isolated plants

can be found many meters from others, which indicates at least some sexual reproduction and propagation by seed (Knight and Cully 1988; Sivinski, unpublished observations 1991, 1999, 2004). Seed production is evident in all populations, but can sometimes be depressed, possibly by abortion or lack of pollination (USFWS, 2007). It generally flowers from May to June, with fruiting from June to July (USFWS, 1988).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodlands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: 20 - 40% slopes (USFWS, 1988)

Geographic or Habitat Restraints or Barriers

Adult: 7,500 - 8,400 ft. elevation (USFWS, 2007)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs in Pinyon-juniper woodlands on steep easily eroded sandstone slopes and clay banks, usually in close association with the Chinle and Baca Formations. The environmental specificity is very narrow (specialist or community with key requirements scarce) (NatureServe, 2015). Zuni fleabane is specialized to nearly barren shale outcrops that have not yet been occupied by any exotic plant or animal species (Sivinski, unpublished observations, 1991, 1999, 2004). Occupied habitats range in elevation from 7,500 to 8,400 feet (USFWS, 2007). The core of most of the population sites is centered on loose, non-crusted soil on slopes of 20 - 40% (USFWS, 1988).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Resiliency:

Resiliency ensures that populations are sufficiently large to withstand stochastic events, and the identified threats have been ameliorated. A stable or increasing trend in abundance indicates that annual mortality is compensated by recruitment events, and at the scale of the population this indicates the resiliency of subpopulations. A minimum of 5,000 individuals has emerged as a conservation metric across taxa (Traill et al. 2007: 164); this number allows for the maintenance of genetic diversity (representation) within each population and across the species. Chuska and

Datil Populations fluctuate around this population level so should be able to be maintained at this level (their respective numeric goals were generated from the median calculated from limited available data). Because of its smaller area (only two known sub-populations) of suitable habitat, 800 individuals should be sufficient to maintain the Zuni Population. We used these numbers as the minimum number of individuals needed to maintain a viable population. A robust monitoring plan will need to be designed and implemented to provide the data necessary to identify statistically significant trends at the population and species level. The establishment of a seed banking program that would protect the species in perpetuity, and would provide the ability of a transplant program in the future, would provide a measure of species' resiliency in the face of climate change. (USFWS, 2019)

Representation:

Maintaining populations across a range of environmental conditions builds representation into the conservation framework at the species level by requiring functioning populations in three distinct geographic areas spread across the species range. Two large populations (7,500 and 4,500 individuals) help maintain genetic diversity across the species range. (USFWS, 2019)

Redundancy:

Redundancy provides for security against extinction from catastrophic events that could impact a single population. An estimated annual patch occupancy rate of 80 percent allows for annual variability in localized patch occupancy due to stochastic events, while ensuring both population persistence (redundancy) and the localized resiliency of subpopulations. As there are only two known subpopulations in the Zuni Population, both subpopulations must remain occupied concurrently over a reasonable period of time (75 percent of the 20-year survey period) to demonstrate redundancy. Maintaining each population (Datil, Chuska, and Zuni) builds redundancy into the conservation framework at the species level. (USFWS, 2019)

Number of Populations:

49 (USFWS, 2020)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Adaptability:

High (inferred from USFWS, 2007)

Population Narrative:

The southernmost metapopulation occurs in the Datil/Sawtooth Mountains of northern Catron County, New Mexico, and consists of 32 known local subpopulations ranging in size from 4 to over 700 individuals. The Zuni Mountains metapopulation in McKinley County, New Mexico is smaller, with only two isolated local subpopulations of 143 and 22 plants, respectively. The Chuska Mountains metapopulation in McKinley and San Juan counties, New Mexico and adjacent Apache County, Arizona was discovered in 1999. A 2004 survey of the Chuska Range documented a total of 15 local subpopulations ranging in size from 25 to greater than 2,500 individuals, and surveys in 2019 expanded the total to 18 known subpopulations. Additional local populations will likely be found within the three known metapopulations, and it is possible that new discoveries of Zuni fleabane could be made in northeastern Arizona that would extend the range of this species to the north or west. (USFWS, 2020)

Threats and Stressors

Stressor: Mineral exploration and development (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: All known populations of Zuni fleabane are within Federal or tribal jurisdictions where there are few potential threats at this time. The only significant potential threat to Zuni fleabane at this time is mineral exploration and development. This species is confined to the Chinle and Baca geologic formations, which are known for uranium claims and subsequent mining. Oil and gas exploration and development is currently occurring in the vicinity of a Chuska Mountains local population. No other populations are within known areas of active gas or oil exploration or development. The Energy Bill passed by Congress in 2005 may reinvigorate development plans for new nuclear energy generating stations that would use uranium as fuel. Greater future demand for this mineral could increase its market price and potentially revive the uranium mining industry in New Mexico. The northern-most Chuska Mountain population of Zuni fleabane in Arizona is the only population that has actually been impacted by a mineral prospect, possibly for uranium (Sivinski and Tonne 2004) (USFWS, 2007).

Stressor: Climate change (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Climate change could result in more intense and frequent periods of drought in Zuni fleabane habitats, with increased temperatures exacerbating conditions of limited moisture availability. Data indicates that Zuni fleabane has historically been exposed to decades-long droughts (Stahle et al. 2000), and populations have persisted. Despite Zuni fleabane being well adapted to drought conditions, extended dry periods coupled with elevated temperatures may significantly affect this species (Roth and Sivinski 2014). Recent drought conditions appear to be responsible for continuing population declines within the Zuni Mountains metapopulation. Climate responses may vary among populations and reflect the degree of limitation by growing season length (Christie and McBride 2020). Overall, it is difficult to predict the magnitude of climate change effects on the rangewide persistence and/or recovery of Zuni fleabane. (USFWS, 2020)

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Over a 20-year survey period, monitoring demonstrates a stable or increasing trend in abundance (including evidence of a stable demographic structure) across the Datil Population.* During a minimum of 80 percent of the survey period (i.e., 16 years), an estimated minimum population of 7,500 individual plants will remain extant in the Datil Population. Monitoring will demonstrate a minimum estimated patch occupancy rate (number of subpopulations with occupied habitat divided by total number of subpopulations) of 80 percent per annum (USFWS,

2019)

2. Over a 20-year survey period, monitoring demonstrates a stable or increasing trend in abundance (including evidence of a stable demographic structure) across the Chuska Population*. During a minimum of 80 percent of the survey period (i.e., 16 years), an estimated minimum population of 4,500 individual plants, will remain extant in the Chuska Population. Monitoring will demonstrate a minimum estimated patch occupancy rate (number of subpopulations with occupied habitat divided by total number of subpopulations) of 80 percent per annum. (USFWS, 2019)

3. Over a 20-year survey period, monitoring demonstrates a stable or increasing trend in abundance (including evidence of a stable demographic structure) across the Zuni population*. During a minimum of 80 percent of the survey period (i.e., 16 years), an estimated population of 800 individual plants, will remain extant in the Zuni population. Monitoring will demonstrate that both subpopulations remain occupied an estimated minimum of 75 percent of the survey period (i.e., 15 years). If future surveys discover additional subpopulations, then the 80 percent estimated patch occupancy rate described in criteria 1 and 2 would apply. (USFWS, 2019)

4. The permanent withdrawal from mineral entry for Zuni Fleabane occupied habitat on Forest Service lands or the development and implementation of a habitat management plan (HMP) will be completed. The HMP should include a minimum of a 100 meter (300 foot) surface disturbance buffer around occupied Zuni Fleabane habitat, and would prioritize avoidance of occupied habitat, and ensure connectivity for pollination between subpopulations. (USFWS, 2019)

5. A Service approved post-delisting monitoring plan will be implemented. (USFWS, 2019)

6. A robust seed banking program should be established, thus providing the potential for species resiliency and recovery over evolutionary time. (USFWS, 2019)

Recovery Actions:

- Remove threats by coordinating with the Bureau of Land Management and the U.S. Forest Service (USFWS, 1988).
- Enforce existing laws and regulations (USFWS, 1988).
- Assemble documentation on mineral potential or planned development (USFWS, 1988).
- Develop a habitat management plan in cooperation with the involved agencies for the long-term protection of habitat (USFWS, 1988).
- Install permanent monitoring plots at population and initiate biological, ecological and geological studies of the species and its habitat to develop an understanding of the requirements needed to sustain healthy populations (USFWS, 1988).
- Develop public support for the preservation of Zuni fleabane (USFWS, 1988).
- The highest priority to facilitate recovery for Zuni fleabane is to revise the recovery plan. Threat assessments and recovery criteria should incorporate new information and clearly define recovery actions. Because the only significant potential threat to Zuni fleabane at this time is uranium mining, the revised recovery plan should contain objective, measurable criteria to alleviate this threat. Administrative actions by Federal land management agencies to reduce the threats from mining activities will be necessary to fully recover the species

(USFWS, 2007).

- After the Recovery Plan is revised, the Service should work with the U.S. Forest Service and Bureau of Land Management to develop priorities and protocols for withdrawing current and future mineral claims from portions of Zuni fleabane habitats. Administrative mineral withdrawals should be quickly implemented. Although the recovery priority for this species is low, its potential for recovery is presently high. Should the price of uranium increase in the future, the minerals under significant populations of Zuni fleabane could be claimed again and the opportunity for recovery lost (USFWS, 2007).
- Special management areas, such as Areas of Critical Environmental Concern, may not provide the long-term assurance suitable for recovery criteria. Special management area prescriptions to withdraw minerals from claim are temporary and could be eliminated after Zuni fleabane is removed from the list of threatened species. Should the special management area protections cease, Zuni fleabane may need protection afforded by its current threatened status again. Therefore, the recovery criteria should address the long-term need for special management after Zuni fleabane is removed from the list of threatened species (e.g., Recovery Management Agreement; Scott, et al. 2005) (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The highest priority action remains the protection of occupied Zuni fleabane habitat in perpetuity, either through permanent withdrawal of mineral claim or another habitat protection mechanism. This action constitutes recovery criteria number (4), and would significantly reduce the risk of land use practices that may negatively affect Zuni fleabane. In an effort to safeguard Zuni fleabane from unexpected or unavoidable threats (i.e., climate change), development of a seed collection and banking program is recommended. Included as recovery criteria number (6), a robust seed bank would allow for a potential ex situ propagation and transplant program, and would increase the species' resiliency moving forward. The Service should investigate opportunities to collaborate with the Navajo Native Plants Program in collecting, banking, and growing native plant seeds, including Zuni fleabane. Continued survey efforts are integral to the management of Zuni fleabane, and must be supported. Recurring surveys should be maintained at the known populations to monitor population trends, and partnerships should be explored to survey suitable habitat that is currently unoccupied or on private lands. Adequate survey efforts are necessary to demonstrate compliance with recovery criteria numbers (1), (2), and (3), and provide support for adaptive management as different recovery tools become available. The Service should continue to work with land and resource managers to achieve consistent, long-term habitat protections and stable population trends for all populations of Zuni fleabane. An immediate need is for additional information to support a U.S. Forest Service application for withdrawal of Zuni fleabane habitats from mineral exploration and development. The Service should work with agency and academic partners to develop, refine, and validate a habitat model for Zuni fleabane. This would provide the most defensible scientific basis possible for protecting occupied and unoccupied habitats necessary to achieve recovery of this species. (USFWS, 2020)

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SPECIES ACCOUNT: *Eriodictyon altissimum* (Indian Knob mountain balm)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1/17/1995; California/Nevada (Region 8)

Physical Description

Indian Knob mountainbalm (Eriodictyon altissimum) is a narrowly endemic, perennial shrub in the Namaceae (nama) family. It grows up to 5.5 meters (m or 18 feet [ft]) tall. Indian Knob mountainbalm has dark green, linear leaves with revolute (strongly rolled under) margins. The inflorescences are scorpioid cymes, where the oldest flower in the arrangement terminates the main axis and continues to branch and curl over in a one-sided coil, like a scorpions' spiraling tail. The individual flowers occur on pedicels, are purple, and are funnelform in shape with five lobes (USFWS, 2024)

Taxonomy

First collected on Indian Knob by Philip V Wellsin 1960, and was described by him two years later (Wells 1962). In the waterleaf family (Hydrophyllaceae). (USFWS, 1998) Recognized by Kartesz (1994 checklist and 1999 floristic synthesis); Kartesz notes (pers. comm. to Larry Morse, 25Nov99) that "this appears to be a large-flowered expression of Eriodictylon angustifolium, but is probably worthy of recognition as a species." Skinner and Pavlik (1994) note that its taxonomic relationship to E. angustifolium needs clarification. The 2nd edition of The Jepson Manual (Baldwin et al. 2012) accepts it as distinct. (NatureServe, 2015)

Historical Range

Endemic to western San Luis Obispo County, California (USFWS, 2019b)

Current Range

Known from sevel locations in San Luis Obispo County, California (USFWS, 2019b)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1998)

Lifespan

Adult: Long-lived (USFWS, 1998)

Breeding Season

Adult: March to July (USFWS, 2024)

Other Reproductive Information

Adult: Indian Knob mountainbalm blooms March through July. It has capsule fruits with four valves (and two separate chambers), and most members of the genus generally produce many seeds (Hannan 2021, website; Keil 2022, pp. 555–556). However, seed production in Indian Knob mountainbalm is considered low to absent. The species has both above-ground stems and underground rhizomes. A single genetic individual can spread vegetatively via the rhizomes, producing a colony (genet) of identical above-ground stems ([ramets], Guilliams and Hasenstab-Lehman 2021, pp. 1–2). This clonality can pose challenges in the field when trying to assess the actual number of individuals present in a given stand because groupings of Indian Knob mountainbalm ramets likely contain few distinct individuals (USFWS, 2024).

Reproduction Narrative

Adult: The Indian Knob mountain balm is believed to be relatively long-lived; slow-growing lichens can be found attached to its woody stems. Fruits contain a single ovule and seed set is low in those plants in which it has been recorded (John Chesnut, pers. comm. 1997). It is not known if Indian Knob mountain balm is self-compatible; however, it is possible that some colonies are also composed of a single clone. In addition to sexual reproduction, this species regenerates by root sprouts. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, Shrubland/chaparral, Woodland - Hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers sandstone ridges (NatureServe, 2015)

Environmental Specificity

Adult: Very Narrow (USFWS, 1998)

Habitat Narrative

Adult: Indian Knob mountain balm occurs in soils derived from marine sandstones containing tar deposits referred to as “tarsands” and, in the northern part of its range, on Baywoodfine sands and weathered ancient dune soils. This species co-occurs with Morro manzanita in several locations in maritime chaparral. Vanderwier (1987) did a detailed study ofthe chaparral and oak woodland communities at the type locality forIndian Knob mountain balm. (USFWS, 1998). Indian Knob mountainbalm occurs on sandstone substrates largely derived from ancient sand dunes within the San Luis Range, in western San Luis Obispo County, California. It occurs in maritime chaparral habitat types, where it is a local component of these plant communities originating from the Indian Knob landform (located roughly north-northeast of the City of Pismo Beach). This landform is located between the cities of San Luis Obispo and Pismo Beach. Its range extends from the community of Los Osos, roughly southeast to the City of Pismo Beach (USFWS, 2024)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Stable (USFWS, 2009)

Number of Populations:
5 extant (USFWS, 2024)

Population Size:
>6,400 individuals in 2016 (USFWS, 2019b)

Population Narrative:
In 2019, Indian Knob mountainbalm is still known from seven occurrences, six of which are in protected areas and one (the largest) mostly in a protected area, with a total population count of 6,489+ individuals in 2016. Two occurrences are likely extirpated. A figure is available in the 5-Year Review depicting known geographic distributin in western San Luis Obispo County, California. One new occurrence (Occurrence 8) is new. (USFWS, 2019b). Indian Knob mountainbalm is currently known from six EOs (CNDDB 2024b, website), and 20 georeferenceable herbarium specimens from CCH2 (CCH2 2024, website). Of the six EOs, we presume one is likely extirpated (EO number 3, see p. 7; CNDDB 2024b, website). We are not able to ascertain the status of Indian Knob mountainbalm at the CCH2 documented locations. We also lack updated census or survey information to report about the species abundance throughout its range and are unable to assess population status trends, even at the spatial scale of individual occurrences (USFWS, 2024).

Threats and Stressors

Stressor: Habitat loss (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, loss of habitat due to development, surface mining, and oil well drilling was identified as the primary threat to Eriodictyon altissimum. Since the time of listing, the threat of habitat loss due to development in the Los Osos area and surface mining, and oil well drilling in and around Indian Knob has been reduced to the point that we no longer consider this to be a significant threat to the species. The populations outside of Montaña de Oro State Park, with the exception of element occurrence 1 (Broderson), are now protected. Element occurrences 4 and 6 now are found within a Department ecological reserve and the majority of the plants in occurrence 5 (Indian Knob) are protected under a conservation easement held by the City of San Luis Obispo. (USFWS, 2009)

Stressor: Non-native invasive plants (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: Modification of habitat due to the spread of invasive, non-native plant species was also a concern at the time of listing. Absent site-specific information from the implementation of management and monitoring programs, it is difficult to determine the actual severity of invasive, non-native species. No management plans or monitoring programs have been developed and implemented to detect change on conserved lands. Absent the type of information that would be collected and analyzed as part of such programs, it is not possible for us to determine if the occurrences are being adversely affected by competition from non-native invasive plant species. It does appear from anecdotal observations that all occurrences (except element occurrence 1) are stable and have not been significantly affected by competition from non-native invasive plant species. At element occurrence 1, veldt grass (Ehrharta calycina) appears to be degrading habitat, but its effect on Eriodictyon altissimum is unknown. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, we did not discuss stochastic extinction as a threat. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, although the plants are long-lived, the small sizes of all but the Indian Knob population may make it difficult for those populations to persist if conditions are not suitable for the establishment of new individuals. (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in these higher elevations and northern locations due to climate change have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" with unknown consequences to the species which currently exist there (Loarie et al. 2008). While, we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Eriodictyon altissimum; small ranged species, such as E. altissimum, are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008). (USFWS, 2009)

Recovery

Reclassification Criteria:
1. At least five occurrences from throughout its range are on lands secure from human-induced threats. (USFWS, 1998)

2. Surrounding habitat is protected in amounts adequate to permit management of the vegetation community using prescribed fire, if it is deemed beneficial to the species. (USFWS, 1998)

3. Populations are projected to be self-sustaining and either stable or increasing as determined by long-term monitoring and research results. (USFWS, 1998)

Delisting Criteria:
When the downlisting criteria have been met for a species, the species can be considered for delisting if:

1. Threats are reduced or eliminated so that occurrences are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) integrate, or find a replacement for, a fire regime as a means of revitalizing declining or senescing colonies; b) manage adjacent shrub habitat through thinning to provide sufficient space for the species to expand in numbers, and c) educational signing to deter the public from cutting shrubs along trails; (USFWS, 2019a)

2. The occurrences remain viable for at least 15 years to demonstrate long-term viability under a range of environmental conditions. Rangewide surveys in 2016 and 2017 provide a baseline for numbers of stems or individuals, and in some cases, additional information regarding vigor of individuals, as measured by size. These data should provide a basis for monitoring occurrence attributes to determine viability over time; (USFWS, 2019a)

3. An ex situ collection of plant material is established in a Center for Plant Conservation-affiliated botanic garden. A soil seedbank would typically provide a strategy for a species to regenerate populations in the face of stochastic events as well as natural senescence. However, this species is suspected to have low seed production. Research on seed production and viability will be undertaken in the near future. Whether reproduction through banked seed proves to be efficacious or not, reproduction through vegetative propagation (e.g. cuttings) also holds potential as a means of replenishing occurrences, should it be necessary in the future. (USFWS, 2019a)

Recovery Actions:
- Secure populations and habitat on unprotected lands. Methods for securing lands include in-fee purchase, gifts of easement or fee interest by the property owner, deed restrictions (provided restrictions cannot be changed privately without the knowledge of Federal, State and County agencies), acquisition of property rights (e.g., development rights) or permanent conservation easements. (USFWS, 1998)
- Manage secured lands to control or eliminate other known threats. Although habitat alteration through development is currently the most substantial and irreversible threat facing all of the species in this plan, the management of lands secured from development will remain a formidable task, made more so in those cases where the secured habitats are adjacent to high density residential and urban development. (USFWS, 1998)
- Evaluate potential threats and conduct management-oriented research. Conduct habitat-oriented research for Morro Bay species. Conduct species-specific research. Evaluate research results and use in future management. (USFWS, 1998)

- Determine population dynamics and effects of recovery efforts. Studies should be conducted to learn the number and size of successful self sustaining populations for the species to establish criteria for its reclassification. (USFWS, 1998)
- Develop and implement an education/information program. The benefits of protecting native species and their habitats and maintaining native biological communities should be explained clearly to all concerned parties. (USFWS, 1998)
- Reevaluate recovery criteria and revise recovery plan based on expanded knowledge from research, monitoring, and management. The scientific validity of the recovery criteria and recovery plan should be reviewed and revised as more information becomes available. The criterion of maintaining sufficient numbers of populations or conservation areas should be assessed, and the success or failure of management actions should be evaluated. (USFWS, 1998)
- Recommendations for Future Actions from 2019 5-Year Review: Little is known about the biology and ecology of Indian Knob mountainbaim in 2019. Therefore, coordinated conservation and research are needed to further understand the species, and to restore and maintain the five extant occurrences. These efforts should include: • Management actions to benefit the occurrences. • Searches for additional locations. • Introduction of Indian Knob mountainbalm into living collections at botanic gardens. • Seed collection for seed banking, with a subset of seeds used to investigate germination requirements, including cues associated with fire-following species. • Collection and cultivation of cuttings along with seeds to develop protocols for propagation of the species. • Studies of genetic diversity and reproductive biology, potential barriers to recruitment, and the species' relationship with fire. In particular, genetic diversity within and among the occurrences should be investigated. (USFWS, 2019b)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access to all six known Indian Knob mountainbalm occurrences (CNDDB 2024b, website) to conduct comprehensive surveys of abundance, assess the overall status of the species, and evaluate current threats to the species at each location. Include estimates of the total number of Indian Knob mountainbalm individuals present at each location, using the metric provided in Guilliams and Hasenstab-Lehman 2021 (pp. 17–18) and map the total occupied area using global positioning system (GPS). Collect other pertinent ecological and demographic data including cooccurring and co-dominant species, estimate of canopy cover, presence and abundance of nonnative, invasive species, timing of phenology, and observations of any potential insect pollinators. Provide data and interpreted findings to the Service and CDFW to ensure that resource databases and species relevant updates remain both accurate and current. 2. Conduct experimental research to better understand Indian Knob mountainbalm's reproductive biology. Specifically, investigate germination cues related to fire, seed bank dynamics, and seed viability. We also need to better understand why seed production is low to near absent, in wild populations and which environmental cues or conditions may stimulate production of seed. 3. Conduct experimental research to determine the most effective/optimal management techniques to apply to extant, wild populations of Indian Knob mountainbalm to ensure both persistence and expansion of the species within currently occupied areas. In particular, we must evaluate the use of prescribed burns and other disturbance techniques to stimulate new plant growth and regenerate senescent stands. 4. Work with partners who own or hold conservation easements on occupied Indian Knob mountainbalm sites and help them develop and implement conservation and recovery actions through habitat management plans for their properties. Support these partners and assist them to acquire and secure adequate funding and other endowments to manage the species and its

habitat for conservation and recovery in perpetuity. 5. Conduct introductions at suitable sites that include long-term management strategies to ensure success and persistence of the species at introduced locations. Develop protocols for propagation of the species from both cuttings and seed. 6. Make adequate accessions of Indian Knob mountainbalm seed for conservation banking so that all known occurrences are represented in the established collections. Conduct seed bulking activities, if feasible, to have an ample source of seed for recovery efforts and to serve as a backup in the event of stochastic loss and possible extirpation (USFWS, 2024).

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SPECIES ACCOUNT: *Eriodictyon capitatum* (Lompoc yerba santa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/20/2000; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

An evergreen shrub, growing to about 3 m tall with narrow, leathery leaves. Lavender flowers are tubular, borne in head-like, densely hairy clusters. Blooms May-August. (NatureServe, 2015)

Taxonomy

Since the time of listing, a phylogenetic study provided evidence supporting the transfer of the genus Eriodictyon from the waterleaf family (Hydrophyllaceae) to the borage family (Boraginaceae) (Jepson Online Interchange 2010). (USFWS, 2011)

Historical Range

According to records available through the CNDDB (2010) and the Consortium of California Herbaria (Consortium) (2010), all historical collections and unvouchered observations of Eriodictyon capitatum are from the southwestern corner of Santa Barbara County. Other studies (Elam 1994, Jacks et al. 1984) recognized seven populations of E. capitatum based on the number of "Element Occurrences" (occurrences) at the time and as defined by CNDDB criteria. five populations are from three geographically distinct areas referred to here as Solomon Hills, west Burton Mesa, and Santa Ynez Mountains (USFWS, 2011)

Current Range

Eriodictyon capitatum is endemic to southwestern Santa Barbara County, California. It is found in three areas of the county: on Vandenberg Air Force Base, on the west crest of the Santa Ynez Mountains on Hollister Ranch, and on Graciosa Ridge in the Solomon Hills southeast of Orcutt. The entire range extent covers about 365 sq mi. (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/7/2002.

Legal Description

On November 7, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriodictyon capitatum (Lompoc yerba santa) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (67 FR 67968-68001).

Critical Habitat Designation

The critical habitat designation for Eriodictyon capitatum includes three CHUs in Santa Barbara County, California. This species critical habitat encompasses approximately 9,709 acres (67 FR 67968-68001).

Primary Constituent Elements/Physical or Biological Features

The primary constituent elements of critical habitat for Eriodictyon capitatum are the habitat components that provide: (i) Soils with a large component of sand and that tend to be acidic; and (ii) Plant communities that support associated species, including maritime chaparral, particularly

where the following associated species are found: Dendromecon rigida (bush poppy), Quercus berberidifolia (California scrub oak), Quercus parvula (Santa Cruz Island scrub oak), and Ceanothus cuneatus (buck brush); and in southern bishop pine forests that intergrade with chaparral Arctostaphylos spp. (manzanita) and Salvia mellifera (black sage). (67 FR 67968-68001):

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for the two taxa within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of the plants are maintained at those sites, and have the ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for the two taxa. We have outlined below the kinds of special management and protection that these two taxa would most likely require. These recommendations for management and protection are general in nature. Specific management actions should be developed according to local site conditions. Not all of these will apply to each plant taxon equally. (1) Existing soil conditions should be protected by avoiding activities that cause the erosion or compaction of soils. Maintaining an intact soil profile may be necessary to maintain edaphic features such as a horizon of permeable sandy soils on the surface layer. For example, Deinandra increscens ssp. villosa is thought to be restricted to acidic, fine sandy loams with a subsurface clay layer that may act as a reservoir of soil moisture. (2) Existing hydrologic conditions should be protected by avoiding activities that cause a change in surface or subsurface water flows upon which the plant taxa depend. For example, development of areas adjacent to a population may result in an increase in runoff and surface water flow. This alteration may affect the soil moisture content to which the local population has adapted. (3) In all plant communities where these taxa occur, invasive, non-native species, such as harding grass (Phalaris aquaticus), veldt grass (Ehrharta calycina), and iceplant (Carpobrotus edulis), should be actively managed. Invasive non-natives pose a serious threat to the survival of Deinandra increscens ssp. villosa and Eriodictyon capitatum and remaining habitat of the taxa. For example, accumulated dead leaves and stems (thatch) from nonnative grass species that dominate the habitat effectively prevent the establishment of D. increscens ssp. villosa at a site. Iceplant is known to invade native maritime chaparral vegetation occupied by Eriodictyon capitatum. Once non-native grasses and other invasive plants (e.g., iceplant) have become established, they cannot be removed without great expenditure of time and effort. (4) The composition of the native plant and animal communities associated with the taxa must be maintained. Native plant diversity may limit the ability of aggressive non-native plants to invade a population (Dukes 2002). In addition, a decline in biodiversity may increase the potential impact of invasive plants on a community (e.g., suppression of growth). Recent research suggests that grassland communities with fewer species may be more likely to decline as a consequence of invasion (Dukes 2001). In addition, native plant diversity may increase pollinator activity and therefore enhance the conservation of a plant species. Biologists have suggested that a plant population may persist as long as it occurs within an area of a diversity of plant species that are attractive to pollinators (Kwak 1988). Habitat fragmentation and isolation of species-rich grasslands, with intervening areas of no or low diversity of native plants, has been found to negatively affect plant-pollinator interactions (Stephann-Dewenter and Tscharntke 1999). (5) The local distribution of plant communities should be managed to provide for the physical requirements of the taxa (e.g., space for establishment). For some grassland areas, it may be important to maintain openings within or between coastal scrub communities that might otherwise encroach upon

grassland patches that support Deinandra increscens ssp. villosa. (6) Certain areas where these taxa occur may need fencing to protect them from accidental or intentional trampling by humans and livestock. Portions of three of the five units are currently used by livestock

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) and asexual (vegetative) (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: While pollination ecology has not been specifically studied for E. capitatum, other Eriodictyon taxa are known to be pollinated by wasps, butterflies, and a variety of bee taxa, especially from the genera Anthophora, Bombus, Chelostoma, Hylaeus, Osmia, and Nomadopsis (Moldenke 1976). (USFWS, 2011)

Breeding Season

Adult: May to August (USFWS, 2011)

Reproduction Narrative

Adult: Eriodictyon capitatum is capable of both sexual and asexual reproduction. The importance of sexual reproduction in maintaining populations is unclear. Research indicates that E. capitatum is a self-incompatible species; intentionally cross-pollinated flowers produced a mean of 1.77 seeds per fruit, and intentionally self-pollinated flowers produced a mean of 0.03 seed per fruit (Elam 1994). This species spreads vegetatively through the production of rhizomes (underground stems), and thus producing colonies of ramets (genetically identical stems) from only a few individuals. The lavender flowers are tubular and clustered in heads that bloom from May to August. While pollination ecology has not been specifically studied for E. capitatum, other Eriodictyon taxa are known to be pollinated by wasps, butterflies, and a variety of bee taxa, especially from the genera Anthophora, Bombus, Chelostoma, Hylaeus, Osmia, and Nomadopsis (Moldenke 1976). (USFWS, 2011)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Highly acidic soils with high water-retaining capacity on inland sites (USFWS, 2011)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: Eriodictyon capitatum occurs within two different habitat types. Near the coast, it occurs within maritime chaparral and coastal sage scrub on sandstone soils from the Orcutt, Marina,

and Oceano series. In this habitat type, it typically occupies disturbed areas near roads or exposed ridgetops (Jacks et al. 1984). On sites that are farther inland, Eriodictyon capitatum is found on diatomaceous Monterey shales. The structurally dominant Pinus muricata is one species that occurs at these sites. These sites have characteristic soils that are highly acidic and have a high water-retaining capacity (Cole 1974). Eriodictyon capitatum apparently can tolerate and may be encouraged by minor disturbance (Savage 1978, CNPS 1987, Myers 1987). (USFWS, 2011; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Declining by 8.5% since 2006 (USFWS, 2011)

Number of Populations:

5 (USFWS, 2011)

Population Size:

1,520 (USFWS, 2011)

Population Narrative:

During surveys for E. capitatum, approximately 1,520 individuals were documented within known populations (SRS 2010). Overall, since 2006, there was an 8.5 percent decrease in the total number of individuals. This decline in the number of individuals has been attributed to low rainfall in previous years (SRS 2010). (USFWS, 2011)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The increased use of the launch facilities at Vandenberg AFB due to nationwide Department of Defense base closures was identified as a threat to this species at the time of its listing (Service 2000). According to the final listing rule (Service 2000), increased use of Vandenberg AFB would potentially result in the loss or alteration of Eriodictyon capitatum habitat. Wildfires were cited as one example of how habitat could be lost or altered. In 1993, debris from a missile that was intentionally destroyed shortly after launching caused several fires and burned more than 162 ha (400 ac). In September of 1997, a 200-ha (500-ac) fire and a 600-ha (1,500-ac) fire burned near habitat occupied by E. capitatum (Los Angeles Times 1997a). In November of 1997, a 495-ha (1,225-ac) fire was accidently started on Vandenberg AFB by an Air Force explosives disposal team and was partially contained by setting a backfire through a population of E. capitatum (Los Angeles Times 1997b). Although increased use of Vandenberg AFB could result in the loss or alteration of E. capitatum habitat (e.g., wildfires), the number of

launches per year is restricted. Habitat alteration and loss from development for military and commercial purposes was also identified as a threat to this species at the time of its listing (Service 2000). Habitat fragmentation within the Burton Mesa area continues. The original extent of Burton Mesa chaparral was approximately 9,000 ha (22,000 ac); by 1938, the extent had been reduced to 5,890 ha (14,554 ac), and by 1988, less than 3,500 ha remained (8,649 ac) (Davis et al. 1988). The only population of Eriodictyon capitatum on Vandenberg AFB that could be threatened by future development would be the 35th Street population. However, at this time, there are no plans to develop this area (Lum pers. comm. 2010). This population is also subject to disturbance from human activities because of its close proximity to paved and unpaved roads and the cantonment area. At present, it appears that the destruction and alteration of habitat due to an increased use of Vandenberg AFB remains a threat to E. capitatum. (USFWS, 2011)

Stressor: Non-native species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: On Vandenberg AFB, Ehrharta calycina (veldt grass) was planted to stabilize sand dunes in the 1950s; with the aid of the prevailing onshore winds, it rapidly spread across Vandenberg AFB and onto Burton Mesa between 1979 and 1996 (Air Force 1996). This species spreads rapidly, both vegetatively and through a persistent seedbank, and is extremely difficult to eradicate once it has become established (Bossard et al. 2000). Carpobrotus edulis and C. chilensis are other nonnative species that threaten to alter the maritime chaparral habitat by forming dense mats (Odion et al. 1992). The Eriodictyon capitatum population located at 35th Street is the only population on Vandenberg AFB whose habitat is actively managed (e.g., removal of nonnative and invasive plant species). This population is located next to paved and unpaved roads and the cantonment area. Nonnative species such as Cortaderia jubata, Pinus radiata (Monterey pine), and Eucalyptus globulus (eucalyptus) have all invaded E. capitatum habitat in this area. The alteration of habitat due to an increase in nonnative species is still a threat to E. capitatum populations located on Vandenberg AFB. There is no information available on nonnative species that may threaten the populations of E. capitatum located in the Solomon Hills and Santa Ynez Mountains. (USFWS, 2011)

Stressor: Altered fire regime (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Habitat for Eriodictyon capitatum may be altered by the increase in Ehrharta calycina and subsequent increases in the frequency of wildfires. Invasive plants such as E. calycina can change the fuel properties of a site, which can in turn affect fire behavior, and ultimately alter fire regime characteristics such as frequency, intensity, extent, and seasonality of fire. If the regime changes subsequently promote the dominance of the invaders, then an invasive plant-fire regime cycle may be established, and restoration to preinvasion conditions becomes more difficult (Brooks et al. 2004). Although the natural fire return interval is unknown, because of its low elevation and infrequent lightning strikes, it was probably greater than the 20 to 30-year fire return interval found across most of Vandenberg AFB (Hickson 1988). A shorter fire return interval than the one that naturally occurs could negatively impact native plant species by destroying plants before seed set occurs or destroying the seed bank. (USFWS, 2011)

Stressor: Oil extraction and energy activities (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Although we did not discuss it in Factor A in the rule to list Eriodictyon capitatum, we discussed elsewhere in the rule that oil extraction and refinement (e.g., maintenance activities, hazardous waste cleanup) are activities taking place at the Solomon Hills site where this species occurs. Since the time of listing, several activities have been conducted within habitat for this species in the Solomon Hills. In 2007 and 2010, projects to maintain well pads and adjacent roads were undertaken by Breitburn Energy Company. The purpose of these projects was to trim or remove E. capitatum stems that had encroached onto cleared well pads, oil drilling and processing equipment, wells, power poles, and other areas. During such activities, only stems that are in areas where they pose a fire safety risk or operational constraint are removed. At this time, it does not appear that oil extraction and energy development activities are a threat to E. capitatum. (USFWS, 2011)

Stressor: Development of Hollister ranch (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: While development on Hollister Ranch is considered low-density (approximately 50 single-family homes as of 2009), these residential homes are often associated with other development including accessory buildings, agricultural development, reservoirs and roads, all of which have increased the demand on limited water resources and have resulted in the alteration and degradation of portions of the natural landscape (County of Santa Barbara Planning and Development Department 2009). An undated botanical survey (Hollister Ranch Conservancy 2003) indicates that E. capitatum occurs on six contiguous parcels in the western portion of Hollister Ranch. Of these six parcels, an undeveloped parcel has been sold and a second parcel has a completed residence and is available for purchase (Hollister Ranch Realty 2010). All six of these parcels are located within designated critical habitat for the species and could be developed. Development on Hollister Ranch is regulated under CEQA and requires the lead agency (i.e., County of Santa Barbara) to avoid or mitigate a project's significant environmental impacts if alternatives or mitigation measures are feasible. However, determination of the adequacy of avoidance or mitigation strategies is at the discretion of the County of Santa Barbara. Therefore, we believe that development is a threat to the population of E. capitatum located on Hollister Ranch. (USFWS, 2011)

Stressor: Stochastic extinction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: As stated in the 2000 final listing rule, we continue to believe that the existence of five populations of Eriodictyon capitatum and the species' restricted distribution place this species at risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Groom et al. 2006; Primack 2006). This vulnerability can arise due to uncertainty with stochastic events, such as environmental stochasticity, natural

catastrophes, genetic stochasticity, and demographic stochasticity. Populations of E. capitatum are subject to all of these stochastic events. Elam (1994) found that two of the six populations she studied were uniclonal. Because E. capitatum is self-incompatible and cannot produce viable seed, a uniclonal population can be extirpated by both environmental stochasticity (e.g., prolonged drought) and natural catastrophes (e.g., wildfire). Furthermore, genetic stochasticity can result in a loss of genetic variation and subsequently decrease population viability. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, we did not discuss the potential effects of climate change on the long-term persistence of Eriodictyon capitatum. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to Eriodictyon capitatum at this time. (USFWS, 2011)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Complete a Recovery Outline and Species Action Plan for Eriodictyon capitatum as a first step in preparing a recovery plan for the species. (USFWS, 2011)
- Develop a survey protocol for Eriodictyon capitatum. Because of its clonal habit, surveyors may develop their own methods or may avoid counting the number of individuals. Creating a survey protocol would encourage documentation of the number of plants and would allow comparison across the species range. (USFWS, 2011)
- Work with representatives from Breitburn Energy Company, CDFG, and Hollister Ranch to ensure that management of their lands is consistent with the long-term persistence of Eriodictyon capitatum at those sites. In addition, maintain contact with these representatives to ensure that survey information is updated on a regular basis. (USFWS, 2011)
- Conduct genetic testing in collaboration with representatives from the Air Force, Breitburn Energy Company, CDFG, and Hollister Ranch. Genetic testing can determine if a population is uniclonal or multiclonal. This information could aid in developing appropriate management decisions and conservation strategies for each population. (USFWS, 2011)

- Discuss with conservation experts if cross-pollination of uniclonal populations with multiclonal populations would be an appropriate management strategy to increase the amount of viable seed produced. This would aid in increasing genetic diversity within uniclonal populations. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Throughout this document, our own use of the word stem refers to all vertical vegetative parts including ramets. However, in our analysis of reports prepared by other observers, it was often impossible to determine the intended use of the words "stem," "ramet," "individual," and "plant," and it was often confusing and not consistent from one observer to the next (e.g., ManTech 2020a, p. 18). In accordance with IUCN (2014, p. 23–24) recommended guidelines for colonial and modular organisms, we recommend counting the number of all vertical stems (including ramets) and reporting that number as vertical stems along with a statement of this method. Little is known about the biology and ecology of Lompoc yerba santa in 2021. Therefore, coordinated conservation and research are needed to further understand the species, and to restore and maintain the 11 known occurrences. These efforts should include: • Implement management actions to reduce threats and benefit the occurrences of Lompoc yerba santa. • Conserve and protect habitat in vicinity of and near existing occurrences, with particular attention to maritime chaparral on Burton Mesa, Vandenberg Space Force Base. • Conduct searches for additional locations of Lompoc yerba santa, including use of helicopters and drones for searching large expanses of potential habitat and potential habitat in difficult terrain. Priority should be given to searching in vicinities of occurrences 12 (Jack and Laura Dangermond Preserve) and 13 (Upper LaSalle Canyon, Vandenberg Space Force Base). • Collect tissue samples from occurrence 12 for genetic analyses. • Continue seed collection for seed banking. In coordination with Santa Barbara Botanic Garden and contingent upon results of previous sampling, multicolonal locations should be visited to determine if seed production is occurring, in particular at occurrences 2, 13 and 14 as a matter of urgency (these three occurrences are on Vandenberg Space Force Base). • Collect and cultivate cuttings and seeds to develop protocols for propagation and outplanting for long-term restoration success. In consideration of the threat of climate change with severe drought and increased temperatures, the methods employed for outplanting in arid lands by Abella et al. (2012, entire), Abella et al. (2015, entire), Abella (2017, entire) and Abella et al. (2020, entire) should be considered. • Study genetic diversity and reproductive biology, pollinator network and potential network disruption, potential barriers to recruitment, and the species' relationship with fire. • Introduce Lompoc yerba santa into living collections at botanic gardens. (USFWS, 2021)

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed June 2016.

USFWS. 2011. Eriodictyon capitatum (Lompoc yerba santa) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California

U.S. Fish and Wildlife Service. 2002. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Eriodictyon capitatum (Lompoc yerba santa) and Deinandra increscens ssp. villosa (Gaviota tarplant)

Final Rule. 67 FR 67968-68001 (November 7, 2002).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed 06/27/2016

USFWS. 2021. Lompoc yerba santa (Eriodictyon capitatum) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Ventura Fish and Wildlife Office Ventura, California. 30 pp.

SPECIES ACCOUNT: *Eriogonum apricum (incl. var. prostratum)* (Ione (incl. Irish Hill) buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Low-growing, herbaceous perennial; Polygonaceae. (NatureServe, 2015)

Historical Range

Known only from an approximate 16-kilometer (km) (10-mile (mi)) stretch along the Ione Formation in western Amador County. Although little information is available to determine the historical extent of either E. apricum variety, and there has been a loss of natural occurrences within the range, the species still persists throughout its estimated historical range. All of the historical and current occurrences are between the village of Buena Vista in the south and Highway 16 in the north 6 (CNDDB 2008). At the time of listing, it was suggested that the range of E. apricum var. apricum may extend to cover portions of Sacramento County (Service 1999, p. 28406); however, surveys conducted in 2001 have placed all of the E. apricum var. apricum plants in Amador County (Service 2005, p. 15). (USFWS, 2010)

Current Range

Ione Formation, Amador Co, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Chaparral (Natureserve, 2015)

Dependencies on Specific Environmental Elements

Adult: Coarse, very acidic, nutrient-poor soils with cement-like, iron oxide crusts (NatureServe, 2015).

Environmental Specificity

Adult: Very Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits coarse, very acidic, nutrient-poor soils with cement-like, iron oxide crusts. On these soils - developed under a tropical or subtropical climate 35-57 million years ago - a distinctive, low-growing chaparral community occurs, usually surrounded by taller, more common chaparral types. Eriogonum apricum is restricted to otherwise barren red clays within these "Ione chaparral" communities. Most populations occur between 90 and 280 m elevation.

(NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Narrative:

Occupies a total of approximately 4 hectares (Fish and Wildlife Service 1999). 6 sites ranked above C; 10 total EOs in NDDB. According to Fish and Wildlife Service (1999), there are nine occurrences. (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The primary threat to Eriogonum apricum habitat is mining for silica sand, clay, lignite, common sand and gravel. Development for commercial or residential development, clearing for agriculture, and fire protection are lesser threats (USFWS, 2010).

Stressor: Stochastic events and climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Events such as disease outbreaks, reproductive failure, extended drought, landslides, or a combination of several such events, could destroy part of a single population or entire populations. A local catastrophe could also decrease a population to so few individuals that the risk of extirpation due to genetic and demographic problems inherent to small populations would increase. Climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2010).

Recovery

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed June 2016.

USFWS 2010. Eriogonum apricum (inclusive of vars. apricum and prostratum) (Ione Buckwheat = Irish Hill Buckwheat) Arctostaphylos myrtifolia (Ione Manzanita) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Sacramento Fish and Wildlife Office Sacramento, California. Accessed June 2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A."

USFWS. 2010. Eriogonum apricum (inclusive of vars. apricum and prostratum) (Ione Buckwheat = Irish Hill Buckwheat)

Arctostaphylos myrtifolia (Ione Manzanita)

5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California. 24 pp.

SPECIES ACCOUNT: *Eriogonum codium* (Umtanum Desert buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/23/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A low, mat-forming woody perennial. Slow-growing and long-lived. Leaves are covered with dense white hairs. Flowers are yellow. (NatureServe, 2015)

Taxonomy

Species from Washington state published in: Reveal, J.L., Caplow, F.E., Beck, K.A. 1997. Eriogonum codium (Polygonaceae: Eriogonoideae), A new species from south-central Washington. Rhodora. 97: 350-356. (NatureServe, 2015)

Historical Range

Umtanum desert buckwheat was discovered in 1995 during a botanical survey of the Hanford installation (Reveal et al. 1995, p. 353). It is unknown if the historic distribution of Umtanum desert buckwheat was different than the species' current distribution, but it is likely the species has been confined to this location during at least the last 150 years (USFWS, 2013).

Current Range

One ridgeline, Benton County, southeastern Washington. (NatureServe, 2015) Found only on the Hanford Reach of the Columbia River. The only known population of Umtanum desert buckwheat occurs along the top edges of the steep slopes on Umtanum Ridge (USFWS, 2013).

Critical Habitat Designated

Yes; 12/20/2013.

Legal Description

On December 20, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriogonum codium (Umtanum Desert buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (78 FR 76995-77005; 78 FR 24008-24032).

Critical Habitat Designation

The critical habitat designation for Eriogonum codium includes one CHU in Benton County, Washington. This species critical habitat encompasses approximately 334 acres (ac) (139 hectares (ha)) (78 FR 76995-77005; 78 FR 24008-24032).

This critical habitat unit was mapped using Universal Transverse Mercator, Zone 11, North American Datum 1983 (UTM NAD 83) coordinates. These coordinates establish the vertices of the unit boundaries. The maps in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which the map is based are available to the public at the field office Internet site (http:// www.fws.gov/wafwo/HanfordPlants/ FLFCH.html), http:// www.regulations.gov at Docket No. FWS–R1–ES–2013–0012, and at the Service's Washington Fish and Wildlife Office. You may obtain field office location information by contacting one of the Service regional offices, the

addresses of which are listed at 50 CFR 2.2.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum codium critical habitat consists of five components (78 FR 76995-77005; 78 FR 24008-24032):

(i) North- to northeast-facing, weathered basalt cliffs of the Wanapum Formation at the eastern end of Umtanum Ridge in Benton County that contain outcrops, cliff breaks, slopes, and flat or gently sloping cliff tops with exposed pebble and gravel soils.

(ii) Pebbly lithosol talus soils derived from surface weathering of the top of the Lolo Flow of the Priest Rapids Member of the Wanapum Formation.

(iii) Sparsely vegetated habitat (less than 10 percent total cover), containing low amounts of nonnative or invasive plant species (less than 1 percent cover).

(iv) The presence of insect pollinator species.

(v) The presence of native shrub steppe habitat within the effective pollinator distance (300 m (approximately 980 ft)) around the population.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Umtanum desert buckwheat. In all of the described units, special management may be required to ensure that the habitat is able to provide for the biological needs of the species. Further studies leading to an enhancement or reintroduction plan may be necessary to increase population size and prepare for recovery postwildfire. More research is needed to determine habitats most suitable for expansion of the current population. In summary, special management considerations or protections should address activities that would be most likely to result in the loss of Umtanum desert buckwheat plants or the disturbance, compaction, or other negative impacts to the species’ habitat. These activities could include, but are not limited to, recreational activities and associated infrastructure, off-road vehicle activity, dispersed recreation, wildfire, and wildfire suppression activities. Special management considerations or protection will conserve the primary constituent elements for the species. Management activities that could ameliorate these threats include, but are not limited to, the fire management plan that has been completed for the Hanford installation (DOE 2011, p. 93) and recently revised to incorporate more detailed management objectives and standards. Though not intended to specifically address Umtanum desert buckwheat, implementation of this plan will contribute to the protection of the primary constituent elements (and physical or biological features) by: (1) Using a map of ‘‘sensitive resources’’ on the site during implementation, including the location of Umtanum desert buckwheat habitat; (2) requiring a biologist to assist the command staff in protecting these environments during wildfire suppression efforts; and (3) restricting public access to the entire Umtanum desert buckwheat

site, including the pollinator use area. Public access without security clearance is currently prohibited at the Umtanum desert buckwheat site, reducing the risk of trampling or crushing the plants by ORV use. Special management to protect the designated critical habitat areas and the features essential to the conservation of Umtanum desert buckwheat from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the population and nearby plant community components. These actions may be achieved by detailed fire management planning by the DOE, including rapid response and mutual support agreements between the DOE, the Monument, the U.S. Department of the Army, Bureau of Land Management, and the Washington Department of Fish and Wildlife for wildfire control. These agreements should contain sufficient detail to identify actions by all partners necessary to protect habitat for Umtanum desert buckwheat from fire escaping from other ownerships.

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Growth rates are also extremely slow, with stem diameters increasing an average of only 0.17 millimeters (mm) (0.007 in) per year (The Nature Conservancy (TNC) 1998, p. 9; Dunwiddie et al. 2001, p. 62) (USFWS, 2013).

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2013)

Lifespan

Adult: 100+ years (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Individual plants may exceed 100 years of age, based on counts of annual growth rings on cross sections of the main stems of recently dead plants. Preliminary counts indicate that seed set occurs in approximately 10 percent of flowers observed, potentially limiting reproductive capacity. Based on a pollinator exclusion study (Beck 1999, pp. 25–27), the species is probably capable of at least limited amounts of self-pollination, although the percentage of seed set in the absence of pollinators appears to be low. A variety of insect pollinators were observed on Umtanum desert buckwheat flowers, including ants, beetles, flies, spiders, moths and butterflies (TNC 1998, p. 8). Wasps from the families Vespidae and Typhiidae and a wasp from the species Criosciolia have been observed in the vicinity of Umtanum desert buckwheat, but not on the plant itself. A bumble bee, Bombus centralis, has been observed by Washington Department of Natural Resources (WDNR) specialists utilizing flowers of Umtanum desert buckwheat plants (Arnett 2011b, pers. comm.) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, grassland/herbaceous (NatureServe, 2015); scarp, scree (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 335 and 390 meters (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Habitat Narrative

Adult: Eriogonum codium is restricted to a particular basalt flow, growing on flat or gently sloping areas near the top of the steep basalt cliffs. This species is found at elevations between 335 and 390 meters (Washington Natural Heritage 2002). (NatureServe, 2015) As the basalt of the Lolo Flow weathers, a rocky soil type is formed that is classified as lithosol, a term describing the well-drained, shallow, generally stony soils over bedrock (Franklin and Dyrness 1973, p. 347), and talus slopes associated with eroding outcrops and cliffs. These cliffs (scarps) and loose rock at the base of cliffs or on slopes (defined as scree) are found along the crests and slopes of local hills and ridges, including east Umtanum Ridge, where Umtanum desert buckwheat occurs (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Declining (USFWS, 2021)

Population Growth Rate:

Stable (NatureServe, 2015)

Number of Populations:

1 (3 sub-populations) (USFWS, 2022)

Population Size:

3,016 (USFWS, 2021)

Additional Population-level Information:

Estimates for the population reflect the number of vegetative and flowering plants. When monitoring began, five subpopulations were delineated by breaks in substrate exposure (Dunwiddie et al. 2000, p. 60). Due to additional plants being discovered, the five subpopulations were redefined as three separate subpopulations: East, Middle, and West. Monitoring methods have been inconsistent over the years, and it is widely accepted that the monitoring efforts from 1995 to 2011 did not include all of the outlying plant clusters. In fact, the larger counts in 1997, 2011, and 2019 are attributed to either refined counting techniques

or the discovery of previously unknown plants and clusters (USFWS, 2022).

Population Narrative:

The single Umtanum desert buckwheat population is small and declining. The population has declined from a high of 5,228 plants in 1997 to a low of 3,016 plants in 2019. The Population Viability Analysis (PVA) model for Umtanum desert buckwheat reported an annual population growth rate of 0.9935 with low recruitment indicating that there are greater numbers of plant mortalities occurring than individuals being recruited into the population (Caplow et al. 2007). Therefore, there is a slow decline of less than 1 percent annually without accounting for stochastic events. The population size after stochastic events exhibited sharp declines of 17.7 percent in 1996 and 51.2 percent in 2017. Because the population is small and in decline, it is possible that a single catastrophic event could cause the extinction of the species. (USFWS, 2021)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: climate change represents a potential ongoing threat based on the best available information, more thorough investigations are needed to better understand the potential impacts of climate change to this species.

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Factors adversely affecting habitat of Umtanum Desert buckwheat include wildfire and associated firefighting activities, nonnative plant fuel sources that increase the availability of wildfire fues sources, and potentially wildfire suppression activities. Unauthorized livestock trespassing, prospecting, and off-road vehicle use represent potential threats, which appear to be presently reduced because of improved boundary integrity, access controls, fencing, and enforcement (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation of seeds by ants and removal of flower heads by an unknown species has been observed by researchers during demographic monitoring trips. No Umtanum desert buckwheat seedlings have been observed successfully germinating or becoming established near ant colonies. Because seed predation and the removal of flowering structures could significantly reduce the reproductive potential of the species, which is already in gradual decline based on the results of the PVA, these activities are considered to be ongoing threats to Umtanum desert buckwheat (USFWS, 2013).

Stressor: Small population size and low recruitment (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: Umtanum desert buckwheat has a small population size and distribution, and suffers from low recruitment. These features make it particularly susceptible to potentially changing climate conditions. The lack of establishment and survival of seedlings is a threat, as few plants are becoming established as replacements for plants that die (USFWS, 2013).

Recovery

Reclassification Criteria:
Recovery priority number of 5

Delisting Criteria:
Draft desliting requirement 1. Six Umtanum desert buckwheat populations (USFWS, 2022)

Draft desliting requirement 2. Self-sustaining populations with an average size of 1,200 individuals for at least 15 years (USFWS, 2022)

Draft desliting requirement 3. Populations are in a matrix of native shrubsteppe habitat within effective pollinator distance of 300 meters and threats managed by partners with long-term management commitments (USFWS, 2022).

Draft desliting requirement 4. Populations are adequately protected from wildfire (USFWS, 2022)

Draft desliting requirement 5. Seed collections are established, stored, and maintained at seed banks (USFWS, 2022)

Recovery Actions:
- Not available.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Recovery Action 1: Protect the extant population and reduce the risk from wildfire. Improve access to Umtanum Ridge for emergency activities and recovery actions. Implement habitat restoration activities within and adjacent to occupied habitat to reduce wildfire risk due to abundant invasive plants. • Recovery Action 2: Preserve and augment the extant population by connecting subpopulations and isolated individuals to increase reproductive rates. • Recovery Action 3: Identify potentially suitable habitat sites and survey for additional Umtanum desert buckwheat populations. • Recovery Action 4: In areas of suitable habitat, establish and/or identify at least five additional populations to increase the species' redundancy, representation, and resiliency. • Recovery Action 5: Monitor the rangewide population, track trends, and assess threats. Implement a rangewide monitoring protocol and determine population trends. Develop and implement a detailed monitoring plan to assess known threats and identify potential new threats to the species and its habitat. • Recovery Action 6: Study the species ecology and breeding system, factors limiting reproductive success, the effect of climate change, and the response to management actions to guide conservation efforts. • Recovery Action 7: Promote awareness and conservation of Umtanum desert buckwheat throughout its geographic range.

(USFWS, 2021)

References

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

NatureServe. 2015. NatureServe Explorer: an online encyclopedia of life [web application]. Accessed August 2016

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed August 2016

USFWS. 2013. Threatened Status for Eriogonum codium (Umtanum Desert Buckwheat) and Physaria douglasii subsp. tuplashensis (White Bluffs Bladderpod)

Final Rule. 78 Federal Register 78, April 23, 2013. Pages 23984 - 24005.

U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Threatened Status for Eriogonum codium (Umtanum Desert Buckwheat) and Physaria douglasii subsp. tuplashensis (White Bluffs Bladderpod) and Designation of Critical Habitat. Final Rule. 78 FR 76995-77005 (December 20, 2013). U.S. Fish and Wildlife Service. 2013. Endangered and Threatened Wildlife and Plants

Threatened Status for Eriogonum codium (Umtanum Desert Buckwheat) and Physaria douglasii subsp. tuplashensis (White Bluffs Bladderpod) and Designation of Critical Habitat. Final Rule. 78 FR 24008-24032 (April 23, 2013).

NatureServe. 2015. NatureServe Explorer: an encyclopedia of life [web application]. Accessed August 2016

Final Rule. 78 Federal Register 78, April 23, 2013. Pages 23984 - 24005. USFWS. 2022. Recovery plan for Umtanum desert buckwheat (Eriogonum codium). Portland, Oregon. viii + 28 pp.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A. USFWS. 2021. Umtanum Desert Buckwheat (Eriogonum codium) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Columbia – Pacific NW Region (Region 9) U.S. Fish and Wildlife Service Wenatchee, Washington. 10 pp. USFWS. 2022. Recovery plan for Umtanum desert buckwheat (Eriogonum codium). Portland, Oregon. viii + 28 pp.

USFWS. 2022. Recovery plan for Umtanum desert buckwheat (Eriogonum codium). Portland, Oregon. viii + 28 pp.

USFWS. 2021. Umtanum Desert Buckwheat (Eriogonum codium) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Columbia – Pacific NW Region (Region 9) U.S. Fish and Wildlife Service Wenatchee, Washington. 10 pp.

SPECIES ACCOUNT: *Eriogonum gypsophilum* (Gypsum wild-buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/19/1981; Southwest Region (R2) . Proposed for Delisting (USFWS, 2017).

Physical Description

This plant is a woody stemmed perennial that grows in dense clumps and is approximately 20 cm high. The leaves are dark green, thick, mainly hairless, 1.5 - 2.5 cm wide and often wider than long, attached at the base, and have an outline like a hen's egg or a kidney. In the. fall the leaves turn bright red. The yellow flowers, 1-2 mm long, and in a broad dense cluster, appear from May to July. (USFWS, 1984)

Taxonomy

This species was first collected by E. O. Wooton on August 6, 1909, and described by Wooton and Standley in 1913. There are many species in this genus but Eriogonum gypsophilum is not closely related to any other western species (Wooton and Standley 1913). (USFWS, 1984) Gypsum wild-buckwheat is a distinct species without synonyms or taxonomic controversy. (USFWS, 2016)

Historical Range

See Current Range.

Current Range

In Eddy County, New Mexico. (USFWS, 2016). Gypsum wild buckwheat is represented by populations at Seven Rivers Hills, Black River, Ben Slaughter Draw, and Hay Hollow, which comprise the species' 60.8 kilometer (km) (37.8 miles (mi)) range (USFWS, 2022).

Critical Habitat Designated

Yes; 2/18/1981.

Legal Description

On January 19, 1981, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 18, 1981) for Eriogonum gypsophilum (Gypsum wild-buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in New Mexico (46 FR 5730-5733).

Critical Habitat Designation

The critical habitat designation for Eriogonum gypsophilum includes one CHU in Eddy County, New Mexico. This species critical habitat encompasses approximately 130 acres. A map is included in the Final Rule (USFWS, 1981; USFWS, 1984).

New Mexico: Eddy County; T20S. R25E. Section 19: N½, N½ NE¼ SE¼, N½ NW¼ SE¼; and T20S, R24E. Section 24: N½ NE¼, N½ S½ NE¼, NE¼ NW¼, N½ SE¼ NW¼; gypsum soils.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum gypsophilum critical habitat are not listed but are thought to be the following (46 FR 5730-5733):

Gypsum soils.

Special Management Considerations or Protections

Any activity which would result in disturbance of the area where Eriogonum gypsophilum occurs would probably adversely modify the Critical Habitat. The long-term solution on how to best protect Eriogonum gypsophilum may be to develop a protection plan for the species, which would address and remove present threats. In this respect, Critical Habitat designation may affect Federal activities. The Water and Power Resources Service should include in their planning process for the Brantley Dam Project ways to insure the continued existence of Eriogonum gJpsophilum. These plans should address the problems of slumping of the gypsurm soils and ways to protect the habitat of the Eriogonum gypsophilum so that it is not used for any activity which would not be compatible with the plant's continued existence. The Bureau of Land Management may need to limit future stocking rates of cattle and offroad vehicle use in the small area where the Eriogonum gypsophilum occurs. This increased planning and the steps required by these agencies should not constitute a large impact or hardship on either agency. (USFWS, 1981)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual: vegetative (USFWS, 2007)

Lifespan

Adult: 2+ (inferred from USFWS, 2007)

Breeding Season

Adult: May - July (USFWS, 1984)

Reproduction Narrative

Adult: Gypsum wild buckwheat is a perennial species that reproduces both by producing seed and also asexually by producing clone rosettes from rhizomes or rootsprouts (USFWS, 2007). Flowers appear from May to July (USFWS, 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grama grassland, creosote bush communities (NatureServe, 2015); Chihuahuan desert scrub (USFWS, 1984)

Geographic or Habitat Restraints or Barriers

Adult: 900 - 1,500 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patchy and linear (USFWS, 2007)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015 and USFWS, 2007)

Habitat Narrative

Adult: Inhabits open, gypsum in grama grassland, at about 1,500 m; semi-arid. Eroded gypsum clay hills and fans, creosote bush communities, 900-1,100 m (Flora of North America Editorial Committee 2005) (NatureServe, 2015). It occupies gypsum soils and gypsum outcrops of the Permian-age Castile Formation. Distribution of gypsum wild buckwheat plants within its populations is patchy and follows geographic patterns of suitable gypsum outcrops, which are generally elongate and narrow (USFWS, 2007). It occurs in the Chihuahuan region of the Desert Scrub Formation (Donart et al. 1978) (USFWS, 1984).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Number of Populations:

4 (USFWS, 2022)

Population Size:

Estimated to be 50,548 individuals (USFWS, 2016)

Additional Population-level Information:

Distribution of gypsum wild-buckwheat plants within its populations is patchy and follows geographic patterns of suitable gypsum outcrops, which are generally elongate and narrow. The lengths of these occupied outcrops are approximately 2.7 kilometers (km) (1.7 miles (mi)) long for the Seven Rivers Hills population, 1.6 km (1 mi) long for the Black River population, and 3.5 km (2.2 mi) long for the Ben Slaughter Draw population. Patches of gypsum wild-buckwheat within populations are also relatively small. The area of occupied habitat is only 16.3 hectares (ha) (40.3 acres (ac)) at Seven Rivers Hills, little more than 11.9 ha (29.5 ac) at Black River, and 66.4 ha (164.1 acres) at Ben Slaughter Draw (including Hay Hollow) for a total range-wide extent of approximately 94.7 ha (233.9 ac) of habitat occupied by this species (Tonne 2005, Sivinski 2013). (USFWS, 2016)

Population Narrative:

Estimated numbers of individual plants are the three known locations are as follows: Seven Rivers Hills: 14,168; Black River: 16,660; Ben Slaughter Draw (including Hay Hollow): 19,720. Refined mapping techniques resulted in the delineation of 16.3 ha (40.3 ac) actually occupied by gypsum wild-buckwheat. This is a significant reduction from the approximately 44 ha (109 ac) of occupied habitat identified previously by Spellenberg (1977) and Knight (1993). It appears BLM and Knight used the approximately 109 acres of occupied habitat as the multiplier for an

average density estimate, thereby overestimating this population. This original acreage estimate was the basis for the recovery criteria to maintain a population of 10,000 plants at Seven Rivers Hills designated critical habitat area. The Black River and Ben Slaughter Draw populations of gypsum wildbuckwheat also occur as discontinuous patches of plants on the gypsum outcrops. Knight (1993) used belt transects to determine average density of plants within the Black River habitat. He estimated 32 ha (80 ac) of occupied habitat to arrive at a population estimate of 45,280 plants (rosettes). Subsequent GPS mapping (Tonne 2005) of this population significantly reduced the area of occupied habitat on BLM and state- owned lands within this population (the private land portion of this population was not mapped by Tonne). The discrepancies between the population boundaries in Knight's 1993 map and Tonne's 2005 map are more likely the result of the more accurate methods (e.g., use of a Global Positioning System) employed by Tonne than an actual reduction of population coverage between 1993 and 2005. A combination of Knight's (1993) average density estimate of 0.14 plants per m2 (0.01 per ft2) and Tonne's map showing 11.9 ha (29.5 ac) of occupied habitat results in a minimum population number of 16,660 plants at Black River. This estimate may increase when the area of occupied habitat on the private land portion of this population is known. The largest population of gypsum wild-buckwheat occurs at Ben Slaughter Draw. Knight (1993) also sampled this population with belt transects to determine an average density of 0.03 plants per m2 (0.002 per feet2) within occupied habitat. He arrived at a population estimate of 47,233 plants (rosettes) on 117 ha (288 ac). Subsequent GPS mapping of this population conforms to the general population boundaries of Knight's 1993 map, but significantly decreased the occupied habitat area to a more precise 62.4 ha (154.1 acres) (Tonne 2005). A total population estimate of 18,720 plants is obtained by using Knight's 1993 average density estimate and Tonne's 2005 mapped area of occupied habitat. These calculations for Ben Slaughter Draw do not include the 2013 rediscovery of the Hay Hollow portion of the population that he estimated 1,000-1,500 plants across less than 4.0 ha (10.0 ac) (Sivinski 2013). (USFWS, 2016). Gypsum wild buckwheat remains represented by few (4), small (1–21 ha (3–52 ac)), isolated (by 4.0–71.3 km (2.5–45.3 mi)) populations (see Table 2.1) (Service 2022, pp. 22, 42). These populations are not securely stable (they have average population growth rates below 1.00, and only Seven Rivers Hills currently has good viability) and are unable to rescue one another in the event of catastrophic decline (Service 2022, pp. 50, 103). Note, however, that current population growth rate results are from only two transition-year sets while ten or more consecutive transition year sets may be needed to draw inferences about population growth rates for species with pulsed recruitment (USFWS, 2022).

Threats and Stressors

Stressor: Mineral extraction and development (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: All gypsum wild-buckwheat habitats are within areas with high potential for fluid minerals leasing and extraction. Oil and gas well pads, roads, and pipelines are proliferating in this region of New Mexico. The BLM SMA on the designated critical habitat of the Seven Rivers Hills population presently eliminates this threat through the requirement of "no surface occupancy" for mineral leases within the designated critical habitat. Roads and pipelines associated with mineral development also must avoid this area. The Seven Rivers Hills SMA protects about 95 percent of the occupied habitat from this land use. SMAs with "no surface

occupancy" stipulations for oil and gas leases were also administratively placed on BLM jurisdictions containing gypsum wild-buckwheat habitats at the Black River and Ben Slaughter Draw populations in 1997 (BLM 1988, BLM 1997). These SMAs protect approximately 50 percent of the total habitat at Black River and Ben Slaughter Draw from oil and gas development (Tonne 2005). Approximately 65 percent of total habitat area in all three gypsum wild-buckwheat populations is presently protected from surface impacts associated with oil and gas development. Knight (1993) concluded that mineral development for oil and gas, and possibly gypsum, was the only serious potential threat to gypsum wild-buckwheat. At this time, surface disturbance associated with federal mineral development is very unlikely to occur on gypsum wild-buckwheat habitats within the BLM SMAs. Mineral development could potentially affect nearly 50 percent of the Black River population. The private land portion of the Black River population could also be impacted by future minerals development. However, about 50 percent of the Black River habitat, about 95 percent of the Seven Rivers Hills habitat, and approximately 50 percent of Ben Slaughter Draw habitats have been protected by the "no surface occupancy" stipulation of the BLM SMAs (Tonne 2005). Oil and gas may be leased on these lands, but must be extracted by directional drilling from outside the SMAs. Directional drilling allows a company to develop fluid minerals without needing to be directly above (vertical of) the target, meaning this technology may afford greater avoidance options for conserving sensitive habitats. Rights-of-ways for the roads and pipelines associated with oil and gas development must also avoid disturbance of the SMAs. The Seven Rivers Hills and Ben Slaughter Draw SMAs also requires the withdrawal of minerals, such as gypsum, sulfur and salts, from claim and mine development. Mineral claims are not specifically withdrawn from the Black River SMA. The chemical analysis found the gypsum of the Castile Formation to be 85 percent hydric gypsum, which is a suitable quality for mining (Weber and Kottlowski 1959, Knight 1993). Potential for gypsum mining of the Castile formation however, is low at this time because of large deposits of higher quality gypsum presently being mined elsewhere in New Mexico (Knight 1993). (USFWS, 2016)

Stressor: Reservoir Development and Flooding (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The threat of flooding from Brantley Reservoir has not been fully realized, primarily due to the use of a spillway in the central section of the main dam (BOR 2009). The elevation of the spillway is 993.5 m (3,259.5 ft) mean sea level and the maximum water surface elevation of the reservoir is 1,006.9 m (3,303.5 ft) mean sea level. Water level peaked on March 29, 2015 (U.S. Geological Survey 2016) at approximately 4.0 m (13 ft) above the spillway at 997.5 m (3272.5 ft) elevation. Even at this highest level, the pool remained to the east of U.S. Highway 285 and the gypsum wild-buckwheat population. Knight (1993) analyzed the potential impacts from Brantley Reservoir reaching the maximum flood pool with the assumption that the water level would rise similarly across U.S. Highway 285. Under this assumption, the maximum flood event pool in Brantley Reservoir could temporarily flood a few hectares of gypsum wildbuckwheat habitat. He found eight gypsum wild-buckwheat plants at or below the 1,002.8 m (3,290 ft) level on the west side of U.S. Highway 285. The soils in this area would become saturated for a time after a flood and could potentially be invaded by saltcedar (Tamarix spp.), an invasive tree that often lines the banks of reservoirs. Knight surveyed another 6 m (20 ft) vertical up to the 1,009 m (3,310 ft) level where saltcedar might become established and located an additional 44 gypsum wild-buckwheat plants. In 1993, there were 52 plants in the hypothetical zone of maximum flood impact. A flood event could potentially impact about 100 plants in this

population of several thousand plants. However, at the highest water level recorded in 2015, the water did not reach U.S. Highway 285 and the gypsum wild-buckwheat was not impacted. Therefore, Brantley Reservoir is not a significant threat to gypsum wild-buckwheat. The populations at Black River and Ben Slaughter Draw are not near any existing or proposed reservoirs and therefore, are not threatened by flooding. The Seven Rivers Hills population is the only known population that could be affected by flooding. (USFWS, 2016)

Stressor: Drought (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Inadequate seasonally appropriate soil moisture is typically caused by drought and may be exacerbated by hydrological alteration (Factors A and E). Climate change projections for gypsum wild buckwheat's range predict increased temperatures (+2–5 °C (+4–9 °F)), and relatively unchanged precipitation (+3.8 to -6.6 millimeters (mm) (+0.15 to -0.26 inches (in))) through 2099 under representative concentration pathway RCP) scenarios 4.5 and 8.5, respectively. These changes would increase evaporation and drought, adversely affecting survival and recruitment of gypsum wild buckwheat plants. Gypsum wild buckwheat's tolerance of desiccation and ability to go dormant in response to soil moisture stress provides some resilience to climate change, but increases in the intensity, frequency, and/or duration of drought would likely stress this adaptive capacity. Increased drought may also lead to increased predation (Factor C) resulting from reduced availability of alternative preferred forage for herbivores. It is unknown if gypsum wild buckwheat's ability to obtain scarce nutrients and its strategies for surviving drought and herbivory can support self-sustaining wild populations through climate change (USFWS, 2022).

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 14

Delisting Criteria:
The criteria for delisting are based upon the designation of the critical habitat as a Bureau of Land Management (BLM) Area of Critical Environmental Concern (ACEC) to maintain the population of 10,000 individuals. Some other special use designation which would secure the area from degradation due to human activities would be acceptable. (USFWS, 1984)

Recovery Actions:

- Prevent further impacts by designating the critical habitat area as an ACEC; develop a management plan; manage livestock grazing and study its effects; regulate recreational use, including Off-Road Vehicle (ORV) traffic, in the habitat; and monitor the effects of raised water level in Brantley Reservoir (USFWS, 2016).
- Maintain healthy populations by studying gypsum wild buckwheat biology and habitat characteristics (USFWS, 2016).
- Inventory suitable habitats for new populations (USFWS, 2016).
- Develop public appreciation and support for gypsum wild buckwheat. (USFWS, 2016)

- Recommendation for Future Action from 2016 5-Year Review: Through Section 4 of the ESA, the Service is required to conduct a 12-month finding to review the petition request to delist the gypsum wild-buckwheat and concurrently propose to delist. A post-delisting monitoring plan will be developed and made available for public review and comment prior to a final rulemaking. (USFWS, 2016)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Direct Conservation Actions • Maintain and extend barricades that block motor vehicle access to occupied areas. Close vehicle access to populations and to linear features intersecting populations. • Increase avoidance distances to 300 m for all potentially adverse land use or treatment activities. Maintain avoidance distances over time and across land jurisdictions. • Expand the Hay Hollow population to increase occupied extent and area. For example, establish subpopulations of plants from at least 50 Hay Hollow-sourced maternal lines in suitable soils on the adjacent escarpments north and south of the current Hay Hollow population. • Discover and/or introduce populations that increase gypsum wild buckwheat's range extent and diversity of associated vegetation types, geological units, and climate zones. Research and Monitoring • Expand long-term demographic monitoring across land jurisdictions. Maintain monitoring plots and continue demographic studies until the average transition matrix from 10–15 consecutive years of data demonstrates a stable or increasing population growth rate. • Identify and document gypsum wild buckwheat seed germination and seedling establishment requirements. • Identify and document specifications for suitable gypsum wild buckwheat soils (e.g., soil testing for percent gypsum, other nutrients, and soil microorganisms; soil depth probing; etc.). • Proactively model, survey, and map suitable gypsum wild buckwheat soils. • Identify and document techniques for restoring the gypsum wild buckwheat suitability of compacted, hypergypsic soils. Building Community Support • Install and maintain signs that support education about, and enforcement of, current and existing protective land use designations. Stay ahead of emerging adverse recreational use trends. • Recruit and retain botanical expertise amongst agency environmental review and project management staff (USFWS, 2022).
- Discretionary conservation measures (including project clearance surveys, environmental review of potential impacts, and avoidance distances for surface disturbing activities) currently account for a significant proportion of gypsum wild buckwheat protections (77% of population areas are protected by discretionary conservation measures versus 40% of population areas by special land use designations). Since federal listing under the Act, gypsum wild buckwheat populations have been managed for conservation and expansion primarily through local stakeholder initiative and discretionary programs, practices, and funding. The comprehensive suite of discretionary conservation actions has been effective at minimizing risks from threats and maintaining the status of this species. However, discretionary conservation is vulnerable to rollbacks as budgets and/or administrative priorities change. They are also vulnerable to staff attrition and turn-over. If the species were delisted, continuation of these conservation actions would be uncertain in the absence of formalized administrative direction to retain them (USFWS, 2022).

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SPECIES ACCOUNT: *Eriogonum kennedyi var. austromontanum* (Southern mountain wild-buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Eriogonum kennedyi var. austromontanum (southern mountain wild buckwheat) is a woodybased, cushion-like, perennial plant in the buckwheat family (Polygonaceae). Individual plants are 8 to 15 cm (3.1 to 5.9 in) tall, with stems forming loose, leafy mats, 14 to 36 cm (5.5 to 14.1 in) wide. The leaves are oblanceolate (broadest above the middle and tapering toward the base) and 0.5 to 1 cm (0.2 to 0.4 in) long, with dense white hair. The inflorescences (flower clusters) are 8 to 15 cm (3.2 to 5.9 in) high, bearing head-like inflorescences. The perianth is white to rose, and composed of inner and outer lobes that are similar in appearance (Reveal 1989, pp. 326–327; Hickman 1993, p. 874). (USFWS, 2015)

Taxonomy

One of several species in a large and complex genus of western and southern North America. Eriogonum kennedyi var. austromontanum is distinguished from other members of the species within its range (E. k. var. kennedyi and E. k. var. alpigenum) by longer plant parts (inflorescences, leaves, fruits, and involucres) (Reveal 1989, pp. 326–327; Hickman 1993, p. 874). This taxon could also be confused with Eriogonum wrightii subsp. subscaposum, but E. w. subsp. subscaposum has branched inflorescences, wider leaves, shorter fruits, and is found in pine forests rather than on pebble plain habitat (Neel and Barrows 1990, p. 51; Rosatti 2013, pp. 1, 3). (USFWS, 2015)

Historical Range

See current range/distribution.

Current Range

Eriogonum kennedyi var. austromontanum is found in pebble plain habitat in the northeastern San Bernardino Mountains of southwest San Bernardino County. (USFWS, 2015)

Critical Habitat Designated

Yes; 1/25/2008.

Legal Description

On December 26, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 25, 2008) for Eriogonum kennedyi var. austromontanum (Southern mountain wild-buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 critical habitat units (CHUs), in California (72 FR 73092-73178).

Critical Habitat Designation

The critical habitat designation for Eriogonum kennedyi var. austromontanum includes 13 CHUs in San Bernardino County, California. approximately 904 ac (366 ha) of Federal, State, and private land are being designated as critical habitat (72 FR 73092-73178). Units are grouped by

pebble plain complexes (e.g., Arrastre/Union Flat) as identified in the USFS's 2002 Management Guide. Detailed coordinates and maps are provided in the Final Rule. The 13 units total 904 ac (366 ha).

Units ERKA 1 and ERKA 2. Arrastre/Union Flat, San Bernardino County, California. ERKA 1 contains 69 ac (28 ha); ERKA 2 contains 229 ac (93 ha); the landowner is the U.S. Forest Service. ERKA 1 is USFS Pebble Plain Number 100; ERKA 2 is USFS Pebble Plain Number 87.

Unit ERKA 3, Big Bear Lake, San Bernardino County, California. ERKA 3 contains 6 ac (2 ha). The landowner is the U.S. Forest Service. ERKA 3 is USFS Pebble Plain Number 254.

Units ERKA 4 and ERKA 5. Fawnskin, San Bernardino County, California. ERKA 4 contains 15 ac (6 ha); ERKA 5 contains 24 ac (10 ha. The landowner is the U.S. Forest Service. ERKA 4 is USFS Pebble Plain Number 301; ERKA 5 is USFS Pebble Plain Number 302.

Units ERKA 6, ERKA 7, and ERKA 10. Gold Mountain and North Baldwin Lake, San Bernardino County, California. ERKA 6 contains 62 ac (25 ha); ERKA 7 contains 43 ac (17 ha); ERKA 10 contains 320 ac (129 ha). The landowner is the U.S. Forest Service. ERKA 6 is USFS Pebble Plain Number 188; ERKA 7 is USFS Pebble Plain Number 192.; ERKA 10 is USFS Pebble Plain Number 128.

Units ERKA 8 and ERKA 9. Holcomb Valley, San Bernardino County, California. ERKA 8 contains 28 ac (11 ha); ERKA 9 contains 44 ac (18 ha). The ERKA 8 landowner is the U.S. Forest Service (22 ac) and a private owner (6 ac). The ERKA 9 landowner is the U.S. Forest Service. ERKA 8 is USFS Pebble Plain Numbers 98 and 109; ERKA 9 is USFS Pebble Plain Number 153.

Units ERKA 11 and ERKA 12. Sawmill, San Bernardino County, California. ERKA 11 contains 36 ac (14 ha); ERKA 12 contains 5 ac (2 ha) The ERKA 11 landowner is the U.S. Forest Service (15 ac) and a private landowner (21 ac). ERKA 12 is privately owned. ERKA 11 is USFS Pebble Plain Number 236; ERKA 12 is USFS Pebble Plain Number 224.

Unit ERKA 13. South Baldwin Ridge/Erwin Lake, San Bernardino County, California. ERKA 13 contains 23 ac (9 ha) and is owned by the U.S. Forest Service. ERKA 13 is USFS Pebble Plain Number 212.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum kennedyi var. austromontanum critical habitat are the habitat components that provide (72 FR 73092-73178):

(i) Pebble plains in dry meadow-like openings within upper montane coniferous forest, pinyon-juniper woodlands, or Great Basin sagebrush in the San Bernardino Mountains of San Bernardino County, California; at elevations between 5,900 to 9,800 ft (1,830 to 2,990 m) that provide space for individual and population growth, reproduction and dispersal.

(ii) Seasonally wet clay, or sandy clay soils, generally containing quartzite pebbles, subject to natural hydrological processes that include water hydrating the soil and freezing in winter and drying in summer causing lifting and churning of included pebbles, that provide space for

individual and population growth, reproduction and dispersal, adequate water, air, minerals, and other nutritional or physiological requirements to the species.

Special Management Considerations or Protections

Critical habitat does not include manmade structures (such as buildings, aqueducts, airports, roads, and other paved areas) and the land on which they are located existing on the effective date of this rule and not containing one or more of the primary constituent elements.

Threats to listed pebble plains plants throughout their range include land development, off-highway vehicle (OHV) use off of designated routes, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, and nonnative plant species (63 FR 49006; September 14, 1998). Pebble plain habitat is also threatened by vegetation and fuels management, hazard tree removal, and wildfire suppression activities (Eliason 2006). However, of the above threats, land development remains the primary cause of habitat loss on private lands; while on Federal lands, OHV use off of designated routes has historically been, and continues to be, the most significant threat to pebble plains habitat. Increasing residential populations adjacent to pebble plains habitat on private and Federal lands has also resulted in degradation of habitat, as dispersed recreation and unauthorized OHV use increases (Eliason 2006). Also, while forest system road use and maintenance, mining activities, and dispersed recreation continue to have adverse ongoing effects to pebble plain habitat and the species it supports, the magnitude and severity of effects caused by these activities are relatively small compared to the effects of unauthorized motorized vehicle use (Eliason 2006). The primary constituent elements for the listed pebble plains plants may require special management considerations or protection to minimize impacts associated with, (1) vehicle use and road maintenance; (2) recreational activities; and (3) the presence of nonnative species (63 FR 49006, September 14, 1998; USFS 2002, p. 17; USFS 2005, pp. 207, 249, 293).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (USFWS, 2015)

Dependency on Other Individuals or Species

Adult: Numerous types of wasps, bees, and flies have been recorded as pollinators on this plant (O'Brien 1979, p. 99; Freas and Murphy 1990, p. 6). (USFWS, 2015)

Breeding Season

Adult: July to September (USFWS, 2015)

Reproduction Narrative

Adult: This taxon flowers from July through September (Neel and Barrows 1990, p. 51). Eriogonum kennedyi var. austromontanum produces seeds by selfing (self-pollinating) and entomophilous (insect-mediated) outcrossing (O'Brien 1979, p. 97). Numerous types of wasps, bees, and flies have been recorded as pollinators on this plant (O'Brien 1979, p. 99; Freas and Murphy 1990, p. 6). (USFWS, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, Forest - Conifer, Forest Edge, Forest/Woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers no canopy cover, low leaf litter, and sunny areas; found at elevations between 2,000 to 2,200 m (6,557 to 7,213 ft) (USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist

Site Fidelity

Adult: High (inferred from USFWS, 2015)

Habitat Narrative

Adult: Eriogonum kennedyi var. austromontanum is restricted to pebble plain habitat (USFS 2002, p. 17), so described because of the layer of orange quartzite pebbles that are pushed to the clay soil surface by frost heaving and thawing (Krantz 1983, p. 10). Pebble plains are treeless, open patches within pine forests and pinyon-juniper woodlands (USFS 2002, pp. 12, 15). They contain unique plant associations and soil characteristics, associated with climatic features (Derby and Wilson 1979, p. 463; USFS 2002, pp. 12, 22–23). The deep clay deposits support an assemblage of small cushion-forming plants, tiny annuals, grasses and succulents that are low growing, sun tolerant and well-spaced (USFS 2005a, p. 100). Pebble plain endemic plants seem to have a specific competitive advantage for their particular specialized habitat, but lack that advantage in adjacent forest and woodland habitat (Derby and Wilson 1979, p. 472). Eriogonum kennedyi var. austromontanum prefers areas with low levels of shade and leaf litter accumulation (Derby and Wilson 1979, p. 471). Although this taxon typically occupies clay soils with pebbles or cobbles, E. k. var. austromontanum also occurs on sandy, clay soils (e.g., Burnt Flat) or clay soils lacking pebbles or cobbles (e.g., areas at North Baldwin Lake) (USFS 2002, p. 94). This species is restricted to the San Bernardino Mountains at elevations from 2,000 to 2,200 m (6,557 to 7,213 ft) in San Bernardino County, California. (USFWS, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Pollen analog transfer was not detected greater than 4 m (13.1 ft) from marked plants, with more than 90 percent of dye transfer occurring within 1 m (3.3 ft) of each plant (Freas and Murphy 1990, p. 6). Freas and Murphy (1990, pp. 7, 8) state that there is no evidence indicating that either wind- or pollinator-mediated dispersal plays a role in gene flow between pebble plain sites. (USFWS, 2015)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

16 (extant occurrences) (USFWS, 2022)

Population Narrative:

Currently, Eriogonum kennedyi var. austromontanum is known to occur in 10 pebble plain complexes, which include Arrastre/Union Flat, Big Bear Lake, Broom Flat, Fawnskin, Gold Mountain, Holcomb Valley, North Baldwin Lake, Sawmill, South Baldwin Ridge/Erwin Lake and Sugarloaf Ridge. (USFWS, 2015). In the 2015 5-year review, we considered Eriogonum kennedyi var. austromontanum extant at 37 occurrences. Since then, we received new survey, monitoring, and threats information for this species. We updated the status of occurrences described in our previous status review, merged 1 former CNDDB occurrence into part of an existing occurrence, added 1 new USFS, 1 new CNDDB occurrence, 4 Ventura County occurrences, and 5 historical Kern County occurrences that were not considered in the 2015 review, and updated the determination of the Rattlesnake Canyon pebble plain complex occurrence, bringing the total number of occurrences to 48 (Table 1). Of the 48 occurrences, 16 are extant, 19 are presumed extant, 8 are possibly extirpated, and 5 are unknown (USFWS, 2022).

Threats and Stressors

Stressor: Urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Much of the habitat of Eriogonum kennedyi var. austromontanum historically found on private lands has been lost to residential and commercial development (USFS 2012a, p. 31). At the time of listing, the Service indicated that relatively unrestricted development of privately owned parcels of land was a threat to E. k. var. austromontanum and other pebble plain plants and we specifically described losses due to urbanization in the Big Bear Lake pebble plain complex (USFWS 1998, p. 49013). In the 2008 5-year review, the Service indicated that development continued to be an ongoing threat at several pebble plain complexes including North Baldwin Lake, South Baldwin Ridge/Erwin Lake, Big Bear Lake, Fawnskin, Sawmill, and Gold Mountain (USFWS 2008, p. 6). Urban development (primarily residences) and related recreational development on city, county or private lands within the Big Bear Lake and Baldwin Lake areas continue to represent an ongoing threat to Eriogonum kennedyi var. austromontanum at six of the pebble plain complexes. Urban development threats to this taxon within portions of the Big Bear Lake and Fawnskin pebble plain complexes result from the effects of residential improvements (e.g., landscaping) and services provided by local entities (e.g., drainage structures), as well as new, proposed residential developments (USFS 2012b, pp. 63–64). Large areas of non-Federal land are also found within the eastern half of Bear Valley, which includes Eriogonum kennedyi var. austromontanum occurrences found within the Sawmill, North Baldwin Lake, South Baldwin Ridge/Erwin Lake, and Gold Mountain pebble plain complexes. Where this taxon is found on the small lots and private lands in residential neighborhoods within these complexes, potential impacts include those related to home improvements, maintaining defensible space, or administration of County services (USFS 2012b,

pp. 75, 80). Threats resulting from development or associated infrastructure within private inholdings managed by San Bernardino County within the Holcomb Valley and Arrastre Pebble Plain complexes are possible, but unknown (USFS 2012b, p. 74). Several utilities operating within the San Bernardino Mountains provide either direct services to urbanized areas in the region or related infrastructure, and their operation and maintenance activities can affect populations of Eriogonum kennedyi var. austromontanum or its critical habitat. The primary threats to E. k. var. austromontanum from these utilities include ground disturbance and localized trampling of habitat related to operation and maintenance activities, such as pole replacements. (USFWS, 2015)

Stressor: Roads and trails (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In our final listing rule, the Service described impacts from Roads and Trails under the category of offroad vehicle activity, citing over 7 miles (mi) (11 kilometers (km)) of USFS roads and 10 mi (16 km) of unauthorized routes that directly impact pebble plain sites (Odell 1988, p. 4). Approximately 2.5 percent of SBNF land consists of roads (USFS 2005b, Vol. 1, p. 114). The SBNF implements a Roads and Trails Management Program that incorporates roads, motorized trails, motorized interpretive trails, and non-motorized trails found within the SBNF (USFS 2012b, pp. 9–10). An estimated 4.3 mi (6.9 km) or 101 ac (41 ha) (using 100 ft (30 m) of centerline) of roads and trails affect Eriogonum kennedyi var. austromontanum occurrences within an estimated 1,129 ac (456 ha) of occupied habitat located on lands owned and managed by the USFS (USFS 2012b, p. 22). Threats to Eriogonum kennedyi var. austromontanum from roads and trails include both direct effects, such as habitat alteration, and indirect effects, including alteration of water flow and drainage patterns, sedimentation, deposition of particulates (dust), and effects related to wildfire (USFS 2012b, pp. 21–24). Roads, road construction, and road maintenance can also facilitate the introduction and establishment of nonnative plants by creating open, continually disturbed habitat as well as disrupt hydrological processes within pebble plains habitats. Nonnative plants can be transported along these road corridors by equipment and vehicles, and are often more easily established on exposed cut-and-fill slopes of roads than native plants (USFS 2005b, Vol. 1, p. 114). USFS roads present ongoing threats in the Holcomb Valley area (Holcomb Valley, Arrastre Flat pebble plain complexes), Baldwin Lake area (Gold Mountain pebble plain complex) and the Sugarloaf–Onyx area (Broom Flat pebble plain complex) where Eriogonum kennedyi var. austromontanum occurs. The SBNF installed fencing, rock barriers, and signage at the most disturbed locations to minimize impacts to the habitat, including effects related to crushing, uprooting or burial of plants (USFS 2012b, pp. 71–72, 77, 82–84). The SBNF also closed unauthorized routes originating from USFS roads in the Baldwin Lake area (Sawmill pebble plain complex) and, following these closures, implemented habitat restoration activities (USFS 2012b, p. 77). Periodic maintenance work on State Routes 18 and 38, and County roads (Holcomb Valley Road) has the potential to impact E. k. var. austromontanum and its habitat in the Baldwin Lake area (North Baldwin Lake, Sawmill pebble plain complexes) (USFS 2012b, p. 79). Ongoing use and maintenance of USFS trails likely subjects Eriogonum kennedyi var. austromontanum to occasional localized crushing, uprooting or burial of habitat and individuals in the Big Bear Lake, Baldwin Lake, and Sugarloaf–Onyx areas (USFS 2012b, pp. 59, 76–77, 82). In their biological assessment for the South Big Bear Bike Trails project, the SBNF identified potential threats to E. k. var. austromontanum habitat including the re-routing and restoration of portions of the Pine Knot trail (USFS 2012a, p. 30). The SBNF determined that,

after closure and restoration of the section of trail that currently travels through pebble plain habitat, this project would produce beneficial effects to E. k. var. austromontanum and other listed species with the potential for re-colonization of the currently disturbed areas (USFS 2012a, pp. 30–34).

Stressor: Collection of wood for fuel (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Associated with OHV activity is unauthorized collection of wood for fuel including removal of downed vegetation or trees. The SBNF has an active, personal use fuel-wood program in which the public can purchase permits for cutting wood from marked, downed logs in designated areas (USFS 2012b, p. 30). However, unauthorized collection of fuel-wood is a current threat in some areas within the SBNF and on private lands (e.g., Sawmill Creek area (S. Eliason, USFS, 2012b, pers. comm.)). This activity reduces natural barriers to sensitive areas and creates additional access for unauthorized OHV activities (Eliason, 2012a, pers. comm.). The Baldwin Lake area (Sawmill, North Baldwin Lake, South Baldwin Ridge/Erwin Lake, and Gold Mountain pebble plain complexes) continues to experience a high intensity of these activities as well as a high frequency of use (USFS 2012b, pp. 77–78). (USFWS, 2015)

Stressor: Recreation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The high frequency of OHV activity was described as the most significant and persistent threat in the final listing rule for Eriogonum kennedyi var. austromontanum and other pebble plain plants and was reiterated as such in our 2008 5-year review (USFWS 1998, p. 49013; USFWS 2008, p. 6). Unauthorized OHV use has impacted all pebble plain complexes to varying degrees (USFS 2002, p. 25). Threats also result from the effects of non-motorized trails and mountain biking due to the proximity of E. k. var. austromontanum and its habitat to urban areas (USFS 2012b, pp. 60–61). Along with soil compaction, soil erosion resulting from OHV use could significantly alter Eriogonum kennedyi var. austromontanum habitat. Vehicle traffic during the wet season is of particular concern, as this activity directly disturbs or destroys vegetation and creates deep ruts that change the hydrological patterns over the pebble plain (USFS 2002, p. 20). Vehicle traffic also increases breakdown in natural soil aggregates (structure) (Sadler 1989, pers. comm., cited in USFS 2002, p. 23). (USFWS, 2015)

Stressor: Alteration of hydrology (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The listing rule identified alteration of hydrological conditions as a threat to Eriogonum kennedyi var. austromontanum habitat, noting that the majority of pebble plain complexes are directly impacted by vehicle routes that may lead to alterations in the surface hydrology (USFWS 1998, p. 49013). This threat is often the result of OHV activities and direct and indirect impacts from urbanization (USFS 2002, p. 25). As discussed above, vehicle traffic within pebble plains habitats during the wet season is of particular concern because this activity creates deep ruts that change hydrological patterns within pebble plains. Alteration of hydrology can

also result from land disturbance due to mining and fire suppression activities, which are discussed as separate threats to E. k. var. austromontanum below. Normally, surface water flows evenly across the relatively impervious pebble plains (Odell 1988, p. 19). However, changes in the hydrological pattern associated with a disturbed pebble plain could alter the soil composition by allowing for erosion of clay sediments during rainfall events, leaving only large cobbles and pebbles (Neel and Chaney 1992, p. 1). These potential changes to soil morphology and composition could theoretically result in invasion of both native and nonnative plant species that then out-compete Eriogonum kennedyi var. austromontanum for space and resources. Once established, native trees and shrubs alter the surrounding microhabitat by shading, increasing leaf litter, and probably by reducing temperature extremes (Derby 1979, pp. 72–73; USFS 2002, p. 15). (USFWS, 2015)

Stressor: Trampling of habitat (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In our listing rule, the Service described prior moderate-to-heavy degradation of certain sites occupied by Eriogonum kennedyi var. austromontanum from trampling by cattle and indicated that some pebble plains continued to be impacted by cattle, horses, and feral burros (USFWS 1998, p. 49016). However, the Service anticipated this threat would be reduced with the removal of feral burros from several pebble plain complexes under the provisions of the Big Bear Wild Burro Territory Management Plan (USFWS 1998, p. 49017). At present, the threat of trampling to pebble plain habitat and to individual plants, including Eriogonum kennedyi var. austromontanum, due to burro activity is estimated to be very minor and the threat of trampling from cattle no longer exists for this taxon (Eliason, 2012a, pers. comm.). In addition to potential impacts from burros, Hitchcock Ranch, a private inholding in the Holcomb Valley area, grazes approximately 30 to 40 horses in the Hitchcock Meadow (located within the Holcomb Valley pebble plain complex), which is occupied by Eriogonum kennedyi var. austromontanum and other federally listed plants (USFS 2012b, p. 74). The extent and severity of effects of trampling by horses in this portion of the Holcomb Valley to E. k. var. austromontanum habitat and individual plants is currently unknown. (USFWS, 2015)

Stressor: Non-native plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In our final listing rule, the Service identified exotic (nonnative) plants as a threat to Eriogonum kennedyi var. austromontanum in the context of disturbances related to grazing, urban and rural development, and various recreational activities (USFWS 1998, p. 49017). These activities can threaten native plants by facilitating the establishment of non-native species and resulting in the alteration of habitat through crowding or competition for resources (USFWS 1998, p. 49017). In our 2008 5-year review, the Service used the assessments provided in the 2002 Pebble Plain Habitat Management Guide (USFS 2002) in determining that nonnative plants, including grasses and forbs, continued to impact Eriogonum kennedyi var. austromontanum habitat, potentially displacing the taxon through competition for nutrients, water, light, and space (USFWS 2008, p. 10). Treatment activities for nonnative plants under the SBNF's Invasive Species Management program may also threaten E. k. var. austromontanum through trampling and crushing, but these effects are considered incidental and localized relative to the larger

beneficial effects to these and other native species (USFS 2012b, p. 92). In addition, ground disturbance from mining (discussed below) and recreational activities (discussed above) can disturb soils and create the potential for the introduction and spread of nonnative plants. The 2002 Pebble Plain Habitat Management Guide described nonnative plants as a threat to the unique plant communities for the following pebble plain complexes where Eriogonum kennedyi var. austromontanum occurs: (1) Arrastre Flats, (2) Broom Flat, (3) Fawnskin, (4) Gold Mountain, (5) North Baldwin Lake, (6) Sawmill, and (7) South Baldwin Ridge/Erwin Lake (USFS 2002, pp. 46, 48, 51, 53, 57, 62, 65). Bromus tectorum (cheatgrass) represents the primary species of concern for these pebble plain areas. The presence of Bromus tectorum within pebble plain habitat can provide a continuous "flashy" fuel load and the potential to increase the fire return interval (USFS 2005a, p. 101), though it is unclear to what extent fire has affected pebble plain communities (USFS 2005a, p. 100). Bromus tectorum as well as Erodium cicutarium (filaree), represent very old invasions in the San Bernardino Mountains and are persistent threats within these complexes (Eliason, 2012a, pers. comm.). More recent invasions of nonnative plant species within some of these pebble plain complexes include Linaria dalmatica (dalmatian toadflax), Ranunculus testiculatus (bur buttercup), and Lepidium perfoliatum (clasping pepperweeed) (Eliason, 2012a, pers. comm.). (USFWS, 2015)

Stressor: Mining (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In our listing rule, the Service indicated that mining activities had contributed to the decline of Eriogonum kennedyi var. austromontanum due to effects from habitat destruction, degradation, and fragmentation of pebble plain habitats (USFWS 1998, p. 49013). However, the Service later described mining as a secondary threat to habitat degradation in our 2008 5-year review (USFWS 2008, p. 6), based on expected implementation of avoidance measures by the USFS for regulated mining activities (USFWS 2005, p. 235). Gold mining in the Holcomb Valley area during the late 1800s greatly affected pebble plains habitat, though the scale of gold mining has been much reduced (USFS 2005b, Vol. 1, p. 107). Small-scale gold mining activities, however, continue to occur in several pebble plain complexes (e.g., Fawnskin, Gold Mountain, and Holcomb Valley; USFS 2005a, pp. 10, 54), and Plans of Operation for mining on the SBNF have the potential to affect pebble plain plant habitat (USFS 2005b, Vol. 1, p. 107). Prospecting has also become more dispersed, and is of concern because of the lack of restrictions governing this activity (USFS 2005b, Vol. 1, p. 107). Unpatented mining claims on USFS lands were previously reported for five pebble plain complexes occupied by Eriogonum kennedyi var. austromontanum: (1) Holcomb Valley (83 ac (33.6 ha), (2) Fawnskin (24 ac (9.7 ha)), (3) Arrastre Flats (69 ac (28 ha)), (4) North Baldwin Lake (62 ac (25 ha)), and (5) Broom Flat (0.2 ac (0.08 ha)) (USFS 2002, pp. 42, 46, 48, 57, 65). These claims continue to represent a potential threat of ground disturbance for E. k. var. austromontanum, specifically, gold prospecting activities or mining operations related to the ownership of mineral rights. The Holcomb Valley area, which includes the Holcomb Valley and Arrastre Flats pebble plain complexes, is a particularly active area for small-scale mining activities (e.g., prospecting by clubs and individuals) and represents an area of concern for pebble plain plants and their habitats (USFS 2012b, p. 74). Small-scale mining activities around Doble in the North Baldwin Lake pebble plain complex could affect a small portion of occupied habitat (USFS 2012b, p. 80). (USFWS, 2015)

Stressor: Fire suppression (USFWS, 2015)

Exposure:
Response:
Consequence:
Narrative: Activities related to management of fire and fuels can also threaten Eriogonum kennedyi var. austromontanum and its habitat. Although not recognized as a threat at the time of listing, fire suppression was known to impact habitat at one pebble plain complex in 2003, as described in our 2008 5-year review (USFWS 2008, p. 7). However, fuelbreaks and vegetation treatment units are very rarely located in pebble plain habitat due to the scarcity of fuels (USFS 2005c, p. 212). Fire suppression activities typically include fire line construction, fire retardant and water drops, establishment of temporary fire camps, staging areas, parking sites, safety zones, helipads, and post-fire rehabilitation (USFWS 2005, p. 27). Each of these activities can have negative impacts to E. k. var. austromontanum and its habitat. For well-conserved pebble plain habitats, the interior of the plain is highly resistant from high intensity burning because of the large percentage of bare ground, rock cover, and limited and discontinuous fuel (USFS 2005a, p. 100). Pebble plain habitats may therefore function as a natural fuelbreak, with fire moving around the margins of the plain through tree litter and shrubs (USFS 2005a, pp. 100–101). Given the protective mechanisms being implemented to avoid impacts from fire suppression actions to listed species and the limited fuel and vegetation treatment units in pebble plain habitat, we believe that threats to Eriogonum kennedyi var. austromontanum and its habitat from these fire suppression activities will be localized, only occasional, and do not constitute a widespread threat to the species or its habitat. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Climate change has already altered, and will continue to alter, the water cycle. Changes in the water cycle, which are consistent with the warming observed over the past several decades, include, but are not limited to: (1) changes in precipitation patterns and intensity; (2) changes in the incidence of drought; (3) widespread melting of snow and ice; (4) increasing evaporation; and (5) changes in soil moisture and runoff (USGCRP 2009, p. 41). Although the effects of climate change on Eriogonum kennedyi var. austromontanum and its habitat have not been measured and there is uncertainty in future predictions of downscaled climate change models, projected climate change effects mentioned above could significantly alter the hydrology that sustain and characterize pebble plain habitat occupied by E. k. var. austromontanum. Considerable erosion of the clay soils can occur with heavy rains when the ground is not covered by protective snow, or held together as a frozen matrix of clay, pebbles, and water. Local erosion can expose the roots of the small pebble plain plants to desiccation and lead to the death of the plants. Although these weather-related erosion events seldom occurred historically, earlier thawing, decreased snowpack, and other changes in precipitation patterns in the future could lead to an increase of these erosion events. Additionally, increased temperatures could reduce the extent of frost heaving, theoretically leading to increased encroachment of native trees and shrubs into pebble plain habitat. (USFWS, 2015)

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
A Recovery Plan has not been developed for this species.

Recovery Actions:

- Recommendation for Future Action from 2015 5-Year Review: Work with biologists at the SBNF to reduce impacts from recreational use of roads and trails through uncontrolled access to pebble plain habitat occupied by Eriogonum kennedyi var. austromontanum. Prioritize protective measures being implemented (or planned) for controlling access to areas occupied by E. k. var. austromontanum. This should include providing comment on biological assessments for proposed activities to support SBNF program of road closures and/or assistance in securing resources for placement of more effective barriers in the areas that receive the highest recreational uses from motorized vehicles. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Conserve or preserve Eriogonum kennedyi var. austromontanum occurrences on private lands. Continue to work with the State and local groups to purchase E. k. var. austromontanum habitat from willing sellers, particularly within the Sawmill pebble plain complex. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Develop a monitoring plan to provide early detection of downward trends in the populations of pebble plain plants, such as Eriogonum kennedyi var. austromontanum, and quality of pebble plain habitat (adapted from USFS 2005a, p. 125). This monitoring plan should identify and prioritize surveys of plant populations, including abundance, and habitat conditions, in those areas most vulnerable to threats (e.g., pebble plain complexes with high levels of recreational activity) and should include remote sensing and mapping of unauthorized OHV trails. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Evaluate reproductive life history characteristics such as seed germination requirements, mechanism of seed dispersal, and seed viability. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Determine the distribution of genetic diversity in the species occurrences and identify the most appropriate means to preserve the diversity. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be completed over the next 5 years. Successful implementation of these actions will reduce threats to Eriogonum kennedyi var. austromontanum and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Work with USFS land managers to reduce impacts to E. k. var. austromontanum and its habitat from recreation and unauthorized OHV use. Provide comment on biological assessments for proposed activities to support SBNF program of road closures and assistance in securing resources for the placement of more effective barriers in the areas that receive the highest recreational uses from OHV. Coordinate with USFS on implementation of the Pebble Plains Habitat Management Guide (USFS 2002). 2. Work with private landowners, local governments, and conservation organizations to conserve and manage habitat. Continue to work with state and local groups to purchase E. k. var. austromontanum habitat from willing sellers. Use resources from USFWS' Partners for Fish and Wildlife Program and Section 6 Grants as a tool to conserve, manage, or purchase habitat. 3. Continue to monitor E. k. var.

austromontanum occurrences to provide early detection of downward trends in the population numbers, quality of pebble plain habitat, or both, particularly in areas that have not been surveyed for over 10 years. Historical locations in Kern County should be included in survey efforts as there have been no observations in over 50 years, and surveys identifying E. k. var. austromontanum in Kern County could expand the species' range. Regular monitoring can also help with early detection of increasing threats to specific areas such as OHV trails. Monitoring may include remote sensing and mapping of unauthorized OHV trails. 4. Evaluate reproductive life history characteristics such as seed germination requirements, mechanism of seed dispersal, and seed viability. Collect E. k. var. austromontanum seed and conserve seed in an ex-situ conservation seed bank to preserve the genetic diversity in the species. Determine the distribution of genetic diversity in the species occurrences (USFWS, 2022).

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SPECIES ACCOUNT: *Eriogonum longifolium var. gnaphalifolium* (Scrub buckwheat)

Species Taxonomic and Listing Information

Listing Status: Threatened; 5/27/1993; Southeast Region (R4)

Physical Description

Eriogonum longifolium var. gnaphalifolium is a perennial herb. It has a taproot and one to three above-ground stems up to 1 m tall, but upwards of 10 stems have been observed in vigorous specimens, especially post-fire. It has a basal rosette of leaves that are 15 to 20 cm long, narrow, and white-woolly on the underside. The stem leaves are smaller than the rosette leaves. The stem terminates in a corymb, with each branch of the corymb ending in a cup-shaped involucre that holds a cluster of 15 to 20 small flowers, with each flower hanging on its stalk down below the involucre. The involucre is silvery, silky-pubescent, and the flowers are green with pink anthers (Rickett 1967) (USFWS, 1999)

Taxonomy

The genus Eriogonum includes about 150 species, most of them in western North America. Florida has only two species, both native to high pineland. Eriogonum tomentosum is common throughout the northern part of the state, as far south as Highlands County. The second species, scrub buckwheat, was named Eriogonum floridanum by J.K. Small (1903). Subsequent publications on Florida?s flora consistently adopted Small?s treatment of E. floridanum as a full species (Small 1933, Kral 1983, Ward 1979, Wunderlin 1982), but James Reveal (1968), an expert on the genus, treats the Florida plants as a variety of Eriogonum longifolium, a widespread species of the Great Plains that is represented east of the Mississippi by var. harperi in northern Alabama, Tennessee, and Kentucky (Kral 1983), and by var. gnaphalifolium in Florida (USFWS, 1999).

Historical Range

In Florida, in the following counties: Highlands, Hillsborough, Lake, Orange, Osceola, Marion, Pasco, Polk, and Sumter (USFWS, 1996)

Current Range

In Florida, in the following counties: Highlands, Hillsborough, Lake, Orange, Osceola, Marion, Pasco, and Polk (USFWS, 1996; USFWS, 2018)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: Unknown (NatureServe, 2015)

Breeding Season

Adult: January to November (NatureServe, 2015); May - October (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Disturbance or fire; hunting wasps and bees (NatureServe, 2015); open sand, moist soils (USFWS, 1999)

Reproduction Narrative

Adult: Eriogonum longifolium var. gnaphifolium is an herbaceous perennial that presumably is long-lived and slowly growing. It flowers and reproduces primarily after fires or other disturbances (e.g. logging, mowing) that increase light availability. Although it readily resprouts after fires or other disturbances such as mowing, it does not reproduce vegetatively. Flowering can occur from January to November, but is usually synchronized with fire or other disturbance; most flowering occurs within the first year after a fire. Although a plant is usually in flower for two to three months, the individual flowers are short-lived and open asyncronously. Typically, a maximum of one to two flowers per involucre are open at any one time. The flowers, although inconspicuous, must be insect-pollinated for seed set to occur. Several types of hunting wasps (families Vespidae, Eumenidae, Sphecoidea, Pompilidae) and a few bee species (Halictidae) visit the flowers. These insects, all with an excellent locational sense, may be "traplining" the plants daily for their nectar. Although the flowers provide a dependable source of nectar, it is thought that these insects are the only potential pollinators able to repeatedly located the scattered, inconspicuous flowers (Deyrup pers. communication). Seeds have no dormancy, but germinate only in microsites with little or no litter and sufficient moisture (Carrington unpubl. data). Virtually all seedling establishment, therefore, must occur within the first year after a fire; litter buildup is prohibitive afterwards. Seedling establishment tends to be rare, however, probably because moisture conditions are usually not optimal due to high soil surface temperatures and evaporation rates following growing season fires. Most seedling establishment probably occurs in very wet periods after fires. In the low-light conditions of long-undisturbed communities, Eriogonum longifolium var. gnaphifolium individuals are present as inconspicuous basal rosettes; flowering individuals are rare, and occur only in openings or on edges such as road shoulders or fire breaks (pers. obs.). Plants may be capable of surviving without leaves in undisturbed communities by subsisting on stored carbohydrates in their large roots; this possibility is suggested by the "sudden appearance" of previously undetected adult plants in populations monitored for several years (Menges pers. communication). Longevity of individuals is unknown, but since establishment from seed is extremely rare in long-unburned communities, populations may decline or vanish in sites unburned for several decades. Drought tolerance assumed from habitat. Reproduction is sexual (NatureServe, 2015). Although little information on the reproduction of this species is available, plants in the Ocala NF have been observed with immature flower stalks between April and mid-July and bloom from May to mid-October. Seedlings germinate in summer in open sand (R. Yahr, Archbold Biological Station, personal communication 1998) (USFWS, 1999).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: oak-hickory scrub, turkey oak barrens, and sandhill vegetation communitied on the Lake Wales Ridge (USFWS, 2018)

Dependencies on Specific Environmental Elements

Adult: 5 - 20 year fire intervals (USFWS, 2018)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2018)

Habitat Narrative

Adult: Scrub buckwheat occurs in oak-hickory scrub, turkey oak barrens, and sandhill vegetation communities on the Lake Wales Ridge from Highlands County north to Lake County. It is also found to a limited extent on the Mount Dora Ridge in the ONF in Marion County and on two parcels of private property in Orange County. Each of the vegetation communities where scrub buckwheat occurs evolved with periodic fire. Demographic modeling suggests population viability is highest when fire return intervals are 5 - 20 years (Satterthwaite et al. 2002) . Scrub buckwheat occurs in several xeric plant communities that may be burned at intervals of 1-8 years for sandhill to 5-12 years for oak-hickory scrub. On the ONF, scrub buckwheat occurs within actively harvested timber stands and habitats that are not managed specifically for timber production. (USFWS, 2018).

Dispersal/Migration

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seeds have no obvious dispersal mechanism, and usually drop beneath the parent plant; some may be carried a short distance in runoff during a rain (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Unknown (USFWS, 2018)

Number of Populations:

67 extant (USFWS, 2023)

Additional Population-level Information:

A total of 93 E. longifolium var. gnaphalifolium EO records have been reported to FNAI since 1961. Based on FNAI's most recent EO database (2022), there are 67 extant populations with over two-thirds occurring on conservation lands (USFWS, 2023).

Population Narrative:

The spatial distribution of scrub buckwheat has not changed from that reported in the 1996 recovery plan. However, additional populations have been located on properties that have been subsequently acquired for conservation purposes within the historic range. Turner et- al. (2006) indicated that there are 27 populations of scrub buckwheat on protected public and private lands and 21 populations on unprotected private lands. Scrub buckwheat populations that are located on unprotected lands are susceptible to extirpation because of land use changes. However, periodic censuses are not conducted and it is not possible to quantify the number or location of extirpations that have occurred due to habitat destruction. The Service is aware of two populations, both in Lake County, that have been extirpated due to issuance of incidental take permits under section 10 of the Endangered Species Act. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Twenty-seven of the 48 known scrub buckwheat localities occur on private, local, State, or Federal lands that are protected. This number of sites is substantially higher than the nine protected sites specified in recovery criterion number 1. Habitat loss or modification due to land use changes is not anticipated at these 27 sites because most were acquired for conservation purposes. Nonetheless, simply protecting scrub buckwheat habitat is insufficient to ensure long-term persistence because, as discussed above, this species requires periodic habitat management actions. Except for those properties described above, we do not currently have information about the type or frequency of land management activities on public lands where scrub buckwheat occurs. However, in general, it is widely documented that most public land managing agencies have not been able to burn as many acres as are targeted in their management plans. Consequently, most agencies are backlogged in prescribed burning (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2008). Even though we know managing agencies are faced with difficulties in use of prescribed fire in general, we do not know whether specific areas that contain scrub buckwheat habitat on public lands are threatened with modification due to lack of management. - The 21 scrub buckwheat populations occurring on unprotected private lands are susceptible to degradation of habitat due to lack of management and destruction due to land use changes. Habitat degradation will likely continue on these lands because private landowners have no incentives to manage their properties for scrub buckwheat. Even though scrub buckwheat can persist for long periods in fire suppressed conditions, a reduction in flowering and seedling recruitment can be expected in long-unburned habitats (McConnell and Menges 2002, Satterthwaite et al. 2002, Menges 2007). These adverse effects are expected to continue into the future on unprotected and unmanaged parcels. In addition, urban development is projected to increase in Florida in the coming decades (Zwick and Carr 2006), and we expect a commensurate decline in native vegetation communities. Such assessments, however, cannot project absolute risks of habitat destruction, on a parcel-by-parcel basis. Consequently, while we acknowledge the future risks of destruction of unprotected scrub buckwheat populations, we do not know which, if any, of the 20 populations are imminently at risk. - As a result of land acquisition efforts over the past several decades by private entities and local, State, and Federal governments, 27 scrub buckwheat populations have been protected from habitat destruction and this level of conservation has exceeded recovery criterion 1 in the recovery plan, Even though 21 of the known populations of scrub buckwheat

are not secure and are vulnerable to destruction or decline, we believe the 77 protected populations represent an adequate number of conserved populations to ensure long-term persistence of this species if protected populations benefit from periodic management activities that create and maintain suitable scrub buckwheat habitat (see Recommendations for Future Actions). While each of the public lands containing scrub buckwheat may undertake management activities, we do not currently have information about what types of management or how frequently management occurs on most public lands. Consequently, scrub buckwheat may still be at risk from habitat modification due to lack of management, but we will not know the extent of this risk until we evaluate more thoroughly the historic and ongoing management actions on public lands (see Recommendations for Future Actions). (USFWS, 2018)

Recovery

Reclassification Criteria:
Recovery Priority Number: 15 (USFWS, 2023)

Delisting Criteria:
1. Complete planned land acquisitions (USFWS, 1996)

2. Protect at least one more site in Lake and/or Pasco counties (one site is protected in Pasco). Demographic monitoring in conjunction with habitat manipulation (prescribed fire or other measures) appears essential, so monitoring is needed for at least five years. (USFWS, 1996)

Recovery Actions:

- 1. Determine current distribution of E. longifolium var. gnaphalifolium. A survey has not been made of the Lake Wales Ridge for this species, making defining a complete distribution in South Florida difficult. (USFWS, 1999)
- 2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. (USFWS, 1999).
- 3. Continue research on life history characteristics of E. longifolium var. gnaphalifolium. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- 4. Continue monitoring the existing populations of E. longifolium var. gnaphalifolium. Evaluate the effectiveness of the monitoring protocol used to assess population trends for E. longifolium var. gnaphalifolium. Monitor and detect changes in demographic characteristics, such as growth, survival, mortality. Monitor the effects of various land management actions on E. longifolium var. gnaphalifolium. Continue to work with private landowners. Monitor introduced plants. Monitoring of reintroduced plants will be essential for assessing the status of new plants and their contribution to the population as a whole. (USFWS, 1999).
- It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed. Public outreach efforts must also continue to address the increasing concern that horticultural demand for rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial

production and horticultural uses of endangered species provide little benefit to species, since the recovery of E. longifolium var. gnaphalifolium and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999).

- Revise the recovery criteria to establish measurable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, and the demographic performance levels/rates that should be met (USFWS, 2018).
- Monitoring of scrub buckwheat populations should be initiated on the ONF to evaluate the response of scrub buckwheat to soil disturbances associated with timber harvesting/site preparation activities and to determine the status of the species on the ONF (USFWS, 2018).
- The demographic status of scrub buckwheat populations may be inferred with minimal additional information. We believe that information regarding the number of individual plants and land management history can allow for a reasonable estimation of the current demographic status of extant scrub buckwheat populations. In this regard, we do not currently know how many plants exist on 23 of the 27 public lands where records indicate scrub buckwheat occurs. Consequently we recommend that surveys be conducted on public lands where no count data are available. Surveys initiated soon after fire would be valuable in assessing post-fire response of scrub buckwheat. We also suggest that a synthesis be conducted of historic and ongoing management actions on the same parcels for which counts are conducted. Knowing the historic and ongoing management strategy will provide information about whether land management strategies are conducive to long-term persistence of scrub buckwheat. (USFWS, 2018)
- The use of temporally and spatially appropriate management actions (e.g., prescribed fire or other disturbance regime) in areas containing scrub buckwheat should be encouraged on all public lands (USFWS, 2018).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Conduct surveys on all conservation lands where the species is known to occur. Surveys should include locations of plants, estimate number of individuals, and general habitat conditions (i.e. recent habitat management, time since fire). Current survey information for populations are critical for future evaluations. • Establish a standardized monitoring protocol for consistency among populations and conservation lands (USFWS, 2023).

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SPECIES ACCOUNT: *Eriogonum ovalifolium var. vineum* (Cushenbury buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1994; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Cushenbury buckwheat is a low, densely-matted perennial plant in the Polygonaceae (buckwheat family). The flowers are whitish-cream, darkening to a reddish or purple color with age, and are borne on flowering stalks reaching 4 inches (10 centimeters) in height. The leaves are 0.3 to 0.6 inches (0.8 to 1.5 centimeters) long, round to ovate, and white-woolly on both surfaces. The diameter of mats is typically 6 to 10 inches (15 to 25 centimeters), but they may reach up to 20 inches (51 centimeters) (USFWS 1994, p. 43653). (USFWS, 2009)

Taxonomy

Three other varieties of Eriogonum ovalifolium are distinguished on the basis of floral and leaf characteristics, but none occur in the San Bernardino Mountains (USFWS 1997, pp. 6-7). (USFWS, 2009)

Historical Range

See current range/distribution.

Current Range

Cushenbury buckwheat occurs over about 25 miles (40 kilometers) along the northern edge of the San Bernardino Mountains from the White Knob area east to Rattlesnake Canyon, north and east of Big Bear Lake, San Bernardino County, California. There is currently about 1,213 acres (491 hectares) of occupied habitat for this species (USFWS, 2015).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriogonum ovalifolium var. vineum (Cushenbury buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat unit (CHUs), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for Eriogonum ovalifolium var. vineum includes two CHUs (43 subunits) in San Bernardino County, California (67 FR 78570-78610).

(4) Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin, Big Bear City, Rattlesnake Canyon, Butler Peak, and Onyx Peak, California.

(5) Bertha Ridge Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Fawnskin and Big Bear City, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum ovalifolium var. vineum critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from the upper and middle members of the Bird Spring Formation and Bonanza King Formation parent materials that occur on hillsides at elevations between 1,400 and 2,400 m (4,600 and 7,900 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover (generally less than 15 percent cover) and little accumulation of organic material (e.g., leaf litter) on the surface of the soil.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (NatureServe, 2015)

Breeding Season

Adult: May to June (NatureServe, 2015)

Reproduction Narrative

Adult: Cushenbury buckwheat is primarily outcrossed (Neel et al. 2001) and has limited clonal reproduction within populations (Neel and Ellstrand 2003). (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, Forest/Woodland, Shrubland/chaparral, Woodland - Conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found between 4,600 and 7,900 feet (1,400 and 2,400 meters) on gentle to steep desert slopes; prefers low canopy cover (USFWS, 2009)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Located within plant communities including Joshua tree woodland and blackbrush scrub with low densities of singleleaf pinyon and Utah juniper in the overstory at low elevations, singleleaf pinyon-Utah juniper woodland at middle elevations, and Jeffrey pine-mountain juniper and singleleaf pinyon-mountain juniper woodlands at high elevations. Associated species include Fremontodendron californicum (California Flannelbush), Arctostaphylos glauca (Big-Berry Manzanita), Arctostaphylos patula (Green-Leaf Manzanita), Phacelia douglasii (Douglas' Scorpion-Weed), Yucca brevifolia, Pinus monophylla (Single-Leaf Pinyon), Astragalus albens (Cushenbury Milk-Vetch), and Erigeron parishii (Parish's Fleabane). (NatureServe, 2015)

Habitat Narrative

Adult: Cushenbury buckwheat occurs within openings of pinyon woodland, pinyon-juniper woodland, Joshua tree woodland, and blackbush scrub communities between 4,600 and 7,900 feet (1,400 and 2,400 meters) in elevation on limestone or other carbonate substrates. It occurs in open areas with little accumulation of organic material, vegetation canopy cover generally less than 15 percent, and powdery fine soils with rock cover exceeding 50 percent (USFWS 1994, p. 43654). Cushenbury buckwheat is mainly found on gentle to steep slopes with north or west aspects (Neel 2000, p. 129). Cushenbury buckwheat prefers substrates derived from limestone or dolomite (high soil pH, high percentage of soil calcium). Soils are typically powdery-fine, with little accumulation of organic matter and with numerous interspersed rocks (rock cover exceeding 50%). Often found on or adjacent to unstable talus, colluvium, or rock outcroppings; may benefit from naturally unstable sites. Associated species include Fremontodendron californicum (California Flannelbush), Arctostaphylos glauca (Big-Berry Manzanita), Arctostaphylos patula (Green-Leaf Manzanita), Phacelia douglasii (Douglas' Scorpion-Weed), Yucca brevifolia, Pinus monophylla (Single-Leaf Pinyon), Astragalus albens (Cushenbury Milk-Vetch), and Erigeron parishii (Parish's Fleabane). (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Declining (NatureServe, 2015)

Number of Populations:
19 Presumed extant(USFWS, 2022)

Population Size:
13,000 (USFWS, 2009)

Population Narrative:
In summary, we consider there to be 34 known occurrences of Eriogonum ovalifolium var. vineum. Of the 34 occurrences, 13 are extant (i.e., the species was observed during the past 10 years), 19 are presumed extant (i.e., the species was not observed during the past 10 years, but suitable habitat is present), and 2 have an unknown status either because of location uncertainty or because of active mining (Table 1). Seven occurrences are fully protected and 10 are partially protected as part of the Carbonate Strategy's Habitat Reserve (Figure 2; Table 1). The entirety of one occurrence and portions of five occurrences are known to be under active mining (i.e., are being actively mined or have approved plans to be mined) (USFWS, 2022)

Threats and Stressors

Stressor: Mining (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Mining activity remains the primary threat for Cushenbury buckwheat (USFWS 2005a, p. 246). Mining activities can impact habitat for the plants through the removal of mined materials, disposal of overburden, and road construction. (USFWS, 2009)

Stressor: Dust (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Dust can affect Cushenbury buckwheat's habitat by altering soil chemistry and light penetration into seedbanks (USFWS 1997, pp. 17–18). (USFWS, 2009)

Stressor: Artificial lighting (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Artificial lighting may affect Cushenbury buckwheat's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18). (USFWS, 2009)

Stressor: Off-road vehicle use and energy development (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: The final listing rule indicates that off-road vehicle use and energy development projects were also threats to Cushenbury buckwheat and its habitat. Such activities could impact the species' habitat through ground disturbance or dust creation. About 8 acres (3 hectares) of occupied habitat and 36 acres (15 hectares) of designated critical habitat for Cushenbury buckwheat overlap with roads and motorized vehicle trails (USFWS 2005a, pp. 261-262). The San Bernardino National Forest closed road 3N77 and placed signs and barriers for the other roads (USFWS 2001, pp. 5 and 18), which should limit impacts due to off-road vehicle use. Additionally, road 3N11A is proposed for decommissioning and roads 3N03D, 3N54, 3N88, and 3N88B are proposed for reclassification as administrative use only (USFWS 2009, p. 2), which should reduce vehicle activity in the area and further reduce the threat to the species. We are unaware of any energy development or off-highway vehicle projects occurring since listing that affect Cushenbury buckwheat. (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities have been identified since listing (USFWS 2001, pp. 4–11). These activities can result in trampling of Cushenbury buckwheat and impact its habitat through ground disturbance or dust creation. (USFWS, 2009)

Stressor: Fire suppression (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Additionally, fire suppression activities can result in ground disturbance through fire line construction, retardant and water drops, and establishment of fire camps. Suppression of the Willow Fire in 1999 impacted Cushenbury buckwheat through trampling and burning in a backfire operation (D. Volgarino, San Bernardino National Forest, pers. comm. 2002). (USFWS, 2009)

Stressor: Burros (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The threat of predation from burro grazing was identified after listing (USFWS 2001). However, burros are expected to have minimal effects to Cushenbury buckwheat due to the low numbers of burros present (about 60), the dispersal of the burros across a large area, the burros preference for wetter habitats, and the short stature and scarce nature of carbonate plants, which makes foraging on them unlikely (USFWS 2001, p. 39). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: Climate change was not mentioned as a potential threat in the final listing rule for Cushenbury buckwheat. This concern was raised in a letter received by the Service on May 6, 2008 (Potter, in litt. 2008). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (IPCC 2007; Cayan et al. 2005; Field et al. 1999). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. Cushenbury buckwheat is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the species into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction. (USFWS, 2009)

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The final listing rule identified the potential for stochastic extinction as a threat. This threat still exists and is enhanced by habitat loss, fragmentation, and drought. (USFWS, 2009)

Recovery

Reclassification Criteria:
1. The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to: 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000 hectares (5,000 acres) based on known areas occupied by the plants. (USFWS, 2009)

2. Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. (USFWS, 2009)

3. Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available, including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology. (USFWS, 2009)

Recovery Priority Number: 9C (USFWS, 2022)

Delisting Criteria:
1. The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become

available, delisting criteria will be established. (USFWS, 2009)

Recovery Actions:

- Identify, design, and establish carbonate endemic plant species reserves encompassing the extant populations. (USFWS, 1997)
- Identify and conserve additional habitat needed to recover the species. (USFWS, 1997)
- Answer ecological and management questions described in downlisting criterion #2. (USFWS, 1997)
- Identifying monitoring programs needed to support adaptive management and initiate them. (USFWS, 1997)
- Evaluate recovery efforts and implement corrective measures. (USFWS, 1997)
- Begin to establish a public constituency for the endangered taxa by developing and implementing a public education program. (USFWS, 1997)
- Prepare a new threats-based recovery plan specific to Cushenbury buckwheat that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Cushenbury buckwheat. (USFWS, 2009)
- Work with the San Bernardino National Forest to conduct systematic monitoring of Cushenbury buckwheat throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change. (USFWS, 2009)
- Work with partners, such as the San Bernardino National Forest, to help conserve Cushenbury buckwheat by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Cushenbury buckwheat from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Cushenbury buckwheat habitat. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to Eriogonum ovalifolium var. vineum and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Continue implementation of the Carbonate Strategy, particularly additions of Eriogonum ovalifolium var. vineum habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value. 2. Research the variety's susceptibility to climate change by determining climate tolerances (e.g., temperature, drought duration) and identify climate refugia to protect within carbonate habitat. 3. Determine appropriate monitoring frequency and implement a range-wide monitoring strategy that provides useful information about occupancy and population health. 4. Conduct a species status assessment to assess species viability given climate change projections, conservation, and progress in threat reduction. The assessment may be used to revise recovery criteria, or to inform a reclassification decision. 5. Continue managing the threat of roads, off-road vehicle activity, or other recreational

activities to carbonate habitat. This may be achieved through road decommissioning, installation and maintenance of signs and barriers, or other management. 6. Research the efficacy of restoring populations on reclaimed lands that have been restored after mining. 7. Finalize the establishment of the proposed Blackhawk Research Natural Area. 8. Collect additional seeds from different occurrences to expand the conservation seed bank (USFWS, 2022).

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SPECIES ACCOUNT: *Eriogonum ovalifolium var. williamsiae* (Steamboat buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/7/1986; Pacific Southwest (R8)

Physical Description

Steamboat buckwheat (Figure 2) is a low, densely matted, compact perennial herb, 0.5-4.5 dm across, with numerous, densely-leaved, woody branches. The above-ground portions of the plant arise from a shallow but stout, woody, reddish brown taproot (usually in older plants), or a shallow, fibrous, rhizomatous root system (in younger plants). Each plant bears numerous oval to reniform leaves congested in tight rosettes. Leaf blades are generally 3-8 mm, 5-10 mm wide, and are densely covered with greenish-white to tannish-white hairs. Some leaves exhibit a faint brown margin at maturity. Petioles are generally 3-6 mm long, woolly, and often wavy or curled. Inflorescences are borne on erect, partly woolly stems, up to 2.5 dm (10 in) long, and are enclosed in cone shaped involucres covered with densely-matted, woolly hairs. Five to eight involucres are clustered in a head at the top of each stem. Flowers are generally white with a central greenish-brown rib, turning pinkish-tan with age (Reveal 1981; Williams 1982). Blooms May-early June. (USFWS, 1995)

Taxonomy

Named for Margaret Williams (1917-2000). Genetic analysis by Archibald et al. (2001) revealed var. williamsiae has high genetic variability, with levels of variation similar to that typical of a widespread species rather than a narrow endemic; and that all six varieties (note: var. depressum, var. monarchense, var. ochroleucum, var. pansum, and var. vineum were not sampled for the study) are very similar allozymically with var. williamsiae being the most similar to the widespread var. ovalifolium. Also, although var. williamsiae and var. ovalifolium are morphologically distinct, their genetic similarity warrants further study to determine whether or not they should be treated as separate taxa. Further, evidence of male sterility in var. williamsiae plus other data led Archibald et al. (2001) to hypothesize that this taxon might be either a hybrid or undergoing cytoplasmic introgression. (NatureServe, 2015)

Historical Range

See Current Range.

Current Range

This species is known from a single population in Washoe County, Nevada, located approximately 10 miles south of Reno. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Flowers are visited by a diverse group of smallish insects including bees, wasps, flies, and butterflies (Archibald et al., 2001). Some observers have suggested that butterflies pollinate them and that ants disperse the seeds (Soper, 1987). (NatureServe, 2015)

Breeding Season

Adult: May to June (NatureServe, 2015)

Reproduction Narrative

Adult: The plant reproduces by seed and vegetative spread. Clonal propagation may be the primary mode of reproduction in Steamboat buckwheat, coupled with occasional occurrences of seed production through sexual recombination (Ten Knight, TNC and Jim Morefield, NNHP, pers. comm., May 19, 1994). Flowers are visited by a diverse group of smallish insects including bees, wasps, flies, and butterflies (Archibald et al., 2001). Some observers have suggested that butterflies pollinate them and that ants disperse the seeds (Soper, 1987). The plant can spread clonally by rhizomes, so individual genets are difficult to distinguish (Knight, 1993). It is gynodioecious and males are sterile, or female plants produce flowers whose stamens bear anthers that are either small, poorly developed and knob-like, or larger but flattened; neither type produces pollen. The flowers of hermaphroditic plants produce normal, plump anthers that produce pollen. These flowers are self-compatible, but require a pollinator (Archibald et al., 2001). Genotype frequencies indicate mating is random and cloning has been documented but the frequency of this occurrence is not known (Archibald et al., 2001). Individuals were transplanted to containers at the Nevada Division of Forestry nursery and produced seed successfully, suggesting that this species does not depend on the pollination services of a highly specific pollinator. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Playa, salt flat (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: The species colonizes the deposits only after precipitation has leached high concentrations of sodium, potassium, and other soluble chemicals from the substrates. Moisture is derived from precipitation rather than spring sources. (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Largely restricted to moderately deep, siliceous hot springs deposits known as sinter. Over time, as soils accumulate and develop on the deposits, other species invade and eventually out-compete the buckwheat (USFWS, 1995). (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Open areas on the slopes of deep (approximately 25 m), dome-shaped, siliceous hot springs deposits in an area that has been intermittently geothermally active for the past 2.5 million years. It is largely restricted to moderately deep, siliceous hot springs deposits known as sinter which originated from the discharge of hot-spring waters and thermal ground water saturated with amorphous silica (USFWS, 1995). The species colonizes the deposits only after precipitation has leached high concentrations of sodium, potassium, and other soluble chemicals from the substrates. Moisture is derived from precipitation rather than spring sources. Over time, as soils accumulate and develop on the deposits, other species invade and eventually out-compete the buckwheat (USFWS, 1995). (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Williams (1982) suggested that the seeds of Steamboat buckwheat are disseminated by wind. Viability of seeds may be quite low. (USFWS, 1995)

Population Information and Trends

Population Trends:

Uncertain (USFWS, 2019)

Number of Populations:

1 (USFWS, 2019)

Population Size:

See narrative; difficult to estimate (USFWS, 2019)

Population Narrative:

Various estimates of the abundance of Eriogonum ovalifolium var. williamsiae have been made over the 32 years since the plant was listed. These estimates have ranged from 10,000 to 15,000 individual plants in the final rule listing the species (Service 1986) to 85,000 plants by Knight (1997), to 200,000 plants by Morefield (2001). Knight 1993 noted that a precise enumeration of individual plants is infeasible because the species is rhizomatous and propagates primarily by vegetative runners. (USFWS, 2019)

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: A substantial portion of the Steamboat buckwheat occurs on a private parcel adjacent to U.S. Highway 395, giving it high potential for commercial development. About 60 percent of this 12 ac (4.9 ha) parcel, labeled Moana Lane Nursery in Figure 1, is occupied habitat comprising an estimated 15 percent of the total occupied habitat for the Steamboat buckwheat and over 20 percent of the two-thirds of the entire population that occurs on private land; moreover, the habitat on this property is believed to support dense concentrations of the buckwheat based on observations of similar habitat on adjacent Ormat-leased lands. For these reasons, conservation of this habitat is considered integral to the recovery of the Steamboat buckwheat. The landowner has repeatedly expressed interest in protecting the property either through fee title acquisition or through a conservation easement. The Nevada Department of State Lands has indicated a willingness to accept the property and the NDF has agreed to manage it, but to date no funding has been available to secure this part of the population. Although this private property remains subject to the permitting requirements of NDF (see Factor D, Section II.C.2.d), the development of this property remains a potential threat. (USFWS, 2009)

Stressor: Cessation of hot spring activity (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: As noted in the biological discussion above (Section II.C.1.e.), hot spring activity on the site has ceased, and while the complex geothermal system is still not well understood, the cause is likely related to numerous factors including geothermal production, drawdown of the regional groundwater table resulting from increased domestic and municipal use, and possible lack of recharge due to drought (BLM 1993). It should be noted, however, that surface flow has not reappeared despite several wet/dry climatic cycles since the latter conjecture was made. Nevertheless, there is currently adequate habitat to support a robust population of the Steamboat buckwheat, and while the cessation of sinter creation may pose a long-term threat to its persistence, the species' survival does not appear at current risk due to the cessation of hot spring activity. (USFWS, 2009)

Stressor: Mining (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: An active mining claim exists on a portion of the population on BLM land, but seems unlikely to be developed while the surrounding private lands are in geothermal production. Therefore, mining does not appear to be a significant threat at this time and is unlikely to become significant while the geothermal plant remains in operation. (USFWS, 2009)

Stressor: Off-road vehicles (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Off-road vehicle use has been substantially reduced due to fencing of the industrial areas, vigilance of the geothermal facility staff, and the installation of a right-of-way fence along U.S. Highway 395 by NDOT. The geothermal facility has recently installed a locked gate along their main access road which limits unauthorized access from this point. Occasional off-road vehicle use, usually by motorcycle, still occurs via other access points, but does not constitute a

significant threat to the species. There is no evidence of recent refuse dumping in the area so this activity is no longer considered to be a significant threat. (USFWS, 2009)

Stressor: Moisture availability (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Changes in moisture availability were cited in the final rule based on observations that plants have been observed to die when more than normal moisture, presumably precipitation, is received. This led to speculation that off-road vehicle use and refuse dumping might alter moisture patterns, thereby affecting plants. As noted above, both off-road vehicle use and refuse dumping no longer pose a significant threat to the species. The possibility that geothermal test wells might contribute to changes in water regimes has been discussed above. Some alteration in water flow patterns may have resulted from road and/or facility construction, but their effects are unknown and unlikely to be significant because of their limited extent. (USFWS, 2009)

Stressor: Human activities (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Minor impacts continue to affect small numbers of individuals, usually in peripheral areas adjacent to the highway or industrial sites. For example, in 2002 the NDF reported that a Nevada Department of Transportation (NDOT) project resulted in the loss of one plant. In 2004, NDF reported the transplantation of four plants to avoid loss during construction of a pipeline and geothermal facility, the loss of one plant hit by a snow plow during a storm, and the killing of an estimated 15 plants which were driven over by a crew servicing a billboard. In 2005, NDF reported that NDOT had killed one plant during construction of a right-of-way fence. In 2006, NDF reported that a spill of drilling mud had impacted 107 plants, all of which survived. These impacts, individually or collectively, do not constitute a significant loss of habitat for this variety and are far below a level that would jeopardize its existence. The current transportation plan for the area developed by Washoe County proposes a road that would likely impact occupied habitat, but this action would be subject to permitting by NDF. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Some of the poor seed production observed in this variety has been attributed to high seed predation by larvae of a lycaenid butterfly species in the genus Euphilotes (Tepedino et al. 2000, p. 9). However, seed tested by the Berry Botanical Garden has shown seed viability of less than 1 percent, which strongly suggests that other factors, including genetic incompatibility factors, may be more significant in limiting sexual reproduction (see, however, the results of seedling monitoring during 2006 discussed in II.C.1.a. above). At this time, there is no evidence that disease or seed predation are significant threats to the species. (USFWS, 2009)

Stressor: Narrow distribution and small population size (USFWS, 2009)
Exposure:

Response:
Consequence:
Narrative: The final rule listing the Steamboat buckwheat indicated that the narrow distribution and small population size of the Steamboat buckwheat may make it vulnerable to fire or other disturbance in its habitat, and that a loss of individuals may have adverse effects on the reproductive capacity and survival of the species. The vulnerability of the habitat to fire has been addressed above in Section II.C.1.e. in our discussion of weeds. While it appears that the sexual reproductive capacity of the plant is limited, the Steamboat buckwheat does appear to have increased slightly in total area and perhaps numbers due to the control of disturbances caused by public access. No long-term monitoring data are available to precisely evaluate the status of the species, but anecdotal evidence suggests that it has successfully established in disturbed areas where it previously was not present. In addition, areas in which ramets (a unit of clonal growth) were transplanted as mitigation for the original loss of habitat from the cooling tower facility appear to be self-maintaining. Either those ramets have been successful in maintaining individuals through asexual reproduction, or they are successfully reproducing seedlings, or both, in the mitigation areas. (USFWS, 2009)

Stressor: sinter deposition (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: We are also concerned about the long-term sustainability of Steamboat buckwheat habitat because sinter deposition associated with hot spring waters has temporarily or permanently ceased. This is likely due to numerous factors including geothermal production nearby, drawdown of the regional groundwater table resulting from increased domestic and municipal use, and possible lack of recharge due to drought (USFWS, 2022)

Recovery

Reclassification Criteria:
Downlisting for Eriogonum ovalifolium var. williamsiae can be considered when: (USFWS, 1995)

1. Protective conservation easements or fee acquisitions secure approximately 185 acres of occupied habitat currently in private ownership; (USFWS, 1995)

2. Cooperative agreements are established for approximately 80 acres of occupied public lands and approximately 37 acres of occupied State lands within a highway easement; (USFWS, 1995)

3. Comprehensive management plans have been developed and implemented on all occupied habitat. (USFWS, 1995)

Recovery Priority Number: 3

Delisting Criteria:
Delisting Recovery Criteria (amended recovery criteria) Delisting may be warranted when the current downlisting criteria have been met and the species exhibits sufficient resiliency, redundancy, and representation to support long-term viability.

1. Threats are reduced or eliminated so that the species is capable of persisting without substantial human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. Outstanding management needs include: a) implementing the monitoring protocol, b) updating and renewing the Steamboat Buckwheat Management Plan (Knight 1997), c) controlling competition with nonnative weeds, and d) exploring potential methods of restoration of geothermal processes that maintain and create habitat. (USFWS, 2019)

2. All size classes are represented, the population is increasing or stable, and management objectives identified in the monitoring protocol are achieved (Pavlik 2002, Pavlik and Stanton 2003). Monitoring objectives were developed to detect and document 1) trends in the numbers of Eriogonum ovalifolium var. williamsiae plants in characteristic habitats, 2) the frequency and contribution of episodic reproduction to population stability, and 3) successional changes in common species that comprise the plant community of Steamboat Hills. Monitoring objectives are as follows: (a) Eriogonum ovalifolium var. williamsiae in the Main Terrace and Central Drainage habitats are within ± 15% of their 2003 baseline levels after five and ten consecutive years of monitoring with a 95% level of confidence. (b) Eriogonum ovalifolium var. williamsiae in the Main Terrace and Central Drainage habitats each produce a significant cohort of seedlings (20% of the mean density in a given subpopulation in a given year is contributed by "seedlings") at least once during five consecutive years of monitoring (or twice in ten years) with a 95% level of confidence. (c) Total live absolute cover by subpopulations of common shrubs [e.g. Artemisia tridentata (sagebrush), Atriplex confertifolia (shadscale), Chrysothamnus nauseosus (rabbitbrush), Purshia tridentata (bitterbrush)], perennial grasses [e.g. Poa secunda (bluegrass), Leymus cinereus (Great Basin wildrye)], and weeds [e.g. Bromus tectorum (cheatgrass)], as well as E. ovalifolium var. williamsiae are within ± 15% of their 2003 baseline levels after five and ten consecutive years of monitoring with a 95% level of confidence. (USFWS, 2019)

3. The ex situ seedbank is maintained through the collection of fresh seed from Eriogonum ovalifolium var. williamsiae plants every 10 years. Collections that are spread over time produce lower extinction risk to wild populations, while maintaining a species' genetic variation within an ex situ seedbank (Menges et al. 2004). The ex situ seedbank is currently maintained with Center for Plant Conservation-affiliated botanic garden, the Rae Selling Berry Seed Bank and Plant Conservation Program at Portland State University (formally the Berry Botanic Garden). Currently, the ex situ seedbank holds approximately 23,000 viable seeds from collections made from 1992-1995 in long-term storage (i.e. freezer). In 1999, a germination trial on a sample of these seeds found greater than 70% germination (E. Guerrant, Rae Selling Berry Seed Bank, pers. comm. 2018a, E. Guerrant, unpubl. data, 2018b). (USFWS, 2019)

Recovery Actions:

- Protect Steamboat buckwheat habitats from adverse ohysical and biological modifications. The entire population of Steamboat buckwheat is restricted to approximately 100-1 50 ha (250-375 ac) of private and federally managed lands. Comprehensive management of Steamboat buckwheat will require development of a range-wide protection strategy in cooperation with the property owners, the BLM, FHWA, NDOT, and other concerned or knowledgeable entities such as NDF, NNHP, and TNC. (USFWS, 1995)
- Determine Steamboat buckwheat biology and habitat requirements. Maintenance of a viable, self-sustaining population of Steamboat buckwheat well into the future will require: 1) Implementation of a monitoring program for gauging population trends and habitat

conditions; and 2) new research on various aspects of the taxon's biology and habitat requirements. (USFWS, 1995)

- Provide public information and education. Recovery of Steamboat buckwheat will be dependent, in part, on the interest and willing cooperation of the private property owners and other members of the local community. An effective outreach program would help to deter negative sentiment for the recovery process and create an avenue for involvement and support among property owners, other members of the public, and the resource management agencies. (USFWS, 1995)
- Recommendation for Future Action from 2009 5-Year Review: The highest priority should be given to recovery criterion 1, i.e., securing conservation easements or fee acquisition of the estimated 66 percent of the habitat which occurs on private lands. Given the generally industrial nature of the private lands leased by the geothermal company from the Dorothy Towne Trust, the purchase of a conservation easement to secure these populations is likely to be the best option for these lands. The only other parcel of private land, roughly 12 ac (4.9 ha) in size with an estimated 7 ac (2.8 ha) of habitat, would most likely be best acquired in fee title and transferred to either Nevada Division of State Lands or the BLM, with a subsequent recovery management agreement for the entire population to be developed with the NDF or other interested entity. Once the recovery management agreement, with adequate provisions for adaptive management, is in place, the species could be proposed for delisting. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: (optional, but may be helpful to identify priorities for management actions and information needs for next 5-year review) We updated the Recovery Plan for Steamboat buckwheat through a Recovery Plan Amendment in 2019. In the Recovery Plan Amendment, we synthesized the adequacy of the existing recovery criteria, outlined amended recovery criteria, the rationale supporting the recovery plan modification, and analyses of the most recent monitoring data. Future actions for this species should focus on downlisting and delisting recovery criteria such as: protective conservation easements or fee acquisition of occupied habitat in private ownership, updating or developing conservation or management plans and/or cooperative agreements, and reducing threats such as nonnative, invasive species (USFWS, 2022).

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SPECIES ACCOUNT: *Eriogonum pelinophilum* (Clay-Loving wild buckwheat)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/13/1984; Mountain- Prairie Region (R6) (USFWS, 2015)

Physical Description

A low, stout, perennial herb, 5-10 cm high, with narrow, inrolled leaves that look like green scrolls. Clusters of white or cream-colored flowers with a rounded greenish-red to brownish-red perianth borne at the ends of the branches (NatureServe, 2015).

Taxonomy

The species was first recognized as its own taxon in 1969, and officially described by James Reveal in 1973 (Reveal 1969, pp. 75-76; 1973, pp. 120-122). The Eriogonum genus has undergone rapid evolution in the arid regions of the West, with roughly 250 species. This native North American genus is second only to Penstemon (beardtongue) in number of species (Reveal 2005a, p. 1) (USFWS, 2009).

Historical Range

Eriogonum pelinophilum was first collected near Hotchkiss, Colorado, in Delta County in 1958. Eriogonum pelinophilum is endemic to the rolling clay (adobe) hills and flats immediately adjacent to the communities of Delta and Montrose, Colorado (USFWS, 2009).

Current Range

Estimated range is 420 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences. Imprecisely reported occurrences are not included (NatureServe, 2015). The plants extend from near Lazear, east of Delta on the northern end of the species' range, to the southeastern edge of Montrose in Delta and Montrose Counties, Colorado (USFWS, 2009).

Critical Habitat Designated

Yes; 7/13/1984.

Legal Description

On July 13, 1984, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriogonum pelinophilum (Clay-Loving wild buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Colorado (49 FR 28562-28565).

Critical Habitat Designation

The critical habitat designation for Eriogonum pelinophilum includes one CHU in Delta County, Colorado. This species critical habitat encompasses approximately 119.8 acres (49 FR 28562-28565).

Colorado, Delta County. About 3 miles east of Austin near Highway 92. T14S, R94W 6th P.M. Section 26-west 225 feet of Section 26 lying south of State Highway 92 (5.6 acres). Section 27-

that part of the SE¼ SE¼ lying south of State Highway 92 (35.6 acres]. Section 34-an area bounded by a line beginning at the northeast comer of Section 34, thence south along the section line 200 feet to a point; thence southwesterly to a point 1050 feet south and 550 feet west of the northeast comer of Section 34; thence southwesterly to a point 700 feet north and 900 feet east of center ¼ corner of Section 34; thence westerly 900 feet to the north-south ¼ line; thence northerly 600 feet along the ¼ line to a point; thence northeasterly to a point of the east 1/16 line; thence northerly along the 1/16 line 300 feet to the north section line of Section 34; thence easterly along the north section line to the point of beginning (65.0 acres). Section 35-north 200 feet of the west 225 feet (1.0 acres]. Section 27-west 200 feet of Section 27 lying south of State Highway 92 (4.3 acres]. Section 28-east 400 feet of Section 28 lying south of State Highway 92 (8.3 acres). Total 119.8 acres.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum pelinophilum critical habitat are not specified but are thought to be the following (49 FR 28562-28565):

The primary constituent elements include those factors associated with the whitish alkaline clay soils within the sparsely vegetated badlands of Mancos shale.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (NatureServe, 2015)

Lifespan

Adult: 50+ years (inferred from NatureServe, 2015)

Breeding Season

Adult: May - September (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Insect pollinators, cold period (NatureServe, 2015)

Reproduction Narrative

Adult: E. pelinophilum requires an insect pollinator in order to set seed (Bowlin et al. 1993). Experimental study showed that the species is self-compatible (sets viable seed when pollen is transferred between flowers on the same plant); the authors believe that "pollinators moving from male-stage to female-stage flowers on the same plant will occasionally effect pollination" (Bowlin et al. 1993). Pollinators also frequently move between plants, resulting in a mixed breeding system with some pollination from other flowers on the same plant and some from flowers on different plants (Bowlin et al. 1993). A wide variety of insects visit and probably pollinate the flowers. Both ants and flying insects appear to be effective pollinators, with a field experiment showing no significant difference in seed set among flowers visited only by ants, only by flying insects, or by both groups (Bowlin et al. 1993). Results from the Colorado Natural Areas Program (CNAP) monitoring program on E. pelinophilum (1987, 1988) indicate that E.

pelinophilum is a long-lived perennial with a probable population turnover rate of approximately 20-50 years. All Eriogonum species studied thus far have seeds that require a cold period to break dormancy (not necessarily a freeze). Mixed selfing and outcrossing occurs (NatureServe, 2015). Flowering typically occurs from late May to early September with individual flowers lasting fewer than 3 days (Bowlin et al.1992, p. 298) (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Salt desert shrubland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1580 - 1950 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: 75 - 500 individuals per acre (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Eriogonum pelinophilum is found in substrates derived from the Mancos Formation shales. Inhabits whitish, alkaline clay soils on Mancos shale. Vegetation is a sparse salt desert shrub community. Occurs at 1580 - 1950 m elevation. The entire area is typified by rolling adobe (clay) hills and flats. Generally, the plants are found in a sharply defined soil microhabitat with shadscale (Atriplex confertifolia), on mid to lower slopes of the hills. The soil types are part of the Billings Series, known for its fine texture and weak and unstable structure. These soils are calcareous throughout and in some places have visible accumulations of calcium carbonate or calcium sulfate (Cline et al. 1967). Because of the low moisture availability, communities in which E. pelinophilum occur are characterized by low species diversity, low productivity and minimal canopy cover. Eriogonum pelinophilum is codominant with other xerophytic shrubs or subshrubs such as shadscale, the rare Penstemon retrorsus, Castle Valley clover (Atriplex cuneata), mat saltbush, black sagebrush (Artemesia nova) and Xylorhiza venusta (Neely 1985, O'Kane 1985). The communities are apparently stable, climax associations, judging from the lack of invading species capable of dominating the sites. Densities range from 75 - 500 individuals per acre (180 per acre average) (NatureServe, 2015). Eriogonum pelinophilum plants are generally found within swales or drainages that are moister than surrounding areas (USFWS, 2009).

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Most seed is dispersed locally (Bowlin et al. 1993). Seed dispersal is usually passive, either being consumed or carried by animals, windblown, or moved by gravity or water (NatureServe,

2015). Some fruits are removed by harvester ants (Bowlin et al. 1992, p. 299); however, no information is available for the species on seed dispersal mechanisms (USFWS, 2009).

Population Information and Trends

Population Trends:
Unknown (NatureServe, 2015)

Species Trends:
Relatively stable (NatureServe, 2015)

Number of Populations:
14 (USFWS, 2009)

Population Size:
~278,000 (USFWS, 2009)

Adaptability:
High (inferred from NatureServe, 2015)

Population Narrative:
Appears to be susceptible to impacts from grazing. Eriogonum pelinophilum appears to be a long-lived plant, with a calculated half-life of nearly 200 years (Carpenter and Schultz 1994). However, it is facing extreme pressure from residential and agricultural development, and occurrences have been extirpated. The long term population trend is unknown. The short term trend is relatively stable. The total area occupied by the mapped occurrences is 959 acres (calculated by the Colorado Natural Heritage Program in 2012). There are 9 occurrences with good or excellent viability (NatureServe, 2015). Today, the species is known from 12 existing (extant) Eos 2 additional populations. The most recent rangewide population estimate for all A through D ranked Eriogonum pelinophilum EOs is very roughly 278,000 individuals across 582 occupied ac (233 ha). Genetic variation has not been studied and, therefore, is unknown. When a rectangle is drawn around all known occurrences, it measures roughly 11.5 mi (18.5 km) from east to west and 28.5 mi (46 km) from north to south (CNHP 2009, spatial data) (USFWS, 2009).

Threats and Stressors

Stressor: Agricultural, urban, and residential development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The growing human population means more houses, more subdivisions, more industrial development, and increased utility and transportation needs that could impact Eriogonum pelinophilum occurrences as well as its suitable habitat. All EOs near Olathe and Montrose (EOs 004, 006, 011, 012, 013, 016, 018, 021, 022, 024, and 041) have agricultural fields or development immediately adjacent suggesting that some habitat and plants were lost when these areas were developed. The North Selig, Selig, Peach Valley, East, South, and Loutzenhizer Canals are all large canals that run along the eastern side of the Uncompahgre Valley and through Eriogonum pelinophilum habitat. Because of their proximity to E. pelinophilum EOs,

suitable habitat and plants were likely lost during the construction of these canals. All canals and laterals have roads on at least one side, and most have roads running along both sides. These canals and associated roads support nonnative invasive plants and provide conduits for their spread. To reduce salt loading, a salinity control program was initiated in 1990. This program first eliminated flow through the canals during the winter and is now working to line laterals (Bureau of Reclamation 1994, summary). Because many of the E. pelinophilum EOs are located along laterals that are prioritized for lining, further impact to the species from these activities is a possibility. Increasing development continues to fragment and impact Eriogonum pelinophilum and its habitat. This development includes residential and industrial buildings, agricultural fields, power lines, canals, and roads (USFWS, 2009).

Stressor: Off-road vehicle use (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Aside from the direct loss of Eriogonum pelinophilum individuals, cars, motorcycles, and ORVs (collectively ORVs) may impact E. pelinophilum habitat in several ways. One common effect is soil compaction, which diminishes water infiltration, destroys soil stabilizers, and increases erosion from water and wind (ORV effects summarized in Ouren et al. 2007, pp. 1-225). Because of decreased soil moisture and increased compaction, plant size is generally reduced. Soil compaction also increases the potential for invasive, nonnative annuals and other early successional plants to establish rapidly in ORV routes. Other impacts such as edge effects, fragmentation, and dust impacts occur from ORV use. The Mancos shale soils are vulnerable to ORV impacts because the clay is especially vulnerable to compaction and because there are no rocks and little vegetation to resist erosion (USFWS, 2009).

Stressor: Nonnative invasive plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Nonnative species documented within or adjacent to Eriogonum pelinophilum EOs include: Acroptilon repens (Russian knapweed), Alyssum parviflorum or A. simplex (alyssum), Bromus inermis (smooth brome), Bromus tectorum (cheatgrass), Cardaria draba (whitetop or hoary cress), Cardaria pubescens (hairy whitetop), Ceratocephala testiculata (bur buttercup, hornhead, or curveseed butterwort), Chorispora tenella (blue mustard or crossflower), Cirsium arvense (Canada thistle), Descurainia sp. (tansy mustard), Elaeagnus angustifolia (Russian olive), Erodium cicutarium (storksbill or redstem filaree), Erysimum repandum (spreading wallflower), Halogeton glomeratus (halogeton or saltlover), Lactuca serriola (prickly lettuce), Lepidium perfoliatum (clasping pepperweed), Melilotus officinale (yellow sweetclover), Salsola tragus (prickly Russian thistle), Sisymbrium altissimum (tall tumble mustard), Traxacum officinale (common dandelion) (CNHP 2009, pp. 1-81; USFWS 2009a). Because Eriogonum pelinophilum is a long-lived perennial and was established before many of the nonnatives were introduced, impacts may not be immediate and would require longer term monitoring to quantify. However, nonnatives occur at all EOs (USFWS, 2009).

Stressor: Livestock use (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: Threats related to livestock use include the eating of individual plants, physical effects of trampling of plants, and the indirect effects of habitat degradation. During the most extensive survey for the Eriogonum pelinophilum within the most numerous EO (018), minor impacts from livestock, especially from trampling near sheep bed grounds, were documented (Ferguson 2007, p. 2). At one location near sheep bedding grounds, Eriogonum pelinophilum plants were found on root pedestals, apparently due to the increased erosion in the area (Ferguson 2007, p. 8). During 2009, significant livestock impacts occurred within EO 018, the largest Eriogonum pelinophilum site containing over two thirds of the known individuals (USFWS, 2009).

Stressor: Herbicide Use (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The proximity of E. pelinophilum to agricultural fields and nonnative species makes the species vulnerable to this impact (USFWS, 2009).

Stressor: Herbivory (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Tent caterpillar impacts to E. pelinophilum were noted in 2007 (Ferguson 2007, p. 6). Herbivory where several plants were heavily browsed has been documented in two instances, but the herbivore is unknown and the number of individuals impacted was low (Ferguson 2007, p. 7). Herbivory of numerous individuals was documented associated with livestock use in 2009; although, this use has not yet been well quantified (Sharp, in litt. 2009) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Future projections for the southwest predict increased temperatures, more intense and longer-lasting heat waves, an increased probability of drought that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). These changes will affect fire frequency, community assemblages, and the ability of nonnative species to succeed. The Mancos shale is limited in distribution and the plant is a long-lived perennial, both factors will limit E. pelinophilum's ability to migrate with a changing climate. Climate change likely is and will affect all Eriogonum pelinophilum populations (USFWS, 2009).

Recovery

Reclassification Criteria:
Ten healthy populations are secured in their natural habitat (USFWS, 1988).

Recovery Priority Number: 8C

Delisting Criteria:
Twenty healthy populations are secured in their natural habitat (USFWS, 1988).

Recovery Actions:

- Initiate scientific research on known and potential habitat and the biology of the species (USFWS, 1988).
- Remove threats to the clay-loving wild-buckwheat and secure populations and tier ecosystems (USFWS ,1988).
- Develop public awareness and appreciation for the "adobes" habitat on which the clay-loving wild-buckwheat grows (USFWS, 1988).
- Permanently protect all occupied habitat. On public lands, add additional and expand existing ACECs, remove threats (especially ORV activity and negative impacts from livestock use), and provide more stringent protection within RMPs. On private land, pursue conservation easements, appropriate zoning incentives, and land acquisitions to protect populations (USFWS, 2009).
- Coordinate with local governments to better protect Eriogonum pelinophilum. Consider lower densities for new developments, open space, avoidance measures, and other actions to conserve the species. Integrate these actions into county and city land use planning designations (USFWS, 2009).
- Conduct education and outreach efforts for the public. The intent of these efforts will be to secure more Eriogonum pelinophilum sites for conservation. Develop and implement permanent conservation agreements and easements for populations on private lands. Provide technical and financial support for conservations actions on private lands (USFWS, 2009).
- Work with all parties to prevent ORV use within Eriogonum pelinophilum habitat (USFWS, 2009).
- Consider removing livestock from all Eriogonum pelinophilum sites. If livestock use continues, careful monitoring of the species and the livestock use should occur. Research (see below) assessing the effects of livestock use should be conducted (USFWS, 2009).
- Conduct nonnative invasive plant control activities where needed to conserve Eriogonum pelinophilum. Control should be conducted with extreme care to reduce impacts to E. pelinophilum (USFWS, 2009).
- Recommend at least a 200 m/656 ft. buffer between occupied or suitable habitat and ground disturbance or other activities that may affect Eriogonum pelinophilum or its habitat (USFWS, 2009).
- Revise the recovery plan for Eriogonum pelinophilum so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats impacting the species. The recovery plan also should estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2009).
- Revise critical habitat for Eriogonum pelinophilum. “Critical habitat” is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (USFWS, 2009).

- Develop and implement consistent conservation measures in the Uncompahgre Field Office's RMP revision that will avoid and minimize impacts to Eriogonum pelinophilum from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures (USFWS, 2009).
- Expand existing ACECs to include contiguous occupied and suitable habitat for the plant and its pollinators. Revise ACEC management guidelines to better protect Eriogonum pelinophilum. Consider creating new ACECs to conserve the species, especially in the northern portion of the species' range near the Selig Canal sites (EOs 014 and 025) and unsurveyed land in the area (USFWS, 2009).
- Inventory potential habitat for Eriogonum pelinophilum on public and private lands. Report results to CNHP, BLM, and the Service. These surveys will provide better information to guide recovery and conservation actions as well as project planning (USFWS, 2009).
- Initiate range-wide trend monitoring to track the health of Eriogonum pelinophilum. Include a component to analyze potential effects from disturbances, nonnatives, and climate change (USFWS, 2009).
- Monitor the effects of development activities located within 200 m/656 ft. of plant populations on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2009).
- Conduct demographic monitoring that determines critical life history stages that will enhance management of the species (USFWS, 2009).
- Conduct research studying demographic parameters that identifies critical life history stages (USFWS, 2009).
- Conduct research studying genetic diversity and taxonomic relations of Eriogonum pelinophilum. This research should address what populations are most important to conserve and investigate if genetic diversity is a problem for small isolated populations (USFWS, 2009).
- Conduct research investigating the effects of various threats. For example, impacts of various levels of livestock use, the impacts of ORVs, the impacts of nonnative species, and the effects of various disturbance levels (USFWS, 2009).
- Incorporate demographic, genetic diversity, and threat research into a population viability analysis that addresses minimum population size, and trajectories factoring in effects of threats (USFWS, 2009).

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SPECIES ACCOUNT: *Eriophyllum latilobum* (San Mateo woolly sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/06/1995; Pacific Southwest (R8)

Physical Description

An herbaceous (nonwoody) perennial of the aster family (Asteraceae) with leafy stems 30 to 60, exceptionally 90, centimeters (12 to 16 inches) high (J. Mooring, in !itt., 1998). The upper surfaces of the deeply cleft leaves are a smooth dark green and the lower surfaces are covered with densely interwoven white hairs. The golden flower heads are borne in loose clusters (Munz and Keck 1959, McGuire and Morey 1992). Eriophy!lum latilobum differs from Eriophyllum confert~florum (golden yarrow) in having seven to eight ray flowers (the flowers usually located on the edge of the head of members of the aster family) rather than five ray flowers, and a more open inflorescence (Abrams and Ferris 1960, J. Mooring, in litt., 1998). Eriophyllum lanatum var. arachnoideum (common woolly sunflower) differs from the other two species in having 13 ray flowers and shallowly cleft leaves (Abrams and Ferris 1960, Hickman 1993). San Mateo woolly sunflower can be mistaken for plants from several populations that seem to be of hybrid origin between Eriophyllum lanatum and Eriophyllum conferflorum. Plants of these populations have either four or six sets of chromosomes and are located near Black Mountain and Montebello Ridge (Mooring 1994, J. Mooring, in litt., 1996, 1998). (USFWS, 1998)

Taxonomy

Eriophyllum latilobum is a tetraploid (having four sets of chromosomes) (Carlquist 1956, Mooring 1973) and is believed to have originated as a hybrid between Eriophyllum confertiflorum var. confertiflorum and Eriophyllum lanatum var. arachnoideum (Constance 1937, Munz and Keck 1959, Hickman 1993, Mooring 1994) (USFWS, 2011). A member of the aster family (Asteraceae) (USFWS, 1998).

Historical Range

San Mateo County, California. (USFWS, 2011)

Current Range

San Mateo County, California. (USFWS, 2011)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2011)

Breeding Season

Adult: April - June (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2012)

Reproduction Narrative

Adult: Blooms from April to June. Its pollinators include syrphid flies and bees. Eriophyllum latilobum is not a vigorous reproducer; low germination rates and low seedling survival have been observed under greenhouse conditions (John Mooring, in litt., 1992; McGuire and Morey 1992) (USFWS, 2011).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cismontane woodland, Gen oak woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 45 - 150 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Quercus agrifolia (USFWS, 2011)

Habitat Narrative

Adult: Inhabits moist, steep slopes of serpentine-influenced rocky soil, mostly in shaded spots. Inhabits cismontane woodland (serpentinite, often on roadcuts) at elevations of 45 - 150m (California Native Plant Society 2001) and Gen oak woodland at elevations of 100 - 150m (Hickman 1993). The environmental specificity is very narrow; it is only known from a few sites on serpentine in San Mateo County, California (NatureServe, 2015). Eriophyllum latilobum is restricted to shaded moist sites on steep grassy or sparsely wooded slopes. It apparently grows best under or very near coast live oak (Quercus agrifolia) (J. Mooring, in litt., 1998) (USFWS, 2011).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seed dispersal is by gravity, so most seeds fall close to the parent plant (J. Mooring, pers. comm. as cited in McGuire and Morey 1992) (USFWS, 2011).

Population Information and Trends

Population Trends:

Decline of 30-50% (NatureServe, 2015)

Species Trends:
Additional occurrences discovered since listing (inferred from USFWS, 2011)

Number of Populations:
4 (USFWS, 2011)

Population Size:
250 - 1000 individuals (NatureServe, 2015); variable from year to year (USFWS, 2011)

Adaptability:
Low (inferred from NatureServe, 2015)

Population Narrative:
Apparently highly vulnerable though the exact biological reasons are unknown. This species has experienced a long-term decline of 30-50%. The main population near Crystal Springs, San Mateo County, has declined from many plants to a few hundred after an unfortunate mowing incident in 2001 (?). However there were about 200 seen in the latest survey. An additional 200 seen at Montara Mtn site in 2004. 3 and possibly a couple more sites known. Only two are currently mapped at CNDDB; backlog contains a few more. 1 from La Honda is historical. The estimated population size is 250 - 1,000 plants (NatureServe, 2015). Some years the number of plants in some subpopulations ranges from zero to less than five; other years the same subpopulations contain 500 percent more plants. At the time of listing, there was only one known population on Crystal Springs Road. Since then, there have been three additional occurrences discovered (USFWS, 2011).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The steep slopes along Crystal Springs Road provide a very unstable habitat for E. latilobum. The slopes are subject to erosion and soil slippage. After soil slippage occurs, road maintenance crews remove the slumped soil, which may contain mature individuals, seedlings, and/or seeds of E. latilobum. The road cut is then reshaped, which may damage plants remaining on the banks. Dumping of garden debris and downhill seepage of pesticides from homeowners living above the population may have negative impacts on Eriophyllum latilobum habitat (USFWS, 2011).

Stressor: Nonnative vegetation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The plant is threatened by competition with nonnative plants; its habitat is more densely populated with Carduus sp. and Bromus sp. than it was 10 years ago (John Mooring, pers. comm., 1992). In a 2009 report prepared by Nomad Ecology for San Francisco Public

Utilities Commission and M&E/WRE Joint Venture, the non-native invasive plants considered a threat to habitat along Crystal Springs Road included fennel, French broom, and jubata grass. Other non-native invasive plants teasel, poison hemlock, bull thistle, and milk thistle were also present in this area (Nomad 2009). In the natural population, competing species such as plumeless thistle (Carduus sp.) may affect germination and seedling establishment (J. Mooring, in litt., 1998). (USFWS, 2011)

Stressor: Low reproductive output (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Germination rates for E. latilobum are lower than for any other sunflower, less than 10% (CDFG 1997). In the 2009 seed bank collection report from Rancho Santa Ana Botanic Garden, seed collected from CNDDB #4 had a germination rate of 28% (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The small number of populations and low numbers of individual plants are also a factor. Because of the existence of few populations exhibiting low viability and located in an unstable habitat, this species is extremely vulnerable to extinction from random catastrophic events (Menges 1991, Primack 1993, Meffe and Carroll 1994) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these models, Eriophyllum latilobum plants would likely be unable to shift their range because of their dependence on a rare soil type and their supposed limited ability for seed dispersal (USFWS, 2011).

Recovery

Reclassification Criteria:
A/1: A minimum of five colonies1 of San Mateo woolly sunflower are fully protected and managed with the primary intention of preserving the occurrences in perpetuity. Each protected colony includes occupied habitat along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer at the known site. If genetic research confirms that additional historical and/or extant Eriophyllum populations in San Mateo County were/are San Mateo woolly sunflower, these sites are also protected and managed as described above. If additional individuals, sub-populations, or populations are discovered on private lands, they are secured through land

acquisitions, conservation easements, or other means and protected as described above. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are implemented for the colonies described in A/1 and any occupied or unoccupied habitat identified as essential to survival. The plans include provisions for standardized annual monitoring of populations and provisions for the collection and preservation of viable genetic material that might otherwise be lost because of planned habitat destruction or modification. (USFWS, 2019)

E/1: Each colony described in A/1 contains a minimum of 150 (but preferably more) individuals each year for a minimum of 20 years. (USFWS, 2019)

E/2: Each colony described in A/1 has numbers of individuals that exhibit a stable or increasing trend over a period of 20 years that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

E/3: Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in A/1. (USFWS, 2019)

E/4: Seeds, representative of the breadth of the species' genetic diversity, are stored in at least two Center for Plant Conservation certified facilities and reliable seed germination and propagation techniques are understood. Unless storage techniques and/or research show otherwise, stored seeds are replenished every 5 years in order to ensure seed viability. (USFWS, 2019)

E/5: If genetic research confirms that CNDDB occurrences #2 and #3 contained populations of San Mateo woolly sunflower that have since been extirpated, these occurrences are reestablished using appropriate habitat restoration and plant propagation techniques. These additional occurrences are important due to the limited availability of the appropriate habitat. (USFWS, 2019)

Delisting Criteria:
A/1: A minimum of 20 self-sustaining colonies of San Mateo woolly sunflower are established on suitable habitat within or near the plant's known historical range, and are fully protected and managed with the primary intention of preserving the populations in perpetuity. Each protected area includes occupied habitat with adjacent unoccupied habitat and a 150-meter (500-foot) buffer, where possible. If historical and/or extant Eriophyllum colonies (outside of the San Mateo Creek Watershed) are determined to be San Mateo woolly sunflower, a minimum of 40 self-sustaining colonies are protected and managed as described above. Additional colonies are protected if indicated by modeling or research. (USFWS, 2019)

A/2: All lands upslope from the colonies described in A/1 are protected from incompatible uses.

A/3: Potential negative effects to San Mateo woolly sunflower habitat from sudden oak death infestations are absent or below a level that threatens colony health and/or persistence. (USFWS, 2019)

E/1: For a minimum of 20 consecutive years that include two normal precipitation cycles each colony described in A/1 exhibits a stable or increasing population trend with a rolling average of at least 300 individuals. During low density years (presumably from natural population fluctuations), each colony described in A/1 contains a minimum of 150 individuals. (USFWS, 2019)

E/4: Impacts from competition with native and nonnative species are managed so they do not pose a threat to the persistence of any of the San Mateo woolly sunflower colonies described in A/1. (USFWS, 2019)

E/5: Long-term management of San Mateo woolly sunflower habitat is both practically and financially sustainable. Financial resources for long-term habitat management are secured. (USFWS, 2019)

Recovery Actions:

- 1. Protect San Mateo woolly sunflower colonies and identify or establish additional colonies. 1.1. Ensure that all road and utility maintenance personnel are aware of San Mateo woolly sunflower along Crystal Springs Road and mark colonies with permanent signs/markers. Implement other protection measures as needed. (Priority 1). 1.2. Secure colonies through land acquisitions, conservation easements, or other means. (Priority 1). 1.3. Identify and protect potential introduction sites. (Priority 1). 1.4. Search for additional colonies on private and city land. Secure additional colonies through land acquisitions, conservation easements, or other means. (Priority 2). 1.5. Implement a seed increase and/or propagation program that may be used to establish new colonies and supplement existing colonies when necessary. (Priority 2). 1.6. Establish new colonies, to the extent described in the recovery criteria, within or near the species' known historical range. Colonies should be established in suitable habitats that exhibit a range of natural environmental conditions. Numerous introductions may be necessary to achieve adequate success rates and determine the range of habitat conditions under which successful establishment can be achieved. (Priority 2). (USFWS, 2019)
- 2. Research San Mateo woolly sunflower life history and conservation strategies. 2.1. Conduct genetic research on existing colonies to determine the species' genetic structure and genetic diversity. (Priority 1). 2.2. Study the historical and extant Eriophyllum occurrences that have been classified as San Mateo woolly sunflower to determine accurate species identities. Delineate the actual and historical range of San Mateo woolly sunflower. (Priority 1). 2.3. Research and develop reliable seed germination and propagation techniques. (Priority 1). 2.4. Determine the most effective and efficient habitat management practices to enhance colony health and reduce impacts from competing species and erosion. Experimentally test fire disturbance104 as a management tool. (Priority 1). 2.5. Research optimal habitat characteristics, factors influencing seed germination, mechanisms of dispersal, impacts of seed predation, and potential impacts from climate change. (Priority 2). 2.6. Study the demography (including seedling survivorship). , reproductive biology, and phenotypic plasticity (the capacity for marked variation in observable structural and functional properties of an organism because of environmental influences during development). of colonies. (Priority 3). (USFWS, 2019)
- 3. Monitor and manage San Mateo woolly sunflower colonies. 3.1. Implement site-specific management plans. Manage habitat in occupied areas and in surrounding areas that affect, or could affect, conditions in occupied areas (e.g. weedy species invade from adjacent

areas). . Best habitat management and restoration practices may include complete eradication of nonnative species, planting coast live oak trees, and/or treating sudden oak death infestations. (Priority 1). 3.2. Implement a standardized annual monitoring program with the power to detect population trends. (Priority 2). 3.3. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 5 years to ensure seed viability. (Priority 2). 3.4. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3). (USFWS, 2019)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2011 5-year review, 2019 Recovery Plan Amendment (Service 2019), scientific literature, and as a result of discussions with species experts. 1. Protect San Mateo woolly sunflower colonies and identify or establish additional colonies. Ensure that all road and utility maintenance personnel are aware of San Mateo woolly sunflower along Crystal Springs Road. 2. Monitor and manage San Mateo woolly sunflower colonies. Conduct regular protocol surveys and implement site-specific management plans. Establish an encroachment threshold for invasive plants that triggers management action. 3. Research San Mateo woolly sunflower life history and increase understanding of its germination and propagation to determine the potential for reintroduction success. (USFWS, 2021)

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SPECIES ACCOUNT: *Eryngium aristulatum var. parishii* (San Diego button-celery)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/03/1993; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial or biennial herb arising from a taproot. The flowers occur on stems and have rigid spiny bracts (NatureServe, 2015).

Taxonomy

A member of the Apiaceae (parsley/carrot family). Eryngium aristulatum var. parishii is one of three varieties of Eryngium aristulatum (Constance 1993, p. 147). Eryngium aristulatum var. parishii is separated from Eryngium aristulatum var. aristulatum (common) by having styles in fruit that are about the same length as the calyx (outer whorl of protective structures around the flower) and is separated from Eryngium aristulatum var. hooveri (Hoover's button-celery) by having bractlets (modified leaves) without callused margins (Constance 1993, pp. 147–148) (USFWS, 2010).

Historical Range

At the time of listing, Eryngium aristulatum var. parishii was considered extant in Riverside County at Santa Rosa Plateau, in San Diego County at Otay Mesa, Kearny Mesa, Del Mar Mesa, Marine Corps Air Station (MCAS) Miramar, and Marine Corps Base (MCB) Camp Pendleton, and in northern Baja California, Mexico (USFWS 1993, p. 41385). The historical distribution of Eryngium aristulatum var. parishii habitat included a coastal swath from Mesa de Colonet and San Quintin in Baja California, Mexico, north to Los Angeles County, California in the United States (USFWS, 2010).

Current Range

Eryngium aristulatum var. parishii currently occurs in 14 geographic areas in Riverside and San Diego Counties (USFWS, 2010). Occurs in the Santa Rosa Plateau in Riverside Co. and San Diego Co. California, and Baja California, Mexico. This species occurs in a small portion of the southwest portion of Riverside Co., and from San Diego Co. from Camp Pendelton Marine Base south into Baja California, Mexico to Ensenada (USFWS 1998) (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2010)

Lifespan

Adult: 2+ years (inferred from USFWS, 2010)

Breeding Season

Adult: April - June (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Ephemerally wet conditions; insect pollinators, based on closely related species (USFWS, 2010)

Reproduction Narrative

Adult: Relies on ephemerally wet conditions to reproduce; blooming from April to June. It is an outcrossing taxon that reproduces exclusively by seeds. E. a. var. parishii is presumably insect-pollinated (Zedler 1987, pp. 61–64), potentially by bee flies (Bombyliids) (Schiller et al. 2000, pp. 386–396) and solitary bees (Apoidea), as are many vernal pool species (Thorpe 2007, pp. 51–57) (USFWS, 2010).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pool (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Succession (inferred from USFWS, 2010)

Environmental Specificity

Adult: Very narrow (inferred from USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2010)

Habitat Narrative

Adult: Grows in vernal pools (Smith and Berg, 1988) (NatureServe, 2015). It is a clay soil, surface and non-surface hard pan, vernal pool obligate. Eryngium aristulatum var. parishii seems more tolerant of peripheral vernal pool habitat than most obligate vernal pool species. It is specifically adapted to surviving in vernally wet conditions due to the presence of aerenchyma tissue (air channels in the roots) that facilitates necessary gas exchange in submerged plants (Keeley 1998, pp. 121–175). Habitat occupied by Eryngium aristulatum var. parishii is dependent upon some form of disturbance to set back succession (e.g., periodic fire and annual inundation) (USFWS, 2010).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

95 - 97% decline in habitat (USFWS, 2010)

Number of Populations:

~98 U.S. locations presumed extant or extant (USFWS, 2023)

Population Narrative:

It is restricted to southern coastal California, with few occurrences in northern Baja California, Mexico. Eryngium aristulatum var. parishii can be locally abundant in remnant vernal pools; however, the distribution of this variety has been dramatically reduced due to loss of most (95 to 97 percent) of the vernal pool habitat in San Diego County (USFWS 1998, p. iii) (USFWS, 2010). In summary, the species is extant or presumed extant at approximately 98 locations within the Unites States. At least 26 locations in the United States are considered extirpated or possibly extirpated. There are likely many more extirpated locations that were not recorded prior to development, because by 1978, 90 percent of vernal pool habitat in San Diego County was already lost (Beauchamp 1979, p. 1). The isolated populations newly documented in Orange County and 100 miles farther south in Baja California, Mexico, appear to be outliers, and the core distribution in Riverside and San Diego counties remains mostly unchanged. Therefore, this information does not substantially alter our understanding of the distribution of Eryngium parishii var. aristulatum (USFWS, 2023).

Threats and Stressors

Stressor: Urbanization and agricultural development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Loss of habitat from development is considered a primary contributor to vernal pool loss throughout California (Holland 1988, p. 1013; Barbour et al. 2007, p. 7), and specifically to vernal pools in southern California (Bauder 1986, p. 9-4; Bauder 1987, pp. 209–213). There is no certainty nor is there any likelihood that pools or pool complexes that fall outside the Multiple Habitat Planning Area (MHPA) will ultimately be conserved; these areas are still subject to development pressures. What was once a large, relatively unbroken expanse of patchy but interconnected pool habitat, has become remnant “islands” of vernal pools within an expanse of varying levels of anthropogenic disturbance, and permanently altered landscape (e.g., pools at N 8 General Dynamics site on Kerney Mesa, I 6C Bob Baker 2 on Mira Mesa, and C17– 18 on Mira Mesa; see Appendix 1) (USFWS, 2010).

Stressor: Off-highway vehicle (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Damage can be caused by motorcycles, quads, mountain bicycles, and four-wheel drive vehicles. Bauder (1987, p. 209) indicated that some impacts from OHVs were considered vandalism, while other damage occurred in the course of legitimate activities including fire

fighting, security patrols, and military maneuvers. Altered pool hydrology may favor invasion of nonnative plants by allowing nonnatives to encroach in areas where the hydrological conditions had been altered by OHVs; vehicles can also break through the clay hard pan, causing hydrological damage that may not be repaired. The use of OHVs causes fragmentation, degradation, and destruction of vernal pools (Hilty et al. 2006, p. 157; Forman et al. 2003, pp. 113–138; Wilcove et al. 1998, pp. 607–615). Transportation corridors have the potential to spread disease, drain or damage pools, and facilitate the invasion of nonnative species (Hilty et al. 2006, p. 157) as well as mixing of otherwise naturally separated native species and genotypes (e.g., fairy shrimp lineages). It is likely that OHV use continues to be a nearly rangewide threat to Eryngium aristulatum var. parishii and its habitat (USFWS, 2010).

Stressor: Trampling (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction associated with livestock and human access was considered to be a threat to Eryngium aristulatum var. parishii at listing (USFWS 1993, p. 41388) and in the Recovery Plan (USFWS 1998, p. 47). Impacts from this threat include soil compaction and erosion, though this is not a predominant threat. Destruction of E. a. var. parishii habitat from cattle is dramatically reduced, though some vernal pools continue to be impacted by livestock, such as horses in the J26 vernal pool complex in Otay Mesa (Wynn, pers. comm. 2010) (USFWS, 2010).

Stressor: Mowing and plowing (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Mowing and plowing/discing of habitat has been used to reduce fire hazards and to shorten vegetative cover for birds to reduce bird air-strike hazards and bird air mortality hazards (U.S. Marine Corps 2006, pp. 7-1–7-36; U.S. Marine Corps 2007, pp. F-47–F-49). Restrictions of these activities where there is a Federal or State nexus via INRMP site management plans and overarching MSHCPs have reduced the loss of habitat due to mowing or plowing; however, impacts from this threat have yet to be quantified (USFWS, 2010).

Stressor: Highway construction (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Road development and inter-related actions were classified as a threat to Eryngium aristulatum var. parishii when it was listed. Roads are closely associated to habitat fragmentation (loss) due to urban and agricultural development. Vernal pools and associated habitat proximal to basins have been eliminated by road and highway construction. Mitigation for roadway development has included the restoration of vernal pool habitat and introduction of key vernal pool species. Restoration of vernal pools has had some degree of success in the short term; however, the long term effectiveness of this mitigation approach is still being studied (Black and Zedler 1998, pp. 195–205). Road development and related construction activities are still a primary threat to the variety (USFWS, 2010).

Stressor: Altered hydrology (USFWS, 2010)

Exposure:
Response:
Consequence:
Narrative: Seasonality (phenology) of vernal pools requires annual hydrologic input during the spring months to moisten and fill pools and basins. Due to urbanization, hydrologic cycles have been affected near vernal pool complexes (Bauder 1987, pp. 209–213). However, impacts from this threat to Eryngium aristulatum var. parishii appear to have decreased since the time of listing due to development standards that are intended to prevent runoff from entering vernal pool basins (Wynn, pers. obs. 2009) (USFWS, 2010).

Stressor: Military activities (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Impacts to vernal pool sites resulted from large equipment (e.g., tanks) and civilian use on base (USFWS 1993 p. 41388). Training activities near and adjacent to vernal pool habitat have resulted in site-specific impacts to vernal pool species, such as rutting of pools. Approximately 70 percent of the remaining vernal pool complexes occur on lands within military jurisdiction (USFWS 2008, p. 16). Since listing, conservation efforts on military lands have been in place due to implementation of the Sikes Act and the Sikes Act Improvement Act described below under Factor D, which require military installations to develop INRMPs (USFWS, 2010).

Stressor: Insect herbivory (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Predation was not identified as a threat at listing, but insect herbivory of E. a. var. parishii was later considered a disturbance concern in the recovery plan and remains a potential threat to the taxon (USFWS 1993, p. 41388; USFWS 1998, p. 67). This can have considerable effects on plant population dynamics, and may include: (1) Damage to roots, leaves, flowers, and developing seeds; and (2) ultimately reduce living plant fitness and reproductive success in the presence of native and nonnative competitors (Louda 1994, pp. 118–138) (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: San Diego County and the range of Eryngium aristulatum var. parishii are in a mild, Mediterranean climate zone that makes the potential and rate for nonnative species incursion high. Nonnative plants are documented to alter natural landscapes and available habitat in San Diego County (Bauder 1987, pp. 209–213). Invasive, nonnative plants have long been considered a concern in vernal pool habitat (Holland 1988, p. 1014). Some of these biological impacts include competition with E. a. var. parishii for water, soil nutrients, space above and below ground, and displacement of natural pollinators. Bauder (2005, p. 2133) states that Agrostis avenaca (Pacific bentgrass) and Polypogon monspeliensis (rabbitsfoot grass) are present in San Diego County vernal pools, and that research in the field and under controlled conditions indicates “both grasses negatively affect native pool species in a variety of ways, ranging from survivorship to reproductive success.” (USFWS, 2010).

Stressor: Altered fire regime (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Fire is a natural component for regeneration and maintenance in E. a. var. parishii habitat (Bauder 1996, p. 2). However, the taxon faces two seemingly diametrically opposed forces: lack of fire, and re-introduction of fire (accidental and purposeful) to an altered landscape. Fire in areas where Eryngium aristulatum var. parishii exist can remove vegetation cover that would otherwise aid in controlling erosion post fire. This may in turn result in local sedimentation of the pools or otherwise disrupt vernal pool ecology. Although habitat occupied by Eryngium aristulatum var. parishii is dependent upon some form of disturbance to set back succession (e.g., periodic fire and annual inundation), fires at critical times can eliminate populations of E. a. var. parishii by killing individual plants or seed banks through intense heat, or overheating soil to create hydrophobic conditions (Agee 1993, pp. 1– 493; Keane et al. 2002, pp. 3–11; Keeley 2001, pp. 81–94; Arno and Fiedler 2005, pp. 7–38) (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Eryngium aristulatum var. parishii is limited by its inherent ecological tolerances and by past and current anthropogenic activities that occur within a vernal pool, in proximity to vernal pool complexes, or within a watershed of a vernal pool or complex. Events outside the range of natural influence or frequency variability, such as floods, fires, contamination, or drought, can substantially reduce or eliminate small populations and increase the likelihood of extinction (Lande 1993, p. 912). Small populations are more vulnerable to natural catastrophes and stochastic demographic, genetic, and environmental events (Barrett and Kohn 1991, pp. 3–30). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61) (USFWS, 2010).

Stressor: Loss of pollinators (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Cumulative effects of habitat loss, drought, and urbanization on native pollinators contribute to an extant and future threat to Eryngium aristulatum var. parishii. The National Research Council of the National Academies (2007, pp. 73–74) indicated that “some pollinators in North America representing a diversity of taxa are, in fact, in decline.” When native pollinators are diminished, redundancies in pollinator systems may be disrupted thus impacting the reproductive output of the variety (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Drought was noted as a threat to Eryngium aristulatum var. parishii at the time of listing; however, its relationship to climate change has been derived since listing. The effects of

an unpredictable precipitation regime on vernal pools, and on vernal pool species will have consequential effects on short and long term persistence of most if not all pools within basins (Bauder 2005, pp. 2129–2135). Ecosystem communities in California are expected to be 'reshuffled' due to climate disruption (Stralberg et al. 2009, pp. 1–8). The Service recognizes that climate change is an important issue with potential effects to listed species and their habitats; however, information to make precise oceanographic and atmospheric predictions regarding its immediate effects to vernal pool species, including Eryngium aristulatum var. parishii and its habitat, is lacking (USFWS, 2010).

Recovery

Reclassification Criteria:
1. Existing vernal pools and their associated watersheds that contain Eryngium aristulatum var. parishii should be secured from further loss and degradation in a configuration that maintains habitat functions and species viability (USFWS, 1998).

2. The existing vernal pools and their associated watersheds contained within the complexes identified in Table 5 are secured in a configuration that maintains habitat function and species viability (as determined by recommended research) (USFWS, 1998).

3. Secured vernal pools are enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 1998).

4. Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. Monitoring should continue for a period of at least 10 years following reclassification to ensure population stability (USFWS, 1998).

Recovery Priority Number: 9C (USFWS, 2023)

Delisting Criteria:
Delisting of the species is conditional on the downlisting criteria shown above, improvement (stabilized or increasing population trends) at all currently known sites; restoration, protection, and management of the minimum habitat area and configuration needed to ensure long-term viability; and establishing historic but locally extirpated species populations when needed to ensure viability (USFWS, 1998).

In the interest of ensuring these criteria are clearly articulated, we are amending the following clarification to the existing recovery plan. This amendment does not represent a revision of the delisting criteria, it simply provides more specific terminology. Delisting for the species covered by the 1998 recovery plan may be considered when the downlisting criteria have been met and: 1. All 74 geographic areas and associated vernal pool complexes as identified in Appendices F and G of the 1998 Recovery Plan under each of the specific management areas are protected and managed to ensure long-term viability. 2. The U.S. Fish and Wildlife Service must determine that the following factors are no longer present, or continue to adversely affect, Eryngium aristulatum var. parishii, Pogogyne abramsii, Pogogyne nudiuscula, Orcuttia californica, and the Riverside and San Diego fairy shrimp: (1) the present or threatened destruction, modification, or curtailment of their habitat range; (2) over utilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory

mechanisms; and (5) other natural and manmade factors affecting their continued existence (50 CFR 424.11). 3. Population trends for all seven taxa continue to be stable or increasing for 10 consecutive years after threats have been sufficiently ameliorated or managed (completion of delisting criterion 2) prior to consideration for delisting. (USFWS, 2019)

Recovery Actions:

- Conduct surveys and research essential to the conservation of the species (USFWS, 1998).
- Secure the existing vernal pools and their associated watersheds (USFWS, 1998).
- Where necessary reestablish vernal pool habitat to the historical structure (USFWS, 1998).
- Manage and monitor habitat and listed species (USFWS, 1998).
- Conduct rangewide monitoring using species-specific protocol to ascertain distribution and abundance; assimilate monitoring data into a standardized database available to all cooperators, researchers, public, and regulators. Publish results in peer reviewed journal(s) (USFWS, 2010).
- Develop a coordinated interagency invasive species prevention and eradication program for all vernal pool habitat where Eryngium aristulatum var. parishii is extant (USFWS, 2010).
- Identify Eryngium aristulatum var. parishii pollinators, their required habitat, and implement measures to ensure their maintenance throughout the range of E. a. var. parishii (USFWS, 2010).
- Conduct hydrological monitoring and modeling to ascertain vulnerability of pools and complexes to likely altered hydrological conditions associated with climate change (USFWS, 2010).
- Determine the utility of enhanced and artificially created vernal pools to the conservation of the species and standardize methods of site selection, selection of propagation materials, outplanting protocols, success criteria, and remediation methods (USFWS, 2010).
- Coordinate with partners, such as MCAS Miramar and MCB Camp Pendleton, to help manage and protect vernal pool habitat (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The actions are intended to reduce threats to Eryngium aristulatum var. parishii and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of E. a. var. parishii will require cooperation and coordination with partners to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. 1. Work with partners to identify opportunities for conservation of Eryngium aristulatum var. parishii occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire E. a. var. parishii habitat. 2. Adaptively manage E. a. var. parishii occurrences to maintain, enhance, or restore habitat and reduce threats. a. Manage nonnative species in vernal pool habitat. b. Coordinate with partners to develop a nonnative species prevention and eradication program for all vernal pool habitat where E. a. var. parishii is extant. c. Ensure the correct species pallet from a nearby source is being selected for areas during restoration projects inside and outside of the known range for E. a. var. parishii. 3. Monitor occurrences to assess management effectiveness. a. Conserve E. a. var. parishii seed in an off-site seed bank. b. Work with partners in Baja California, Mexico to survey additional areas for E. a. var. parishii and identify conservation opportunities. 4. Maintain or enhance E. a. var. parishii genetic diversity. a. Conduct a population genetics study to characterize genetic variation and structure. Based on study results, develop best management practices to

maintain genetic diversity within the species. b. Further investigate the taxonomy and genetic relationships between of E. aristulatum, E. vaseyi, E. aristulatum var. hooveri, E. pendletonense, and other similar Eryngium species; especially those occurring at MCB Camp Pendleton, Costa Mesa, Santa Rosa Plateau, and Baja California, Mexico, and compare to E. a. var. parishii. c. Investigate/monitor the potential for hybridization between E. a. var. parishii and E. pendletonense at Bluff Las Flores [EO 53]. 5. Model species' response to climate change and assess options to translocate the species into projected suitable habitat. a. Develop hydrological monitoring and modeling to determine characteristics and identification of pools and complexes likely to be impacted by prolonged drought, and lack of seasonal rainfall caused by climate change effects to El Niño/Southern Oscillation (USFWS, 2023).

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SPECIES ACCOUNT: *Eryngium constancei* (Loch Lomond coyote thistle)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/01/1985; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Loch Lomond button-celery is a perennial herb. Decumbent. Several flowered inflorescence with spiny bracts (NatureServe, 2015).

Taxonomy

Problematic genus, but E. constancei seems generally agreed upon as an entity (Bittman 1998) (NatureServe, 2015). A member of the carrot family (Apiaceae). Other common names for this species are Loch Lomond button-celery and Constance's coyote-thistle (Smith et al. 1980) (USFWS, 2005).

Historical Range

For over 5 decades, this species was known only from Loch Lomond, where it was first collected in 1941 (Sheikh 1983). Eryngium constancei has always been restricted to the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998) (USFWS, 2005).

Current Range

At the time of listing, the Loch Lomond coyote-thistle was only known to occur within the bed of a 7-acre vernal lake near the mountain community of Loch Lomond in southern Lake County, California (Service 1986, p. 45904). In our previous 5-year review, we described four known occurrences: three in Lake County and one in Sonoma County (Service 2009, p. 10). These occurrences, from north to south include the Dry Lake occurrence south of Clear Lake, the occurrence near Loch Lomond, an occurrence near the town of Cobb, and the Diamond Mountain occurrence near the city of Calistoga in Sonoma County (Service 2009, p. 10). In 2013, a comment reported to the Diversity Database suggested the population in Sonoma County may actually be a pubescent form of Eryngium aristulatum; however, an unpublished occurrence report submitted to the Diversity Database in 2021 confirms the species identification (Diversity Database 2021 unpublished report, p. 1). The current distribution of the Loch Lomond coyotethistle is the same as described in the 2009 5-year review, with all populations currently presumed extant (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: 2+ years (USFWS, 2005)

Breeding Season

Adult: June - August (USFWS, 2005)

Reproduction Narrative

Adult: Eryngium species are biennial or perennial, with an overwintering rootstock. Eryngium constancei flowers after the water evaporates from the pools, typically between June and August (California Department of Fish and Game 1985, 1994) (USFWS, 2005).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Northern volcanic ashflow vernal pool, Northern basalt flow vernal pools (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: ~463 - 853 m elevation (NatureServe, 2015; USFWS, 2009)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Eryngium constancei grows abundantly within the borders of the meadow-like bed of the Loch Lomond lake at an elevation of 853 m. Rain fills the lake bed in winter, but the water evaporates in spring and early summer, leaving a seasonal meadow-like area in which Eryngium constancei and other plants germinate, flower, and set seed. The volcanic soils of the lake basin, together with its particular hydrological characteristics and the surrounding topography, may account for the unique presence of this species. It lives in fragile vernal pool habitat. The environmental specificity is very narrow (NatureServe, 2015). Loch Lomond is a small, intermittent lake with a surface area of about 3.2 hectares (7 acres) at maximum inundation (U.S. Fish and Wildlife Service 1985). This wetland is classified as a Northern Volcanic Ashflow Vernal Pool (Sawyer and Keeler-Wolf 1995; CNDDB 2007) and is on Collayomi-Aiken-Whispering complex soils. The surrounding area is mountainous and supports a mixed forest. On Diamond Mountain, the pools where Eryngium constancei grows are shallow and spring-fed (CNDDB 2007); they are classified as Northern Basalt Flow Vernal Pools (Sawyer and Keeler-Wolf 1995; CNDDB 2007). The Dry Lake pool is at an elevation of 463 meters (1,520 feet) and is surrounded by Quercus douglasii (blue oak) woodland. (USFWS, 2009). Soils underlying Dry Lake are in the Sobrante-Guenoc-Hambright complex (USFWS, 2005).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown; presumed decline of < 30% (NatureServe, 2015)

Species Trends:

3 additional occurrences found since listing (USFWS, 2009); stable (NatureServe, 2015)

Number of Populations:

3 (USFWS, 2023)

Population Size:

Millions (total) (USFWS, 2023)

Adaptability:

Low (inferred from NatureServe, 2015)

Additional Population-level Information:

At the time of listing, abundance estimates were not available for the one population at Loch Lomond, but it was described as abundant (Service 1986, p. 45904). The previous 5-year review reported population abundances of millions for the Loch Lomond population, 50,000 for the Diamond Mountain population, and 25,000 for the Dry Lake population. However, these estimates were from 1991, 1996, and 1997, respectively. There was no abundance estimate reported for the Cobb population (Service 2009, p. 9). Current abundances are similar to what was reported in the previous 5-year review (Diversity Database 2023); however, the unpublished report submitted to the Diversity Database in 2021 reported the Diamond Mountain population had declined to approximately 20,000 plants (Diversity Database 2021 unpublished report, p. 1). As described in the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (Recovery Plan) (Service 2005), which includes the Loch Lomond coyote-thistle, we would not expect the population to vary substantially among years because the species is a perennial (USFWS, 2023).

Population Narrative:

This vernal pool plant is vulnerable, though the biological reasons for it are unknown. The long term trend is not known, but is assumed to have been a slight decline (< 30%). The estimated population size is millions of individuals each year (Bittman 1998). The population trend has been stable for the past 10 years (NatureServe, 2015). Since listing in 1986 and proposed downlisting in 1993, three additional occurrences of Eryngium constancei were found. There are four extant occurrences (USFWS, 2009). The Dry Lake and Sonoma County populations numbered in the tens of thousands in both 1996 and 1997. However, in 1996, the Loch Lomond population was at least two orders of magnitude larger than in 1997 (California Natural Diversity Data Base 2003). The size of the fourth population has not been reported (USFWS, 2005).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Currently, routine highway maintenance, trash dumping and, to a smaller degree, occasional fence vandalism, vehicle trespass, and trampling still threaten E. constancei at the Loch Lomond site. Specific threats to two of the four extant populations are that at least one of the occupied pools at Diamond Mountain may be converted to a vineyard, and the owner of Dry Lake has proposed excavating the pool for a reservoir (CNDDB 2007). Changes in hydrology threaten three of the four occurrences. In addition, runoff from adjacent roads and swimming pools creates excess water flow, whereas drainage ditches, culverts, and diversion of a natural spring are reducing the flow of water to E. constancei habitat (Hrusa and Buckmann 2000; CNDDB 2007). Existing and potential sources of changes to the hydrology at two sites include

adjacent roads, drainage ditches in and adjacent to Loch Lomond, development south of the lake (CNDDB 2007), and a culvert alongside one of the Diamond Mountain pools. Larger-scale hydrological alterations, including commercial development and timber harvesting, are also occurring in all the watersheds where Eryngium constancei grows, thus posing added hydrological threats (U.S. Fish and Wildlife Service 1986, 1993; CDFG 1994; K. Aasen in litt. 1995; B. Hunter in litt. 1996; CNDDB 2007). Not only does removal of trees and construction of logging roads alter the flow of water, but it also causes erosion, which can bury the plants and affect the hydrology (U.S. Fish and Wildlife Service 1985, U.S. Fish and Wildlife Service 1986, U.S. Fish and Wildlife Service 1993; California Department of Fish and Game 1994; Aasen in litt. 1995; B. Hunter in litt. 1996). The Loch Lomond and Diamond Mountain occurrences are threatened by hydrological alterations within their watersheds. By affecting the amount of runoff entering the pools or the rate at which the pools dry, the depth and duration of inundation can increase or decrease, creating conditions unsuitable for the survival of Loch Lomond coyote thistle. The Dry Lake occurrence is threatened by trash dumping and erosion into the pool; the surrounding slopes have been stripped of vegetation and are eroding (CNDDB 2007). The Loch Lomond occurrence is also threatened by occasional fence vandalism and vehicle trespass (S. Zalusky, pers. comm. 2008) (USFWS, 2009).

Stressor: Trampling/grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Currently, the occurrence at Dry Lake is heavily impacted by horse padocking (S. Zalusky, pers. comm. 2008) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The extremely restricted distribution of Eryngium constancei is a threat to its long-term viability. Although the individual populations are sufficiently large that intrinsic problems such as genetic drift are not a concern, other random events could cause the species to go extinct. Catastrophic weather events, climate change, or other unforeseen circumstances potentially could eliminate all of the populations. In particular, small numbers of localities makes it difficult for this species to persist while sustaining the impacts from adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events or additional environmental disturbance (Goodman 1987; Gilpin and Soule 1988). If a locality of E. constancei has several consecutive years of poor rainfall, or changes in hydrology from adjacent development, it is possible that all individuals within the locality will become extirpated (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Drought or flood conditions will place additional strains on the vernal pool ecosystem supporting E. constancei occurrences, some of which are already fragmented or reduced by habitat conversion to wineries and development. Where occurrences persist on only marginal

habitat, the addition of extreme drought conditions is likely to result in higher rates of mortality in the short term with the effects of low reproductive output and survivorship persisting after the drought has ceased. The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level; (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example, isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]; and (3) increased competition among urban, agricultural, and natural ecosystem uses due to decreased precipitation. Although the specific effects of climate change on Eryngium constancei are unknown, the effects of increased winter flooding and drought conditions in the spring and summer have the potential to adversely affect this species (USFWS, 2009).

Recovery

Reclassification Criteria:
recommend the recovery priority number be changed from 14 to 8C (USFWS, 2023).

Delisting Criteria:
1. Suitable vernal pool habitat within each prioritized core area for the species is protected (USFWS, 2009).

2. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there (USFWS, 2009).

3. Reintroductions must be carried out and meet success criteria established in the recovery plan (USFWS, 2009).

4. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the recovery plan (USFWS, 2009).

5. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

6. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E (USFWS, 2009).

7. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc) (USFWS, 2009).

8. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below

average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

9. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2009).

10. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

11. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2009).

12. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions (USFWS, 2009).

13. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat (USFWS, 2009). protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E

14. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

15. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts (USFWS, 2009).

16. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts (USFWS, 2009).

17. Participation plans for each vernal pool region have been completed and implemented (USFWS, 2009).

18. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

Recovery Actions:

- Habitat protection (USFWS, 2005).
- Adaptive habitat management and monitoring (USFWS, 2005).
- Status surveys (USFWS, 2005).
- Research (USFWs, 2005).
- Public participation and outreach (USFWS, 2005).
- Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquire conservation easements or fee title to habitat lands to help guarantee protection of the species in perpetuity (USFWS, 2009).
- Develop and implement standardized population trend survey protocols to complete updated status surveys at all four occurrences (USFWS, 2009).
- Create and convene regional vernal pool working groups in the Lake-Napa Region where Eryngium constancei occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for each of the species in the core areas (USFWS, 2009).
- Collect seeds from populations from which it has not yet been collected following the Center for Plant Conservation Guidelines (1991). Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation (USFWS, 2009).
- Withdraw the proposal to reclassify Eryngium constancei from endangered to threatened (USFWS, 2009).
- Consider modifying the Boggs Lake-Clear Lake core area to incorporate the entire Loch Lomond Vernal Pool Ecological Reserve and adjacent watershed (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Loch Lomond coyote-thistle. Some of these recommendations have already been discussed in the previous 5-year review (Service 2009, pp. 17–18) and remain valid. 1. Protect vernal pool habitat from being destroyed or modified by development, agriculture, or other activities. Acquire habitat through conservation easements or fee title to help guarantee protection of the species in perpetuity. 2. Develop and implement standardized population trend survey protocols to complete updated status surveys at all four occurrences. 3. Create and convene regional vernal pool working groups in the Lake-Napa Region where Loch Lomond coyote-thistle occurs. Regional vernal pool working groups will be important for the tracking the progress of recovery efforts, including the amount of suitable habitat protected for the Loch Lomond coyote-thistle. 4. Collect seeds from populations from which it has not yet been collected following the latest Center for Plant Conservation Guidelines. Seed collections should be stored in at least two sites, including the National Center for Genetic Resources in Fort Collins, Colorado, and a facility certified by the Center for Plant Conservation. 5. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data were lacking at the time the Recovery Plan was developed. Therefore, reassess and refine both down- and de-listing criteria for the Loch Lomond coyote thistle, if appropriate, to better reflect the species' life history and narrow range (USFWS, 2023).

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SPECIES ACCOUNT: *Eryngium cuneifolium* (Snakeroot)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Eryngium cuneifolium is an aromatic perennial herb with a long, woody taproot, and persistent rosette of dark green. It usually has several erect, branching, flowering stems. It ranges from 0.25 to 0.5 m in height, rarely reaching as high as 0.9 m. The leaves are clustered at the base of the plant. The basal leaves are long, stalked, and shaped like narrow wedges, with 3 to 5 bristle-tipped teeth at the apex. Stem leaves are smaller and lack leaf stalks. The flowers are small, with white petals, filaments, styles and stigmas but powdery blue anthers form small heads, with bristly bracts. The sepals and petals are each about 1.5 to 2 mm long. The inferior ovary develops into a fruit about 1.5 to 2 mm long. The flowers and bristle bracts form heads 4 to 8 mm in diameter (Bell 1963, Wunderlin et al. 1981). Sterile plants are easily recognized in the field by their basal rosettes (Wunderlin et al. 1981). Flowering is from August to October (other Eryngium species, including E. aromaticum and E. baldwinii have blue flowers). (USFWS, 1999)

Taxonomy

Eryngium cuneifolium, a member of the parsley family (Apiaceae or Umbelliferae), is most closely related to E. aromaticum (Bell 1963, Wunderlin et al. 1981). It was described by J.K. Small (1933) and its status as a species was upheld by O.R. Bell's (1963) review of the genus. Preparers of status reports (Wunderlin et al. 1981, Kral 1983) have also concurred that this is a distinct species. There are no synonyms in the botanical literature (Bell 1963, Wunderlin et al. 1981). Other common names for this species include wedged-leaved button-snakeroot (Wunderlin et al. 1981) and semantic variations thereof. (USFWS, 1999)

Historical Range

This species was first collected in 1927 near Sebring. Highlands County, Florida. (USFWS, 1999)

Current Range

Southern Highlands County, Florida, near the town of Lake Placid. It occurs only on the southern Lake Wales Ridge. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1999)

Lifespan

Adult: short-lived (less than 10 years) (USFWS, 2019)

Reproduction Narrative

Adult: Reproduction in E. cuneifolium is sexual. The species can reproduce readily by seed. There seems to be no special seed-dispersal mechanism (other than gravity) and pollination is likely to be similar to that of other members of Apiaceae, most likely by generalist insects (Wunderlin et al. 1981, Kral 1983). Germination and leafing dates are unknown. Budding is believed to occur in July. The plant flowers vigorously from September through October. Anthesis occurs from August to October . Fruiting and seed dispersal is believed to occur between October and January . Seeds are mature in November. Specimens have been collected in late November and December. (USFWS, 1999)

Habitat Type

Adult: Scrub vegetation

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: Snakeroot is found in open sand gaps in rosemary habitats within the Lake Wales Ridge in Highlands County. Nearly every aspect of snakeroot's demography is affected by time-since-fire. The beneficial effects of fire are largely indirect, though removal of litter, competing vegetation, and ground lichens. Snakeroot is sensitive to shrub cover and is dependent on the gaps created between rosemary shrubs immediately after fires. (USFWS, 2019)

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (inferred) (USFWS, 2019)

Number of Populations:

13 occurrences (USFWS, 2019)

Population Narrative:

In the last FNAI Element Tracking Summary (FNAI 2015) there were 13 known occurrences, 10 of which were on 5 managed areas. This was a significant decline (approximately 32 percent) from the 19 reported occurrences in the previous 5-year status review (2010c) (USFWS, 2019). Population sizes of snakeroot tend to vary widely with time since fire occurrence (Menges and Quintana-Ascencio 2004). Most EORs do not have regular population size estimates, although some have been reported previously (Service 2010). Population sizes reported by FNAI ranged from 10 to 10,000+ individual plants, but some EORs do not have population sizes indicated (FNAI 2020, Table 1). At ABS, the number of plants in study populations between 2014 and 2019 has ranged from 1,300 to 2,700 individuals, with several hundred additional plants outside of study areas (Menges, unpublished data). At Royce Ranch, plants in plots have varied from about 300 to 500 during the past few years, but there are probably thousands of additional plants at the site (Menges, unpublished data). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic

groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within its historic range, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support E. cuneifolium (USFWS, 1999)

4. When monitoring programs demonstrate that populations of E. cuneifolium on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Delisting Criteria:

1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of E. cuneifolium. This species has been relatively well surveyed and a distribution has been ascertained. Additional surveys will confirm the species' distribution and locate new sites. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of E. cuneifolium. Continue the study of basic biology and ecology of this species. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)

- Monitor existing populations of E. cuneifolium. Develop monitoring protocol to assess population trends for E. cuneifolium. Develop a quantitative description of the population structure of E. cuneifolium. (USFWS, 1999)
- Provide public information about E. cuneifolium. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about E. cuneifolium. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of E. cuneifolium and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Introduce plants to suitable, managed habitats to increase the number of such populations to 20. • Continue demographic monitoring and expand to additional occurrences, especially those that are protected. Menges et al. (2019) suggest level 3 demographic monitoring as the highest priority. • Advocate and support the application of prescribed fire on managed areas to maintain rosemary scrub habitat for snakeroot. • Ensure representation of snakeroot at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. • Service recovery leads should maintain open lines of communication with State land managers and provide updates as appropriate to ensure proper management of occurrences. • Continue to improve the capacity for planting snakeroot as part of restoration efforts. • Acquire land with existing populations from willing sellers and restore scrub habitat on these sites, including the implementation of prescribed fire. • Utilize outreach and assistance programs to encourage private landowners to protect and manage scrub habitat on private lands. (USFWS, 2021)

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SPECIES ACCOUNT: *Eryngium sparganophyllum* (Arizona eryngo)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered

Physical Description

Arizona eryngo is an herbaceous perennial dicot that grows to a height of about 1.5 meters (m) (~5 feet [ft]) with long, linear, parallel-veined leaves that emerge from a basal rosette (Stromberg et al. 2019, p. 3, Makings 2013, p. 74) (Figure 2.1). The plant is conspicuous when flowering (Makings 2013, p. 74) in June through September (Stromberg et al. 2019, p. 8; New Mexico Rare Plants 2013, p 1). The flowers are cream-colored and clustered in dense heads at the end of the branching, scapose inflorescences (Stromberg et al. 2019, p. 3; Makings 2013, p. 74). The flower heads are ovoid or ovoid-oblong and are 12-25 millimeters (mm) (0.47-0.98 inch [in]) long and 10-15 mm (0.39-0.59 in) wide, with several ovate or lanceolate basal bracts and similar, but smaller bractlets within the head that barely exceed to the length of the fruits (New Mexico Rare Plants 2013, p 1). The fruit, a schizocarp splitting into two mericarps, is ovoid and 3-4 mm (0.12-0.16 in) long (Stromberg et al. 2019, p. 8; New Mexico Rare Plants 2013, p 1). Root depth is uncertain, but roots grow to at least 20 cm and likely beyond (Li personal communication December 11, 2019) (USFWS, 2020).

Taxonomy

Eryngium sparganophyllum is an herbaceous perennial flowering plant in the Apiaceae, or carrot family (Wooton and Standley 1915, 475-478; Hooker 1897, p. 42). Arizona eryngo is one of about 250 species in the genus worldwide (Calviño et al. 2008, p. 1130); it is one of 30 Eryngium species native to the U.S. (with an additional two in the U.S. that are naturalized), and one of five known from Arizona, although one (E. phyteumae) has not been seen since 1882 (Calviño personal communication April 5, 2020). Arizona eryngo was first described by botanist William Hemsley and illustrated by Matilda Smith in Hooker's Icones Plantarum (Hooker 1897, p. 42) from the specimens collected by Charles Wright at Las Playas, New Mexico (the type locality) in 1851 (Stromberg et al. 2019, p. 4; Wooton and Standley 1915, p. 478; Hooker 1897, p. 42) (USFWS, 2020). Hemsley and illustrated by Matilda Smith in Hooker's Icones Plantarum (Hooker 1897, p. 42) from the specimens collected by Charles Wright at Las Playas, New Mexico (the type locality) in 1851 (Stromberg et al. 2019, p. 4; Wooton and Standley 1915, p. 478; Hooker 1897, p. 42).

Historical Range

Arizona eryngo is known historically from six sites: three sites in Arizona and one in New Mexico in the U.S., and one site in Sonora and one site in Chihuahua in Mexico (Sánchez Escalante et al. 2019, pp. 16-17; Stromberg et al. 2019, pp. 3-8) (USFWS, 2020).

Critical Habitat Designated

Yes; 7/11/2022.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), determine endangered species status under the Endangered Species Act of 1973 (Act), as amended, for the Arizona eryngo (Eryngium sparganophyllum), a plant species native to Arizona and New Mexico in the United States, and

to Sonora and Chihuahua in Mexico. We also designate critical habitat for the Arizona eryngo. In total, approximately 12.7 acres (5.1 hectares) in Pima and Cochise Counties, Arizona, fall within the boundaries of the critical habitat designation. This rule extends the protections of the Act to this species and its designated critical habitat.

Critical Habitat Designation

Critical habitat units are depicted for Pima and Cochise Counties, Arizona

Primary Constituent Elements/Physical or Biological Features

Within these areas, the physical or biological features essential to the conservation of Arizona eryngo consist of the following components:

(i) Cienegas within the Chihuahuan and Sonoran Deserts: (A) That contain permanently moist to saturated, organic, alkaline soils with some standing water in winter and that are moist at or just below the surface in summer; and (B) That have functional hydrological processes and are sustained by springflow via discharge of groundwater.

(ii) Areas of open canopy throughout the cienega.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the following threats: physical alteration of cienegas, water loss, and changes in co-occurring vegetation. Management activities that could ameliorate these threats include, but are not limited to: Use best management practices (BMPs) to minimize erosion and sedimentation; remove and control invasive, nonnative species (e.g., Johnsongrass) that encroach on critical habitat; selectively manage woody vegetation that encroaches on critical habitat; exclude livestock, or in some instances where such management would further the conservation of cienega habitat and the species, use highly managed grazing; avoid or minimize groundwater withdrawal to maintain adequate springflow to maintain cienegas; and avoid springflow diversion and springhead modification to maintain springflow to cienegas.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Cross pollination (USFWS, 2020)

Reproduction Narrative

Adult: Arizona eryngo grown in nurseries can flower in their first year. At natural sites, plants flower from June to September (Stromberg et al. 2019, p. 8; New Mexico Rare Plants 2013, p 1). Dry fruits ripen in September and October (Li 2020, p. 2; AGFD 2019, p. 2; Stromberg et al. 2019, p. 8). Stromberg et al. (2019, p. 8) studied plants at Lewis Springs and found that mature plants in 2018 produced an average of 1.75 flowering stalks, each with an average of 3.4 inflorescences

per stalk (up to 12 inflorescences per stalk had been observed in prior years). In 2014, they found that each inflorescence contained an average of 96 flowers and therefore, given the two seeds per fruit, estimated that an individual plant could produce several hundred seeds per season. They reported that the observed number of flowering stalks was considerably lower at Lewis Springs in 2018 than in prior years, as surface soils were subjectively drier, with saturated conditions detected only when excavating several centimeters (cm) into the wetland soils. Li (2019, p. 8), based on his observations of the species at La Cebadilla, also hypothesizes that flowering is determined by soil moisture availability and temperature (i.e., summer warmth) Aboveground, plants dieback partially or completely in the winter months such that almost no green or very little green aboveground structure can be seen (Li 2020, p. 9). While little is known about the reproductive strategy/ecology of Arizona eryngo, it is likely that pollinators are required for cross-pollination in this species. Pollinators do not seem to be lacking and abundant animal activity on the flowers is readily observed (Li, p. 8; J. Simms 2019, p. 1, Stromberg et al. 2019, p. 8). Another Eryngium similar in appearance to Arizona eryngo, E. yuccifolium (rattlesnake master) is xenogamous species (transfer of pollen grains from the anther to the stigma of a different plant) with temporal dioecism (Molano-Flores 2001, p. 5). Temporal dioecism is a synchronized flowering sequence that allows pollen to be shed before any stigma becomes receptive, minimizing geitonogamous pollinations (the fertilization of a flower by pollen from another flower on the same or a genetically identical plant) and maximizing outcrossing (Molano-Flores 2001, p. 5). The patterns of seed dispersal, germination percentages, and the rates of seedling establishment in the wild are not known (AGFD 2019, p. 2; Stromberg et al. 2019, p. 8). Arizona eryngo seeds are large and heavy and therefore are not likely to fall far from the mother plant. The height and the swaying of the inflorescence suggests that seeds may be dispersed by wind, but only short distances. Barbs around the seeds, however, likely function as hooks that may enable dispersal via attachment to mammals and birds (Blackwell et al. personal communication May 8-11, 2020). (USFWS, 2020).

Habitat Type

Adult: Spring-fed cienegas (USFWS, 2020)

Habitat Narrative

Adult: Arizona eryngo requires perennially moist, organic alkali soils found in spring-fed cienegas supported by adequate groundwater (Figure 2.3). Plants grow best in full sun in areas with few nonnative plant species, limited woody vegetation, or other vegetation that may shade or otherwise outcompete them. While the species reproduces asexually, pollinators are likely needed for sexual reproduction necessary to maintain genetic diversity (USFWS, 2020).

Dispersal/Migration

Dispersal

Adult: Unknown (USFWS, 2020)

Dispersal/Migration Narrative

Adult: The patterns of seed dispersal, germination percentages, and the rates of seedling establishment in the wild are not known (AGFD 2019, p. 2; Stromberg et al. 2019, p. 8). Arizona eryngo seeds are large and heavy and therefore are not likely to fall far from the mother plant. The height and the swaying of the inflorescence suggests that seeds may be dispersed by wind, but only short distances. Barbs around the seeds, however, likely function as hooks that may

enable dispersal via attachment to mammals and birds (Blackwell et al. personal communication May 8-11, 2020). (USFWS, 2020)

Population Information and Trends

Population Size:

30,422 genets or aggregates with a 95% confidence interval of the population size (USFWS, 2020)

Population Narrative:

The Arizona eryngo population is estimated to be 30,422 genets or aggregates with a 95% confidence interval of the population size, according to the boostrapping estimation, of (19,289, 43,469) genets at Lewis Springs (Li 2020b, p. 1). (Li 2020b, p. 1). As described in section 2.3, each clone has a unique basal stem, and multiple clones can form a clustered aggregate that resembles an individual plant (Li 2020a, p. 2). Li (2020a, p. 2, 2020b, p. 1) refers to such an "individual plant" as a clonal aggregate or genet, which is the basic unit of Arizona eryngo population size. Stromberg et al. (2019, p. 6) estimated Arizona eryngo population size at La Cebadilla in the low thousands (calculated using the estimated spatial extent of 4,494 m2 and assumption of a minimum of one plant per 2 m2 quadrat). Further study indicates that the mean number of individuals per 1m2 (in 30 established study plots) was 6.7, which explains why Stromberg et al.'s (2019) estimate was lower. While this is the largest of the four extant populations, the plants occur in a very confined space and remain tied to the fate of the cienega. The La Cebadilla Cienega occurs within Arizona Upland subdivision of Sonoran Desert Scrub at about 825 m (2,707 ft) in elevation. The climate is semiarid with a mean annual temperature of 20 degrees C and mean annual precipitation of 337 mm (13.27 in) (Stromberg et al. 2019, p 5; Wolkis 2016, p. 35). At this site, Arizona eryngo is primarily associated with Eleocharis palustris, Muhlenbergia asperifolia, Schoenoplectus americanus, and Anemopsis californica. Other associates of Arizona eryngo at La Cebadilla Cienega were Almutaster pauciflorus, Distichlis spicata, Eustoma exaltatum, Juncus balticus and Sisyrinchium demissum (Stromberg et al. 2019, p. 6) (USFWS, 2020).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

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87 FR. No. 112. Pages 35431-35459. Endangered and Threatened Wildlife and Plants

Endangered Species Status for Arizona Eryngo and Designation of Critical Habitat. Final Rule.

SPECIES ACCOUNT: *Erysimum capitatum var. angustatum* (Contra Costa wallflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; Pacific Southwest (R8)

Physical Description

a short-lived perennial and monocarpic (individuals die after setting seed) (Service 1984). Pollination is by bees that nest in open banks and may also be by a variety of other unspecified insects (Service 2002). A study in 1987 by Pavlik et al (1998a) determined that seed production for E.c. var. angustatum was not a limiting factor and germination of new seeds was considered relatively high, with 40-60% typical, comparable to germination rates in non-endangered relatives. Additional work by Pavlik et al (1988b) determined that, at that time, the growth of E.c. var. angustatum populations was not genetically constrained, but was environmentally constrained due to limited habitat, interspecific vegetation competition, and possibly pollination limitations. Seedling emergence (and presumably, germination) was significantly higher in dune soils than unbroken clay soil, and higher (but not significantly) in dune soil than in broken clay soil (Pavlik et al 1988b). The reproductive phenology encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting beginning in April and peaking in July (Service 2008). (USFWS, 2019)

Taxonomy

Note that Erysimum asperum var. angustatum is a different plant, treated as a synonym of the typical E. capitatum var. capitatum by Kartesz (1994 checklist), recognized as a full species (E. angustatum) in Kartesz (Feb. 1999 draft data). Reports of the Contra Costa wallflower from Alaska and Canada are presumably due to confusion of these two similar names (NatureServe, 2015). The Contra Costa wallflower is one of the many varieties of the western wallflower (Erysimum capitatum). A member of the Brassicaceae (mustard) family (USFWS 1984) (USFWS, 2008).

Historical Range

The Contra Costa wallflower is endemic to the riverine dune habitat found within and immediately adjacent to the Antioch Dunes NWR in Contra Costa County, California. (USFWS, 2008)

Current Range

This species is only known known from the Antioch Dunes in Contra Costa County, California. (USFWS, 2008)

Critical Habitat Designated

Yes; 8/31/1978.

Legal Description

On August 31, 1978, the U.S. Fish and Wildlife Service, designated critical habitat for Erysimum capitatum var. angustatum (Contra Costa wallflower) under the authority of the Endangered Species Act of 1973 (43 FR 39042 - 39044). Critical habitat was designated for one unit in

California.

Critical Habitat Designation

One critical habitat unit is designated in California, described as: An area of land, water, and airspace in Contra Costa County with the following components: T. 2 N. R. 2 E. SW 1/4 section 17, E 2/3 of S 1/3 of section 18 (43 FR 39042 - 39044).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements are not described (43 FR 39042 - 39044).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: 2+ years (USFWS, 2008)

Breeding Season

Adult: March - May (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2008)

Reproduction Narrative

Adult: This species is a biennial or short-lived perennial. The reproductive phenology of this species encompasses germination in October, leafing from October through December, budding in February, flowering in March (peaking in April or May), and fruiting in April (peaking in July). Unlike other members of the mustard family, pollination of the Contra Costa wallflower is by a variety of unspecialized insects, including bees nesting along the open banks (USFWS 2002) (USFWS, 2008). According to Harper (1977), it may best be thought of as a monocarpic perennial (USFWS, 1984).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2008)

Habitat Vegetation or Surface Water Classification

Adult: Grassland, sand dune, savanna, shrubland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wind disturbance regime (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 3 - 20 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2008)

Habitat Narrative

Adult: Inhabits inland dunes at 3 - 20 m elevation (Skinner 1997). More or less consolidated (stabilized) dunes of fine sand and some clay dust, with sparse herbs and shrubs, or less often with pasture grasses, herbs, and scattered Quercus agrifolia (Niehaus 1977) (NatureServe, 2015). The wallflower grows in soil types classified as sand to sandy loam. Precise information about the specific requirements of the Contra Costa wallflower are not well known; however, the plant has been observed growing in steep areas of unstable sand, especially on north-facing slopes adjacent to the river (USFWS 1984, 2002; S. Euing, USFWS, pers. comm. 2007). This plant has also been observed growing in a variety of conditions, including stable dunes of fine sand containing some clay and sparsely vegetated with herbs and shrubs; uneven river front bluff faces and edges; flat terrain in excavated areas; and flat hard pan areas 160 to 660 feet from the river where the hard pan is broken and loose, sandy soil is exposed (USFWS 2002). A natural disturbance regime is caused by the wind shifting the sandy environment in which the Contra Costa wallflower thrives (USFWS, 2008).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are wind-dispersed beginning in mid-May and peaking in September (USFWS, 2008).

Population Information and Trends

Population Trends:

not considered stable or self-sustaining (USFWS, 2019)

Species Trends:

not considered stable or self-sustaining (USFWS, 2019)

Number of Populations:

4 (USFWS, 2019)

Population Size:

Approximately 9,287 individuals in 2017 (USFWS, 2019)

Population Narrative:

According to the CNDDB (2018b), Erysimum capitatum var. angustatum is known from four EOs, all of which are presumed extant (Table 3). Of the four EOs, three are considered natural occurrences and one is considered transplanted outside of native habitat and/or range. The two CNDDB EOs that occur at the ADNWR (EO #1, which includes the Stamm Unit and EO #3, which includes the Sardis Unit) represent the majority of, and possibly the entire, known range-wide natural/native population. Nearly annual plant counts have been conducted in at least some of the subunits of the Stamm and Sardis Units since about 1985. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction from sand mining, industrial and urban/suburban development, and/or conversion to agriculture (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Habitat for the this species and pollinators, and area available for habitat restoration is threatened by destruction and conversion to other uses. This threat is largely ameliorated on the ADNWR and other properties with protection/management agreements in place, but not on properties without such agreements. (USFWS, 2019)

Stressor: Habitat degradation due to loss of natural disturbance regime (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The reduction in sand deposition in Antioch Dunes habitat as a result of water management/use (dams, levees, etc.) in the Sacramento/San Joaquin River Delta system and reduced effectiveness of wind-driven dispersal of sand and disturbance of dunes has and continues to reduce overall size and connectedness of the dune natural community. (USFWS, 2019)

Stressor: Habitat degradation due to non-native and native invasive vegetation (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Invasive vegetation colonizes open sand habitat, reducing available suitable E.c. var. angustatum, and pollinator, habitat. Invasive plants out-compete native species, including E.c. var. angustatum, for sunlight, space, nutrients, and moisture. They also stabilize the sand/soil, eliminating the natural disturbance regime and may cause soils to become more eutrophic (Thomson 2005a, Thomson 2005b, Chin 2012, McNally 2014). The 2008 Five-Year Review notes that the proliferation of non-native invasive plants has been increasing rapidly since 1998 (Service 2008) and these conditions continue (Chin 2012, McNally 2014, Service 2018a, Service 2018b, Service 2018c, Service 2018d). The use of herbicides to control non-native and native invasive vegetation may also present potential threat to E.c. var. angustatum occurring in the same vicinity. Applying herbicides selected for the target species and using appropriate rates and technique should minimize effects to non-target E.c. var. angustatum. These practices have been instituted at the ADNWR, so this threat is considered largely ameliorated there (Service 2008), but it may pose a risk to current and future occurrences of these listed species elsewhere. (USFWS, 2019)

Stressor: Habitat degradation due to gypsum dust deposition from neighboring plant (facility) (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The 2008 Five-Year Review reported that gypsum dust building up on plants may reduce exposure to sunlight and decrease photosynthesis. It may also alter soil chemistry due to introduction of calcium and sulphates, which may affect the growth of E.c. var. angustatum and promote colonization by invasive species. Deposition is noted as affecting mostly the Sardis Unit.

The ADNWR staff have met with Georgia-Pacific (G-P) about concerns over the dust and G-P increased efforts to reduce airborne gypsum (beyond the standards for air pollution control) by keeping it wetted down when possible during production activities. At the time of the 2008 Five-Year Review, staff noted a reduction in dust from G-P efforts. The review noted that there was no evidence that gypsum dust was adversely affecting any of the three species (Service 2008). However, it also cited a study that demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1945 in Service 2008), which may affect pollinators of O.d. subsp. howellii or E.c. var. angustatum. The ADNWR staff reported an increase in gypsum dust deposition at ADNWR in 2017-2018 (Susan Euing pers. comm. December 12, 2018). In 2018, staff noted that gypsum was being deposited on the refuge at concentrations that coats plants, leading to cancellation of surveys for the Lange's metalmark in some parts of the refuge (Susan Euing pers. comm. August 17, 2018). In 2019, after several weeks into the Lange's metalmark survey season, ADNWR staff confirmed that no surveys had been canceled due to concerns about gypsum dust deposition (Louis Terrazas pers. comm. September 10, 2019). The magnitude of this potential stressor requires further investigation and Service partnership with G-P is ongoing. (USFWS, 2019)

Stressor: Habitat degradation due to rogue hiking/trails (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: This activity may cause direct injury or mortality E.c. var. angustatum from trampling while also increasing potential for accidental introduction of wildfire from hikers. These threats and stressors were significantly reduced when ADNWR was fenced in 1986 and the 2008 Five-Year Review (Service 2008) no longer considered recreational and pedestrian traffic to be a significant threat. However, ADNWR staff note that incidence of trespassing and human encampments at ADNWR has increased in the past several years (Susan Euing pers. comm. December 12, 2018). (USFWS, 2019)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: These activities represent a threat to the Antioch Dunes species from direct mortality of any individual(s) collected and a reduction in annual recruitment by killing or injuring reproductive individuals. (USFWS, 2019)

Stressor: Disease or predation (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Three moth taxa are known to prey upon E.c. var. angustatum; a fairy moth (Chalceopla simpliciealla), an egg-eating moth (Calcus spp.), and the diamond back moth (Plutella xylostella) (Service 2008). Pavlik et al (1988b) determined that pre-dispersal predation of seeds significantly impacted reproduction during studies conducted in 1987 and 1988. The magnitude of this stressor requires further investigation. (USFWS, 2019)

Stressor: Wildfire (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Wildfire may cause direct mortality of E.c. var. angustatum plants during vulnerable life stages. These stages include the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. However, historical evidence indicates that the native plants may recover rather quickly from a wildfire (Service 2008). Any mortality would also result in reduced annual recruitment by killing or injuring reproductive individuals. The threat extends to pollinators and other pollinator plant species. (USFWS, 2019)

Stressor: Fuelbreak discing (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Fuelbreak discing may cause direct injury or mortality to E.c. var. angustatum. However, it also creates open, disturbed, sand/soil that may be suitable for colonization by E.c. var. angustatum, as well as invasive vegetation. The net impact of this activity to listed plant resilience is unquantified. (USFWS, 2019)

Stressor: Loss of pollinators (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Lange's metalmark is addressed as a pollinator for this discussion of the potential threat posed by possible insecticide drift from mosquito abatement spraying on neighboring properties (Richmond et al 2015). The Mosquito Abatement District allows for spraying of insecticides to reduce the incidence of West Nile Virus at a wetland adjacent to the Stamm Unit of the ADNWR. The spray could drift on to the refuge and affect pollinators, such as Lange's metalmark and those that pollinate E.c. var. angustatum. While ADNWR staff have worked with county mosquito control staff to minimize effects from this potential threat, the magnitude of this stressor requires further investigation. As of the 2008 Five-Year Review, there was no evidence that lack or loss of pollinators has negatively impacted or E.c. var. angustatum (Service 2008), but the species requires cross-pollination, so an adequate pollinator population is necessary. Bees are suspected pollinators for both species and hawkmoths may also be pollinators for the primrose; however, actual pollinator taxa are unknown. This potential threat requires investigation. (USFWS, 2019)

Stressor: Low population numbers (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: E.c. var. angustatum is threatened by few and small populations that are limited to a small and localized distribution, which increases the risk of extirpation and extinction due to: (1) Reduced resiliency (the ability of a species to withstand stochastic disturbance; resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations); (2) Low redundancy (spreading risk among multiple populations or a large

area to minimize the potential loss of the species from catastrophic events); and (3) Low representation (the breadth of genetic and environmental diversity within and among populations that influences the ability of a species to adapt to changing environmental conditions over time). (USFWS, 2019)

Stressor: Climate change (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: E.c. var. angustatum is threatened by multiple environmental effects anticipated with climate change, which may result in loss of habitat, altered temperature and moisture regimes causing direct mortality and/or impaired reproduction, and altered temperature and moisture regimes causing indirect mortality and/or impaired reproduction via phenological mismatches with pollinators and between pollinators and their host and/or other nectar plants (Richmond et al 2015). (USFWS, 2019)

Recovery

Reclassification Criteria:
Erysimum capitatum var. angustatum will be considered for downlisting when: 1. There are at least five separate self-sustaining (all plants are naturally recruiting) populations of: at least three populations, each with a 15-year moving median of at least 7,000 flowering plants; and least two populations, each with a 15-year moving median of at least 4,000 flowering plants. (a) A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. (b) Populations should be protected and have in place a long-term management plan for the conservation of E.c. var. angustatum and commitment for implementation of the plan. (USFWS, 2019)

Any flowering individuals counted as naturally recruiting would have to be ≥ two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ. (USFWS, 2019)

Delisting Criteria:
Erysimum capitatum var. angustatum will be considered for delisting when: 1. There are at least seven separate self-sustaining (all plants are naturally recruiting) populations of: at least five populations, each with a 15-year moving median of at least 7,000 flowering plants; and at least two populations, each with a 15-year moving median of at least 4,000 flowering plants. OR, population viability analysis determines that E.c. var. angustatum has a range-wide 95% probability of persistence over a 100-year period. (a) A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. (b) Populations should be protected and have in place a long-term management plan for the conservation of E.c. var. angustatum and commitment for implementation of the plan. (USFWS, 2019)

2. A post-delisting monitoring plan for the species has been developed. (USFWS, 2019)

Any flowering individuals counted as naturally recruiting would have to be ≥ two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ. (USFWS, 2019)

Recovery Actions:

- Protect Antioch Dunes ecosystem and essential habitat for the Contra Costa wallflower (USFWS, 1984).
- Restore Antioch Dunes ecosystem, and increase numbers and improve habitat for the Contra Costa wallflower (USFWS, 1984).
- Initiate information and education programs (USFWS, 1984).
- Recommended Actions from 2008 5-Year Review: Continue restoration of riverine dune habitat at Antioch Dunes NWR. - Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys. - Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR. - Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Several areas of future action are suggested over the next five years, which build on the actions articulated in the revised recovery plan (Service 1984) and the riverine dune ecosystem conservation strategies articulated in Service (2019b). These areas include: continuing to restore riverine dune habitat at ADNWR and considering nearby locations for restoration activities; continuing to collect and bank seeds, and propagating and out-planting seedlings; continuing research on habitat requirements, life history, and seed bank dynamics; improving statistical analysis and numerical modeling related to Erysimum capitatum var. angustatum; considering development of a publicly-accessible website for documents, literature, and data related to Erysimum capitatum var. angustatum; and establishing an Antioch Dunes Recovery Implementation Team or recovery working group. Continued research on the habitat requirements and seed bank dynamics of Erysimum capitatum var. angustatum could include identifying areas for possible development of new populations of Erysimum capitatum var. angustatum. For example, the Service's experience with dune restoration at the Refuge provides a strong foundation for expanding dune restoration work over the coming years. This future work could include an analysis of how environmental variables, such as precipitation and temperature patterns, and seeding and out-planting influence population dynamics in currently occupied areas and colonization of newly restored dunes. The status of the assemblage of invertebrate species that pollinate Erysimum capitatum var. angustatum is not currently clear. A study of the current pollinators of wallflower at Antioch Dunes would help add to the Service's understanding of the natural history of this plant and identify which potential pollinators, or groups of pollinators, to monitor to ensure that healthy and diverse pollinator populations continue to occur at and near the Antioch Dunes ecosystem. Statistical and numerical modeling, such as with habitat suitability analysis and population dynamics modeling, can provide insights into possible future locations for development of Erysimum capitatum var. angustatum populations, and future dynamics of these populations. Jones et al. (2019) began developing habitat suitability models for Antioch Dunes eveningprimrose at Antioch Dunes using remote-sensed vegetation metrics (NDVI). It is possible that a continuation of this line of investigation, perhaps including Erysimum capitatum var. angustatum, will lead to improved insights into where and how to develop additional restored sand dunes that will support the recovery of Erysimum capitatum var. angustatum. It may also be useful to consider developing population viability analyses (PVA) that are specifically developed for Erysimum capitatum var. angustatum. For example, it is possible that a stage-structured matrix population model similar to the model developed by Thomson (2005a) for Antioch Dunes evening-primrose could be used to form a foundation for PVA analysis. It is also possible that building and

parameterizing such a model, and then projecting this model into various possible futures, including under the influence of changing climate conditions, could help provide insights beyond the PVA's discussed in Service (2019a). As part of efforts to improve statistical analysis and modeling, creating a well-vetted and archived dataset of all Erysimum capitatum var. angustatum surveys, and resolving any discrepancies in counts identified during this review will be critical to progressing on this objective. In late 2019, staff of the Bay-Delta Fish and Wildlife Office met with the staff of the ADNWR and considered convening a recovery implementation team (RIT) for the listed species that occur at the Refuge, including Erysimum capitatum var. angustatum. The primary purpose for convening this group would be to encourage Service biologists, managers and external experts to consider recovery priorities for these species and the Antioch Dunes ecosystem, and continue to stay abreast of emerging research related to Erysimum capitatum var. angustatum and related taxa, riverine dune ecology, and other relevant topics. This group would also help develop a recovery implementation strategy for Antioch Dunes. (USFWS, 2021)

References

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USFWS. 2008. Lange's metalmark butterfly (Apodemia mormo langei)

Antioch Dunes evening-primrose (Oenothera deltoides subsp. howellii)

Contra Costa wallflower (Erysimum capitatum var. angustatum)

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SPECIES ACCOUNT: *Erysimum menziesii* (Menzies' wallflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A member of the mustard family and a biennial or a short-lived perennial depending on the particular population. Each plant usually has several flowering stems from 0.5 to 1.5 decimeters tall. The flower petals are usually yellow (light or rich yellow), 15-20 mm long. The flowers are grouped into an inflorescence. Fleshy leaves form a basal rosette and are somewhat spoon-shaped, narrowing abruptly to the leaf stalk. Leaf margins are entire, dentate, or lobed. Fruit is a silique, four-sided when green and flattened when dry (Fish and Wildlife Service 1997) (NatureServe, 2015).

Taxonomy

Erysimum menziesii is a member of the mustard family (Brassicaceae) (USFWS, 2008). As treated here, following FNA (2010, vol. 7), Erysimum menziesii includes subspecies eurekense, menziesii, and yadonii, but excludes subspecies concinnum. This is the treatment followed by USFWS when the species was listed endangered, Kartesz's 1994 checklist, and the second edition of The Jepson Manual (Baldwin et al. 2012). This treatment is based on Price's 1987 doctoral dissertation. According to FNA, Price's 1993 treatment (followed by Kartesz 1999) accepted four subspecies (concinnum, eurekense, menziesii, and yadonii), three of which were never validly published (NatureServe, 2015).

Historical Range

Endemic to California in Monterey, Mendocino, and Humboldt Counties (Fish and Wildlife Service 1997). The range extent is 14,506 sq. km (R. Bittman, pers. comm. 2013) (NatureServe, 2015).

Current Range

It is distributed predominately in the nearshore dune community of four disjunct dune systems in northern and central California: Humboldt Bay in Humboldt County, Ten Mile River in Mendocino County, the Marina Dunes at Monterey Bay, and the Monterey Peninsula in Monterey County (Price 1993) (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2008)

Lifespan

Adult: 8 years (USFWS, 2008)

Dependency on Other Individuals or Species

Adult: Erysimum m. ssp. eurekense: Emphoropsis miserabilis (USFWS, 2008)

Breeding Season

Adult: February - April (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Fall/early winter rains (USFWS, 2008); insect pollinators (USFWS, 1998)

Reproduction Narrative

Adult: Its life history is that of a semelparous (monocarpic) perennial, meaning that it flowers and produces fruit only once during its life, after which it dies (E. m. ssp. yadonii reportedly can flower and fruit twice). The wallflower forms a basal rosette of leaves that may persist for up to 8 years before flowering. Blooming typically occurs from March through April, although it may begin as early as late February. The species is self-compatible; therefore, the reproduction of this species involves selfing and facultative outcrossing (able to produce seed either by self-pollination, or pollination by other plants). Erysimum m. ssp. eurekense is pollinated by a solitary bee species (Emphoropsis miserabilis) in Humboldt County (USFWS 1998). The fruits mature by mid-June. Germination follows the first rains in fall or early winter. Fecundity is high, with individual plants producing numerous seeds; however, the wallflower does not have a persistent seed bank in the soil (Carothers 1996), and seedling survivorship is low, with 98.3 percent mortality shown to occur in the first year (Pickart and Sawyer 1998) (USFWS, 2008). The plant's pollinators are thought to be bees, bumblebees, butterflies, and moths (Price 1986) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Northern foredune or dune mat community, coastal strand (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from NatureServe, 2015 and USFWS, 1998)

Habitat Narrative

Adult: The habitats of the Monterey county populations differ from those of the northern California populations. The plants are generally distributed in clusters or patches. In northern California, the species occurs in northern foredune or dune mat community, on the flanks or crests of dunes, open sand areas, sparsely vegetated dunes, and the borders of lupine scrub. The plants can tolerate some sand movement. The associated vegetation community is composed of low-growing suffrutescent perennial and herbaceous native species. Common

associates are beach sagewort (Artemisia pycnocephala), dune goldenrod (Solidago spathulata), coast buckwheat (Eriogonum latifolium), sand verbena, beach pea (Lathyrus littoralis) and seashore bluegrass (Poa douglasii). In Monterey County, the species occurs on coastal strand, close to the high tide line, but largely protected from wave action. The species has high exposure to strong wind, salt spray, and occasional wave action from storms and high tides. The substrate is loose sand lacking in organic matter and minerals. Associated species along the Monterey Peninsula include beach primrose (Camissonia cheiranthifolia), beach-bur, sea rocket (Cakile maritima), beach knotweed (Polugonum paronychia), sand verbena and iceplant. Monterey County habitats are relatively free of the invasive Ammophila arenaria (Fish and Wildlife Service 1997) (NatureServe, 2015). These habitats are not spatially fixed, and are subject to cycles of erosion, deposition, and re-establishment of plant communities over decades (USFWS, 1998).

Dispersal/Migration

Dispersal

Adult: Low to moderate (USFWS, 1998)

Dispersal/Migration Narrative

Adult: The seeds remain attached to the fruit walls after dehiscence and disperse over a long period, primarily in conjunction with winter storm events that dislodge the mature inflorescences and scatter them by way of a wind-driven tumbling action (Pickart and Sawyer 1998) (USFWS, 2008). Most seed dispersal is restricted to the immediate vicinity of the parent plants. Long distance dispersal of seed may occur by fragmentation of seed-bearing branches breaking offend tumbling with the prevailing wind. Isolated individuals of E. menziesii occur on slipfaces of bare, active dunes downwind of vegetated dunes at Ten Mile dunes. This indicates that long-distance seed dispersal may occur where the surface roughness of the dune is minimized (USFWS, 1998).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2008)

Species Trends:

30 - 50% decline (NatureServe, 2015)

Number of Populations:

16 (USFWS, 2008); 15 (NatureServe, 2015)

Population Size:

Unknown (USFWS, 2008); 33,300 (NatureServe, 2015)

Population Narrative:

The three subspecies of Erysimum menziesii: ssp. eurekense, ssp. menziesii, and ssp. yadonii, are known from at least 33,300 individuals (Fish and Wildlife Service 1997). Together, the three rare subspecies of Erysimum menziesii, ssp. eurekense, ssp. menziesii, and ssp. yadonii are known from 19 occurrences, 15 of which are presumed to be extant (California Natural Diversity

Database, 2012). Subspecies concinnum is not included here. This species has experienced a short-term decline of 30 - 50% (NatureServe, 2015). Erysimum menziesii is known from at least 16 extant occurrences. With the exception of Erysimum menziesii ssp. eurekense, no statistically valid population estimates have been made of the subspecies of E. menziesii. Therefore, population data are generally inadequate for the purpose of determining trends or assessing response to past management (USFWS, 2008).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Uncontrolled recreational use, such as hang gliders and hikers, continue to impact some populations (Imper pers. obs. 2006). Threats from off-road vehicle use, equestrian use and sand mining remain local threats in some areas. The privately owned occurrences of E. menziesii, particularly in Monterey County, are near expanding urban centers subject to growing demand for recreational opportunities (Imper pers. obs. 2006) (USFWS, 2008).

Stressor: Disease and predation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Deer have significantly impacted a population of E. m. ssp. eurekense on the South Spit of Humboldt Bay (Clifford 2006), and nearly all E. m. ssp. menziesii occurrences on the Monterey Peninsula Disease caused by the crucifer rust (Albugo candida), a pathogenic fungus, affects a significant portion of E. m. ssp. menziesii in Humboldt County (Pickart 2004). An unidentified fungus was also observed affecting Erysimum menziesii ssp. yadonii (Zoger and Pavlik 1987). In E. m. ssp. eurekense, disease symptoms are more prevalent on reproductive individuals, where they can decrease fecundity by reducing seed number or viability (Pickart and Sawyer 1998) (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. The effects to particular species is unknown at this time (USFWS, 2008).

Stressor: Invasive species (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: The primary threat to Erysimum menziesii when it was listed, and which continues to be the major threat for most populations is displacement by invasive non-native plant species. In Humboldt County the primary threats are European beachgrass, yellow bush lupine, iceplant, and jubata grass (Cortaderia jubata). European beachgrass and iceplant are the primary threats in Mendocino County, and iceplant in Monterey County. No efforts have yet been made to control or map burclover (Medicago polymorpha), ripgut brome (Bromus rigidus), or other invasive species that may be competing with E. m. ssp. menziesii within MacKerricher State Park.

Recovery

Reclassification Criteria:
1. Habitat occupied by the three endangered subspecies of Erysimum menziesii needed to allow delisting has been secured, with long-term commitments and, if possible, endowments to fund conservation of the native vegetation (USFWS, 2008).

2. Management measures are being implemented to address the threats of invasive species and other problems, including grazing, pedestrians, and off-road vehicles at some sites (USFWS, 2008).

3. Monitoring reveals that management actions are successful in reducing threats of invasive non-native species (USFWS, 2008).

Additional restored habitat has been secured, with evidence of either natural or artificial long-term establishment of additional populations, and long-term commitments (and endowments where possible) to fund conservation of the native vegetation (USFWS, 2008).

Delisting Criteria:
1. Studies have elucidated its life history requirements so that it is possible to predict the responses of populations to management and their viability (USFWS, 2008).

2. The dune systems supporting the 3 subspecies are actively protected from recreational violations, particularly by off-road vehicles (guaranteed funding to enforce ordinances), development, invasive weeds (including European beach grass, iceplant, and yellow bush lupine for subspecies eurekense in Humboldt County and iceplant for the entire species), and predators (deer in Monterey County) (USFWS, 2008).

3. Each occupied dune system has reasonable numbers of plants distributed widely enough to minimize the risk from accidental or catastrophic events. Erysimum menziesii ssp. eurekense (Humboldt Bay dune system) Goals: 3 populations with minimum 300 plants each; 2 populations with minimum 5,000 plants; Erysimum menziesii ssp. menziesii (Ten Mile Dunes system/Monterey Peninsula) Goals: 4 distinct sites and 5 total populations across the range; 3 populations averaging at least 300 plants; 2 populations averaging at least 5,000 plants; Erysimum menziesii ssp. yadonii (Marina dune system) Goals: Taxon to be present throughout its present range from south of Salinas River to Marina Dunes and potentially the Fort Ord area, with 2 populations averaging at least 5,000 individuals, and 3 populations averaging 300 plants or more (USFWS, 2008).

Recovery Actions:

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plant (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).
- Completion of population estimates for the Monterey and Mendocino County populations of Erysimum menziesii (USFWS, 2008).
- Establishment of a uniform reporting protocol for agencies conducting population inventories and habitat restoration across the range (USFWS, 2008).
- Increased Service support, in the form of funding and staff involvement, of habitat restoration and population enhancement efforts along the Marina Dunes on private and public lands (USFWS, 2008).
- completion of a Genetics evaluation and taxonomic review of E. menziesii across its range to help resolve outstanding questions on the identity of several large populations (USFWS, 2008).
- Investigation of methods and reliable funding mechanisms for ensuring future invasive species monitoring and control programs at critical sites (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The recommendations in the 2008, 5-Year Review remain our top priorities for the recovery of Menzies' wallflower. These include: 1. completion of population estimates for the Monterey and Mendocino County populations of Menzies' wallflower 2. establishment of a uniform reporting protocol for agencies conducting population inventories and habitat restoration across the range 3. increased USFWS support, in the form of funding and staff involvement, of habitat restoration and population enhancement efforts along the Marina Dunes on private and public lands 4. completion of a genetics evaluation and taxonomic review of Menzies' wallflower across its range to help resolve outstanding questions on the identity of several large populations 5. investigation of methods and reliable funding mechanisms for ensuring future invasive species monitoring and control programs at highly valuable sites (USFWS, 2020)

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SPECIES ACCOUNT: *Erysimum teretifolium* (Ben Lomond wallflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/07/1994; Pacific Southwest (R8)

Physical Description

Ben Lomond wallflower is a short-lived perennial plant, or occasionally an annual. Seedlings form a basal rosette of leaves which then wither as the main stem develops a raceme (flowers clustered in a terminal spike). The flowers are a deep yellow with petals 1 .3—2.5 centimeters (0.5—1.0 inch) long. The fruit, a slender capsule, reaches 10 centimeters (4.0 inches) in length and is covered with three-parted hairs. Characteristics that separate this plant from other wallflowers include simple, narrowly linear leaves that have small marginal teeth and a purplish cast. (USFWS, 1998)

Taxonomy

In the mustard family (Brassicaceae). Erysimum teretifolium was first collected at Glenwood, Santa Cruz County by Horace Davis in 1914. This plant was described by Alice Eastwood in 1938 as Erysimum filifolium, not realizing that this combination had already been applied to another plant (Eastwood 1938). Therefore, it was renamed Erysimum teretifolium the following year (Eastwood 1939). (USFWS, 1998)

Historical Range

Endemic to Santa Cruz Mtns., Santa Cruz County, California. (USFWS, 2008)

Current Range

Endemic to Santa Cruz Mtns., Santa Cruz County, California. (USFWS, 2008). Ben Lomond wallflower (Erysimum teretifolium) occurs within the sandhills of the Santa Cruz Mountains. The central range of the species is generally bounded by the communities of Ben Lomond, Glenwood, Scotts Valley, and Felton in Santa Cruz County (Figure 1). An outlying population is found at Bonney Doon Ecological Reserve approximately 5 miles west of the central concentration of occurrences (USFWS, 2022).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2008)

Lifespan

Adult: 1 - 2+ years (inferred from USFWS, 2008)

Breeding Season

Adult: March - July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, heavy fall rains (USFWS, 2008)

Other Reproductive Information

Adult: Ben Lomond wallflower is a monocarpic biennial plant that produces leaves but not flowers in the first year after germination. Flowers are typically produced in the second year (less frequently 3 years and rarely 4 years after germination) and die after seed set. Rarely will plants flower in the first year following germination or survive to flower and set seed more than once. In a recent experimental introduction study, approximately 11 percent of seedlings survived to produce an inflorescence in the second year (McGraw et al. 2020, p. 41). Herbivory pressure is high on both vegetative and flowering individuals, reducing the number of plants that set seed (McGraw and Chrislock 2019a, p. 15). Germination and survivorship have been observed to follow annual rainfall patterns, with wetter years having greater germination and survivorship than drought years (McGraw and Jordan 2021, pp. 19-20). Ben Lomond wallflower is largely self-incompatible, needing pollen from flowers not on the same plant in order to produce seed (Melen et al. 2016, p. 1983). Self-pollination sometimes results in fruit development, but the number of seed produced averages 6.5 times less than the amount of seed produced from cross pollination (Melen et al. 2016, p. 1983). Cross pollination between populations produces slightly more seed per fruit than cross pollination within population, suggesting that the small populations may be experiencing inbreeding depression (Melen et al. 2016, p. 1983). Bees, butterflies, and beetles are the most commonly observed floral visitors (Melen et al. 2016, p. 1982-1983). Pollen limitation was evaluated as a potential source of population declines, but manually adding pollen to flowers did not increase seed set, suggesting that populations of Ben Lomond wallflower are not pollen limited (USFWS, 2022).

Reproduction Narrative

Adult: Flowers from March to July (NatureServe, 2015). Erysimum teretifolium is a short-lived perennial or sometimes annual plant. This species is self-incompatible, and crosspollination is necessary for fertilization to occur. Chalcedon checkerspot butterflies (Euphydryas chalcedona), ants, European honeybees, and bumble bees have all been seen on the flowers of this species, but the potential for these insects to achieve pollination is unknown (McGraw 2004b). Observations by McGraw (2004b) indicate that the numbers of siliques produced per plant is quite variable (10- 107) and that seed production is positively correlated to silique length (9-15 centimeters produced 5-65 seeds). Seeds germinate after the first heavy rains in the fall, and were found to germinate at least up to 5 years after reaching maturity (McGraw 2004a and McGraw 2004b) (USFWS, 2008).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ponderosa pine woodland, northern maritime chaparral (NatureServe, 2015); Zayante sandhills (USFWS, 2008)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 200 - 400 m elevation (NatureServe, 2015); succession (USFWS, 2008)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2008)

Habitat Narrative

Adult: Inhabits inland pockets of sandstone-derived coarse sandy soils; these are uplifted ancient marine terraces persisting in a mountain range of volcanic origin. These coarse sands create drier soil conditions than those in the surrounding substrates and support unusual, open, park-like ponderosa pine woodland and northern maritime chaparral communities. The species occurs preferentially in loose, uncompacted sand in openings between scattered chaparral shrubs, at 200 - 400 m elevation (NatureServe, 2015). The Zayante sandhills is a unique habitat type that is comprised of outcrops of sandy soils derived from marine deposits. Suppression of natural fire regimes has led to habitat conversion via the encroachment of woody invasive and native species and invasive annual grasses (Brunette 1997, USFWS 1998). This encroachment has led to conversion of much of the existing open, sandy soil habitat required by E. teretifolium and other shade intolerant sandhills plants, resulting in the establishment of shade-providing species and a build-up of leaf litter. The poor recovery record for sandhills habitat suggests a fragile system where biotic and abiotic factors coevolved in delicate balance over long time periods (USFWS, 2008).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Seeds usually fall directly below the parent plant (USFWS, 2008).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

17 (USFWS, 2008)

Population Size:

1,000 - 3,000 (USFWS, 2008)

Additional Population-level Information:

Population abundance data are only available for Quail Hollow Quarry Conservation Areas, Zayante Sandhills Conservation Bank, Bonny Doon Ecological Reserve, and Quail Hollow Ranch Park. The remaining locations have no information on abundance and population trends, or

have infrequent single year data (Table 1). Data from Quail Hollow Ecological Reserve (also known as Quail Hollow Ranch County Park) between 2012 and 2022 suggest that the population is stable, with reproductive adults ranging between 200 and 400 plants (T. Kasteen 2022, pers. com.). The abundance of adult plants is measured as density and frequency at the Quail Hollow Quarry Conservation Areas and has remained relatively stable, but low, ranging between 1 and 6 plants within 20-meter squared plots between 2006 and 2020 (McGraw and Jordan 2021, p. 42). The number of plants within the Zayante Sandhills Conservation Bank has been historically low because that location captures only a small portion of a larger population that occurs within the Quail Hollow Quarry Conservation Areas. There was only a single adult plant observed in 2015 when annual monitoring began. However, through management and experimental outplanting the number of adult plants increased to 10 in 2021 (McGraw and Chrislock 2021, p. 27). The plants at the Zayante Sandhills Conservation Bank are best viewed as a small portion of a larger population that is increasing due to management efforts. The naturally occurring population at Bonny Doon Ecological Reserve has declined to six naturally occurring adult plants in 2022 (Kasteen 2022, pers. com.). The population has ranged between 1 and 50 adult plants since annual data began being collected in 2005. Experimental reintroductions have also taken place at this location with 837 adult plants observed in reintroduction areas in 2021 but declining to 189 plants in 2022 (Kasteen 2022, pers. com.). Herbivory, invasive species, litter, and drought have been attributed to the decline of the natural population and threaten the persistence of the reintroduction effort (Kasteen 2022, pers. com) (USFWS, 2022).

Population Narrative:

There are 17 extant populations. Trends are impossible to determine at many sites since either there are only data from a single survey or no survey data was available. The annual total of individuals over all populations has ranged between 1,000 and 3,000 individuals per year in the most productive recent years. Of the remaining known populations, half are either declining or possibly extirpated (USFWS, 2008).

Threats and Stressors

Stressor: Sand mining (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Current sand mining is still destroying occupied E. teretifolium habitat. Unless new mining operations are proposed, future sand mining will be a reduced threat to the remaining habitat of the species because many of the mining operations are either being closed or are nearing closure (McGraw 2004b; B. Davilla, pers. comm. 2006). A substantial amount of the sandhills habitat had already been destroyed by mining operations prior to the listing of Erysimum teretifolium.

Stressor: Development and agriculture (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Urban development is not occurring at as rapid a rate as it was in the past, but the lasting effects of past development remain (e.g., habitat fragmentation, habitat alteration from landscaping). There are several sites that are immediately adjacent to existing homes on private

property that could provide good preservation opportunities. However, even if these areas were preserved, and little to no further development occurred, fragmentation at these sites would remain an issue. There is some grape production in the Bonny Doon area for winemaking purposes. Recent aerial photos do indicate the existence of exposed sandy soils in the area that may provide suitable habitat; however, private ownership of most of the surrounding properties has precluded any recent surveys of the area for Erysimum teretifolium. Additionally, signs posted in fallow vineyard areas indicate the application of insecticides and/or herbicides to the soil (C. West, pers. obs. 2007). Effects of these applications directly on E. teretifolium or on its pollinators are unknown (USFWS, 2008).

Stressor: Recreation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: At this time, recreational use continues to threaten some populations of Erysimum teretifolium. Fences are often cut and neighboring equestrians use the area, resulting in large quantities of erosion (J. McGraw, pers. comm. 2006; C. West, pers. obs. 2007). Another population (EO #14) on private land also shows much erosion due to recreation. This site is visible from nearby public land and supports some large specimens of E. teretifolium (C. West, pers. obs. 2007). Although there are “no trespassing” signs in place and wire fencing, there is extensive erosion, apparently from sandboarding (C. West, pers. obs. 2007). The effects of recreational activities are also apparent at the South Ridge site in Quail Hollow Quarry (former EO #1). Recreational activity at this site seems to be limited to hikers and dog-walkers accessing areas on foot, despite fencing and signage (C. West, pers. obs. 2007) (USFWS, 2008).

Stressor: Herbivory (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Observations of herbivory and potential effects at the population level have been noted by researchers (Brunette 1997, McGraw 2004b). Pocket gophers (Thomomys bottae) have been shown to consume up to 8 percent of rosettes prior to seed set in monitored populations (McGraw 2004b). Observations indicate that up to 37 percent of adult plants may be browsed by mule deer (Odecoileus hemionus), which greatly increases the likelihood of those plants dying without successfully reproducing (J. McGraw, pers. comm. 2007a) (USFWS, 2008).

Stressor: Fire suppression and succession (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Sandhills communities are fire-adapted, and fire plays a major role in resetting soil succession (McGraw 2004b). Fire has also been shown to play a role in the reduction of invasive non-native species in the sandhills parkland and chaparral habitat types (McGraw 2004b). Not only does suppression of fire directly leave leaf litter in place to accumulate, but McGraw (2004a) found that nonnative species prevented sloughing of this litter that otherwise occurs easily during rain and wind events from the bare sandy soil. Even with litter removal via manual methods such as raking, McGraw (2004a) found that the remaining non-native plants reduced soil moisture content, causing an increased risk of desiccation in E. teretifolium seedlings. At the

time of listing, vegetation succession leading to increased canopy density due to fire suppression was considered a threat to Erysimum teretifolium, which is relatively intolerant of shade. Perhaps more importantly, the habitat conversion leading to this increased canopy density will eventually result in a habitat type which cannot support many of the open sand specialists unique to sandhills parkland (McGraw 2004b, P. Levine, pers. comm. 2006). Many areas where E. teretifolium formerly occurred have undergone extensive habitat conversion; in several of these areas, it is doubtful whether the open sandy soil required by this species still exists (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: With increased successional pressures due to fire suppression, encroachment by nonnative plants, and human development, sandhills "islands" have shrunk in size and become even more fragmented (McGraw 2004b). Because seed dispersal distance is limited in Erysimum teretifolium (seeds usually fall directly below the parent plant), fragmented populations are likely to remain isolated. Of the populations surveyed in recent years, most have had very low numbers of individuals, and many had no individuals present. As habitat conversion increases due to various factors and remaining habitat is further fragmented and reduced in size, populations will continue to shrink and the risk of stochastic extinctions will increase (USFWS, 2008).

Stressor: Invasive Species (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Invasive species outcompete Ben Lomond wallflower by decreasing the amount and size of vegetation gaps within sand chaparral and sand parkland habitat, as well as through shading and competition for nutrients and water (McGraw 2004, pp. 240-244, 253-254). Invasive species that have established within former sand quarries are difficult to control, making reintroduction and recovery of Ben Lomond wallflower at those sites difficult. Portuguese broom (Cytisus striatus), French broom (Genista monspessulana), and silver wattle (Acacia dealbata) are three common woody invasive species that have been observed to establish rapidly in areas with low levels of disturbance (BEC 2021a, p. 6; BEC 2021b, p. 4; McGraw and Chrislock 2022, p. 4)). Once established, these and related species require annual removal efforts. Sand chaparral and sand parkland soil is typically low nutrient, which may inhibit invasive herbaceous species colonization. Pollution may increase nitrogen deposition and increase the fertility of the nutrient-poor soils, facilitating the potential establishment of invasive species (McGraw 2019a, p. 39). Herbaceous exotic species such as rat-tail fescue, rip-gut brome, rattlesnake grass, smooth cat's ears, and sheep sorrel already constitute a major component of sand parkland habitat. These species are in lower densities in sand chaparral habitat (McGraw 2019a, pp. 7, 10-19). Complete removal of herbaceous exotic species is difficult due to established seed banks and presence in surrounding areas facilitating passive dispersal. Where herbaceous invasive species are limiting Ben Lomond wallflower presence continued active management will be required for recovery (USFWS, 2022)

Recovery

Reclassification Criteria:
1. The 17 currently known populations have been secured through fee-title acquisition, conservation easements, or Habitat Conservation Plans. (USFWS, 1998)

2. Management plans for populations on Quail Hollow Ranch County Park and Bonny Doon Ecological Reserve are developed and being implemented. (USFWS, 1998)

3. Management plans for populations on Quail Hollow Ranch County Park and the adjacent State-owned parcel, Bonny Doon Ecological Reserve, Henry Cowell Redwoods State Park, Big Basin State Park, and Gray Whale Ranch State Park are developed and being implemented.

4. Population numbers are stable or increasing. (USFWS, 1998)

Delisting Criteria:
When the downlisting criteria have been met for a species the species can be considered for delisting if: 1. Threats are reduced or eliminated so that populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. (USFWS, 1998)

Recovery Actions:
- 1. Protect habitat for Santa Cruz Mountains species on private land through Habitat Conservation Plans and landowner agreements. Because of the extremely limited amount of habitat that exists, recovery cannot be achieved by the management of State and County lands alone (see task 2). Habitat Conservation Planning with local governments, quarry owners, and developers will provide additional protection. The long-term survival of these species will depend to a large extent on the protection that can be achieved on private lands (USFWS, 1998)
- 2. Manage habitat for Santa Cruz Mountains species. Management of the seven species included in this recovery plan and the habitats that support them will depend on data gathered from monitoring, threat analyses, and available conservation measures. Development and implementation of management programs should be specific to the species complex, ecological process, landowner, and particular threats to be managed. (USFWS, 1998)
- 3. Conduct research on the life history. ecology, and population dynamics of these species that will contribute to appropriate management strategies Research is needed to ensure that management actions that are undertaken are appropriate and will contribute to the long-term survival of these species and the habitats on which they depend. (USFWS, 1998)
- 4. Locate additional habitat/populations within the historic range of the species. The status of any new populations of these species that are discovered in the future should be evaluated and an assessment made of appropriate management actions. The value to the recovery strategy for these species of any additional habitat that is located should be assessed. (USFWS, 1998)
- 5. Develop and implement a public outreach program. An educational program should be established for the public, including private landowners whose property supports these taxa or suitable habitat, to encourage conservation and proper management of the taxa. Nongovernmental organizations such as the California Native Plant Society and the Santa Cruz Mountains Biodiversity Task Force should be approached about participating in this effort. (USFWS, 1998)

- 6. Evaluate progress of recovery effectiveness of management and recoverv actions and revise management plans. (USFWS, 1998)
- Recommended Action from 2008 5-Year Review: Surveys and monitoring should be undertaken for all known populations and potential habitat to ensure that potential populations are identified and reliable demographic information is collected. Outreach to owners of private holdings with potentially conservable habitat and populations should be attempted and permission should be secured to survey these private holdings where necessary. Specifically, all populations listed in the CNDDB and McGraw (2004b) should be surveyed to focus future recovery efforts, especially the areas between and surrounding Vista Robles Drive and Marion Avenue in Ben Lomond and the area around the intersection of Pine Flat Road and Bonny Doon Road in Bonny Doon. In addition, coordination of recovery partners and consolidation of population data into the CNDDB records should be undertaken. Additionally, survey methods should be standardized to insure data accuracy. Methods employed by Brunette (1997) may be suitable for this purpose (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: Expand research efforts focusing on potential causes of reproductive failures and methods to increase reproductive success as mentioned in the "Needed Recovery Actions" section of the recovery plan. As part of these efforts, the effects of predation on the species should be examined and pollination mechanisms should be identified. With clarification of such processes, management of landscape level influences on the species may be undertaken, such as predatory deterrence and management of potential pollinator barriers. Such research may contribute greatly in the form of increased survival, boosting reproductive success, and maintaining interfragment pollination to maximize gene flow, thereby avoiding inbreeding depression (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: More detailed knowledge of populations and completion of management plans should allow active management to prevent encroachment of both native and non-native species in fire-suppressed areas, which threaten type conversion of the habitat and potential extirpation of individual populations. Prescribed burns mimicking natural fire cycles would be the most effective way to thin vegetation and restore open habitat; however, in many areas the proximity of human habitation precludes this as an option. Mechanical means of vegetation and leaf litter removal (i.e., raking) have proven effective in reducing the chances of habitat type conversion (McGraw 2004a and McGraw 2004b). Effectiveness of this method to improve Erysimum teretifolium habitat and increase reproductive success is being examined at Bonny Doon Ecological Reserve. If these studies prove effective, this method should be initiated in occupied habitat where fire would create unacceptable risk to local communities. Outreach to local landowners in such areas may facilitate the implementation of such management strategies over larger, contiguous pieces of occupied habitat and thereby maximize the conservation potential of all remaining populations. Such vegetation clearing efforts should be approached from a fuels reduction angle, which further benefits all parties involved (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: Increased USFWS oversight as time allows may accelerate completion of the draft HCP with the County of Santa Cruz and other management plans under development. These plans need to be completed to help guide implementation of effective recovery efforts (USFWS, 2008).
- Recommended Action from 2008 5-Year Review: We suggest the USFWS consider revising the third criterion for downlisting in the recovery plan. This criterion lists specific HCPs by

name. Many HCP projects are abandoned for various reasons. Additionally, entities listed on HCPs may change name and ownership over time. Such changes may in turn lead to alterations of the HCP title or content. For these reasons, including specific HCPs in draft form as downlisting or delisting criteria should be avoided. A blanket statement reflecting the need to include the species in any HCP that covers its occupied range would be more appropriate (USFWS, 2008).

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SPECIES ACCOUNT: *Eugenia bryanii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Eugenia bryanii (NCN), a perennial shrub in the Myrtle family (Myrtaceae), is known only from Guam (USFWS, 2015).

Historical Range

Historically, E. bryanii occurred on windy, exposed clifflines along the west and east coasts of the island, and from along the Pigua River, in the forest ecosystem (Costion and Lorence 2012, p. 82; Gutierrez 2012, in litt.) (USFWS, 2015).

Current Range

Currently, E. bryanii is known from 5 occurrences totaling fewer than 420 individuals (Gutierrez 2014, in litt.) (USFWS, 2015). Distribution: Guam (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Coastal cliffs (USFWS, 2015)

Habitat Narrative

Adult: Species inhabits windy, exposed clifflines along the west and east coasts of the island, and from along the Pigua River, in the forest ecosystem (Costion and Lorence 2012, p. 82; Gutierrez 2012, in litt.) (USFWS, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2015)

Number of Populations:

10 (USFWS, 2023)

Population Size:

> 1,000 (USFWS, 2023)

Population Narrative:

Populations of E. bryanii, a single island endemic, are decreasing from initial numbers observed on Guam (USFWS, 2015). There are currently 929- 2,311 individuals of Eugenia bryanii throughout 8 populations, with the large majority found within two populations on AAFB. There are 45 plants in ex situ propagation in the GPEPP nursery. Surveys are ongoing and there is some protection from habitat degradation through exclusion fencing for ungulates, as well as research on BTS control. (USFWS, 2020). Number of Known Populations: 10. Number of Individuals: > 1,000 (USFWS, 2023).

Threats and Stressors

Stressor: Agricultural and urban development (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Agricultural and urban development are listed as threats to this species habitat (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Nonnative plants are listed as a threat to this species (USFWS, 2015).

Stressor: Nonnative animals (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Nonnative animals (deer) are listed as a threat to this species (USFWS, 2015).

Stressor: Typhoons (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Typhoons are listed as a threat to this species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change is listed as a threat to this species (USFWS, 2015).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Minimum Number of Stable Populations: 5. Reproducing Individuals / Population: 200 (USFWS, 2023)

Delisting Criteria:
Minimum Number of Stable Populations: 10. Reproducing Individuals / Population: 200 (USFWS, 2023).

Recovery Actions:
- A recovery plan has not been completed for this species.
- Threat and Recovery Potential: Full species with a moderate degree of threat and a high recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to assess the status of known occurrences of Eugenia bryanii in historical locations and potentially suitable habitat including an island wide survey. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. • Predation and herbivory by rodents—Implement effective control methods for rats at all populations. • Disease prevention from myrtle rust—Implement effective prevention and plans for control methods for rust at all populations. • Protect all remaining extant populations by controlling threats leading to habitat degradation. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts for maintenance of genetic stock, and keep track of individual founders. Conduct genetic testing to resolve taxonomic questions, and ensure the best practices in cultivation, out planting, and genetic diversity measures. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change • Reintroduction and translocation—Increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of habitat degradation by feral ungulates, nonnative plants, and events associated with climate change; and predation/herbivory by feral ungulates, and rats. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and monitoring—The Guam Plant Extinction Prevention Program (GPEPP) searches for occurrences of Eugenia bryanii within suitable habitat and the known range. • Propagule collection and propagation: GPEPP has 35 plants and 35 seeds in their nursery representing one wild individual from Mangilao (University of Guam campus; GPEPP 2018). • A 2020 Memorandum of Understanding between Joint Region A 2020 Memorandum of Understanding between Joint Region Marianas (JRM) and the U.S. Fish and Wildlife Service (FWS) outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative to address threat control and habitat restoration within the range of Eugenia bryanii, as well as other federally listed species on Guam. (USFWS, 2020)

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SPECIES ACCOUNT: *Eugenia haematocarpa* (Uvillo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

Uvillo is a small evergreen tree reaching 6 meters (20 feet) tall and 12 - 13 centimeters (4.8 - 5.2 inches) in diameter. The bark is gray or whitish and smooth, shedding in plates. Twigs are hairless, slightly two-angled, and rusty brown (Little et al. 1974). The paired, relatively large, hairless, oblong to elliptical leaves are thick and leathery, 13 - 18 centimeters (5.2 - 7.2 inches) long, 6 - 8 centimeters (2.4 - 3.2 inches) wide and almost stalkless. The upper surface of the leaves is dull dark green with light green beneath. Blades contain many slender, slightly raised veins, forming a prominent network. The flowers, many in clusters, are produced on the trunks with slender, nearly equal stalks. Flowers have a four-lobed rounded calyx 1 millimeter (.04 inch) long, four rounded light pink petals 23 millimeters (.12 inch) long, many stamens, and pistil with an inferior ovary. The fruit is a dark red, round berry, 2.3 - 2.9 centimeters (.9 - 1.1 inches) in diameter and containing a rounded 1.6 centimeter (.6 inch) light brown colored seed (USFWS, 1998).

Taxonomy

Not available

Historical Range

The natural distribution of Chupacallos remains limited to the Luquillo Mountains in El Yunque National Forest and to the Río Abajo Commonwealth Forest (USFWS, 2014).

Current Range

Uvillo was originally reported from the Luquillo Mountains and from a single locality within the Sierra de Cayey. The range within the Cayey region has expanded to include four additional localities, as new populations have been discovered in this area. Therefore, we expect that further populations may occur within this area, including within the boundaries of the Carite Commonwealth Forest. Furthermore, during the last decade, at least three new populations have been reported in the municipality of Isabela, extending its distribution now to the northwestern corner of Puerto Rico (USFWS, 2014).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Probably Apis melifera (USFWS, 2014)

Breeding Season

Adult: May (USFWS, 1998)

Reproduction Narrative

Adult: A recent site visit to Las Robledas indicates plants flower vigorously and flowers are frequently visited by honeybees (Apis melifera) (Omar Monsegur, USFWS, pers. obs. 2012.) (USFWS, 2014). Eugenia haematocarpa has been collected with flower buds and fruits in May (Little et al. 1 974) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest, subtropical wet forest (USFWS, 2014)

Habitat Narrative

Adult: It occurs primarily within the subtropical moist forest and the subtropical wet forest life zones (Ewel and Whitmore 1973). It also grows in moist limestone forest (USFWS, 2014).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (USFWS, 2014)

Species Trends:

Increasing (USFWS, 2014)

Number of Populations:

3 (USFWS, 2022).

Population Size:

~1,313 individuals (USFWS, 2022).

Additional Population-level Information:

Additionally, six new localities (sub-populations) (Isabela-Guajataca; La Robleda, Cayey; Sotomayor del Toro, Caguas; Rio Grande, Las Piedras, and Guayama) with approximately 247 individuals have been reported since listing (USFWS 2014). More recently, Sustache (2016) assessed three populations in the Rio Grande Municipality at EYNF and on adjacent private lands and one in the municipality of Juncos (Rio Gurabo site). He reported a total of 1,169 individuals, of which 230 individuals are adult trees (Sustache 2016). One of the populations studied contained at least 30 individuals of different size classes with natural recruitment evident. Also, additional individuals were recently found at the CCF (Zegarra 2017, pers. comm.). In 2018, 10 individuals were found in Sierra la Guardarraya, a forest area between Patillas and Maunabo municipalities. This area is known as Marin Alto, a protected land managed for conservation by Para La Naturaleza (Monzon 2018, pers. comm.). New uvillo populations have been found

throughout its range, particularly in the southeast part of the Island (i.e., Caguas, Patillas, Maunabo, Juncos, and Cayey). In total, we have documented about 17 localities of uvillo comprising a total of 1,426 individuals. (USFWS, 2019).

Population Narrative:

The species status is improving; several new populations have been recorded and there is evidence of natural recruitment. Uvillo is currently known from approximately 247 individuals in nine natural populations. The Service believes that during the last decade the overall status of these species was uncertain. (USFWS, 2014). In the case of uvillo, the known populations at EYNF, Sierra de Cayey, and Guajataca are estimated to contain approximately 1,313 individuals, 96% of which occur in areas managed for conservation. However, the core of these individuals is concentrated within EYNF, representing 33% of all the known individuals across the species entire three populations (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The largest known population of Uvillo lies within Las Robledas along a ridge that marks the boundary of several private properties and some clusters of individuals lie within neighboring properties that are not managed by the PRCT. Boundary management practices (clearing and fencing) may affect individuals along these areas. Similarly, land clearing for agricultural purposes and urban development may affect the small populations of Uvillo within private properties at the Sierra de Cayey, including the private properties adjacent to Las Robledas. Undetected populations of Uvillo might be affected by deforestation for urban development on the periphery of El Yunque National Forest. In the northern Karst region, suitable habitat for these species may be affected by rock quarries, particularly in the Quebradillas and Isabela area (USFWS, 2014).

Stressor: Stochastic events and climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. The frequency of landslides is expected to increase, as landslides are triggered by severe rain events or droughts, whose frequency and severity is expected to increase as a result of climate change (Hopkinson et al. 2008). Given the steep slopes on which these species usually grow (associated to remnants of forest that were not cleared due the inaccessibility of the area), massive landslides may extirpate entire populations. Climate change is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario, populations of Uvillo may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting

the survival of seedlings (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Despite the reports of new populations of Uvillo, this species may be affected by genetic depression due to the low number of individuals in some populations, as it is evident that the species was severely affected by former habitat fragmentation due primarily to extensive deforestation for agriculture. However, the wide distribution and geographical isolation of the species, from the eastern to the northwestern side of the Island (i.e., El Yunque National Forest, Sierra de Cayey, and Guajataca Commonwealth Forest), with different environmental conditions, suggests that the species may show high interpopulation genetic variability (USFWS, 2014).

Recovery

Reclassification Criteria:
1. An agreement between the USFWS and the USFS concerning the protection of Uvillo within the Caribbean National Forest property has been prepared and implemented (USFWS, 2014).

2. An agreement between the USFWS and the PRDNER concerning the protection of this species in Commonwealth Forests, specifically Río Abajo, for Chupacallos, has been prepared and implemented (USFWS, 2014).

3. New populations (the number of which will be determined by appropriate scientific studies) capable of self-perpetuation have been established within protected areas (USFWS, 2014).

Recovery Priority Number: 5 (USFWS, 2022)

Delisting Criteria:
1. Three (3) natural populations of uvillo and two (2) populations of chupacallos exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).

2. Establish or discover two (2) new populations of uvillo and seven (7) new populations of chupacallos within the historic range of the species that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).

3. Threat reduction and management activities (e.g., trail maintenance) have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A). (USFWS, 2019).

Recovery Actions:
- Prevent further habitat loss and population decline (USFWS, 1998).

- Collect information on the distribution and abundance of these two endangered trees (USFWS, 1998).
- Conduct research on habitat requirements, reproductive biology, and ecology (USFWS, 1998).
- Establish new populations (USFWS, 1998).
- Refine recovery criteria (USFWS, 1998).
- Refined recovery action for 2019: Monitoring should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., natural recruitment, lack of pollinators or seed dispersers). This recovery action should be coordinated with Puerto Rico Department of Natural and Environmental Resources and United States Forest Service and be included within Task 121,212,323, 324: Monitor all known populations, Assess periodicity of flower production and pollination activity, Assess seed viability and Evaluate seedling establishment and growth of the approved recovery plan. (USFWS, 2019).
- Studies should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., lack of pollinators or seed dispersers) (USFWS, 2014).
- All known populations should be marked and monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine any possible adverse effects on the populations (USFWS, 2014).
- The previous ex situ conservation efforts (individuals reintroduced to the wild) should be monitored and further similar efforts should be undertaken to enhance the status of both species (USFWS, 2014).
- The USFS and USFWS should develop a comprehensive survey program to inventory areas with potential habitat. This program should include training to field biologists of both agencies so these personnel is able to recognize listed species on the field (USFWS, 2014).
- The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed material should be developed and implemented to avoid altering the natural recruitment of the species. Enhancement of natural populations should be considered particularly for Chupacallos. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2014).
- The recovery plan should be revised to establish measurable downlisting and delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist these species (USFWS, 2014).
- Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. Studies should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., pollinators and seed dispersers). 2. Previous and ongoing planting efforts (individuals reintroduced into the wild) should be monitored, and further similar efforts should be undertaken to enhance the status of both species. 3. The U.S. Forest Service and the Service should develop a comprehensive survey and monitoring program to inventory known localities and potential habitat. This effort should provide continuity to the surveys and methodology implemented by PRDNER (2016). Populations should be

monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine adverse effects on the populations. 4. A propagation plan that considers the species populations genetics (geographic distribution) and habitat, should be developed for both species. A protocol to collect seed material should be developed and implemented to avoid altering the natural recruitment of the species. Enhancement of natural populations should be considered, particularly for chupacallos. 5. Studies should be conducted to determine the patterns of genetic variation within and among populations to develop a plan to preserve the species genetic variability (USFWS, 2022).

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SPECIES ACCOUNT: *Eugenia woodburyana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/9/1994; Southeast Region (R4) (USFWS, 2015). Species reclassified from Endangered to Threatened on January 3, 2023.

Physical Description

May reach 6 meters in height. The leaves are opposite, obovate, pilose on both sides, glandular-punctate below, and from 1.5 to 2 centimeters long and 1 to 1.5 centimeters wide. The inflorescence is axillary, 2 to 5 flowered and with a peduncle 1 to 3 millimeters long. The calyx is 4-lobed and the petals are white, 4 millimeters long and 3.5 millimeters wide. The striking fruit is red upon maturity, 8-winged and 2 centimeters in diameter (Liogier 1994) (USFWS, 1998).

Taxonomy

This species belongs to the family Myrtaceae, a large family that includes from 100 to 140 genera and 3,000 or more species of trees and shrubs, mostly of tropical and subtropical regions (Cronquist 1981). The largest genus is Eugenia, which is very diverse in the Antilles and includes more native species than any other genus of flowering plants in the flora of Puerto Rico (Breckon and Kolterman 1994). Eugenia woodbuiyana was only recently discovered and described by Alain Liogier (Liogier 1980) (USFWS, 1998).

Historical Range

E. woodburyana is endemic to Puerto Rico (USFWS, 1994).

Current Range

Currently known from the range of hills known as the Sierra Bermeja in the municipalities of Cabo Rojo and Lajas, Puerto Rico. Some individuals are located on land recently added to the Laguna Cartagena National Wildlife Refuge and others are located on adjacent private land. The species is also known from the Guánica Commonwealth Forest in Guánica. An additional individual has been reported from the Cabo Rojo National Wildlife Refuge, adjacent to the Sierra Bermeja. Approximately 150 individuals are known from these localities (USFWS, 1998). Currently, E. woodburyana is known from about 3,200 individuals in 6 populations along the southern region of Puerto Rico: from the municipality of Caho Rojo in the south-west, eastward to the municipality of Salinas in the south (USFWS 2017). Additionally, the species has been propagated in tree nurseries and planted at 9 sites: Caho Rojo National Wildlife Refuge (CRNWR), Laguna Cartagena National Wildlife Refuge (LCNWR), Gabia Farm, Toa Vaca Conservation Area, SCF, Cueva El Convento, Caguas Botanical Garden, Parque Dona Ines, and Rio Piedras Botanical Garden. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: October and May (USFWS, 1998)

Reproduction Narrative

Adult: Information obtained from herbarium specimens indicates that buds and flowers were present on specimens collected in October and May from Guánica, but that specimens collected in February and April were sterile. One specimen, collected from the Sierra Bermeja in March, had remnants of old flowers. No flowers or fruit were observed during preliminary studies of several individuals for a 1-year period (USFWS, 1998). New in 2017: This plant has been observed flowering in February, May, June, August, and October (Figure 3; C. Pacheco, Service, pers. obs.). In Sierra Bermeja, not all adult individuals flower at the same time and not all produce fruit. Flowers have been observed 3 to 5 days after rain events of more than 1 inch (25.4 mm) of precipitation in one day. Fruit are observed about three weeks later. (USFWS, 2017).

Habitat Type

Adult: Terrestrial (USFWS, 1998)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest (USFWS, 1998)

Habitat Narrative

Adult: All areas where these three species are located are found within the subtropical dry forest life zone (Ewel and Whitmore 1973). Fire is common on many soils, and occurs frequently on lands where the plants are located. Soils have been described as Guayama cherty clay loam, 20 to 60 percent slopes, a soil series which covers most of the steep slopes of the Sierra Bermeja. This soil is from 14 to 30 centimeters deep to weathered siliceous rock and is acid in nature. In stony rock outcrop areas (approximately 15 percent of the mapping unit), from 50 to 75 percent of the surface is covered by rock outcrops and hard volcanic cobbles and stones. Eugenia woodburyana is found in the semi-evergreen forests of the bottoms of the more mesic canyons in the Guánica Commonwealth Forest. Silty alluvial soils, which retain a greater moisture content, are found among large limestone rock outcrops in these drainage (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Improving (USFWS, 2017).

Number of Populations:

3 (USFWS, 1994). As of 2019: 6 populations (USFWS, 2019).

Population Size:

~45 (USFWS, 1994). As of 2017, Eugenia woodburyana population is estimated at over 2,597 individuals. (USFWS, 2017). As of 2019: 3200 individuals (USFWS, 2019).

Population Narrative:

E. woodburyana is known only from approximately 45 individuals at three locations in southwestern Puerto Rico (USFWS, 1994). Since 1998, additional adult individuals of Eugenia woodburyana have been discovered within the Sierra Bermeja area (Laguna Cartagena National Wildlife Refuge - Tinaja Tract, Lozada Farm, Cerro El Conuco and Finca Maria Luisa, Almacigo Bajo - Municipality of Yauco, and Encarnacion Ward - Penuelas) and the Guanica Commonwealth Forest (GCF); and new species' localities have been found in the municipalities of Yauco, Peñuelas, and Salinas. The locality in Salinas expands the natural range of the species along the southern region of Puerto Rico. Additionally, the species has been successfully propagated under tree nursery conditions, producing over 714 individuals. A total of 333 of those individuals have been planted at nine sites in southwest Puerto Rico. At present, we estimate the Eugenia woodburyana population at over 2,597 individuals. (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: In the Sierra Bermeja, Eugenia woodburyana is found on both public (managed by the Fish and Wildlife Service) and privately owned land. The privately owned land is subject to intense pressure for agricultural, rural, and tourist development. The land is currently being cleared for grazing by cattle and goats. Adjacent land is being subdivided for sale in small farms, some destined for tourist and urban development. Both public and private lands in these hills are frequently affected by wildfires, which adversely affect seedling recruitment and habitat restoration efforts (USFWS, 1998). Additional related threats: human-caused fire, landslides, floods, erosion and sediment (USFWS, 2017). As of 2019: The species and their habitats continue to be affected by development of residential and tourist projects, unsustainable agricultural practices, and improvement of existing facilities (e.g., trails, access roads) for recreational uses. (USFWS, 2019).

Stressor: Limited distribution (USFWS, 1998)
Exposure:
Response:
Consequence:
Narrative: One of the most important factors affecting the continued survival of this species is its limited distribution. Because so few individuals are known to occur in a limited area, the risk of extinction is extremely high (USFWS, 1998).

Stressor: Climate change (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: An expected effect of climate change is the increase of hurricanes and tropical storms, followed by extended periods of drought (IPCC 2012). This climate change may alter (modify) the

microclimate and the surrounding vegetation around the populations of the E. woodburyana. Hurricane effects followed by extended periods of drought may result in change in soil conditions and microclimate and allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. Megathyrsus maximus) may spread and colonize the E. woodburyana habitat, and it could alter fire regimen, microclimate, and nutrient cycling of the habitat that the species depend. (USFWS, 2017).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. A management plan which considers the protection and recovery of the species has been prepared and implemented for the Guernica Commonwealth Forest and for the Cabo Rojo and Laguna Cartagena National Wildlife Refuges (USFWS, 1998).

2. Protection has been provided for those individuals known to occur on privately owned land (USFWS, 1998).

3. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within protected areas, such as other areas in the Guernica Commonwealth Forest (USFWS, 1998).

Amended delisting criterion 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and Factor E). (USFWS, 2019).

Amended delisting criterion 2: Existing natural populations of M maxwelliae (2 populations), M polycladus (6 populations) and E. woodburyan (6 populations) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Amended delisting criterion 3. Within the historic range, establish at least three (3) new populations of M maxwelliae and M. polycladus, and E. woodburyana on lands protected by a conservation mechanism that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1998).
- Protect the existing populations and their habitat through the development and implementation of a management plan for the Guánica Commonwealth Forest, the Cabo Rojo National Wildlife Refuge, and the Laguna Cartagena National Wildlife Refuge (USFWS, 1998).
- Protect populations on privately-owned land (USFWS, 1998).
- Monitor known populations (USFWS, 1998).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1998).

- Educate the public on conservation values and regulations (USFWS, 1998).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1998).
- 2017 action 1: Develop measurable and objective criteria for the delisting of the species based on the new information available for the species. (USFWS, 2017).
- 2017 action 2: Publish a propose rule to reclassify the species to threatened. (USFWS, 2017).
- 2017 action 3: Continue conducting comprehensive surveys on the species within traditional (e.g., Cerro Mariquita in Sierra Bermeja, GCF, Encarnación Ward in Peñuelas, Camp Santiago in Salinas and Almácigo Bajo in Yauco), and non-traditional sites (e.g., Sierra Bermeja mountain range and SCF) to determine relative abundance and distribution of the species in a wider range. (USFWS, 2017).
- 2017 action 4: Conduct surveys at Peñones de Melones to determine if the species is still present in that area. (USFWS, 2017).
- 2017 action 5: Promote Conservation Agreements with private landowners under the Service's Partners for Fish and Wildlife, and Coastal Programs to protect and enhance existing populations. (USFWS, 2017).
- 2017 action 6: Work closely with the PRDNER and landowners to ensure the protection of the species and its habitat in private lands. (USFWS, 2017).
- 2017 action 7: Continue with the propagation program to enhance the existing populations and establish new populations in protected areas in southwestern Puerto Rico. (USFWS, 2017).
- 2017 action 8: Continue implementing fire prevention practices in Sierra Bermeja, CRNWR and GCF during dry season. (USFWS, 2017).
- Conservation measures provided to federally listed species include recognition, recovery actions, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in conservation actions by Federal, State, and private groups and individuals. The Endangered Species Act provides for possible land acquisition in cooperation with the States and requires that recovery actions be carried out for all listed species. Section 7(a) of the Act, as amended, requires Federal agencies to evaluate their actions with respect to any species that is listed as federally endangered or threatened. If a Federal action may affect a listed species or its critical habitat, the responsible Federal agency must enter into formal consultation with the Fish and Wildlife Service (USFWS, 1998).
- Studies of the distribution, abundance, population size and structure, and reproductive biology of these three species are currently ongoing. Some preliminary results have been incorporated into this plan. - The Fish and Wildlife Service works closely with the Puerto Rico Department of Natural and Environmental Resources in their review of development projects in order to avoid adverse effects to the species. The Fish and Wildlife Service recently acquired 270 acres in the Sierra Bermeja, which were added to the Laguna Cartagena National Wildlife Refuge (USFWS, 1998).

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SPECIES ACCOUNT: *Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii* (Ewa Plains `akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1982; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Chamaesyce skottsbergii var. skottsbergii is a perennial, erect to prostrate shrub measuring 0.5 ft (0.2 m) to 3.3 ft (1 m) tall (occasionally reaching as tall as 6.6 ft or 2 m), with brittle, slender, usually jointed branches that are minutely hairy, especially when young. The opposite, two-ranked, oval leaves measure 0.5 to 0.8 in (12 to 20 mm long and 0.1 to 0.5 in (3 to 12 mm) wide, often have toothed margins, and have a hairless upper surface. Each cyathium (flower cluster resembling a single flower) is situated singly in a leaf axil and consists of a female flower made up of one pistil surrounded by several male flowers, each with a single stamen. The green capsules are 0.06 to 0.08 in (1.5 to 2 mm in length, have a curved stalk, and open to release gray to brown seeds measuring from 0.04 to 0.05 inches (1 to 1.3 mm) long. (USFWS, 2007)

Taxonomy

In a taxonomic revision of the native Hawaiian taxa of the genus Chamaesyce published in 1990 (Koutnik 1990) two varieties within the species Chamaesyce skottsbergii were recognized: var. skottsbergii and var. vaccinioides. Variety skottsbergii was considered to include Euphorbia skottsbergii var. kalaeloana along with populations of the species from northwestern Molokai. Variety vaccinioides included plants from central Molokai, Kahoolawe, and the southern side of East Maui. Currently, DNA sequence analysis indicates that Chamaesyce skottsbergii populations on Oahu and Molokai are genetically distinct, and the extent of this differentiation supports the recognition of these populations as distinct varieties. The Molokai population is more closely related to var. vaccinioides, and should be recognized by the previously used variety name, C. skottsbergii var. audens and the Oahu variety should be recognized as C. skottsberii var. kalaeloana (Morden and Gregoritza 2006). (USFWS, 2007)

Historical Range

Chamaesyce skottsbergii var. skottsbergii has historically been restricted to the arid coral plain of 'Ewa, O'ahu, and arid coastal sites on northwestern Moloka'i (HHP 1991a). (USFWS, 1994)

Current Range

Its current range includes Ewa plains, Oahu & west Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii (Ewa Plains `akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii (77 FR 57648-57862).

The critical habitat designation includes four critical habitat units, which encompass approximately 345 acres on the Island of Oahu, Hawaii.
The critical habitat designation for Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii includes four critical habitat units, covering one ecosystem type, which encompasses approximately 345 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2,3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 8, 9, 10, 11. Lowland Dry. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (E) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Euphorbia (=Chamaesyce) skottsbergii var. skottsbergii to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 1994)

Key Resources Needed for Breeding

Adult: Winter rains (USFWS, 1994)

Reproduction Narrative

Adult: Plant growth and flowering occur with the onset of the winter rains and continue through the wet season. The onset of the dry season causes a reduction in these activities, and the plants lose their leaves and become dormant during the peak of the summer drought. Although seed germination rates were found to be rather low (10 to 30 percent), the sheer abundance of seed produced often results in the appearance of many seedlings after the first heavy rains. Chamaesyce skottsbergii var. skottsbergii plants grow slowly and require insect pollinators for adequate fertilization. (USFWS, 1994)

Habitat Type

Adult: Marine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Near shore, forest- hardwood, forest/woodland, shrubland/chaparral, woodland-hardwood (NatureServe, 2015)

Habitat Narrative

Adult: Open or closed Prosopis forest on bare, corraline soils (Oahu). Open, mixed shrubs on lithified dunes or raised reef (Molokai). The habitat occupied by Chamaesyce skottsbergii var. skottsbergii consists of limestone topography characterized by sinkholes and coralline rubble. The population at Mo'omomi is found on lithified and raised limestone and populations along the western coast of Moloka'i occur on basaltic substrata. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds, distributed by explosive discharge from their capsules, have no germination inhibitors in their seed coats and are not dependent on exposure to sunlight for germination (AECOS 1981). (USFWS, 1994)

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

9 occurrences (NatureServe, 2015)

Population Size:

<200 wild. 233 surviving outplanted individuals (USFWS, 2019)

Population Narrative:

As of 2006, the Navy has outplanted and augmented the C. skottsbergii var. kalaeloana populations, which currently total 1,345 natural and outplanted adult individuals. There are a total of 9 extant and 5 historical occurrences. (USFWS, 2007; NatureServe, 2015) Currently there are fewer than 200 wild individuals of Euphorbia skottsbergii var. skottsbergii in the lowland area of the Waiʻanae mountains. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that E. skottsbergii is highly vulnerable to the effects of climate change. The USFWS is working to create a stable reintroduced population of this species within the Kalaeloa Unit of the Pearl Harbor NWR, and almost 1,000 individuals have been outplanted at that site since 2016, with 233 currently surviving. (USFWS, 2019)

Threats and Stressors

Stressor: Loss of habitat (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Direct human-induced loss of habitat is considered the major cause of the decline of Chamaesyce skottsbergii var. skottsbergii and Achyranthes splendens var. rotundata on the 'Ewa Plain of O'ahu. The history of direct, human-induced disturbance in this area dates back at least 500 years to the first use of sinkholes for cultivation by native Hawaiians. More intensive disturbances have occurred since the 19th century, when diversified agriculture became widespread throughout the Plain. More recently, urbanization and the establishment of a rock quarry, military bases, Campbell Industrial Park, and the deep draft harbor have contributed to the virtual extinction of the original ecosystem. Today, approximately 90 percent of the Plain is occupied by residential developments, sugar cane fields, an industrial complex, a deep-draft harbor, military installations and recreational areas. As the need for urban and industrial sites on O'ahu increases, the demand for land in the 'Ewa Plain will also increase. Thus, the continued loss of habitat, albeit completely modified, must still be considered the major threat to both taxa. (USFWS, 1994)

Stressor: Encroachment by alien plant species (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: In addition to the physical loss of habitat, all populations of Chamaesyce skottsbergii var. skottsbergii and Achyranthes splendens var. rotundata have been adversely affected by habitat degradation caused by invading alien shrubs and trees. Today, intact native plant communities are non-existent in the 'Ewa Plain; only remnant individuals remain. Aggressive species such as kiawe, Pluchea, Australian saltbush, asystasia and various grasses have altered the natural habitat and are competing with both endangered taxa for space, light, water, and nutrients. Particularly detrimental alien species are: kiawe, which often forms closed-canopied forests; Pluchea x fosbergii, which is extremely aggressive; and grasses and Asvstasia which can

prevent seedling establishment. On Moloka'i, invasion by aggressive weeds is listed by The Nature Conservancy (1991) as a threat to all rare plants on the Hawaiian Home Lands' Ho'olehua parcel (Population 5), and weed control, specifically kiawe removal, is a part of The Nature Conservancy's management program on the Mo'omomi Preserve on Moloka'i (Populations 6 and 7) (TNCH, 1993). Similar encroachment of alien plants occurs in the Ka'ena Point area. (USFWS, 1994)

Stressor: Parasitism by Cassytha filiformis (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The parasitic native vine, kauna'oa pehu (Cassvtha filiforrnis) has been noted as a possible threat to both taxa in the Barber's Point area (AECOS 1981; Nagata 1981). This vine is locally common at Barbers Point where it enshrouds shrubs and smaller trees. Heavy infestations weaken the host plants, leaving them vulnerable to disease-causing organisms and insect predation. (USFWS, 1994)

Stressor: Fire (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Fire must be considered a potential threat for all populations because of the highly localized distribution of both taxa. During long, annual drought periods, vegetation becomes exceptionally dry, particularly in the 'Ewa Plain and in western Moloka'i, and the accumulated litter during these months represents potential fuel for brush fires. In the 'Ewa Plain, residential and industrial development represents an increased threat of fire, although there tends to be a concomitant rise in awareness of such a threat and contingencies for fire are considered in urban planning. (USFWS, 1994)

Stressor: Insect predation (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Potentially damaging insects have been reported on both Charnaesyce skottsbergii var. skottsbergii and Achyranthes solendens var. rotundata. An unidentified borer the croton moth caterpillar (Aechaea ianata), and spiralling white fly (Aleurodicus disoersus) have been noted on Chamaesyce skottsbergii var. skottsbergii (AECOS 1981). The croton moth caterpillar is known to denude Chamaesyce skottsbergii var. skottsbergii of leaves and flowers (AECOS 1981). A severe infestation of white fly is usually debilitating to its host plants (Borrer, et al. 1981). A lack of seed set has been noted on heavily infested plants since the spiralling white fly has become established at Barbers Point (C. Corn, personal communication 1994). An unidentified scale has been noted on Achyranthes splendens var. rotundata and an unidentified mite seems to be an occasional pest on cultivated specimens (Nagata, unpublished data). Nematodes (Meloidogyne spp., Pratylenchus spp. Rotylenchulus reniformis) are also known to infest cultivated Achyranthes sulendens var. rotundata (Mew 1987). (USFWS, 1994)

Stressor: Destruction by cattle and feral animals (USFWS, 1994)
Exposure:

Response:
Consequence:
Narrative: Threats on western Moloka'i include destruction of native ecosystems by feral animals and cattle (TNCH, 1991; Nagata, unpublished data). Ungulates at the Mo'omomi Preserve are actively controlled, although they remain a threat. At Ka'ena Point, ungulates are not a threat at present, but do represent a potential threat as the range of goats in neighboring areas continues to expand. (USFWS, 1994)

Stressor: Trampling by humans (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Chamaesyce skottsbergii var. skottsbergii is a low, rather inconspicuous shrub with brittle stems. It is especially difficult to discern during the dry season when it is dormant and leafless. Plants have been damaged by persons intruding into some of the populations (AECOS 1981). (USFWS, 1994)

Stressor: Runway disaster (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Populations of Achyranthes splendens var. rotundata and Chamaesyce skottsbergii var. skottsbergii occur on either end of one of the runways at NAS Barbers Point. While this location may, in some ways, have protected them by precluding development in these areas, it also leaves them vulnerable to devastation in the case of a runway disaster resulting in fire, a chemical spill or physical destruction of the population. (USFWS, 1994)

Stressor: Natural disasters (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The 'Ewa Plain is one of very low relief and inundation by tsunamis is thus a threat. Unusually high tides were recorded at Barbers Point during the tsunamis of 1946 and 1960. Although no damage was reported (Pararas-Carayannis 1977), no structures were located near the coast at that time. (USFWS, 1994)

Stressor: Contamination by ambient pollution or chemical spill (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Potential chemical spill or contamination of the soil due to ambient pollution are threats to nearly all populations in the Barbers Paine area due to heavy industrial and military activities, and there is a further potential for spread of contamination within the tsunami zone. (USFWS, 1994)

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:

Consequence:
Narrative: Habitat degradation and competition from invasive nonnative plant species are a significant threat to Chamaesyce skottsbergii var. kalaeloana. The primary nonnative plant species impacting C. skottsbergii var. kalaeloana include Prosopis pallida (kiawe), which often forms closed-canopied forests; Pluchea xfosbergii (marsh fleabane), Asystasia gangetica (Chinese violet), Cenchrus ciliaris (bUffel grass), and Leucana leucocephala (koahaole) (AECOS 1981). Another fast-growing native vine, Sicyos pachycarpus (kupala), can sometimes overgrow C. skottsbergii var. kalaeloana, but these plants are removed when they appear to pose a threat (Guinther 2006). (USFWS, 2007)

Recovery

Reclassification Criteria:
1. There must be at least three self-reproducing populations with a minimum of 1,000 reproductive plants per population in each of the two geographically distinct regions in which they occur. (USFWS, 1994)

2. Populations should be growing beyond or stable at the minimum size and threats should be removed or controlled for at least ten years prior to downlisting. (USFWS, 1994)

3. Land area for each of these populations should be sufficient to provide a buffer of 30-50 meters around the expanded population. (USFWS, 1994)

4. The population containing 30,000 Chamaesyce skottsbergii var. skottsbergii plants on Moloka'i should be maintained at this number. (USFWS, 1994)

Delisting Criteria:
1. All criteria for downlisting should be met. (USFWS, 1994)

2. At least three populations with a minimum of 1,000 reproductive plants each should be re-established within the taxon's historical range on the island(s) of Lana'i and/or Moloka'i to ensure against losses due to a catastrophic event affecting the island of O'ahu. (USFWS, 1994)

3. All populations should be stable and self-sustaining, with no human manipulation, for a minimum of ten years prior to delisting and expected to remain so into the foreseeable future. (USFWS, 1994)

Recovery Actions:
- Protect and manage existing populations. (USFWS, 1994)
- Augment or re-establish populations, if necessary. (USFWS, 1994)
- Validate recovery objectives. (USFWS, 1994)
- Ensure long-term monitoring of in situ and outplanted subpopulations of Oahu Chamaesyce skottsbergii var. kalaeloana. (USFWS, 2007)
- Determine whether any plants or propagules remain of the subpopulations of Chamaesyce skottsbergii var. kalaeloana from the Kalaeloa Barbers Point Harbor and West Beach Resort areas. This plant material may be in situ, at outplanting sites, or in nurseries or botanic gardens. Conduct genetic studies on any remaining plant material in order to assess its genetic value with respect to the conservation of C. skottsbergii var. kalaeloana. (USFWS,

2007)
- Study Oahu C. skottsbergii var. kalaeloana subpopulations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2007)
- Increase the number of suitable and available outplanting sites for C. skottsbergii var. kalaeloana. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information other than new data on this taxon's vulnerability to climate change and the potential impacts of the introduced Nysius seed bug. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2019. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with Euphorbia skottsbergii var. skottsbergii at all populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Invertebrate predation and herbivory—Research effects of nonnative insects including the small seed bug, Nysius palor, the croton caterpillar or castor semilooper, Aechaea janata, and the spiraling white-fly, Aleurodicus dispersus), and possible effective control methods. • Captive propagation for genetic storage and reintroduction— o Continue to monitor in situ and reintroduced individuals. o Determine if any wild plants remain at the West Beach Resort areas. o Continue to collect seeds for future propagation and reintroduction efforts. • Reintroduction and translocation—Continue to augment and establish new populations within historical habitat to increase numbers of individuals and populations. • Genetic studies—Continue to conduct genetic studies to assess best management practices for wild and reintroduced populations. • Alliance and partnership development—Continue to work with the U.S. Navy and other land managers to contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)
- New Management Actions: • In 2009, the U.S. Navy and the USFWS initiated consultation under section 7 of the Endangered Species Act for the disposal and reuse of Lot 13058-D at the former Naval Air Station Barbers Point, Oahu, Hawaii (U.S. Navy 2009, in litt.). This consultation indicated the proposed actions and area for redevelopment, including possible impacts to the wild ‘akoko. The USFWS continues to work with the U.S. Navy to protect the existing plants and augment and maintain the population. • In 2016, Cooperative Recovery Initiative funding was awarded to a project for protection and reintroduction of populations of two endangered plants at the Kalaeloa Unit of the Pearl Harbor National Wildlife Refuge (Honolulu, Hawai‘i), Achyranthes splendens var. rotundata (‘Ewa hinahina) and Euphorbia skottsbergii var. skottsbergii (‘akoko) (USFWS 2016, in litt.). Goals of this project are to eliminate invasive nonnative plants that degrade the habitat and outcompete ‘akoko, and to collect seeds, propagate, and outplant enough individuals so that there are 1,000 mature, reproducing plants. In addition, other more common native plants are to be outplanted and established to improve habitat conditions. By 2018, 928 ‘akoko individuals were outplanted, nonnative plants are removed and the area is monitored (USFWS 2018, in litt.). Currently there are 233 plants surviving (USFWS 2019, in litt.). • Lyon Arboretum Seed Conservation Laboratory reports over 39,000 seeds collected from five individuals since 2006. Over 8,000 were withdrawn from collection for testing or propagation, leaving approximately 30,000 seeds in storage (Lyon Arboretum 2018). • The Pahole Rare Plant Facility (PRPF) reports two plants propagated and in storage from seeds pooled from a collection at Kalaeloa (PRPF 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Euphorbia haeleeleana* (`Akoko)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree 3 - 14 m tall with thick succulent branches. In drier regions the trees are summer deciduous, with the leaves turning orange-yellow and then dropping before the height of the summer. Fruits large and yellow (NatureServe, 2015).

Taxonomy

A member of the spurge family (Euphorbiaceae) (USFWS, 2016).

Historical Range

See current range/distribution

Current Range

Euphorbia haeleeleana is known historically and currently from 15 populations (between 450 and 625 individuals) from northwestern Kauai and the Waianae Mountains of Oahu (Service 1995a, 1995b, 1999a) (USFWS, 2016). Island Distribution: Found on Kauai and Oahu. (USFWS, 2021c)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Euphorbia haeleeleana (`Akoko) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Euphorbia haeleeleana (77 FR 57648-57862). The critical habitat designation includes 9 critical habitat units, which encompass approximately 6,359 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Euphorbia haeleeleana includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Euphorbia haeleeleana (`Akoko) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat desisgnation for Euphorbia haeleeleana includes 9 critical habitat units, covering two ecosystem types, which encompass approximately 6,359 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu— Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

The critical habitat designation for Euphorbia haeleeleana includes three CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—Euphorbia haeleeleana—a: This unit is critical habitat for Euphorbia haeleeleana and is 262 ha (649 ac) on State land (Kuia NAR). This unit contains portions of Milolii Ridge and Mahanaloa Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Euphorbia haeleeleana and is currently occupied with between 355 and 405 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland mixed mesic or dry Diospyros forest that is often co-dominated by Metrosideros polymorpha and Alphitonia ponderosa. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—Euphorbia haeleeleana—b: This unit is critical habitat for Euphorbia haeleeleana and is 193 ha (476 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Euphorbia haeleeleana and is currently occupied with over 120 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes

habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland mixed mesic or dry Diospyros forest that is often codominated by Metrosideros polymorpha and Alphitonia ponderosa. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—Euphorbia haeleeleana—c: This unit is critical habitat for Euphorbia haeleeleana and is 204 ha (505 ac) on State land, containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Euphorbia haeleeleana and is currently occupied with two plants. This unit is important to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland mixed mesic or dry Diospyros forest that is often co-dominated by Metrosideros polymorpha and Alphitonia ponderosa. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Euphorbia haeleeleana critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Euphorbia haeleeleana occurs within the Lowland dry and Lowland mesic ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (E) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu— Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Euphorbia haeleeleana critical habitat consists of two components (68 FR 9116-9479):

(i) Lowland mixed mesic or dry Diospyros forest that is often codominated by Metrosideros polymorpha and Alphitonia ponderosa and containing one or more of the following native plant species: Acacia koaia, Antidesma platyphyllum, Carex meyenii, Carex wahuensis, Claoxylon sandwicense, Diplazium sandwichianum, Dodonaea viscosa, Erythrina sandwicensis, Kokia kauaiensis, Pisonia sandwicensis, Pleomele aurea, Pouteria sandwicensis, Psychotria greenwelliae, Psychotria mariniana, Pteralyxia kauaiensis, Rauvolfia sandwicensis, Sapindus oahuensis, Tetraplasandra kavaiensis, or Xylosma spp.; and

(ii) Elevations between 284 and 1,179 m (931 and 3,866 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Euphorbia haeleeleana to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016)

Lifespan

Adult: < 10 years (USFWS, 2010)

Breeding Season

Adult: August - October (USFWS, 2016)

Reproduction Narrative

Adult: Individual trees of Euphorbia haeleeleana bare only male or female flowers, and must be cross-pollinated from a different tree to produce viable seed (Wagner et al 1990). This species sets fruit between August and October (USFWS, 2016). Euphorbia haeleeleana is a short-lived perennial (< 10 years) (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry and moist forests (NatureServe, 2015); lowland mixed mesic or dry forest (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at 680 - 2,860 ft. elevation (USFWS, 2016)

Habitat Narrative

Adult: Inhabits dry and moist forests on steep rocky gulch slopes (NatureServe, 2015). Euphorbia haeleeleana is usually found in lowland mixed mesic or dry forest that is often dominated by ohia, ohia and koa, lama, or kukui. The plant is typically found at elevations between 205 and 670 m (680 and 2,200 ft), but a few populations have been found up to 870 m (2,860 ft) (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

15 (USFWS, 2016)

Population Size:

252-404 wild individuals (143-295 on Kauai; 109 on Oahu; USFWS, 2017). ~14 (USFWS, 2021c)

Minimum Viable Population Size:

25 mature, reproducing individuals (USFWS, 2016). ~400 (USFWS, 2021c)

Population Narrative:

On Kauai, 11 populations of approximately 360 to 510 individuals are known from valley slopes and cliffs along Kauai's northwestern coast from Pohakuao to Haeleele Valley and Hipalau Valley within Waimea Canyon. All of the Kauai populations occur on State land, including Kauia Natural Area Reserve and the Na Pali Coast State Park (Service 1995b; S. Perlman, pers. comm. 1996). On Oahu, two populations of approximately 90 to 115 individuals are known from the northern Waianae Mountains. One population of 79 individuals occurs at Keawaula in Makua,

and one population occurs on privately owned land (B. Totten, pers. comm. 1998; Service 1995a). There are five population of E. haeleeleana with more than 25 mature, reproducing individuals (the minimum number suggested in the recovery plan for this species (Service 1999a) (USFWS, 2016). There were 445 wild individuals in 2008 (USFWS, 2010).; In the previous review, there were estimated to be six occurrences on Oahu with as many as 115 individuals. On Oahu, the most current population estimates are from the Oahu Army Natural Resources Program in 2010. In these surveys there are four wild and two reintroduced occurrences totaling about 260 wild individuals and 34 reintroduced individuals (U.S. Army 2016). On Kauai, Euphorbia haeleeleana is known from eight locations, totaling approximately 350 individuals (Wood and Ching Harbin 2017, in litt.). (USFWS, 2017)

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Threats to this species on Kauai and Oahu include habitat disturbance and predation by pigs (Sus scrofa) and goats (Capra hircus), and on Kauai, mule deer (Odocoileus hemionus). More than half of the critical habitat in Puulu to Alaiheihe is on private land currently used to raise cattle (Bos taurus) and goats (USFWS, 2010).

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Rats eat the seeds of this tree (Hawaii Biodiversity and Mapping Program 2008; Perlman 2008). Browsing by ungulates has been observed (USFWS 2008). Unknown species of leaf hoppers were noted as a threat to individuals on Oahu and Kauai (National Tropical Botanical Garden 2008a). The individuals in Hanakapiai were observed to have signs of goat damage to the bark (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Invasive introduced plant species alter the mesic habitats for Euphorbia haeleeleana and compete with it for resources. Some of these invasive species on Kauai include Lantana camara (lantana), Adiantum hispidulum (rough maidenhair fern), Ageratum conyzoides (billy goat weed), Aleurites moluccana (candlenut), Andropogon glomeratus (beardgrass), Axonopus fissifolius (narrow-leaved carpetgrass), Bryophyllum pinnatum (airplant), Grevillea robusta (silk oak), Hedychium gardnerianum (kahili ginger), Passiflora ligularis (sweet granadilla), Pinus elliottii (slash pine), Psidium cattleianum (strawberry guava), Rubus argutus (blackberry), R. rosifolius (thimbleberry), and Setaria parviflora (yellow foxtail) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008b; Perlman 2008; Tangalin 2008). In drier Hipalau population, the primary invasive introduced plant threats are Melia azedarach (pride-of-India), Grevillea robusta, and Lantana camara (National Tropical Botanical Garden 2008b; Perlman 2008). Invasive introduced plants are also a threat to Euphorbia haeleeleana on Oahu. Some of

the invasive species there include Caesalpinia decapetala (wait-a-bit), Coffea arabica (Arabian coffee), Digitaria insularis (sourgrass), Grevillea robusta, Hyptis pectinata (comb hyptis), Lantana camara, Leucaena leucocephala (haole koa), Psidium cattleianum, Panicum maximum (guinea grass), Passiflora suberosa (corky passionflower, huehue haole), Rivina humilis (coral berry), Schinus terebinthifolius (Christmas berry), and Toona ciliata (Australian red cedar) (Hawaii Biodiversity and Mapping Program 2008; Institute of Pacific Islands Forestry 2008; Perlman 2008) (USFWS, 2010).

Stressor: Fire (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Fire is a concern on both islands, but on Oahu the concern is increased by a history of fires in designated critical habitat areas managed by the Army. Threats to Euphorbia haeleeleana critical habitat in the military training action areas include fires ignited by the public and military training, and invasion by introduced plant species, some of which, like Panicum maximum, are particularly flammable. Up to half of critical habitat in Kaluakauila was burned in 1970, 1984, 1995, and 2003 fires (USFWS, 2010).

Stressor: Climate change (USFWS, 2010; USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Euphorbia haeleeleana is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.661 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2017)

Stressor: Hurricanes—Loss and degradation of habitat (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Hurricanes were accidentally not highlighted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are endemic to the island. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and

Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013). (USFWS, 2017)

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perenials (USFWS, 1999).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on islands where they now occur or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perenials (USFWS, 1999).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1999).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against wild and feral ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Reduce threat from rats (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).
- Surveys and inventories—Survey for populations of Euphorbia haeleeleana in areas of potentially suitable habitat. (USFWS, 2017)
- Ungulate monitoring and control—Continue to construct and maintain fenced exclosures around all populations. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017)

- Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species around all populations. Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017)
- Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. (USFWS, 2017)
- Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017)
- Predator and herbivore monitoring and control—Implement effective control methods for rodents around all known populations. Study Euphorbia haeleeleana populations to determine the level of threat from invertebrate herbivory and the need for additional recovery actions. (USFWS, 2017)
- Fire monitoring and control—Develop and implement fire management plans for all occurrences in fire-prone areas. (USFWS, 2017)
- Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides. (USFWS, 2017)
- Population biology research—Research reproductive biology of Euphorbia haeleeleana to enhance seed production and possible propagation and augmentation of wild populations. (USFWS, 2017)
- about 200 individuals (30 percent of all remaining individuals) of this species occur in the Kaluakauila Management Unit where they will benefit from population unit and/or ecosystem-level protection. The Nature Conservancy of Hawaii's long-range management plan for Honouliuli Preserve includes management actions to control non-native plants, feral ungulates, and fire, and to recover rare species and restore native habitats; this plan will benefit any E. haeleeleana within the preserve. This species is represented in ex situ collections that include 13 embryos in micropropagation (Harold L. Lyon Arboretum), five plants in a nursery (Harold L. Lyon Arboretum), 10 plants in a botanical garden (Waimea Valley Audubon Center), and 17 ungerminated seeds in a nursery (Harold L. Lyon Arboretum) (Service 2005b, U.S. Army Garrison 2005d) (USFWS, 2016).
- Fence to exclude feral ungulates (USFWS, 2010).
- Develop and implement fire management plans for fire-prone populations (USFWS, 2010).
- Control introduced invasive plants (USFWS, 2010).
- Develop and implement rodent control to reduce seed predation (USFWS, 2010).
- Propagate both common and endangered native species for restoration of habitat in the Army managed areas of Euphorbia haeleeleana on Oahu (USFWS, 2010).
- Research reproductive biology of Euphorbia haeleeleana to enhance seed production and possible propagation and augmentation of wild populations (USFWS, 2010).
- Continue to work with U.S. Army, Hawaii Division of Forestry and Wildlife, and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021. • Surveys and inventories—Continue to survey geographical and historical range for a current assessment of the species' status. • Ungulate monitoring and control—Continue to construct ungulate exclosures or

strategic fencing where possible to protect all occurrences from browsing and disturbance by feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species at all occurrences. • Fire monitoring and control—Continue to implement fire management plans for Oʻahu and develop and implement fire management plans for occurrences on Kauaʻi. • Predator and herbivore monitoring and control— o Continue to implement effective rat control methods at populations to improve viable seed production. o Study effects of invertebrate herbivory and determine the need for implementation of effect controls. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction. • Reintroduction and translocation— o Continue reintroduction into suitable habitat within historical range in areas that are managed for known threats. o Increase numbers of populations and individuals to increase resiliency of populations and species' redundancy and reduce impacts from landslides, flooding, fire and hurricanes. • Population biology research—Research reproductive biology of E. haeleeleana to enhance seed production and viability. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon.

- New Management Actions: • Surveys and inventories— o PEPP continues to survey and monitor populations at Poʻopoʻoiki, Paʻaiki, and Mākaha (Kauaʻi) and at Kaluakauila and Kapuna (Oʻahu) (PEPP 2016, 2017, 2019). o ANRP monitors the population at Keawaʻula (ANRP 2019, appendices). • Rat control—PEPP installed and maintains rat traps at Kaluakauila. This management implementation allowed successful fruit collection from plants in the area for the first time in several seasons (PEPP 2019). • Collection and propagation— o Lyon Arboretum Seed Conservation Laboratory reported collection and storage of 504 seeds representing 19 founders from Kaluakauila, Oʻahu (Lyon Arboretum 2020). o Three plant nurseries for the State's Native Ecosystems Protection and Management (NEPM) program reported propagation of 101 plants representing nine founders from Kaluakauila, Oʻahu (NEPM Nursery 2020). In addition, 13 plants were propagated representing one founder from Keaʻau (Oʻahu). o The Pahole Rare Plant Facility (PRPF) stores five plants representing one founder from Kaluakauila (Oʻahu) (PRPF 2019). o The Waimea Arboretum reported propagation and storage of 12 plants representing two founders from Oʻahu, currently six plants remain in the collection (Waimea Arboretum 2013, 2014, 2015, 2017, 2018). o PEPP reported collection of seeds from Poʻopoʻoiki (Kauaʻi) in 2016, from Mākaha (Kauaʻi) in 2017, and from Kaluakauila (Oʻahu) in 2019 (163 seeds sent to Lyon Arboretum) (PEPP 2016, 2017, 2019). o The National Tropical Botanical Garden (NTBG) reported storage of 20 seeds and propagation of 20 plants representing one founder from Mahanaloa (Kauaʻi). In 2018, NTBG planted two individuals as a living collection in their Limahuli Garden and one plant in their Southshore Garden representing three founders from Mahanaloa, Kauaʻi (NTBG 2020). • Reintroduction— o The Kōkeʻe Rare Plant Facility reported reintroduction of 26 individuals representing three founders into a management unit at Kuʻia Natural Area Reserve, Kauaʻi (Kōkeʻe 2020). o In 2016, PEPP reported a successful reintroduction site at Paʻaiki (a subpopulation of Miloliʻi, Kauaʻi) (PEPP 2017). In 2019, PEPP reported establishment of a living collection of 17 plants at Koko Crater Botanical Garden (Oʻahu), and reintroduction of three plants to Kapuna (Oʻahu) (grown at PRPF) (PEPP 2019). (USFWS, 2021b)

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SPECIES ACCOUNT: *Euphorbia telephioides* (Telephus spurge)

Species Taxonomic and Listing Information

Listing Status: Threatened; 6/8/1992; Southeast Region (R4) (USFWS, 2015)

Physical Description

Euphorbia telephicides is a perennial herb with a stout storage root. Stems are numerous, giving the plant a bushy appearance, and are up to 30 cm (1 ft)2 tall. Stems and leaves are smooth and have latex (milky sap). The largest leaves are 3-6 cm (1-2 in) long, elliptic or oblanceolate, with the midrib and margins usually maroon. The inflorescence is a cyathium (a structure resembling a flower, containing a single stalked female flower and several male flowers, each reduced to a single stamen). flowering is from April through July (Kral 1983). Clewell (1985) and Kral (1983) provide guidance for distinguishing this species from the most similar species, Euphorbia inundata, a taller plant of moister habitats. (USFWS, 1994)

Taxonomy

Euphorbia telephioides is a member of the spurge family (Euphorbiaceae). It was named by Alvin Wentworth Chapman (1860), who provided no explanation for his choice of name, but rather clearly intended to indicate a resemblance to another plant, most likely the garden plant Sedum telephium (orpine, live-forever, or stonecrop) or the similar North American Sedum telephioides. Small (1933) preferred to split the huge genus Euphorbia into smaller genera, renaming this species Galarhoeus telephioides. Taxonomists since then have left the genus Euphorbia intact. Webster (1967) established a new subsection of the genus Euphorbia, Inundatae, that includes Euphorbia telephioides and two other species native to the Florida panhandle: Euphorbia floridana and E. inundata (USFWS, 1994).

Historical Range

Endemic to the Florida panhandle and restricted to Bay, Gulf, and Franklin counties. It is unknown whether E. telephioides was once continuously distributed throughout the three counties or populations were restricted to local habitat patches (USFWS, 2015).

Current Range

Currently known from Bay, Gulf, and Franklin counties from Panama City Beach to east of Apalachicola (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Breeding Season

Adult: April - July (USFWS, 1994)

Reproduction Narrative

Adult: Several staminate flowers surrounding a pistillate flower in a cyathium (Gleason, 1952). The species is monoecious and reproduction is sexual (NatureServe, 2015). Flowering is from April through July (Kral 1983) (USFWS, 1994).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); wetland (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Longleaf pine-slash pine savanna/flatwoods (NatureServe, 2015); coastal pinelands (USFWS, 1994)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Excessive shade, development (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Wiregrass dominated, longleaf pine-slash pine savanna/flatwoods or on contiguous low, sandy rises dominated by pine-scrub oak near the coast. Cannot tolerate shade, needs fire to maintain community structure; can survive initial conversion of flatwoods to pine plantation. Separation barriers are created by clearing and development of habitat; fire-suppressed scrub and flatwoods (NatureServe, 2015). Although uncommon, telephus spurge was observed growing in wetlands with seepage slope species and in small thick clumps of wire grass surrounded by pine or cypress (Rountree et al. 2005). In general, the plants do well on sandy, acidic soil, with no litter, and low organic and moisture content (Peterson & Campbell 2007) (USFWS, 2015). Inhabits poorly-drained coastal pinelands (USFWS, 1994).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Seeds are not dispersed over large distances (Negrón-Ortiz, 2014, pers. observ.) (USFWS, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2015)

Number of Populations:
42 (USFWS, 2021)

Population Size:
>20,000 individuals

Population Narrative:
The species status is stable; seven populations are properly protected; three new occurrences were documented; recent surveys conducted on several sites found the species in excellent condition. The number of populations has increased to 41 sites based on recent survey work (FNAI 2007; 2013 -2014 FWS surveys; consultation surveys). Trapnell et al. (2012) found species-wide genetic diversity was high, ranking E. telephioides among the highest 10% of plant species surveyed. However, genetic differentiation among populations is lower than that observed for other herbaceous outcrossing perennial plant species (USFWS, 2015).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Urban development continues to threaten telephus spurge since most E. telephioides documented locations are found in private land. 380,000 acres of land will maintain timber and agriculture uses, included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Many E. telephioides' locations are found along US 98, and powerline ROW maintenance (removal of existing and installation of new transmission poles), road widening and new roads continue to negatively affect plant abundance and habitat loss. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million. Suppression of fire during the dormant season continues to threaten the pineland and savanna's flora as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity (USFWS, 2015).

Stressor: Sea level rise (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter (m) above current sea level. Wolf and Lopez (2014) estimated the potential for inundation of habitat areas for the Telephus spurge at sea level rise projections from 0.305 to 1.83 m (one to six feet) within this century. The projections indicated that coastal habitat areas in Escambia, Bay, Franklin, and Gulf Counties would be largely inundated beginning at 0.305 m (one foot) of SLR. Therefore, SLR projections of changes, under above all scenarios, will most likely

affect several coastal populations specifically those located in Gulf and Franklin counties. Euphorbia telephioides is at risk of further decline from SLR because its seeds are not dispersed over large distances (Negrón-Ortiz, 2014, pers. observ.), so sea level may rise more quickly than the species can establish populations further inland. In addition, E. telephioides does not respond well to transplantation (Ecological Resource Consultants 2006; Negrón-Ortiz, 2010, pers. observ.). Another major concern is that as more coastline is inundated with water, urban development will expand, decreasing the amount of suitable habitat for E. telephioides and impeding the ability of these species to move landward (USFWS, 2015).

Recovery

Reclassification Criteria:
Not defined (USFWS, 1994; USFWS, 2015)

Delisting Criteria:
1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery (USFWS, 1994; USFWS, 2015).

Recovery Actions:

- Protect populations in Apalachicola National Forest and on other public lands. This includes Management/general monitoring in Apalachicola National Forest, Conduct of population biology studies, and Conduct of botanical inventories on public land, possible purchase areas, and selected private land. (USFWS, 2015)
- Manage rights-of-way. Highway and utility rights-of-way (mostly electric powerlines along highways) harbor populations of all four plant species. Experience with managing Harperocallis flava (Harper's beauty), an endangered plant, on a highway right-of-way in Apalachicola National Forest may suggest approaches for conserving these species. (USFWS, 2015)
- Protect and manage populations outside Apalachicola National Forest through purchase, conservation easements, or other means; develop conservation plans for these sites (USFWS, 2015).
- Conduct systematic and other studies; arrange reintroduction where appropriate and feasible (USFWS, 1994).
- Garden propagation and reintroduction. Reintroduction of Euphorbia telephioides depends on suitable, protected habitat being available and methods being developed. It is not yet clear whether it would be useful to maintain garden populations of this species. (USFWS, 2015)
- Establish monitoring program: i. Identify additional populations of conservation importance based on information from the genetic studies (ongoing). ii. Conduct a demographic population viability analysis to assess whether the species is declining, increasing, or stable, and where in the life cycle the management should be targeted. This is an ongoing action conducted by Ms. Natali Miller, a graduate student from FL State University (USFWS, 2015).
- Collect voucher specimens (e.g., herbarium specimens, samples for DNA analyses, preserve material, seeds and whole plants) from areas proposed to be developed and 1) transplant to suitable sites, and 2) distribute to herbaria, botanical gardens, and interested scientists (USFWS, 2015).

- Expand germination studies. i. Determine seasonal fluctuations that influence germination timing and recruitment and identify traits that correlate with seed viability and dormancy ii. Conduct ex situ germination studies and clarify limits of seed desiccation and cold tolerance (USFWS, 2015).
- Develop a Species Distribution Model (SDM) to assist with locating new populations and identifying prospective sites for reintroductions such as areas that will not be affected by SLR and future development. Sites should be validated or inspected for plants, and then protected by land acquisitions, conservation easements. This is an ongoing action conducted by Ms. Alexa Mainella, a graduate student from Miami University, OH (USFWS, 2015).
- Phenological data (timing, duration and abundance of recurrent biological processes, including reproductive events such as flowering, fruiting, seed dispersal and germination) have emerged as useful tools for studying the impact of climate change on plants. Lacking phenological adaptability may require a stronger signal or may be unable to adapt to climate warming, and therefore may experience greater stress or even extinction during extended climate change. Therefore, phenological studies should include both long-term observations coupled with herbarium specimens' records (USFWS, 2015).
- Since E. telephioides occurs in fire prone habitats, the effect of this disturbance on survival and fecundity should be monitored to determine the best frequent fire regimes, on selected areas to maintain optimal conditions of E. telephioides populations (USFWS, 2015).
- Continue fostering a working partnership with the St. Joe Company, AgReserves, Inc. and other developing companies and consulting agencies, such as Flatwoods Consulting Group to address and minimize potential impacts associated with development and fire suppression (USFWS, 2015).
- Outreach: Promote the implementation of the recovery actions via academia, private landowners, and public agencies. Develop and distribute information to the general public (USFWS, 2015).
- The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Establish monitoring program i. Conduct a demographic population viability analysis to assess whether the targeted populations are projected to decline, increase, or remain stable, and where in the life cycle the management should be targeted. This is an ongoing action conducted by Ms. Natali Ramirez-Bullon, a graduate student from FL State University. Projected completion late 2021. She constructed and analyzed stage-structured stochastic demographic models for three E. telephioides populations to answer the projected growth rate of each population, and whether incorporation of a larger sample alters the projected growth rate. Overall, the models suggested a decline over the next 100 years. ii. Identify additional populations of conservation importance based on information from the genetic studies (ongoing). a. Collect seeds targeting all E. telephioides sexual morphs for ex-situ seed conservation -ongoing and conducted by the ABG b. Establish permanent plots on at least three additional protected locations throughout the species' historical range. For each plot: a. Estimate the sex ratio, density, and abundance of individuals. b. If possible, investigate basic ecological questions (e.g., pollinators; flowering period; annual variability in flowering; seed production and seedling survival). c. Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure. 2. Collect voucher specimens (e.g., herbarium specimens, samples for DNA analyses, preserve material, seeds and whole plants) from areas proposed to be developed and 1) distribute to herbaria, botanical

gardens, and interested scientists, and 2) relocate to suitable sites with appropriate tools and best management (e.g., avoid transplant shock and high temperatures, and whether dormant plants are the optimal stage for relocation). For details see Negrón-Ortiz & Kaeser (2020). i. Knowledge of this species' sexual expression is necessary during plant rescue and the establishment of new populations. For establishment, all E. telephioides sexual morphs should be represented. ii. If seeds are collected for establishment or ex-situ approaches, a large number may be required to overcome low germination and seedling establishment, and the unpredictability of the sex ratio. 3. Develop a Species Distribution Model (SDM) to assist with locating new populations and identifying prospective sites for reintroductions such as areas that will not be affected by SLR and future development. Sites should be validated or inspected for plants, and then protected by land acquisitions, conservation easements. This is an ongoing action, see Appendix 1, recovery criterion 4. 4. Expand germination and seedling survivorship studies. i. Determine seasonal fluctuations that influence germination timing and recruitment and identify traits that correlate with seed viability and dormancy ii. Conduct ex situ germination studies and clarify limits of seed desiccation and cold tolerance. This is an ongoing action conducted by the ABG for 2021-2023 iii. Look at historical data, such as herbarium specimens recorded observations, to understand what abiotic and biotic factors influenced germination timing and recruitment in the past. Note: Atlanta Botanical Garden planned to collect seeds from known and any discovered populations (based on SDM, action 3) to conduct germination and viability studies, establish collections in their Conservation Seed Bank, and for propagation for use in reintroduction experiments within protected lands where suitable habitat is found (ongoing action 2021-2023); funds were obtained from the Coastal Program. iv. Further investigate in-situ seedling survivorship and growth across years to help to understand E. telephioides population persistence (see NegronOrtiz & Kaeser 2020) 5. Phenological data (timing, duration and abundance of recurrent biological processes, including reproductive events such as flowering, fruiting, seed dispersal and germination) have emerged as useful tools for studying the impact of climate change on plants. Lacking phenological adaptability may require a stronger signal or may be unable to adapt to climate warming, and therefore may experience greater stress or even extinction during extended climate change. Therefore, phenological studies should include both long-term observations coupled with herbarium specimens' records. Complete for long-term in-situ observations (Negron-Ortiz & Kaeser 2020); Not initiated: document phenology using herbarium specimens' records. 6. Since E. telephioides occurs in fire prone habitats, the effect of this disturbance on survival and fecundity should be monitored to determine the most appropriate fire return intervals, on selected areas to maintain suitable habitat conditions of E. telephioides populations. Complete for the effect of this disturbance on survival and fecundity (Negron-Ortiz & Kaeser 2020); partially complete/understood: determining the appropriate fire return intervals. 7. Euphorbia telephioides changes in sex expression occurred in response to factors such as temperature, specifically after fire (Negron-Ortiz & Kaeser 2020). The impact of elevated temperatures (and photoperiod) on changes in sex expression should be further investigated as it can provide insights into the performance of this species under the impacts of frequent disturbance and climate change. i. The long-term effect of temperature on tagged individuals can be measured by establishing permanent monitoring plots across the entire range of E. telephioides at sites maintained with prescribed fire. 8. Continue fostering a working partnership with the St. Joe Company, AgReserves, Inc. and other developing companies and consulting agencies, such as Flatwoods Consulting Group to address and minimize potential impacts associated with development and fire suppression. 9. Outreach: Promote the implementation of the recovery actions via academia, private landowners, and public agencies. Develop and distribute information to the general public. This is an ongoing action, see Appendix 1, recovery criterion 4. (USFWS, 2021)

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SPECIES ACCOUNT: *Eutrema penlandii* (Penland alpine fen mustard)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/28/1993; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Eutrema penlandii is a small herbaceous perennial plant that grows to 3-8 cm in height. It is a shiny-green glabrous (hairless) plant with long-petioled (long-stemmed) heart-shaped basal leaves that grow up to 3.5 cm long. It also has clusters of small, white flowers atop the stems that grow 2-3.5 mm in length. It has small and rounded hollow fruits. (USFWS, 1993a)

Taxonomy

Rollins (1982) recognized Eutrema penlandii at the species level, but Weber (1987) treated it as a subspecies of E. edwardsii (E. edwardsii ssp. penlandii). (USFWS, 1993a)

Historical Range

E. penlandii never has been collected outside the Mosquito Range in Colorado, and it appears unlikely that the plant exists outside of this area. (USFWS, 1993a)

Current Range

The Penland alpine fen mustard is known from Lake, Park, and Summit counties in Colorado. The plant is found only in the Mosquito Range at elevations ranging from 3,625 to 4,050 meters (11,900 to 13,280 feet). The species is known from an area measuring 11 miles from north to south as well as east to west. (USFWS, 2016) The mustard occurs in the high elevation, alpine habitats of Lake, Park, and Summit Counties, in central Colorado (Colorado Natural Heritage Program (CNHP) 2012). The geographic area where the mustard is found runs in a north to south direction for approximately 64 kilometers (km) (40 miles (mi)), generally to the east of the Continental Divide (Figure 1). Only three mustard sites have been located west of the Continental Divide. The overall rangewide distribution of the mustard is approximately 29.0 km (18.0 mi) north to south and 16.7 km (10.4 mi) east to west. Within this area the species' habitat and distribution are highly restricted, such that the species likely occupies less than 100 hectares (ha) (246 acres (ac)). (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2016)

Breeding Season

Adult: Flowering from June to August (USFWS, 2016)

Reproduction Narrative

Adult: Flowering of the Penland alpine fen mustard occurs from June into August, depending on snow-melt. Fruits mature from late-July into August and possible September. We are unsure how many seeds are in each seed pod or when seed pods split to release seeds. Mosquito Range mustard reproduces only by seed, with no means of vegetative reproduction (spread by vegetative growth). Little is known about reproduction, pollinators, or seed dispersal. (USFWS, 2016)

Habitat Type

Adult: Alpine tundra (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Peat fens, bogs, or marshes (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Possibly calcareous substrate (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: The species occurs only in alpine meadows at elevations above 11,800 feet in the Mosquito Range of the Rocky Mountains in central Colorado. Plants are most often found along east facing, gentle slopes and basins that are fed moisture by slow-melting snowfields above. However, they can also be found in dryer locations. In either habitat, they are often rooted in tufts of mosses or hidden among short-bladed grasses. (USFWS, 2016)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Little is known about reproduction, pollinators, or seed dispersal. (USFWS, 2016)

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

26 (USFWS, 2021)

Population Size:

Approximately 30,885 individuals (USFWS, 2021)

Adaptability:

Very low (USFWS, 2016)

Population Narrative:

Currently, there are 26 known populations of the mustard, delineated based on a 1 km (0.6 mi) buffer and topographical and elevational fragmentation (Figure 1). There may be subpopulations within a population. Rangewide surveys estimate that there are currently approximately 30,885 individuals distributed across the 26 known populations. Our biological report provides additional detail regarding trends and abundance, including summaries of abundance and occupied area for each of the 26 populations (Service 2019). (USFWS, 2021)

Threats and Stressors

Stressor: Hydrological alterations (USFWS, 1993a)
Exposure:
Response:
Consequence:
Narrative: The most fragile aspect of the Penland alpine fen mustard's habitat is the continuous supply of water needed to maintain peat fens. E. penlandii grows in peat mounds along saturated stream margins and small hummocks within streams, and it rarely occurs more than 0.55 yards away from flowing meltwater. Populations of E. penlandii are small, and some are found on areas of less than about 1 acre. Some subpopulations occupy only a few square yards. Because stands of the plant are so small, they are vulnerable to surface disturbances that reroute the needed water supply. This can occur from ditching, diking, or other watershed perturbations that alter surface water flow (e.g., roads, trails, ruts of vehicle tracks, footpaths, or mining construction). Desiccation and loss of a peat fen can cause a loss of plants and reduction in the amount of its highly specialized habitat. (USFWS, 1993)

Stressor: Mining (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Mineral extraction could have a significant impact on this taxon. The mining companies contested the Mosquito Range Research Natural Area; mining remains a big threat to plants in the Mosquito Range because of the thousands of mining claims - a change in the economic viability of mining could cause mining to increase there (CNHP 2004). Also, ditching associated with mining could affect the delicate hydrology and could cause water pollution, both of which would adversely affect the species. (USFWS, 2016)

Stressor: Recreational activities (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Recreational use is also a threat including trampling by ORV's and hikers. Any activity that directly or indirectly alters the surface or ground water supply and alters the wetland habitat required by this species could pose a significant threat. In one occurrence, Jeeps and ATVs were parked directly on top of Eutrema plants (NatureServe Element Occurrence data 2011). The impacts of this seemingly benign activity can destroy large areas of this sensitive bog habitat. (NatureServe, 2015)

Stressor: Localized environmental catastrophes such as fungal blight, drought, or insect infestations (USFWS, 1993a)
Exposure:
Response:
Consequence:
Narrative: The Penland alpine fen mustard has a few small populations on small areas of specialized habitat that makes it particularly vulnerable to localized environmental catastrophes such as fungal blight, drought, or insect infestations. Alpine tundra is a harsh environment for plant growth. If climatic changes (local or global) reduce the amount of persistent snowfields, the habitat might be further reduced. Some occurrences are located in such a small area that they are vulnerable to perhaps a single upslope surface disturbance. (USFWS, 1993)

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The effects of climate change are likely to endanger the survival of Penland alpine fen mustard, as well as many other plant and animal species adapted to alpine ecosystems. (USFWS, 2016)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Delisting Criteria:
Recovery Criterion 1: Population-Based 1. Population trends for the Mosquito Range mustard are stable or increasing according to the following objective measures: a. Species presence and rank is maintained at all the 11 “A” and “B” ranked Mosquito Range mustard populations (the Recovery Populations, as defined above under Recovery Strategy), but if additional Mosquito Range mustard populations are discovered and ranked as either “A” or “B” resiliency, these populations could contribute to meeting this criterion if one of the existing 11 recovery populations declines; and b. Landscape-level populations trends (as measured by density estimates) must be stable or improving over a 10-year period following the Bureau of Land Management’s monitoring methodology (BLM 2017); and c. Maintain at least 80 percent confidence that Mosquito Range mustard density estimates are within 20 percent of their estimated true value over a 10-year period (BLM 2017), a measure which helps ensure the statistical validity of the demographic data for the species. (USFWS, 2022)

Recovery Criterion 2: Threats and Management-Based 2. Regulatory mechanisms or other conservation plans or programs, such as land use management plans, reduce and ameliorate threats associated with habitat loss and degradation in all Mosquito Range mustard populations, such that the protections of the Act are no longer needed to compensate for regulatory inadequacies, according to the following objective measures: a. Existing Federal land protections for the Mosquito Range mustard, such as those described in land management plans, conservation agreements, recreation management plans, and travel management plans, must be maintained for all Mosquito Range mustard populations that occur on Federal lands, and b. Adequate protections for the Mosquito Range mustard are included in any new or amended

land management plans on Federal lands. (USFWS, 2022)

Recovery Actions:

- Known habitat needs protection. (USFWS, 1993b)
- Suitable habitat should be surveyed for additional populations. (USFWS, 1993b)
- Research is needed to determine life history and habitat parameters controlling the distribution and abundance of the species. General ecological characterization of the species population, biotic community and obvious abiotic and biotic ecosystem interactions should be initiated. (USFWS, 1993b)
- Management techniques need to be developed to optimize the species' viability. (USFWS, 1993b)
- Naturally occurring populations should be monitored. (USFWS, 1993b)
- A Recovery Plan should be developed. (USFWS, 1993b)
- Habitat acquisition may be desirable since approximately half of the known occurrences are, at least partially, on private land with patented mining claims. (USFWS, 1993b)
- Coordination is needed with public and private entities to enhance conservation. Habitat management plans and conservation agreements are desirable. (USFWS, 1993b)
-
- Priority 1 Actions 1. Protect and conserve all known, extant Mosquito Range mustard populations and their habitat. 2. Survey suitable habitat for additional populations (USFWS, 2022).
- Priority 2 Actions 3. Monitor all recovery populations and apply conservation measures, if needed (USFWS, 2022).
- Priority 3 Actions 4. Research the biology, habitat, and nutrition requirements (soil nutrients) threat responses, and life history of the Mosquito Range mustard in order to develop and implement appropriate management practices for the purposes of achieving recovery. 5. Coordinate and work with stakeholders in all populations and promote communication by encouraging and creating dialog regarding this species between managing agencies, landowners, developers, and the public in order to raise awareness and coordinate recovery (USFWS, 2022).

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SPECIES ACCOUNT: *Exocarpos menziesii* (Menzies ballart)

Species Taxonomic and Listing Information

Listing Status: Proposed Endangered; 10/31/2016; Pacific Region (R1) (USFWS, 2016)

Physical Description

Exocarpos menziesii (heau) is a shrub in the Santalaceae (sandalwood) family, 0.5 to 2 meters (m) (1.6 to 6.5 feet (ft)) tall. Stems are densely branched, especially toward the ends; the tips are maroon-tinged. Leaves consist of two forms: scale-like or foliaceous, these elliptic to oblanceolate, 10 to 14 millimeter (mm) (0.4 to 0.5 inch (in)) long, 3 to 6 mm (0.1 to 0.2 in) wide. Flowers are perfect with five red petals 3 mm (0.1 in) long. Drupes are reddish brown to red at maturity, ellipsoid to narrowly ovoid, 7 to 10 mm (0.3 to 0.4 in) long with a small terminal beak partially embedded in a yellow, fleshy receptacle (Wagner et al 1999, p. 1218). (USFWS, 2021b).

Taxonomy

Exocarpos menziesii was recognized as a distinct taxon in the 1999 update to the Manual of Flowering Plants of Hawaii (Wagner et al. 1999, p. 1218) (USFWS, 2014).

Historical Range

Exocarpos menziesii is historically known from the island of Lanai (Kaiholena Gulch) and was formerly more wide-spread on the island of Hawaii (from Kahuku Ranch in the south to Hualalai and Puukapele on the leeward slopes) (Wagner et al. 1999, p. 1218; TNCH 2007; HBMP 2010) (USFWS, 2015).

Current Range

Currently, there is 1 scattered occurrence of fewer than 20 individuals on the slopes of Hualalai and approximately 1,800 individuals in the U.S. Army's Pohakuloa Training Area (PTA) on the island of Hawaii (PEPP 2013, pp. 10, 33; Thomas 2014, in litt.; Evans 2015, in litt.). There are no known occurrences of this species on Lanai today (USFWS, 2015). Hawai'i (extant); Lāna'i (likely extirpated) (USFWS, 2021). Distribution: Hawai'i (extant); Lāna'i (possibly extirpated) (USFWS, 2022).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: Long (USFWS, 2022)

Breeding Season

Adult: Little is known about the life history of Exocarpos menziesii. This species has been observed flowering and fruiting in April and July (NTBG 2020). Its pollination vectors, seed dispersal agents, specific environmental requirements, and limiting factors are unknown. (USFWS, 2021b).

Habitat Type

Adult: Shrubland/dry forest (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 1,434 to 2,432 m (4,705 to 7,979 ft) (USFWS, 2021b)

Habitat Narrative

Adult: This species occurs in Metrosideros shrubland or drier forest areas, and on lava flows with sparse vegetation, from 4,600 to 6,900 ft (1,400 to 2,100 m), in the montane dry ecosystem on the island of Hawaii (Wagner et al. 1999, p. 1218; TNCH 2007; HBMP 2010) (USFWS, 2015). Exocarpos menziesii occurs in mesic and dry shrubland and forest in the PTA consisting of a'a and pahoehoe lava flows with sparse vegetation or dominated by the native plant species Metrosideros ('ōhi'a) at 1,434 to 2,432 m (4,705 to 7,979 ft) (CEMML 2019, p. 10). Rainfall ranges from 453 to 1,724 mm (18 to 68 in) annually (USFWS 2020 GIS data, unpublished). At HVNP, E. menziesii occurs in subalpine areas on younger a'a lava flows with scattered native Metrosideros and native shrubs. Vegetation on older pahoehoe is and mix of Metrosideros and Sophora chrysophylla ('ōhi'a and māmane) woodland with understory of native shrubs and grasses including Vaccinium spp. ('ōhelo), Leptecophylla tameiameiae (pūkiawe), Dodonaea viscosa ('a'ali'i), and Deschampsia nubigena (no common name). Vegetation in the Kahuku Unit is similar but depauperate in diversity because of four decades of browsing by mouflon (HVNP 2007, pp. 11–12; NPS 2015, p. 474). (USFWS, 2021b).

Dispersal/Migration

Population Information and Trends

Population Trends:

No information found.

Number of Populations:

17 (USFWS, 2022)

Population Size:

1,941 (USFWS, 2022)

Population Narrative:

17 populations. 1,941 individuals (USFWS, 2022).

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Feral goats, mouflon, and sheep modify and destroy the habitat of Exocarpos menziesii on Hawaii Island, with evidence of the activities of these animals reported in the areas where this species occurs (USFWS Rare Taxon Database 2015, in litt.) (USFWS, 2015).

Stressor: Reduced vegetative vigor (USFWS, 2015)
Exposure:
Response:
Consequence: Extinction
Narrative: Occurrences and numbers of individuals have declined on the island of Hawaii (HBMP 2010; Thomas 2014, in litt.), once widely distributed from the south to the west sides of the island, and are now restricted to two locations;, consequently E. menziesii may experience reduced reproductive vigor due to reduced levels of genetic variability, leading to diminished capacity to adapt to environmental changes, thereby reducing the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361; HBMP 2010) (USFWS, 2015).

Stressor: Fire (USFWS, 2105)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Fire is a potential threat to this species; although the U.S. Army has constructed firebreaks and has standard operating procedures in place for prevention and suppression of wildfires at PTA, wildfires may encroach from other areas (U.S. Army Garrison 2013, in litt.). The small number of individuals outside the occurrence at PTA may limit this species' ability to adapt to environmental change (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change may result in alteration of the environmental conditions and ecosystems that support this species. Exocarpos menziesii may be unable to tolerate or respond to changes in temperature and moisture, or may be unable to move to areas with more suitable climatic regimes (Fortini et al. 2013, p. 76) (USFWS, 2015).

Stressor: Non-native plants (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Additionally, nonnative plants modify and destroy native habitat and outcompete this and other native species for water, nutrients, light, and space, or a nonnative plant may produce chemicals that inhibit growth of other plants, also negatively affecting habitat of E. menziesii (Smith 1985, pp. 180–250; Vitousek et al. 1987 in Cuddihy and Stone 1990, p. 74). (USFWS, 2016)

Recovery

Reclassification Criteria:
Recovery Priority Number = 5 (USFWS, 2022) Number of populations and individuals needed for each plant species to meet the preventing extinction stage based on population and life history characteristics. Number of Populations = 3. Reproducing Individuals per population = 25 (USFWS, 2022). Number of populations and individuals needed for each plant species to meet

the interim stage based on population and life history characteristics. Number of Populations = 3. Reproducing Individuals per population = 100 (USFWS, 2022). Number of population and individuals of each plant species needed for downlisting based on population and life history characteristics. Number of Populations = 5. Reproducing Individuals per population = 200 (USFWS, 2022).

Delisting Criteria:
Number of populations and individuals of each plant species needed for delisting based on population and life history characteristics. Number of Populations = 10. Reproducing Individuals per population = 200 (USFWS, 2022).

Recovery Actions:
- A recovery plan has not been completed for this species.

Conservation Measures and Best Management Practices:
- Current Management Actions: • Surveys and monitoring—The PTA Botanical Program implements conservation measures for Exocarpos menziesii including surveying and monitoring (PTA 2020, p. 56; CEMML 2021a, p. 7). The National Park Service (NPS) surveys and monitors populations in the Kahuku Unit (NPS 2015, pp. 8, 38, 41). • Ungulate control—The PTA has fenced occurrences of E. menziesii in the training area and these areas have been ungulate-free since 2017 (CEMML 2021a, p. 4). • Ecosystem-altering invasive nonnative plant control—PTA monitors and removes nonnative plants (CEMML 2021a, p. 4). • Fire management—PTA and HVNP have both developed and implement fire management plans. • Management of predation and herbivory by sheep, mouflon, and goats—PTA has fenced occurrences of E. menziesii in the training area and these areas have been ungulate-free since 2017 (CEMML 2021a, p. 4). The NPS monitors and removes feral ungulates from managed areas in HVNP. • Captive propagation for genetic storage and reintroduction—The PTA Botanical Program reports collection of 766 fruit representing more than nine founders for storage and propagation and reports 31 plants in accessions (PTA 2020, p. 35; CEMML 2021b, p. 30). • Population biology research—PTA Botanical Program reports conducting 16 seed germination trials using 278 seeds with production of 27 seedlings (PTA 2020, p. 40). (USFWS, 2021b).

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SPECIES ACCOUNT: *Fremontodendron californicum ssp. decumbens* (Pine Hill flannelbush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; Pacific Southwest (R8)

Physical Description

A branched spreading shrub of the cacao family (Sterculiaceae) growing to 1.3 meters (4 feet) tall. Dense star-shaped hairs cover the leaves and the younger twigs and branchlets. Its leaves are elliptic-ovate to ovate, shallowly or deeply palmately lobed with 5 to 7 lobes. Fremontodendron californicum ssp. decumbens produces flower buds in late winter. Showy light-orange to reddish-brown flowers ap-pear from late April to early July. Its fruit is a capsule. Fremontodendron californicum ssp. decumbens can be distinguished from F. californicum ssp. californicum and F. mexicanum (Mexican flannelbush) by its decumbent growth habit (stems lying on the ground and growing upward only at the tip), its rela-tively long peduncles (stalks that support the inflorescence), and its copper-orange flowers. (USFWS, 2002)

Taxonomy

Beecher Crampton made the first collection of Fremontodendron californicum ssp. decumbens in 1956. Robert M. Lloyd (1965) described F. californicum ssp. decumbens as F. decumbens based on the type specimen he collected in May 1964 from ''California, El Dorado Co., Pine Hill, ca. 3 kilometers north of Rescue.'' Munz (1968) reduced F. decumbens to a subspecies of F. californicum. Kelman (1991), in his revision of Fremontodendron, recognized F. californicum ssp. decumbens as a full species based upon morphological variation. This taxon currently is known as Fremontodendron californicum ssp. decumbens (Whetstone and Atkinson 1993). (USFWS, 2002) Although Pine Hill flannelbush is currently considered a subspecies by the Service, Kelman et al. (2006) found that the Pine Hill flannelbush at the Pine Hill Preserve was genetically distinguishable from the California flannelbush (F. californicum) sampled. This distinction, coupled with unique morphology and ecology, was enough for Kelman et al. (2006) to support the treatment of F. decumbens as a species. (USFWS, 2019a)

Historical Range

Endemic to the Pine Hill formation in western El Dorado County, California (USFWS, 2019a).

Current Range

Restricted to the Pine Hill Preserve and immediate vicinity in El Dorado Couty, California; however, there is compelling ongoing research which may indicate it also occurs in Yuba and Nevada Counties (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2002)

Dependency on Other Individuals or Species

Adult: Tetralonia stretchii (USFWS, 2002)

Breeding Season

Adult: April - July (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Fire (NatureServe, 2015); solitary bees (USFWS, 2002)

Other Reproductive Information

Adult: Pine Hill flannelbush resprouts from its crown after a fire (Wilson et al. 2009) and relies on fire or other heat treatment for the establishment of seedlings. (USFWS, 2019a)

Reproduction Narrative

Adult: Heat (fire) is needed to scarify seed coats for germination and to clear the area for seedling development (NatureServe, 2015). Fremontodendron californicum ssp. decumbens produces flower buds in late winter. Showy light-orange to reddish-brown flowers appear from late April to early July. Native solitary bees pollinate the flowers (Boyd 1994). Seventy percent of the developing fruit is destroyed by insects prior to maturing. The remaining fruit dehisces (opens up) during summer and releases seeds onto the soil. The seeds are eaten by rodents and dispersed by harvester ants (Messor andrei). Boyd and Serafini (1992) found the production of seeds in F. californicum ssp. decumbens was severely limited by insect predation. Over 98 percent of flower buds failed to produce fruit because of predation by insects. In addition, rodents destroyed 90 percent of seeds under shrubs within 8 to 10 months (Boyd and Serafini 1992). Boyd (1994) studied pollination biology of Fremontodendron californicum ssp. decumbens. Studies showed that insects were required for pollination. The primary floral visitor to the flowers was an anthrophorid bee (Tetralonia stretchii) (89.4 percent of the visits) (USFWS, 2002).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral, woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Fire (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Succession (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Tops of rocky ridges and on scattered rock outcrops of gabbro in chaparral communities or in the ecotone between chaparral and woodland. Heat (fire) is needed to scarify seed coats for germination and to clear the area for seedling development. The environmental specificity is very narrow; it is narrowly endemic to gabbro soils in Eldorado and Nevada counties, California (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2002)

Dispersal/Migration Narrative

Adult: The seeds are eaten by rodents and dispersed by harvester ants (Messor andrei) (Boyd 1996). Seeds were carried up to 12 meters (39 feet) from the F. californicum ssp. decumbens shrubs (Boyd 1996) (USFWS, 2002).

Population Information and Trends

Population Trends:

Stable (USFWS, 2019a)

Number of Populations:

12 populations; two are stable, the remainder are presumed extant. (USFWS, 2019a)

Population Size:

Greater than 104 individuals (USFWS, 2019a)

Population Narrative:

In general, a direct comparison of species abundance now versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. It is unlikely that abundance of Pine Hill flannelbush has increased since listing, due to a further reduction in their range, lack of suitable habitat, and the fact that both species are long-lived. However, as noted below, with the increased protection of habitat, it is likely that no further significant decline in abundance of these species has occurred. (USFWS, 2019a)

Threats and Stressors

Stressor: Development (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Between 1960 and 1990, the human population in El Dorado County increased 428 percent (California Department of Finance 1998). Nearly 23 percent of the gabbro formation

is urbanized (J. Horenstein unpublished data 1994). Commercial or residential developments have partially or completely destroyed occurrences of all of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

Stressor: Alteration of natural fire regime (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Changes in fire frequency threatens Fremontodendron californicum ssp. decumben. This plant occurs within a fire-adapted plant community, either within chaparral or on the ecotone between chaparral and woodland. Fire suppression policies have altered natural processes within several plant communities in California. Longer than normal fire frequencies leads to the loss of some plant species from the chaparral plant community. Land development and multiple ownership complicate the planning and implementation of controlled burns at the appropriate fire frequency necessary for maintenance of chaparral (USFWS, 2002).

Stressor: Dumping (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Habitat degradation from garbage dumping on ridge-tops around Pine Hill and on undeveloped parcels surrounded by higher density development degrades the habitat and is a minor threat to Fremontodendron californicum ssp. decumbens (J. Wilson pers. comm. 1993, L. Eng in litt. 1999) (USFWS, 2002).

Recovery

Reclassification Criteria:
1. Secure and protect specified recovery areas from incompatible uses: (i) Pine Hill preserve and occupied habitat along with sufficient adjacent unoccupied habitat for fire management and a 150- meter (500-foot) buffer at 8 known sites. See Table III-4 for acreage of preserves. (j) The decumbent Fremontodendron within Nevada and Yuba Counties should be secured and protected unless determined not to be the listed Fremontodendron. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all sites and any adjacent occupied or unoccupied habitat identified as necessary for continued survival. (USFWS, 2002)

3. Monitoring in all recommended preserves shows: (a) Stable or increasing over 60 years (two fire cycles or longer if suggested by results of demographic monitoring). (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000)

conditions. (c) Spatially and temporally, the establishment of occurrences must continue to be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate; (b) Fire management studies; (c) seeds stored in at least two Center for Plant Conservation certified facilities; (d) research on seed germination and propagation techniques; (e) successful introduction onto Salmon Falls/Martel Creek preserve. (f) Maintain metapopulation dynamics of at least 1 very large, 3 medium, and 4 small occurrences on the Pine Hill formation. (USFWS, 2002)

Delisting Criteria:
C/1: For the 8 years following achievement of populations targets for Pine Hill flannelbush, herbivory by insects and rodents must not occur in two consecutive years at levels which cause a population decline at any of the sites contributing to recovery. (USFWS, 2019b)

E/1: Number of populations with specific geographic distribution. The 8 flannelbush populations must persist in at least two different preserve units. Populations species must persist at the size described in E/2, for at least two full fire cycles. (USFWS, 2019b)

E/2 Number of plants per population: Of the 8 populations of flannelbush required for down and delisting, small, medium, large, and very large populations must contain the number of plants described as follows. Based on the size of each population, the minimum number of mature plants in each population are: Small (at least four populations): 15; Medium (at least three populations): 83; Very Large (at least one population): 480; Total number of plants 789. (USFWS, 2019b)

Recovery Actions:
- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of

Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)

- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Serpentine and Gabbro soil areas in Nevada and Yuba Counties if decumbent Fremontodendron is determined to be the listed Fremontodendron . Reproduction and Demography Research: Yes, including age of seed banks for determining when to burn, limiting life stages if Nevada County specimen is determined to be the listed Fremontodendron, seed production and survival in soil to determine appropriate fire return period. Systematics and Genetics research (identify Yuba County and Nevada County material) Other Research Needs: Propagation techniques; fire management techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement; study of disease if necessary. Management Actions Needed: Burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; assessment of disease as threat; introduction; seed banking.
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Conduct controlled burns at all appropriate preserve units to maintain multiple populations of flannelbush within a shifting mosaic of woodland and chaparral that contains early,

middle and late seral vegetation stages. Priority 1 (USFWS, 2019b)

- Conduct outreach to private landowners residing adjacent to existing preserves and/or other private landowners within suitable habitat of these species to provide education on avoiding degradation of habitat and to encourage the voluntary sale of conservation easements by willing landowners. Priority 1 (USFWS, 2019b)
- Conduct genetic analyses to determine areal size of individuals/extent of clonality and population structure in order to define individuals of flannelbush. Priority 2 (USFWS, 2019b)
- Conduct population viability analyses for flannelbush. Priority 2 (USFWS, 2019b)
- Conduct research into the regeneration ecology of flannelbush. Priority 2 (USFWS, 2019b)
- Conduct research to determine effective means of mechanical and other non-fire related control of chaparral to benefit gabbro soil species. Priority 2 (USFWS, 2019b)
- Protect habitat through acquisition of fee title or purchase of conservation easement at the Nevada and Yuba County populations of flannelbush, if they are determined through future research to be the listed flannelbush. Priority 2 (USFWS, 2019b)
- Conduct outplantings of flannelbush, specifically at the Salmon Falls/Martel Creek unit where substantial suitable habitat exists. Priority 2 (USFWS, 2019b)
- Develop a monitoring plan to span 5 years post-delisting of flannelbush and implement the plan at the time of delisting to measure the (USFWS, 2019b)
- Attempts to set up an ecological reserve have been ongoing for more than 20 years. In the fall of 1977, the California Native Plant Society learned of plans to dispose of surplus California Department of Forestry and Fire Protection lands located on Pine Hill in El Dorado County (Howard 1979). Beginning in late fall of 1977, the California Native Plant Society united with other environmental groups to encourage the State of California to begin a coordinated effort to preserve significant natural areas. Through 1978 and into 1979, a multi-constituent committee, including the California Native Plant Society, Audubon Society, and California Resources Agency, met to set up a significant natural area for Pine Hill. Pine Hill Ecological Reserve (97 hectares [240 acres]) was established in 1979 to protect the gabbro plants located on the summit of Pine Hill (USFWS, 2002).
- The State of California listed Fremontodendron californicum ssp. Decumbens as rare in 1979. In 1987, a management plan was written for the Pine Hill Ecological Reserve (Baad and Hanna 1987) (USFWS, 2002).
- In the late 1980's, the California Department of Fish and Game brought to the attention of El Dorado County that many of the development projects in western El Dorado County would likely have significant direct or cumulative effects on eight rare plant species (Economic & Planning Systems, Inc. 1997). At the same time, the development community became aware of the California Department of Fish and Game's concerns regarding these plants. Private developers and El Dorado County contracted a report to determine potential preserve sites (USFWS, 2002).
- In 1992, the California Department of Fish and Game, Bureau of Land Management, and Bureau of Reclamation signed a memorandum of understanding to protect the gabbro plant habitat along the South Fork of the American River (California Department of Fish and Game 1992) (USFWS, 2002).
- In 1992, following an El Dorado County Board of Supervisors' hearing and an informational workshop, the El Dorado County Board of Supervisors requested the formation of the El Dorado County Rare Plant Advisory Committee, consisting of members from the development community, various agencies (California Department of Fish and Game, Bureau of Land Management, U.S. Fish and Wildlife Service), El Dorado County planning

staff, California Native Plant Society, Center for Sierra Nevada Conservation (formerly Friends Aware of Wildlife Needs), American River Conservancy, and others. This committee was established to identify feasible preserve sites, funding mechanisms, and management strategies for these preserves. The Rare Plant Advisory Committee used evaluations from the EIP Associates 1991 report and recommendations from California Department of Fish and Game, and overlaid land use considerations on the biological information to arrive at their own set of recommendations to the Board of Supervisors (USFWS, 2002).

- In 1993, the California Department of Fish and Game applied for and received a section 6 grant from us to investigate funding mechanisms for land acquisition. A draft economic feasibility study for acquiring the rare plant preserves, prepared by Economic & Planning Systems, Inc., was published in 1997 (USFWS, 2002).
- Our February 27, 1995, biological opinion on the interim renewal by Bureau of Reclamation of 67 water service contracts on the Central Valley Project (including water contracts for El Dorado County) identified implementation of a preserve system for the five federally listed gabbro plants as a critical need (U.S. Fish and Wildlife Service 1995). A critical need was defined as those actions needed immediately to avoid extinction or preclusion of recovery. The critical needs analysis for these plants specifically noted the importance of a preserve in the southern zone (Cameron Park) of the Pine Hill formation. During meetings held for technical review of the draft critical needs plan from the February 27, 1995, biological opinion for the Central Valley Project Interim Water Contract renewals, invited experts recommended all five of the preserves identified by the Rare Plant Advisory Committee as the critical need for the five federally listed gabbro species (which were proposed at the time of the meeting) (USFWS, 2002).
- From 1997 through January 2002, 184 hectares (454 acres) were purchased in the Cameron Park area through a multi-agency effort (Table II-6). The American River Conservancy and California Department of Fish and Game submitted a proposal in February 1997, requesting funds from the Central Valley Project Improvement Act (b)(1)“other” program to assist in the acquisition of habitat within the Cameron Park area. In October 1997, the El Dorado County Board of Supervisors approved El Dorado County’s participation in the purchase of 47 hectares (117 acres) in the Cameron Park area to protect rare plants. Also in October 1997, the El Dorado County Board of Supervisors approved in concept the adoption of a rare plant mitigation in-lieu fee that would include all new development within the El Dorado Irrigation District Sphere of Influence, excluding the City of Placerville, to help pay for part of the acquisition of the Cameron Park Preserve (El Dorado County 1998) (USFWS, 2002).
- During May 1997, the El Dorado County Board of Supervisors approved an agreement with Economic & Planning Systems to prepare an economic feasibility study for their approved ecological preserve program. On July 28, 1998, the El Dorado County Board of Supervisors adopted Ordinance 4500, which established an ecological preserve mitigation requirement or an in-lieu fee for certain development projects in western El Dorado County. El Dorado County is currently implementing this impact fee program to augment the funds needed to fund the acquisition and administration of the preserve system (El Dorado County 1998). The fees range from $885 to $386 per dwelling unit equivalent (El Dorado County 1998). El Dorado County also has successfully lobbied the El Dorado Irrigation District to jointly participate with the County to help fund the acquisition of the Cameron Park Preserve (El Dorado County 1998) (USFWS, 2002).
- With Congressman John Doolittle’s support, Congress appropriated $5,000,000 of Land and Water Conservation Fund money to be administered starting in fiscal year 2001 by the Bureau of Land Management. In fiscal year 2002, an additional $3,000,000 of Land and

Water Conservation Fund money were allocated. As shown in Table II-6, $4,008,400 of Land and Water Conservation Funds have been used for land acquisition in the Cameron Park area as of January 2002 (USFWS, 2002).

- In 2001, a cooperative management agreement for the Pine Hill Preserve in El Dorado County was signed by three Federal agencies (Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation), two State agencies (California Department of Fish and Game and California Department of Forestry and Fire Protection), El Dorado County, El Dorado Irrigation District, and the American River Conservancy. With this agreement, the signatories agreed to pool their resources to conserve the rare plant species and ecosystems that they inhabit. The primary goal of the Pine Hill Preserve is the preservation in perpetuity of the rare plant species and communities of the western El Dorado County gabbro formation. By separate agreement, El Dorado County and the Bureau of Land Management, have created funding to employ an interim preserve manager (USFWS, 2002).
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019a)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019a)
- Conduct conclusive genetic research to determine a) whether flannelbush in Yuba and Nevada Counties are truly Pine Hill flannelbush and b) whether Pine Hill flannelbush should be treated as a species (as Fremontodendron decumbens). (USFWS, 2019a)
- Should flannelbush of Yuba and Nevada Counties be determined to be Pine Hill flannelbush, action should be taken immediately to bring those lands under conservation ownership and management. (USFWS, 2019a)

References

USFWS. 2002. Recovery Plan for Gabbro Soil Plants of the Central Sierra Nevada Foothills. U.S. Fish and Wildlife Service, Portland, Oregon. xiii + 220 pp. https://ecos.fws.gov/docs/recovery_plan/020830b.pdf

USFWS. 2019a. Stebbins' morning-glory (Calystegia stebbinsii), Pine Hill ceanothus (Ceanothus roderickii), Pine Hill flannelbush (Fremontodendron californicum ssp. decumbens), El Dorado bedstraw (Galium californicum ssp. sierrae), Layne's butterweed (Packera layneae), 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office. May 2, 2019. https://ecos.fws.gov/docs/five_year_review/doc6009.pdf

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USFWS. 2019b. Amendment 1. Recovery Plan for Gabbro Soil Plants of the Central Sierra Nevada Foothills: El Dorado bedstraw (Galium californicum ssp. sierrae) and Pine Hill flannelbush (Fremontodendron californicum ssp. decumbens). U.S. Fish and Wildlife Service, Sacramento, California. 20 pp. September 26, 2019.

SPECIES ACCOUNT: *Fremontodendron mexicanum* (Mexican flannelbush)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/13/1998; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small evergreen tree or shrub, < 7 m tall. The palmately lobed leaves are thick and leathery. Flowers (March-July or August) lack petals, but have showy, orange sepals (NatureServe, 2015).

Taxonomy

A member of the Malvaceae (mallow family) (in the Sterculiaceae (cacao family) when listed. Fremontodendron is thought to be a relic genus left over from a time period approximately 60 million years ago when California had a more tropical climate (Kelman 1991, p. 15) (USFWS, 2009).

Historical Range

Fremontodendron mexicanum is endemic to southern California and northwestern Baja California, Mexico. At the time this species was listed, only one occurrence containing fewer than 100 plants was known in the United States, and one occurrence in Mexico with no information on the number of plants (USFWS, 2009).

Current Range

Since listing, two additional occurrences have been discovered in the United States (both within 2 miles of the known occurrence), and one additional occurrence has been located in Mexico. It is now known to occur in three canyons in the United States and one canyon in Baja California (USFWS, 2009). Found in Imperial, Kern, Monterey, and San Diego Counties, California and Baja California, Mexico (Smith and Berg, 1988). According to the California Natural Diversity Database, Fremontodendron mexicanum is distributed from the border south to Arroyo Seco (North of San Quintin) in Mexico (NatureServe, 2015).

Critical Habitat Designated

Yes; 9/27/2007.

Legal Description

On September 27, 2007, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Fremontodendron mexicanum (Mexican flannelbush) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes obe critical habitat unit (CHU), in California (72 FR 54984-55010).

Critical Habitat Designation

The critical habitat designation for Fremontodendron mexicanum includes one CHU (2 sub-units) in San Diego County, California. This species critical habitat encompasses approximately 228 acres (ac) (93 hectares (ha)) (72 FR 54984-55010).

Subunit 1A, Cedar Canyon, Otay Mountain, San Diego County, California Subunit 1A, Cedar Canyon, consists of 145 ac (59 ha) of public land managed by the BLM. Subunit 1A contains CNDDB element occurrences 1, 13, and 16. Land in this subunit is entirely within the Cedar Canyon Area of Critical Environmental Concern (ACEC) and a Research Natural Area (RNA) (BLM 1994, pp. 1, 19, 22). The BLM has not yet developed a specific management plan that outlines how the species will be managed in the Cedar Canyon ACEC and RNA. This subunit was occupied at the time of listing and contains all of the features essential to the conservation of the species. In 1998, when Fremontodendron mexicanum was federally listed, less than 100 individual plants were documented from Cedar Canyon. This occurrence was thought to be the only location where F. mexicanum occurred naturally in the United States. Prior to the 2003 Otay fire, the canyon was dominated by Cupressus forbesii (Tecate cypress) and riparian vegetation. In late 2005 and early 2006 when this canyon was surveyed for F. mexicanum by Service biologists, over 1,000 plants were found (Snapp-Cook 2006). This increase in the number of plants may be a result of the 2003 Otay fire that burned Cedar Canyon as this species is a facultative resprouter (i.e., resprouts and produces seedlings after fire). The phenomenon of F. mexicanum resprouting following fire was also recorded following a 1979 fire in Cedar Canyon (CNDDB 2005 p. 1). The PCEs in this subunit may require special management considerations or protection to address negative impacts related to fire fighting activities (PCE 1) and negative impacts from the growth of nonnative species that may affect the space available for this species (PCE 1, 2, and 3). Subunit 1B, Little Cedar Canyon, Otay Mountain, San Diego County, California Subunit 1B, Little Cedar Canyon, consists of 83 ac (34 ha) of public land managed by the BLM. Little Cedar Canyon is located approximately 1.9 mi (3 km) to the west of Cedar Canyon. The land in this subunit is part of the Otay Mountain Wilderness Area. This site was not discovered until after the species was listed; however, we believe that it was occupied at the time of listing. Thirty-one healthy plants were documented in Little Cedar Canyon in the summer of 2006, and evidence of mature seed was detected (Martin 2006). Although this occurrence is small when compared to the more than 1,000 plants observed in Cedar Canyon in early 2006 (Snapp-Cook 2006), the Little Cedar Canyon occurrence will help to stabilize the existence of F. mexicanum in the United States and the discovery of F. mexicanum in Little Cedar Canyon almost doubles the amount of known occupied habitat for this species in the United States. The PCEs in this subunit may require special management considerations or protection to minimize impacts related to fire fighting activities and to the invasion of nonnative species that may affect the space available for this species (PCE 1, 2, and 3).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Fremontodendron mexicanum critical habitat consists of three components (72 FR 54984-55010):

(i) Alluvial terraces, benches, and associated slopes within 500 feet (152 meters) of streams, creeks, and ephemeral drainages where water flows primarily after peak seasonal rains with a gradient ranging from 3 to 7 percent; and stabilized north- to east-facing slopes associated with steep (9 to 70 percent) slopes and canyons that provide space for growth and reproduction.

(ii) Silty loam soils derived from metavolcanic and metabasic bedrock, mapped as San Miguel—Exchequer Association soil series that provides the nutrients and substrate with adequate drainage to support seedling establishment and growth.

(iii) Open Cupressus forbesii and Platanus racemosa stands at elevations of 900 feet (274 meters) to 3,000 feet (914 meters) within a matrix of chaparral (such as Dendromecon rigida ssp. rigida and Malosma laurina) and riparian vegetation that provides adequate space for growth and reproduction.

Special Management Considerations or Protections

Fremontodendron mexicanum does not face direct threats from urban development; however, the PCEs for this species may require special management considerations or protection to address the threat from nonnative species. Nonnative plant species such as Tamarix spp. (salt cedar) and Cortaderia selloana (Pampas grass) could reduce the amount of space available to F. mexicanum (PCE 1 and 2) and alter the vegetation community (PCE 3) if they become well established in either Cedar Canyon or Little Cedar Canyon. In addition, the PCEs for this species may require special management considerations or protection to address negative impacts related to fire fighting activities. Fire fighting activities may alter the alluvial terraces and benches that F. mexicanum grows on (PCE #1) if activities occur directly in the streambed adjacent to where F. mexicanum occurs. Special management may be needed to insure that fire fighting activities do not alter these areas or that measures are in place to restore damage to habitat after the activities occur. Likewise, future fuel breaks should be designed such that they do not create situations were extra run off is channeled into the canyons thus increasing the scouring that occurs in the creek bottoms and eroding the terraces and benches where F. mexicanum grows (PCE #1). In our unit descriptions for this designation, we further describe the threats requiring special management considerations or protection for each subunit.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual: vegetative (USFWS, 2009)

Lifespan

Adult: 2+ years (inferred from USFWS, 2009)

Breeding Season

Adult: March - June (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Presumably insect pollinators (USFWS, 2009)

Reproduction Narrative

Adult: Fremontodendron mexicanum is a perennial plant species that flowers from March to June (Munz 1974, p. 843); however, no studies on the longevity of this species have been conducted. The showy nature of the flower and the presence of nectar pits at the base of the sepals suggest that pollen is transferred from flower to flower by insect pollinators, but a focused pollination study has not been conducted. Fremontodendron mexicanum reproduces, at least partially, by the regrowth from underground roots and runners (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Southern mixed chaparral, closed cone coniferous forest dominated by Tecate cypress (Cupressus forbesii) (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 3,000 ft., elevation (USFWS, 2009)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits slopes covered with southern mixed chaparral, closed cone coniferous forest dominated by Tecate cypress (Cupressus forbesii), and canyons (NatureServe, 2015). This species grows in chaparral habitat, a habitat type that is adapted to periodic fires, and F. mexicanum is associated with species such as Callitropsis forbesii (Cupressus forbesii, Tecate Cypress), that require fire as a part of their life cycle (Dunn 1987, p. 367). It is often found in association with metavolcanic soils (Oberbauer 1991, pp. 1-9; Reiser 1996, pp. 92-92). Fremontodendron mexicanum grows on alluvial benches associated with ephemeral drainages and also on the associated canyon slopes. The elevation range of this species is now considered to range from sea level to 1,000 meters (3,000 feet) (USFWS, 2009).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: When fully ripened, the capsule splits open at the tip and the seed are cast from the plant when shaken by wind, hail, or animal disturbances (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2009)

Number of Populations:

6 presumed extant natural populations (USFWS, 2022)

Population Size:

6,000 (USFWS, 2009)

Population Narrative:

F. mexicanum occurs in three canyons on the northwestern slope of Otay Mountain and that there are approximately 6,000 plants in these three canyons, compared to fewer than 100 plants known at listing (USFWS, 2009). In 2009, we recognized four extant Fremontodendron mexicanum occurrences (three in the United States and one in Mexico). Since then, we received new information about the status and threats of this species. We also received new information about three threats which were not discussed in the 2009 5-year review: trail use, agriculture, and mining. Trail use is present at occurrences in the U.S., and agriculture and mining are threats to F. mexicanum in Mexico. Due to reintroduction activities on the SDNWR and discoveries of new occurrences in Mexico, we are aware of four more locations of Fremontodendron mexicanum in 2022 compared with 2009: two reintroduction sites and two new locations in Baja California. There are 13 site-native occurrences of F. mexicanum across the species' range. Six occurrences are extant or presumed extant (Table 1). In addition to the new occurrences and updated occurrence status, a study of Fremontodendron mexicanum reproductive ecology has provided new information about seed germination, pollination, and seed dispersal (USFWS, 2022).

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Following the 2007 fire on Otay Mountain, hundreds of seedling and sapling tamarisk plants were found growing throughout Cedar Canyon (Gasser 2007, p. 201). Goodwin and Sheley (2001, p. 15) noted that as a result of fire, open areas containing high levels of nutrients in full sun, favor the invasion and spread of weedy nonnative species. Additionally, Tamarix ssp. has been shown to decrease the water available to native plants in riparian habitats (DeLoach et al. 2000, pp. 835–844). At this time, the infestation of tamarisk is in its initial phase and can be controlled in the canyons where Fremontodendron mexicanum grows. This threat could increase in magnitude if left unchecked (USFWS, 2009).

Stressor: Border control activities (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The area where F. mexicanum occurs (i.e., Otay Mountain Wilderness Area) is heavily patrolled by DHS. Although the Otay Mountain Wilderness Area is off-limits to most road construction and vehicle use, the DHS is allowed to conduct operations for border control. Fremontodendron mexicanum could be impacted by road construction and vehicle use. Possible impacts associated with DHS activities could alter the habitat for F. mexicanum, such as (1) the use of all-terrain vehicles in canyon bottoms; (2) construction of roads in canyon bottoms; and (3) cut and fill work associated with road construction (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: In addition to the genetic concerns associated with small population size, the Service is concerned that a single catastrophic event could threaten this species. The three occurrences that we know of are all in close proximity and lack the geographic separation that could provide protection from catastrophic events. As seen in 2003 and 2007, when this area experienced fire, all three of the known occurrences were impacted to some degree. Other events, such as disease or insect infestation, might easily impact all three of these occurrences (USFWS, 2009).

Stressor: Altered fire regime (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Fremontodendron mexicanum grows in mixed chaparral and closed-cone coniferous forest dominated by Callitropsis forbesii. Both of these vegetation types are susceptible and naturally adapted to naturally occurring fires. These habitat types show evidence of time-dependent, self-regulating fire cycles under natural conditions (Minnich 2001, p. 1549). Fires that occur at longer or shorter intervals than the natural cycle or during the reproductive seasons may imperil fire-adapted species in these ecosystems. A change in the frequency of the natural fire regime can impact the effectiveness of these adaptations to fire. If F. mexicanum relies on seed to regenerate such frequent fires may not allow time for a substantial seed bank to collect. If F. mexicanum reproduces mostly by resprouting, then repeated fires at a short interval may be limiting the ability of the population to adapt and react to environmental changes (Keeley 1986, pp. 95–112) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 5–6° F (Morse et al. 1995, p. 393). Whether or not this would include Fremontodendron mexicanum is unknown (USFWS, 2009).

Recovery

Reclassification Criteria:
Recovery Priority Number: 9 (USFWS, 2022)

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Resurvey historical occurrences and survey potential habitat to determine if there are any other native occurrences of Fremontodendron mexicanum that are extant (USFWS, 2009).
- Determine the breeding system and pollinators for the taxon. This will assist us in determining what, if any, bottlenecks in reproductive output are due to these factors (USFWS, 2009).

- Determine the distribution of genetic diversity at the various occurrences. This will assist us in identifying higher priority occurrences for potential translocation source materials. This will help us to better understand how this species will be able to adapt to future environmental changes and how this species will withstand possible catastrophic events (USFWS, 2009).
- Establish site and species monitoring protocols to identify how this species is impacted by future fires and how the occurrences regenerate following fire. This will help us understand the species' responses to the change in fire frequency and what management actions are appropriate (USFWS, 2009).
- Support and provide assistance to the San Diego National Wildlife Refuge in their efforts to introduce new populations of Fremontodendron mexicanum to suitable unoccupied habitat. These efforts are described in the "United States Fish and Wildlife Service Preventing Extinction Grant" discussion above (USFWS, 2009).
- Establish a working group that will coordinate conservation efforts for this species. This group should focus on coordination between Federal agencies (e.g., Service, BLM, DHS), MSCP staff (e.g., County of San Diego), Otay Ranch, and Mexico (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that the following actions be completed over the next 5 years to manage threats to Fremontodendron mexicanum and aid in recovery efforts. We recognize that conservation of this species will require cooperation and coordination with partners. 1. Support partners to enhance habitat and manage nonnative plants at F. mexicanum occurrences. 2. Identify opportunities to work with private landowners to conserve F. mexicanum. Purchase private lands occupied by F. mexicanum from willing sellers. 3. Augment the F. mexicanum reintroduction sites on the SDNWR. Identify other potential reintroduction sites and work with interested landowners to establish additional locations of F. mexicanum. 4. Coordinate with the SDMMP on the development of a Rare Plant Management Plan for F. mexicanum, which includes species-specific best management practices and identifies research needs. 5. Work with partners in Mexico to identify additional survey areas and prioritize conservation actions (USFWS, 2022).

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SPECIES ACCOUNT: *Galactia smallii* (Small's milkpea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/19/1985; Southeast Region (R4)

Physical Description

Galactia smallii is a small, trifoliolate, perennial legume with small, purple flowers and a prostrate habit. The stems are grayish, due to a covering of short hairs, and grow up to 2 m long. The stem internodes are well-developed and have long, straight, soft hairs. The 1 to 2.2 cm long leaflets are broadly ovate to elliptic. The undersides of the leaves have long, soft, wavy hairs lying almost flat against the surface. The upper surface of the leaves are either hairless (glabrate) or have sparse, stiff hairs, lying flat on the surface (strigose). The inflorescences are 2 to 6 cm long with one to five flowers at the apex or along the axis. The flower buds are 5 to 7 mm long, and the calyx is about 7 mm long and loosely strigulose. The corolla is 11 to 12 mm long and pinkish purple or lavender. The legume is 3 to 4 cm by about 4 m in size and is strigulose or villosulous (Isley 1990). (USFWS, 1999)

Taxonomy

Small's milkpea was originally described as G. prostrata by Small in 1933. However, H.J. Rogers (unpublished dissertation, Duke University, 1949) discovered that this name is a homonym, unavailable for use, and suggested G. smallii. Since Rogers' proposal was never published, the incorrect name persisted. Herndon (1981) published Rogers' finding and proposed the name change to G. smallii. (USFWS, 1999)

Historical Range

The historic range of Small's milkpea is not well known. When this species was listed, it was known from two sites near Homestead in Miami-Dade County. (USFWS, 2010)

Current Range

Miami-Dade County, Florida, in a narrow region across a 6.5-mile area, and the Homestead Air Reserve Base (USFWS, 2019).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Small's milkpea is a perennial legume that usually flowers during the summer months. However, numerous flowers may occur following a burn at anytime throughout the year (Small 1933, and Long and Lakela 1971). Fire may synchronize and intensify flowering of plants in the burned area (A. Herndon, personal communication 1998). Its pollinators include three species of bees, one species of wasp, and the Cassius blue butterfly (Leptotes cassius theonus). (USFWS, 1999)

Habitat Type

Adult: Pine rocklands/rockland hammocks (USFWS, 1999)

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: Preliminary results of a study of the abundance, distribution, and habitat preferences of Galactia species in Miami-Dade County pine rocklands indicate that G. smallii prefers higher elevations and lower shrub cover than the more common Galactia species (O'Brien 1994). The distribution of G. smallii is correlated with soil depth and color in Redland pine rocklands. It does not occur in sites with a high amount of exotic plant cover, specifically, Schinus terebinthifolius and Neyraudia reynaudiana (O'Brien and Koptur 1995). (USFWS, 1999)

Dispersal/Migration

Population Information and Trends

Number of Populations:

24 sites (USFWS, 2019)

Population Size:

~120,000 (USFWS, 2019)

Population Narrative:

Galactia smallii is only known from the pine rocklands of Miami-Dade County. The remaining G. smallii populations occur entirely within a narrow region of pine rockland fragments that includes 24 sites – 8 public and 16 private (Bradley, 2010b; Lange, pers. comm. 2017; Possley, pers. comm. 2017) across a 6.5-mile (10.5 km) area within Miami-Dade County. However, a single population at Homestead Air Reserve Base (HARB), contains up to 100,000 individuals (Bradley 2009). Miami-Dade County owns seven of the public sites, purchased for conservation purposes, and is working to restore and manage these lands through their Environmentally Endangered Lands (EEL) program. The final public site, HARB, is seeking to develop their lands, however, they are also coordinating with the Service and IRC to retain and manage the population at this site. G. smallii populations on the 16 private sites range in size from 3 to 1,000 individuals per site (Bradley, 2010b; Lange, pers. comm. 2017; Possley, pers. comm. 2017a). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation
Exposure:
Response:
Consequence:
Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside

of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Indequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: Currently, regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated these species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants, nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Inadequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire suppression continues to affect Amorpha crenulata(Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Nonnative invasive plants
Exposure:
Response:
Consequence:
Narrative: Invasion by exotic plant species continue to affect Amorpha crenulata (Factor E). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree (Bradley and Gann 1999; Bradley 2006; Bradley and Saha 2009; Bradley and van der Heiden 2013). (USFWS, 2019)

Recovery

Reclassification Criteria:
Not developed (USFWS, 1999; USFWS, 2010)

Delisting Criteria:

1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

2. A network of 5 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)

4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:

- Conduct surveys to determine distribution of pine rockland plants. Pine rockland plants have been thoroughly surveyed in Miami-Dade County. However, other populations may be noted during acquisition and restoration program implementation. Fire may eliminate litter concealing listed species, or enable seeds in the seed bank to germinate. For that reason, pine rocklands that did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of pine rockland plants that populations not be lost. (USFWS, 1999)
- Conduct research on the biology of G. smallii. Additional information on the ecology and life history of pine rockland plants needs to be collected. Determine size and viability of all populations. Known populations of the listed pine rockland plants should be evaluated. Population viability needs to be investigated and determined for each listed plant species. (USFWS, 1999)
- Develop standardized monitoring. Standardized monitoring needs to be developed for listed pine rockland species in order to determine the effect of management actions on these species. Use existing standardized monitoring protocols developed by the Florida Natural Areas Inventory to record baseline data regarding the biology and ecology of G. smallii. Initiate quarterly monitoring program. (USFWS, 1999)
- Continue to provide public information about pine rocklands and their unique flora. Public support will increase the chances of recovery for these species. Informational and educational materials have been produced. DERM and Miami-Dade County Natural Areas Management have developed flyers, displays, newsletters, and press releases, and have held workshops with the general public. Organizations best able to carry out information and education programs include: Miami-Dade County Parks and Recreation Department, the Florida Native Plant Society, Everglades NP, and Miami-Dade County DERM. Support of local press coverage should continue. DERM has developed a web page that will also aid in disseminating information about this endangered plant community to the public. (USFWS, 1999)
- Habitat-level Recovery Actions: Continue to protect and prevent degradation of pine rockland plant habitat. Restore areas to suitable habitat. Continue to investigate and refine the habitat needs of each species. Monitor habitat and ecological processes. Continue

implementation of the fire education program and modify as necessary any fire management education program that has been developed. (USFWS, 1999)

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SPECIES ACCOUNT: *Galium californicum ssp. sierrae* (El Dorado bedstraw)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/18/1996; Pacific Southwest (R8)

Physical Description

A softly hairy perennial herb in the coffee family (Rubiaceae). Four narrow leaves are arranged at each node. The pale yellow flowers, which are clustered at the tips of stems, appear in May and June. Minute hairs cover the fleshy fruit. Galium aparine (stickywilly), G. bolanderi (Bolander's bedstraw), G. divericatum (Lamarck's bedstraw), G. porrigens var. tenue (graceful bedstraw), G. parisiense (wall bedstraw), and G. pubens (limestone bedstraw) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). Galium californicum ssp. sierrae is not easily confused with any other species of Galium (Dempster 1977) and can be distinguished from other subspecies of G. californicum by its very narrow leaves. (USFWS, 2002)

Taxonomy

The type specimen for Galium californicum ssp. sierrae was collected 1.7 kilometers (1 mile) north of Pine Hill Lookout in western El Dorado County, California. Dempster and Stebbins (1968) described G. californicum ssp. sierrae. (USFWS, 2002).

Historical Range

Restricted to the Pine Hill formation in western El Dorado County, California. (USFWS, 2002)

Current Range

Restricted to the Pine Hill Preserve and immediate vicinity in El Dorado County, California. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1996)

Lifespan

Adult: 2+ years (inferred from USFWS, 2002)

Breeding Season

Adult: May - June (USFWS, 2002)

Key Resources Needed for Breeding

Adult: Periodic fire (USFWS, 1996)

Other Reproductive Information

Adult: Little is known about the reproductive biology, ecology and demography of El Dorado bedstraw; however, the species was documented to have resprouted post-wildfire (Wilson et al. 2009). (USFWS, 2019a)

Reproduction Narrative

Adult: Flowers appear in May and June. This species is a perennial (USFWS, 2002). Fire is important for seed germination and seedling reestablishment by eliminating competition and shading, as well as replenishing nutrients to the soil. Without periodic fires, the previously mentioned plants either do not reproduce by seed or may become shaded by other plants (USFWS, 1996).

Habitat Type

Adult: Terrestrial (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Oak and oak-pine woodland (USFWS, 2002)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: 453 - 2,060 ft. elevation (USFWS, 1996)

Habitat Narrative

Adult: Galium californicum ssp. sierrae inhabits oak woodland areas, including sites with Pinus ponderosa (ponderosa pine) and Pinus sabiniana (foothill pine) (Wilson 1986). It occurs within black oak woodland on Pine Hill and Cameron Park and within live oak woodland in Shingle Springs and Salmon Falls (L. Eng in litt. 1999). (USFWS, 2002)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information is available regarding dispersal.

Population Information and Trends

Population Trends:

Increasing (USFWS, 2019a)

Number of Populations:

16 (USFWS, 2019a)

Population Size:

Greater than 21,000 individuals (USFWS, 2019a)

Population Narrative:

There have been numerous newly discovered populations of El Dorado bedstrawreported to CNDDB since listing. In general, a direct comparison of species abundance in 2019 versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. However, given the increase in the number of populations of El Dorado bedstraw, it is likely that overall abundance has increased for those species (CNDDB 2018). (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat loss and fragmentation (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

Stressor: Land use activities (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: The increasing number of people and changes in land uses will continue to place an increasing strain on undeveloped areas through activities such as off-road vehicle traffic, unauthorized garbage dumping, and changes in the pattern of wildfires. Horse paddocking in rural residential areas within the central and northern portions of the Pine Hill formation threatens Galium californicum ssp. sierrae. The horses, when confined, severely graze or trample most available vegetation. The herbaceous gabbro plants are especially likely to be grazed (J. Van Ess pers. comm. 1993) (USFWS, 2002).

Stressor: Alteration of the natural fire regime (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for El Dorado bedstraw establishment and possibly the scarification of seeds needed for germination.

(USFWS, 2019a)

Stressor: Invasive plant competition (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). (USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: The State's authority to conserve rare wildlife and plants is comprised of four major pieces of legislation: the California Endangered Species Act, the Native Plant Protection Act, the California Environmental Quality Act, and the Natural Community Conservation Planning Act. The State may authorize permits for scientific, educational, or management purposes, and to allow take that is incidental to otherwise lawful activities. Landowners are exempt from the prohibition for plants to be taken in the process of habitat modification. Protection of listed species through California Environmental Quality Act isdependent upon the discretion of the lead agency involved. The National Environmental Policy Act (NEPA) does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. More details about existing protections are provided in the 2019 5-Year Review. (USFWS, 2019a)

Recovery

Reclassification Criteria:
1. Secure and protect specified recovery areas from incompatible uses: (a) Pine Hill preserve, Salmon Falls/Martel Creek preserve; (b) Cameron Park preserve north of Highway 50; and (c) Specialty Galium preserve and occupied habitat; along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer at all known sites. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all populations and any occupied or unoccupied habitat identified as necessary for survival. (USFWS, 2002)

3. Monitoring in all recommended preserves shows: (a) Stable or increasing with evidence of natural recruitment for a period of 60 years (or longer if suggested by the results of demographic monitoring). (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats; (b) Ecological studies; (c) seeds stored in at least two Center for Plant Conservation certified facilities; (d) research on seed germination and propagation techniques; (e) effects of fire studied; (f) successful enhancement, repatriation, or

introduction at Salmon Falls/Martel Creek. (g) Maintain metapopulation dynamics of at least 1 large, 6 medium occurrences, and 5 small occurrences at any given time throughout the range of the species. (USFWS, 2002)

Delisting Criteria:
E/1: Number of populations with specific geographic distribution. The 12 bedstraw populations must persist in at least four different preserve units. Populations species must persist at the size described in E/2, for at least two full fire cycles. (USFWS, 2019b)

E/2 Number of plants per population: Of the 12 populations of bedstraw required for down and delisting, small, medium, large, and very large populations must contain the number of plants described as follows. Based on the size of each population, the minimum number of mature plants in each population are: Small (at least five populations): 1,750; Medium (at least six populations): 8,400; Large (at least one populations) 14,875; Total number of plants: 74,025. (USFWS, 2019b)

Recovery Actions:
- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species.

Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified.

- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Cameron Park Area, northwest part of Salmon Falls, and Martel Creek . Reproduction and Demography Research: Including determining limiting life stages and reproductive biology, seed production and survival in soil to determine appropriate fire return period. Genetics research. Other Research Needs: Effects of fire; fire management techniques; germination requirements and propagation techniques; metapopulation analysis; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of habitat restoration/ enhancement. Management Actions Needed: General surveys; baseline monitoring; monitoring for trends of populations, success of management actions, and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; enhancement and introduction; seed banking. (USFWS, 2002)
- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Conduct controlled burns at all appropriate preserve units to maintain multiple populations of bedstraw within a shifting mosaic of woodland and chaparral that contains early, middle and late seral vegetation stages. Priority 1 (USFWS, 2019b)
- Conduct outreach to private landowners residing adjacent to existing preserves and/or other private landowners within suitable habitat of these species to provide education on avoiding degradation of habitat and to encourage the voluntary sale of conservation easements by willing landowners. Priority 1 (USFWS, 2019b)
- Conduct genetic analyses to determine areal size of individuals/extent of clonality and population structure in order to define individuals of bedstraw. Priority 2 (USFWS, 2019b)
- Conduct population viability analyses for bedstraw. Priority 2 (USFWS, 2019b)
- Conduct research into the regeneration ecology of bedstraw. Priority 2 (USFWS, 2019b)
- Conduct research to determine effective means of mechanical and other non-fire related control of chaparral to benefit gabbro soil species. Priority 2 (USFWS, 2019b)

- Conduct outplantings of bedstraw, specifically at the Salmon Falls/Martel Creek unit where substantial suitable habitat exists. Priority 2 (USFWS, 2019b)
- 8. Develop a monitoring plan to span 5 years post-delisting of bedstraw and implement the plan at the time of delisting to measure the (USFWS, 2019b)
- Pine Hill Ecological Reserve (97 hectares [240 acres]) was established in 1979 to protect the gabbro plants located on the summit of Pine Hill (USFWS, 2002).
- The California Natural Diversity Data Base, James Wilson's masters thesis (Wilson 1986), survey reports prepared by environmental consultants, interviews with local botanists, and EIP Associates' field surveys were used to determine the location of clusters of rare plants occurring on the Pine Hill formation (EIP Associates 1991). Twenty-two clusters of rare plant species were initially identified. This study, completed in November 1991, identified 12 potential preserve sites (EIP Associates 1991) (USFWS, 2002).
- In 1992, the California Department of Fish and Game, Bureau of Land Management, and Bureau of Reclamation signed a memorandum of understanding to protect the gabbro plant habitat along the South Fork of the American River (California Department of Fish and Game 1992) (USFWS, 2002).
- The Rare Plant Advisory Committee recommended three main preserve sites--Salmon Falls, Pine Hill, and Cameron Park/Shingle Springs--and two smaller satellite preserve areas--Martel Creek and Penny Lane. The total acreage of the five preserves that the Rare Plant Advisory Committee proposed was approximately 1,416.6 hectares (3,500 acres) (USFWS, 2002).
- In 1993, the California Department of Fish and Game applied for and received a section 6 grant from us to investigate funding mechanisms for land acquisition. A draft economic feasibility study for acquiring the rare plant preserves, prepared by Economic & Planning Systems, Inc., was published in 1997 (USFWS, 2002).
- Our February 27, 1995, biological opinion on the interim renewal by Bureau of Reclamation of 67 water service contracts on the Central Valley Project (including water contracts for El Dorado County) identified implementation of a preserve system for the five federally listed gabbro plants as a critical need (U.S. Fish and Wildlife Service 1995). The critical needs analysis for these plants specifically noted the importance of a preserve in the southern zone (Cameron Park) of the Pine Hill formation (USFWS, 2002).
- From 1990 to 1996, California Department of Fish and Game and the American River Conservancy purchased approximately 123 hectares (305 acres) in the Salmon Falls area for $1,600,000. In 1990, the Wildlife Conservation Board approved the purchase of a 16.2-hectare (40-acre) parcel near Salmon Falls with Proposition 70 funds. Proposition 117 funds were used to acquire 16.2 hectares (40 acres) in the Salmon Falls area in 1991 (California Department of Fish and Game 1992). An additional six parcels totaling about 91 hectares (225 acres) in the Salmon Falls Area have been purchased from willing sellers with grant funds raised by the American River Conservancy and the California Department of Fish and Game, as well as funding from mitigation for a private development in Cameron Park. These properties are managed by California Department of Fish and Game (USFWS, 2002).
- On July 28, 1998, the El Dorado County Board of Supervisors adopted Ordinance 4500, which established an ecological preserve mitigation requirement or an in-lieu fee for certain development projects in western El Dorado County. El Dorado County is currently implementing this impact fee program to augment the funds needed to fund the acquisition and administration of the preserve system (El Dorado County 1998) (USFWS, 2002).

- With Congressman John Doolittle's support, Congress appropriated $5,000,000 of Land and Water Conservation Fund money to be administered starting in fiscal year 2001 by the Bureau of Land Management. In fiscal year 2002, an additional $3,000,000 of Land and Water Conservation Fund money were allocated. $4,008,400 of Land and Water Conservation Funds have been used for land acquisition in the Cameron Park area as of January 2002 (USFWS, 2002).
- In 2001, a cooperative management agreement for the Pine Hill Preserve in El Dorado County was signed by three Federal agencies (Bureau of Land Management, U.S. Fish and Wildlife Service, and U.S. Bureau of Reclamation), two State agencies (California Department of Fish and Game and California Department of Forestry and Fire Protection), El Dorado County, El Dorado Irrigation District, and the American River Conservancy. The primary goal of the Pine Hill Preserve is the preservation in perpetuity of the rare plant species and communities of the western El Dorado County gabbro formation (USFWS, 2002).
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019a)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species. (USFWS, 2019a)

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SPECIES ACCOUNT: *Gardenia brighamii* (Hawaiian gardenia (=Na`u))

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/21/1985; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Gardenia brighamii is a small tree up to 20 feet (6.096 m) in height. Trunks are up to 12 in (30.48 cm) in diameter and somewhat smooth. The shiny, dark green leaves are oval-shaped and measure from 1 to 4 in (2.2 to 10.5 cm) long and 1/2 to 2 in (1.5 to 5.5 cm) wide. The solitary flowers are white and very fragrant. The flowers range in size from 1 to 1 1/2 in (2.54 to 3.81 cm) in diameter. Fruits are hard, round, greenish, and moderate in size - about 1 1/2 in (3.81 cm) in diameter. The inside of the fruit is fleshy and contains many small seeds. Gardenia brighamii is not known to reproduce vegetatively in the wild, but can be air-layered using horticultural techniques. (USFWS, 1993)

Taxonomy

There are three gardenia species native to Hawaii: G. brighamii, G. manni, and G. remyi. All three are also endemic to Hawaii. (USFWS, 1993)

Historical Range

Historical records from Maui and Hawaii. (NatureServe, 2015)

Current Range

Current populations from Oahu, Lanai and Molokai. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: >65 years (USFWS, 1993)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 1993)

Breeding Season

Adult: Primarily in spring (March through May) (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Flowering is correlated with rainfall (USFWS, 1993)

Reproduction Narrative

Adult: Gardenia brighamii reproduces sexually. Growth rates and longevity are not known, though the single tree at Kuua, Oahu, has been under observation since at least 1925, a period of over 65 years. Flowering and fruiting times vary among the populations. On Oahu and Hawaii, flowering is primarily from October through December. On Maui, Molokai, and Lanai, flowering is primarily in the spring (March, April, and May) with sporadic flowering in December and July. It has been suggested that flowering is positively correlated with rainfall (John Obata, Hawaii Plant Conservation Center, personal communication to Gagne 1982). The original pollen vector is not known, but the flowers would suggest an insect. Gardenia brighamii is apparently self-compatible and seedlings resulting from self pollination have shown high survivability. (USFWS, 1993; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- mixed, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,000 to 1,800 feet; rainfall from 15 to 35 in per year; and vegetation is low and windswept (below 20 ft in height) (USFWS, 1993)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1993)

Habitat Narrative

Adult: Gardenia brighamii is found in dry scrub and forests on the leeward sides of the main Hawaiian islands. The populations receive 15 to 35 in (38.1 to 88.9 cm) of rain per year and experience a summer drought (Gagne 1982, Spence and Montgomery 1976). Sites are generally located at low to mid elevation (1,000 to 1,800 ft; 304.8 to 548.6 m) with well drained, lateritic soils of low fertility (Gagne 1982). Slope ranges from gradual to steep and the aspect is variable. The surrounding vegetation is usually low and windswept, rarely exceedng 20 ft (6.096 m) in height (Gagne 1982). Gardenia brighamii is a component of the Diospyros sandwicensis, and Erythrina sandwicensis dry forest communities (Gagne and Cuddihy 1990). Associated native species include: Diospyros sandwicensis, Nestegis sandwicensis, Erythrina sandwicensis Nototrichium sandwicensis, Nesoluma polynesicum, Bobea sandwicensis, Santalum freycinetianum, Nothocestrum latifolium Pouteria sandwicensis, Rauvolfia sandwicensis, Dodonaea viscosa, Waltheria indica. (USFWS, 1993)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The original dispersal agent is not known, but was most likely a bird. (USFWS, 1993)

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

~5 (USFWS, 2014)

Population Size:

~10 wild 155 outplanted that persist (USFWS, 2021)

Population Narrative:

In 2011, there were five wild mature individuals, 81 reintroduced seedlings, and 58 augmented seedlings on Lanai; and a single wild mature individual, single mature reintroduced individual, and 20 immature reintroduced individuals on Oahu (PEPP 2011). In 2012, a single wild mature individual remained on Oahu (PEPP 2012). On Lanai, there are 3 populations containing 12 wild individuals (PEPP 2012). (USFWS, 2014) Currently there are approximately are nine wild individuals of Gardenia brighamii on Lānaʻi and one wild individual on Oʻahu. Three subpopulations are within exclosures on Lānaʻi, with some nonnative plant control at two populations on Lānaʻi and one population on Oʻahu. Seeds and propagules are in storage representing three founders from Oʻahu, more than eight founders from Lānaʻi, and one founder from Molokaʻi. Propagation is ongoing and more than 200 individuals were outplanted on Oʻahu, one outplanted on Molokaʻi, three outplanted on east Maui, and 244 outplanted on Lānaʻi (155 persist). At least seven plants comprise living collections at NTBG botanical gardens and many founders from Oʻahu and Lānaʻi are represented at Koko Crater Botanical Garden (USFWS, 2021)

Threats and Stressors

Stressor: Drought (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Unprecedented drought conditions threaten the survival of G. brighamii on Maui and Oahu (PEPP 2009, 2011, 2013), and Lanai (PEPP 2010, 2011, 2012, 2013). (USFWS, 2014)

Stressor: Herbivory by the black twig borer (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Herbivory by black twig borer has been identified as a threat to this species on Lanai (PEPP 2013). (USFWS, 2014)

Stressor: Herbivory by slugs (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Herbivory by slugs is a threat to the reintroduced individual on Molokai (PEPP 2012). (USFWS, 2014)

Stressor: Overutilization (USFWS, 2014)
Exposure:

Response:
Consequence:
Narrative: Overutilization for commercial, recreational, scientific, or educational purposes – Gardenia brighamii that originated from natural populations, but is now grown from seed or vegetative propagules produced in nurseries, is available for sale by multiple nurseries and home improvement stores only within the State of Hawaii. (USFWS, 2014)

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Climate change degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Gardenia brighamii is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2014)

Stressor: Herbivores (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Numerous species of mammalian herbivores have been introduced into Hawaii, notably cattle, goats, pigs and deer. Their introduction (and continued existence) has been the single most destructive aspect of European contact. These animals destroy Gardenia brighamii and other native species not only by grazing, browsing, and trampling, but also indirectly by increasing erosion and soil compaction, dispersing the seed of alien plants, and creating disturbances which allow alien plant competitors to become established. (USFWS, 1993)

Stressor: Land conversion (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: The clearing of dry forest for agricultural and urban uses was without question an important contributor to the endangerment of Gardenia brighamii. However, this activity is not known to be a threat to the existing sites. (USFWS, 1993)

Stressor: Fire (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: The early Hawaiians apparently used fire to clear forests and to maintain desired habitats (Cuddihy and Stone 1990). European colonization also resulted in an increased frequency of fire, though most fires were, and are, unintentional. Fire poses a serious threat to Gardenia brighamii by killing trees outright and by creating disturbances which generally favor alien plant invaders over the slower-growing native species. Because the remaining individuals of

G. brighamii are in small, localized populations, fire should be viewed as a catastrophic event from which the populations would probably not recover. None of the populations or fenced exclosures are protected by firebreaks. (USFWS, 1993)

Stressor: Predation by rats (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Reportedly, rats climb into C. brighamii trees and eat or damage the fruits (Gagne 1982). (USFWS, 1993)

Stressor: Fungus (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Gagne (1982) reported that the C. brighamii trees on Lanai were affected by some sort of fungal infection or rust. The effect of this rust on growth, reproduction, or survival is not known. (USFWS, 1993)

Stressor: Insects (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Gagne (1982) also reported that various scale insects are attracted to G. brighamii. The impact of this factor on C. brighamii is not known. (USFWS, 1993)

Stressor: Alien plants (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: Alien plants pose a serious threat to the existence of Gardenia brighamii. These species probably compete with G. brighamii for light, water, space, and/or nutrients. In addition, some alien weeds may release allelopathic substances or alter the soil chemistry. Many alien species also increase the threat of fire at C. brighamii sites, because they greatly increase the fuel load of these areas. The most important alien weeds at the existing C. brighamii sites are: Lantana camara, Leucaena leucocephala, Panicum maximum, Tecoma stans, Grevillea robusta, and Schinus terebinthifolius. (USFWS, 1993)

Stressor: Soil erosion (USFWS, 1993)
Exposure:
Response:
Consequence:
Narrative: The toppling of plants due to erosion is a problem at the Molokai site, where several plants were lost due to erosion of the gully walls (Herbst 1985). (USFWS, 1993)

Recovery

Reclassification Criteria:

1. The species may be downlisted when it is represented by three naturally reproducing, healthy, fenced populations, each with 50 mature plants, on each of Lanai, Molokai, Oahu, Hawaii and Maui. (USFWS, 1993)

2. Gardenia brighamii is represented by 750 plants in: Three healthy, naturally reproducing, fenced populations, each with 50 mature plants on each of Lanai, Molokai, and Oahu. This would be a total of 450 wild plants. Three healthy, naturally reproducing, fenced populations, each with 50 mature plants on each of Maui and Hawaii. This would be a total of 300 wild plants. (USFWS, 1993)

Delisting Criteria:

1. Gardenia brighamii is represented by at least 3 populations, each with at least 100 mature, healthy, reproductive plants, on secure lands on each of Oahu, Hawaii, Maui, Molokai, and Lanai. (USFWS, 1993)

2. These 15 populations must be unfenced unmanipulated, self-reproducing, and stable over a period of 10 years. (USFWS, 1993)

Recovery Actions:

- Secure habitat of current populations and manage threats. (USFWS, 1993)
- Conduct research on limiting factors. (USFWS, 1993)
- Increase numbers and monitor. (USFWS, 1993)
- Reestablish in former range. (USFWS, 1993)
- Validate recovery objectives. (USFWS, 1993)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2014)
- Continue augmenting populations as genetically appropriate individuals become available in nurseries and as habitat is protected. (USFWS, 2014)
- Continue to survey the geographical and historical range of G. brighamii to assess the status of known populations and possible additional populations. (USFWS, 2014)
- Continue to fence wild and reintroduced populations to protect them from the impacts of feral ungulates. Maintain fencing to exclude browsing by ungulates. (USFWS, 2014)
- Control invasive introduced plants within the vicinity of G. brighamii populations and maintain the habitat free of invasive introduced plants. (USFWS, 2014)
- Continue to control rodents and mites within the vicinity of all known G. brighamii populations. (USFWS, 2014)
- Control slugs at the reintroduction site on Molokai. (USFWS, 2014)
- Continue to irrigate individuals of G. brighamii and maintain water storage tanks on Lanai to alleviate the impacts of drought. (USFWS, 2014)
- Continue to monitor all known wild, augmented, and reintroduced individuals. (USFWS, 2014)
- Develop and implement a fire management plan for populations impacted by fire. (USFWS, 2014)

- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021. • Surveys and inventories—Continue to survey geographical and historical range for a current assessment of the species' status and that of possible additional populations. • Ungulate monitoring and control—Continue to construct ungulate exclosures or strategic fencing where possible to protect all occurrences from the impacts of feral ungulates, including browsing and trampling. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species at all wild and reintroduced populations. • Fire monitoring and control—Continue to implement fire management plans for Oʻahu and develop and implement fire management plans for occurrences on Lānaʻi, Molokaʻi, and Maui. • Drought monitoring—Continue to irrigate individuals of G. brighamii and maintain water storage tanks on Lānaʻi to alleviate the impacts of drought. • Predator and herbivore monitoring and control— o Continue to implement effective rat control methods at populations to improve viable seed production. o Control slugs at the reintroduction site on Molokaʻi. o Study effects of invertebrate herbivory and infestation and determine the need for implementation of effect controls. o Study the effects of seed predation by nonnative gamebirds and develop and implement effective controls if determined to be necessary. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources into long-term storage due to the species' vulnerability to climate change. • Reintroduction and translocation— o Continue reintroduction into suitable habitat within historical range in areas that are managed for known threats. o Increase numbers of populations and individuals to build resiliency in populations and redundancy, to reduce impacts from landslides, droughts, fires, climate change, and low numbers of individuals. • Population viability monitoring and research—Continue to monitor all known wild, augmented, and reintroduced individuals. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to impacts of climate change. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2021)
- New Management Actions: • Surveys and inventories— o PEPP continues to survey and monitor all wild and reintroduced populations (PEPP 2014, 2015, 2016, 2017, 2018, 2019, 2020). o Pūlama Lānaʻi monitors all wild and reintroduced individuals on Lānaʻi (Pūlama Lānaʻi 2020). • Nonnative plant control— o PEPP reports nonnative plant control at the Waiʻanae Kai (Oʻahu) reintroduction (PEPP 2014). o Nonnative plants are controlled at Kānepuʻu Preserve (at the Kānepuʻu and Kahue Units) and at the Wahane population on Lānaʻi (Pūlama Lānaʻi 2020). • Rat control—PEPP installed and maintains rat traps at the Kapa Iki exclosure within the Kānepuʻu unit of Kānepuʻu Preserve and at Lōpā (Lānaʻi) (PEPP 2016). • Collection and propagation— o Lyon Arboretum Micropropagation Laboratory reported 1,593 explants in storage representing five founders from Lānaʻi and one founder from Oʻahu (Lyon Arboretum 2020). The Lyon Arboretum Seed Conservation Laboratory reported nearly 36,000 seeds in storage representing 11 founders from three populations on Lānaʻi, one founder from Maui, two founders from two populations on Oʻahu, and additional plants in a

living collection at Koko Crater Botanical Garden on Oʻahu (Lyon Arboretum 2020). o In 2019, the Maui Nui Botanical Garden (MNBG) reported five wild individuals from Lānaʻi represented by 300 seeds and 35 plants, and in 2020, reported previous propagation of 15 plants stored at the DT Fleming Arboretum at Puʻumāhoe in 2017 (MNBG 2020). MNBG maintained in a living collection at Kahanu Garden (MNBG 2020). o The Olinda Rare Plant Facility (ORPF) reported propagation of 113 individuals representing 10 founders from three populations on Lānaʻi (ORPF 2020). o From 2018 to 2020, the Pahole Rare Plant Facility (PRPF) propagated 77 plants from three Oʻahu founders from from Puʻukuʻua and Nānākuli (Oʻahu) (Native Ecosystems Protection and Management (NEPM) 2020; PRPF 2019). o The plant nursery for Pūlama Lānaʻi reported collection of seeds from Lānaʻi-sourced plants stored at ORPF, with 46 seeds representing three founders at Kānepuʻu, three seeds representing one founder at Lōpā, and 50 seeds representing one founder from Wahane previously stored at NTBG. All seeds were sent to Lyon Arboretum. In addition, one cutting from one wild male plant at Wahane was sent to Lyon (Pūlama Lānaʻi 2020). o PEPP conducted airlayering on one reintroduced plant on east Maui and on at least one plant each at Kānepuʻu and Lōpā (Lānaʻi) (PEPP 2016). PEPP also takes cuttings from plants at Wahane and Lōpā (Lānaʻi) for propagation and storage (PEPP 2016, 2019). o The Volcano Rare Plant Facility (VRPF) reported storage of six plants representing a living collection of two founders at the State's facility on Maui (VRPF 2020). o The National Tropical Botanical Garden (NTBG) reported storage of 275 seeds collected from one plant in a living collection, sourced from one wild plant on Oʻahu; and 335 seeds collected for research from a living collection representing several plants from Lānaʻi (NTBG 2020). NTBG reported four individuals maintained in a living collection at the Southshore Garden representing one plant from Oʻahu; and three plants sourced from Lānaʻi, Leeward Community College (NTBG 2020). o In 2014, Waimea Arboretum reported propagation and storage of 43 individuals representing two founders each from Lānaʻi and Oʻahu. Currently, the arboretum is maintaining five plants representing three founders from Oʻahu (Waimea Arboretum 2014, 2018). o There is one cloned tree representing the last known tree from Molokaʻi (male) planted outside of the State of Hawaiʻi Division of Foresty and Wildlife Baseyard on Maui (M. Keir pers. comm. 2021). o In 2014, PEPP reported that wild populations on Molokaʻi and Oʻahu have 100 percent genetic representation (PEPP 2014). • Reintroduction— o ORPF reported sending out 72 plants for reintroduction representing five founders from one population on Lānaʻi (ORPF 2020). o PRPF reported two individuals outplanted at Pahole, several dozen individuals outplanted to Keaʻau, (PRPF 2019). In addition, in 2019, 40 individuals were reintroduced to Manuwai gulch and 13 individuals were reintroduced to Kaʻawa gulch (DuPont fence) (PRPF 2019). Survival, when reported, is low (PEPP 2019). o In monitoring of reintroductions at Kānepuʻu on Lānaʻi between 2014 and 2015, PEPP reported that 102 plants survived of the 140 initially outplanted; however, by 2017, 51 survived (PEPP 2015, 2017). Three reintroduced individuals survive at ʻĀhihi-Kīnaʻu on east Maui (PEPP 2015). By 2020, there were a total of 32 individuals outplanted at ʻĀwehi (Lānaʻi) (PEPP 2020). o In 2019, the State, in cooperation with the U.S. Army, reintroduced two individuals of G. brighamii to the Manini area of the Waiʻanae mountains (Oʻahu) (Army Natural Resources Program [ANRP] 2019). (USFWS, 2021)

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SPECIES ACCOUNT: *Gardenia mannii* (Nanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Gardenia mannii, is a short-lived perennial in the Rubiaceae (coffee family). This species is a tree 5 to 15 m (16 to 50 ft) tall with lance-shaped leaves, 6 to 27 cm (2.4 to 11 in) long, and 3.5 to 10.0 cm (1.4 to 3.9 in) wide. The solitary white flowers are fragrant, open in the late afternoon, and last about two days. The corolla tube of the flower is 17 to 27 mm (0.7 to 1.1 in) long, and the lobes are 16 to 22 mm (0.6 to 0.9 in) long. The fruit is yellow to orange, broadly ellipsoid, and 1.8 to 4.5 cm (0.7 to 1.8 in) in diameter. This species is distinguished from others in the genus by the shape and number of the calyx spurs. G. mannii and G. brighamii are the only two species in the Waianae Mountains from the genus Gardenia (Wagner et al. 1999).

Historical Range

Historically, Gardenia mannii was known from seven widely scattered occurrences in the Waianae Mountains and 39 occurrences distributed along almost the entire length of the Koolau Mountains of Oahu.

Current Range

Currently, there are 23 occurrences of 93 to 105 G. mannii individuals. However, there may be a number of unrecorded plants, particularly in the wet forests of the Koolau Mountains. The majority of the known occurrences contain fewer than five individuals. They are distributed along a 42-km (26-mi) length of the Koolau Mountains, from Kaunala Gulch and Kaunala-Waimea Ridge in the north to Palolo in the south and along a 7-km (4-mi) distance in the Waianae Mountains from north Haleauau Valley to Kaluaa Gulch. Known occurrences are: Malaekahana-Waimea Summit Area (13 individuals), Pamalu (2), upper Kawainui (2), Kawailoa trail (12), Poamoho to Helemano (22), Opaeula (11 to 22), Kaiwai-Koele (1), south Kaukonahua Gulch (2), north Haleauau Gulch (4), Hanaimoa (1 to 2), Kaipapau (1), Kaluaa and Manauna (6), Kaluanui (1), Kapakahi Gulch (3), Laie trail (2), Makaua (2), Manana to Waimano Ridge (1), Papali (1), Pia Gulch (1), Pukele (1), lower Waimano (1), upper Waimano (2), and Puu Hapapa-Waieli Gulch (1). G. mannii occurrences are declining, and those that remain are small and widely dispersed, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003; Service 1998a; U.S. Army 2003a).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003 (Revised September 18, 2012), the U.S. Fish and Wildlife Service (Service) designated critical habitat for Gardenia mannii (Nanu) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Gardenia mannii (77 FR 57648-57862). The critical habitat designation includes 23 critical habitat units, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Gardenia mannii includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for Gardenia mannii includes 23 critical habitat units, covering two ecosystem types, which encompass approximately 33,624 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu— Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea. Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland

Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Gardenia mannii critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Gardenia mannii occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E)

Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu— Lowland Wet—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (E) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Gardenia mannii to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Habitat Type

Adult: Mesic or wet forests

Habitat Narrative

Adult: Gardenia mannii is usually found on moderate to moderately steep gulch slopes, ridge crests, in gulch bottoms, and on stream banks in mesic or wet forests between 82 and 1,050 m (269 and 3,444 ft) in elevation. Associated native plant species include Acacia koa, Alyxia oliviformis, Antidesma platyphyllum, Bobea sp., Boehmeria grandis, Broussaisia arguta, Cheirodendron trigynum, Cibotium glaucum, Coprosma foliosa, Dicranopteris linearis, Elaeocarpus sp., Freycinetia arborea, Hedyotis acuminata, Ilex anomala, Melicope sp., Metrosideros polymorpha, Perottetia sandwicensis, Pipturus albidus, Pisonia sp., Pouteria sandwicensis, Psychotria mariniana, Syzygium sandwicensis, and Thelypteris sp. The two occurrences located in the Waianae Mountains (Kaluaa Gulch and SBMR) may represent unique environmental adaptations. G. mannii plants have been observed with fruit and flowers throughout the year. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (HINHP Database 2001; Service 1998a).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing

Number of Populations:

23

Population Size:

<70 (USFWS, 2019)

Population Narrative:

Currently, there are 23 occurrences of 93 to 105 G. mannii individuals. However, there may be a number of unrecorded plants, particularly in the wet forests of the Koolau Mountains. The majority of the known occurrences contain fewer than five individuals. They are distributed along a 42-km (26-mi) length of the Koolau Mountains, from Kaunala Gulch and Kaunala-Waimea Ridge in the north to Palolo in the south and along a 7-km (4-mi) distance in the Waianae Mountains from north Haleauau Valley to Kaluaa Gulch. Known occurrences are: Malaekahana-Waimea Summit Area (13 individuals), Pamalu (2), upper Kawainui (2), Kawailoa trail (12), Poamoho to Helemano (22), Opaeula (11 to 22), Kaiwai-Koele (1), south Kaukonahua Gulch (2), north Haleauau Gulch (4), Hanaimoa (1 to 2), Kaipapau (1), Kaluaa and Manauna (6), Kaluanui (1), Kapakahi Gulch (3), Laie trail (2), Makaua (2), Manana to Waimano Ridge (1), Papali (1), Pia Gulch (1), Pukele (1), lower Waimano (1), upper Waimano (2), and Puu Hapapa-Waieli Gulch (1). G. mannii occurrences are declining, and those that remain are small and widely dispersed, which puts the species at risk of extinction from naturally occurring events and/or lack of reproductive vigor (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003; Service 1998a; U.S. Army 2003a). Currently there are fewer than 70 individuals of Gardenia mannii in the Koʻolau and Waiʻanae mountains. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that G. mannii is highly vulnerable to the effects of climate change. The ANRP is working to stabilize three populations of this species within managed areas. Fencing, ungulate control, rodent control, and nonnative plant control are ongoing at several populations. Collection and testing of propagation methods continue, and reintroduction efforts have begun. (USFWS, 2019)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The major threats to Gardenia mannii are habitat degradation and/or destruction by nonnative plants and animals and impacts from military activities. The non-native plants such as Clidemia hirta, Leptospermum scoparium, Passiflora suberosa, Psidium cattleianum, Psidium guajava, Rubus argutus, Schinus terebinthifolius, and Toona ciliata threaten G. mannii by altering its habitat and competing with it for nutrients, light, and space. Feral pigs can impact this species by consumption of plant parts, including fruits, or by rooting the soil, which degrades the habitat. Rats also pose a threat to this species due to consumption of fruits and other plant parts (HINHP Database 2001; Service 1998a; 61 FR 53089). Another threat to G. mannii, especially in Kapakahi Gulch, is the black twig borer. The black twig borer burrows into the branches and introduces a pathogenic fungus, pruning the host severely and often killing branches or whole plants. This pest causes slight to severe defoliation and reduced vigor (HINHP Database 2001; Service 1998a; 61 FR 53089). Occurrences of G. mannii located on military lands are threatened by fire caused by military actions and trampling from foot maneuvers. The wide distribution and small numbers

of remaining individuals make this species extremely vulnerable to inbreeding depression and destruction due to the occurrence of a catastrophic event (HINHP Database 2001; Service 1998a; 61 FR 53089).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Recovery Actions:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of Gardenia mannii. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species has identified important conservation needs. Exclosures should be constructed around the known occurrences of G. mannii to reduce impacts from feral pigs, especially those occurrences containing a few individuals. Subsequent control or removal of pigs from these areas will alleviate their impact on native ecosystems. The black twig borer has been identified as a threat to one occurrence of G. mannii. It is not known how this plant will be affected by defoliation or reduced vigor due to infestations of this non-native insect. A number of parasitic invertebrates have been introduced to control the beetle, though none of them have become established. Further research on biological control of the beetle will need to proceed cautiously as a number of rare native Hawaiian scolytids are closely related to the black twig borer. A coordinated fire protection plan for endangered plant species on City and County of Honolulu, Federal, and private lands needs to be developed and implemented. Occurrences of this species are seriously threatened by rat predation. Rats are a threat to G. mannii and should be controlled in the vicinity of all known occurrences using approved rodenticides and ultimately an aerial dispersal of rodenticide (Service 1998a; U.S. Army 2003a). Ongoing Conservation Actions: The Army is currently experimenting with different methods to control pigs in areas adjacent to Gardenia mannii in SBMR. The Lyon Arboretum and the National Tropical Botanical Garden have successfully propagated and stored the seeds of this species. The Honolulu Botanical Garden has a living collection of G. mannii (Service 1998a; Service 2002). The Service is currently not aware of any other conservation efforts for this species.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys, inventories, and monitoring—Continue monitoring occurrences. • Ungulate monitoring and control—Continue to fence and monitor all populations to provide protection against the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species, and those that compete with Gardenia mannii at all populations. • Fire destruction and habitat degradation—Implement coordinated fire

protection plan and fire control efforts. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Rodent predation and herbivory—Implement rat control methods at all populations. • Insect predation—Research and implement effective methods for control of the black twig borer. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o Develop reliable propagation methods and continue air-layer collection and propagation efforts. • Reintroduction and translocation—Continue to augment populations and establish new populations within historical habitat to increase number. • Population biology research— o Continue pollination and breeding system studies to enhance the likelihood of propagation from seeds. o Study populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Alliance and partnership development—Work with the U.S. Army, the Hawai‘i Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)

- New Management Actions: • Ungulate monitoring and control—The Army Natural Resources Program-O‘ahu (ANRP) undertakes stabilization and management of endangered species to fulfill the requirements of the 2003 and 2008 Biological Opinions for U.S. Army activities in the Mākua and O‘ahu training areas (U.S. Army Garrison Hawai‘i 2010). Gardenia mannii is a species targeted for stabilization and management; and actions including fencing and ungulate control in management units may benefit the occurrences of this taxon (Lihue, Kōloa, Helemano, Lower ‘Ōpae‘ula, Lower Pe‘ahināi‘a, and North Hale‘au‘au) (U.S. Army Garrison Hawai‘i 2010; U.S. Army 2018). • Invasive plant monitoring and control—The ANRP reports 100 percent control of nonnative plants at Lihue and Upper ‘Ōpae‘ula-Helemano, and more than 50 percent control at Lower Pe‘ahināi‘a (ANRP 2018). • Rodent predation or herbivory—Goodnature™ A24 rat traps have been found to be more effective than the Victor® snap traps, and are deployed at ‘Ōpae‘ula, encompassing the entire management unit. Traps are checked at 4-month intervals (ANRP 2018). • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum Micropropagation Laboratory reports two explants in storage representing one individual from Helemano (Lyon Arboretum 2018). o Waimea Arboretum reports two plants in storage representing one individual (Waimea Arboretum 2014). o The Pahole Rare Plant Facility (PRPF) reports one plant in storage (PRPF 2018). o The ANRP reports construction of a taller shade house was completed to accommodate living collections of taller plants, including Gardenia mannii. Five fruits were collected from one individual at Helemano (ANRP 2018). o The ANRP reports the status of genetic storage goals for populations they manage, and includes representation of five plants at Hale‘au‘au, two plants at South Kaukonahua, 19 plants at Helemano-Poamoho, two plants at Kawainui-Mālaekahana, seven plants at Lower Pe‘ahināi‘a, one plant at Upper ‘Ōpae‘ula-Helemano, and two plants at Kaluaa-Maunauna, totaling 39 plants represented in ex situ storage, 29 of which are adequately represented by having three clones each secured in the nursery (ANRP 2018). o The ANRP reports 30 seedlings in storage (from seed viability testing) for planned reintroduction at Lihue and Lower ‘Ōpae‘ula (ANRP 2018). • Reintroduction and population augmentation—The ANRP reports ongoing reintroductions at Hale‘au‘au (62 individuals) and Lower Pe‘ahināi‘a (30 individuals) (ANRP 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Geocarpon minimum* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 6/16/1987; Southeast Region (R4) (USFWS, 2017)

Physical Description

A small (1-4 cm tall), ephemeral, succulent winter annual that usually completes its life cycle within a 4-week period in the spring. Young plants are grayish; mature plants reddish-purple. Flowers are inconspicuous. This unusual species comprises the monotypic genus Geocarpon (NatureServe, 2015).

Taxonomy

Kartesz & Kartesz (1980) had placed this genus in Aizoaceae but Kartesz (1994 checklist) subsequently placed it in Caryophyllaceae (NatureServe, 2015).

Historical Range

Historically found in St. Clair & Jasper Counties, Missouri (NatureServe, 2015).

Current Range

Found in southwestern Missouri (Dade, Polk, Greene, and Lawrence Counties). Found in three southeastern counties in Arkansas (Cleveland, Drew, and Bradley) and one Northwestern County (Franklin). Also found at two locations in Louisiana (Wynn Parish). This species was discovered in Texas in 2004 in Anderson County (Keith et al. 2004) (NatureServe, 2015). The range of Geocarpon has been extended farther west within the Arkansas River Valley and the habitat at this site appears similar to that described for the other known site within this region (Baker and Witsell 2015) (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from NatureServe, 2015)

Lifespan

Adult: 4 - 6 weeks (NatureServe, 2015)

Breeding Season

Adult: February - June (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Spring temperature and moisture patterns, possibly centipede pollinators (NatureServe, 2015)

Reproduction Narrative

Adult: Geocarpon minimum has been variously described as an annual (Tucker 1983, Palmer and Steyermark 1950) and as a winter annual (Mackenzie 1914, Bridges 1986, Morgan 1986), and this question has not been fully resolved to date. The timing of emergence in the spring can vary widely from year to year with temperature having the greatest influence on initiation of growth. Winter rosettes at Bona Glade begin producing flowering stems anywhere from March to mid April (Morgan 1986). Tucker (1983) lists March 23 to April 23 as flowering dates for Geocarpon in Arkansas; however, following a warm winter, Bridges (1986) found plants on the Warren Prairie site producing stems in late January, flowering by mid-February, and dead or dying by April 1. Although the initiation of growth in the spring is controlled by temperature, Morgan (1986) suggests that the vigor of plants and the number of flowers and seeds produced is probably dependent on soil moisture and temperature conditions experienced after the initiation of growth in the spring. Tucker (1983) states that the life cycle of individual plants is completed in a four week period, and Morgan (1986) indicates that a period of 4-6 weeks passes from the initiation of growth in spring to senescence. To date, no insect pollinators have been observed; however, Shephard (pers. comm.) has observed numerous small centipedes within Geocarpon populations and suggests that they be considered as possible pollinators. Flower production varies from plant to plant with some plants producing 5-7 stems with 2-4 flowers per stem and other plants being single stemmed with only 1-2 flowers produced (Morgan 1986). Shephard (pers. comm.) observed that even in apparently good years, a high percentage (ca. 90%) of the plants produced on the Warren Prairie site were one stemmed, one flowered individuals. Morgan (1986) collected 16 capsules and found from 9 to 72 seeds produced per capsule with a mean of 27 seeds per capsule. Groups of seedlings have been observed growing from capsules produced the previous season (Morgan 1986). Although it is apparent that seeds do survive in seed banks since plants are produced in years following poor seed production, little is known about seed viability and longevity. Tucker (1983) suggests that slight disturbance of the soil surface is necessary for Geocarpon seed germination and seedling establishment. This annual species is also known to have good seed set, with lots of capsules (pers. comm. E. Keith) (NatureServe, 2015). The flowering and fruiting period when the plant is usually most visible ranges from late February to early June (Bates 1994; McInnis and Larke 1997; Smith in litt. 1998; MDC 2000; TNC 2004, 2005) (USFWS, 2016).

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sandstone glades, saline prairie, riparian (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits sandstone glades and saline prairies. In Missouri, Geocarpon grows on moist, sandy soils on exposed sandstone outcrops or glades, where ledges of fine sandstone, interbedded with shale, are exposed along small streams. The surrounding area, where deeper soils prevail, is savannah. Sites in Arkansas and Louisiana are characterized by very thin soils that are high in sodium and magnesium. Woody plants are nearly absent. In these saline prairies, the species occurs mostly in very thinly vegetated, barren-like areas. The presence of high

concentrations of magnesium in the soil may be a critical factor in Geocarpon distribution, since the soils of Geocarpon sites in Arkansas are characteristically high in magnesium and/or sodium. All of the Geocarpon sites currently known from Arkansas occur on saline soil prairies on natric or saline soils. Geocarpon is very sensitive to competition from other species of vascular plants and occurs only in very open areas. The environmental specificity of this species is very narrow as it is a specialist only growing in salt prairies of one kind (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seeds remain in dead capsules and are most likely dispersed near the parent plant by wind or rain or by plants simply falling over). Results of monitoring in Missouri (Morgan 1986) and Arkansas (Shephard 1987) indicate that Geocarpon appears in the same areas from year to year and has low vagility. Tucker (1983) suggests that ants be considered as a possible secondary dispersal mechanism since ant mounds are often found in the vicinity of Geocarpon populations in Arkansas (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decline of <30% to increase of 25% (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2009)

Number of Populations:

40 (USFWS, 2016)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Adaptability:

High (inferred from NatureServe, 2015)

Population Narrative:

Survives fairly harsh environmental conditions. Although the long term trend of this species isn't documented, it is suspected that is has been stable (pers. comm. E. Keith). This species has experienced a long-term decline of <30% to increase of 25%. As with many annual species, the size of Geocarpon populations varies greatly from year to year. Shephard (1987) indicates that 2033 plants were found within plots in 1986 (Warren Prairie, Arkansas) and 6761 plants were found within the same plots in 1987. Similarly, Morgan (1986) found 1900 plants in plots (Bona Glade, Missouri) in 1984 and 4055 plant present in the same plots 1986. There are at least 13 occurrences with good viability (NatureServe, 2015). Population surveys indicate that the species status is stable. Populations are currently documented to occur at a total of 37 sites (including three plantings in Missouri) within 17 counties in four states (Osborne in litt. 2005;

Smith in litt. 2006a, 2006c; Reid in litt. 2009; Singhurst in litt. 2009) (USFWS, 2009). Populations are currently documented to occur at a total of 40 sites (including three plantings in Missouri) within 19 counties in four states (Baker in litt. 2015; Baker and Witsell 2015; Briggler in litt. 2015; Reid in litt. 2015; Singhurst in litt. 2015) (USFWS, 2016).

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The primary threat continues to be soil development on suitable sites within saline prairies (slick spots) and sandstone glades (shallow sandy soils) (Logan 1998; Witsell 2004a; Smith and Ely 2006). Geocarpon thrives in these harsh conditions that exclude competing plant species. Accumulation of more suitable soils quickly leads to an invasion of other plants that shade Geocarpon. Such soil development may be facilitated by lack of disturbances such as fire and use by large mammals (Witsell 2004a; Smith and Ely 2006). Excessive soil development and subsequent colonization by competitive plants may also occur when excessive soil movement occurs due to dense cattle use, ATV use, or other factors. Movement of dirt can also alter the microhydrology of sites which may lead to localized extirpation of subpopulations (TNC 2004; Witsell pers. comm. 2006) (USFWS, 2009).

Stressor: Small, isolated populations (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Geocarpon is vulnerable to local extirpations because it occurs in isolated populations and depends on the presence of specific microhabitats in order to compete with other plants. Although extirpations of subpopulations due to encroachment of other vegetation have been observed (Witsell 2004), no known populations have disappeared due to this factor (USFWS, 2009).

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Climate change may affect Geocarpon, although the exact mechanisms and whether these effects will be negative or positive is unknown. Some authors have suggested that plant diversity, species phenology and distribution, and increases in extinction risk are all potential outcomes of climate change (Iverson and Prasad 2002; Bertin 2008; and Maclean and Wilson 2011). Changes in localized weather patterns associated with climate change may lead to more frequent and long-lasting droughts (Rind et al. 1990; Seager et al. 2007; and Rahel and Olden 2008). Climate warming may also increase the spread of non-native species (Rahel and Olden 2008). Changes in drought cycles and increases in air and soil temperatures could have effects on seed set, germination, and general fitness of Geocarpon (USFWS, 2016).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. A total of 15 viable populations, representing the diversity of habitats and the geographic range of the species, are protected as necessary to ensure their continued existence (USFWS, 2009).

2. Populations include the wide spectrum of current genetic variation (USFWS, 2009).

3. Population viability is confirmed through periodic monitoring for at least a 15-year period (USFWS, 2009).

Recovery Actions:
- Protect viable populations across the species' geographic range (USFWS, 1993).
- Evaluate potential habitat and search for additional populations (USFWS, 1993).
- Continue to monitor known sites to determine population trends (USFWS, 1993).
- Support basic research investigating the chemical characterization of the plant's substrate and species biology, dispersal ecology, and population genetics (USFWS, 1993).
- Determine the effects of disturbance factors (natural and manmade) and incorporate findings into management prescriptions (USFWS, 1993).
- Preserve genetic stock (USFWS, 1993).
- Establish additional populations in the Arkansas Valley Natural Division, if deemed necessary (USFWS, 1993).
- Seek funding to complete an investigation into the genetic variability of Geocarpon throughout the range, including the newly discovered populations in Texas and Louisiana (USFWS, 2009).
- Continue to investigate the role of disturbance in the distribution and success of Geocarpon in sandstone glades and saline prairies (USFWS, 2009).
- Initiate studies to determine the mode of seed dispersal. Promising theories include movement by water, insects, and large mammals (USFWS, 2009).
- Continue to search for new populations in suitable sandstone glade habitats in Missouri and Arkansas and saline prairie habitats in the Arkansas River Valley of Arkansas and Oklahoma and other saline prairie sites in Arkansas, Louisiana, and Texas (USFWS, 2009).
- Continue to monitor known sites (USFWS, 2009).
- Work cooperatively with landowners to conserve privately owned sites through fee title or easement purchases or development of management agreements (USFWS, 2009).
- Complete the investigation into the genetic variability of Geocarpon throughout the plant's range (funded in 2015 with completion expected in 2017) to get a better understanding on possible completion of recovery criteria #2 (USFWS, 2016).
- Continue to investigate the role of disturbance in the distribution and success of Geocarpon in sandstone glades and saline prairies. The impacts of extreme disturbance due to feral hogs should be incorporated into these studies. As an understanding develops regarding the role of disturbance, a threats assessment should be conducted to determine which threats should be addressed first (USFWS, 2016).
- Develop standardized monitoring protocols and reach consensus among states regarding the delimitation of populations and sub-populations (USFWS, 2016).

- Continue to search for new populations in suitable sandstone glade habitats in Missouri and Arkansas and saline prairie habitats in the Arkansas River Valley of Arkansas and Oklahoma and other saline prairie sites in Arkansas, Louisiana, and Texas (USFWS, 2016).
- Select sites throughout the range to be demographically monitored. Where it is already occurring this should continue and it should be instituted at other representative sites throughout the range that are currently only monitored opportunistically for presence/absence or rough estimations of population (USFWS, 2016).
- Develop a long-term management plan based on the results of studies on genetics, the role of disturbance, and other life history studies. Specific recovery criteria that address the long-term protection and viability of Geocarpon should be developed as new information becomes available (USFWS, 2016).
- Work cooperatively with landowners to conserve privately owned sites through fee title or easement purchases or development of management agreements (USFWS, 2016).

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SPECIES ACCOUNT: *Geranium arboreum* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Geranium arboreum, a member of the geranium family (Geramaceae), is a large, branched, spreading shrub 2-4 m (6.6-13.1 ft) tall. The green and somewhat hairy leaves, alternating closely after one another on the stem, are oval- or heart-shaped, usually 4-7 cm (1.6-2.8 in) long and 2.5-4.5 cm (1.0-1.8 in) wide with 5-8 noticeable veins and 8-14 small teeth on each edge. The leaf stalks (petioles) are 1-3 cm (0.4-1.2 in) long and are encircled beneath (subtended) by tiny (12-14 mm [0.5-0.6 in]), hairy, leaf-like appendages (stipules), which persist after the leaves have fallen. Magenta flowers 20-25 cm (7.9-9.8 in) long occur in short-stalked groups of usually one to four, originating from the point of attachment of leaves to the stem. The upper three petals are erect, and the lower two petals are bent abruptly backward. Its flowers are the only ones in the genus that are zygomorphic (not symmetrical like pie slices around a central point). A single dark purple, net-surfaced 2.5 mm (0.1 in) seed is produced in each of five cells of the elongated fruit. (USFWS, 1997)

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range is in East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Geranium arboreum (Hawaiian red-flowered geranium) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Geranium arboreum includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Mesic—Unit 1 (and) Palmeria dolei—Unit 18—Montane Mesic (and) Pseudonestor xanthophrys—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Asplenium dielerectum, A. peruvianum var. insulare, Clermontia lindseyana, Cyanea horrida, C. obtusa, Cyrtandra ferripilosa, C.

oxybapha, Diplazium molokaiense, Geranium arboreum, G. multiflorum, Huperzia mannii, Melicope adscendens, and Neraudia sericea. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, Cyanea glabra, C. hamatiflora ssp. hamatiflora, C. kunthiana, C. mceldowneyi, Phyllostegia bracteata, P. mannii, Santalum haleakalae var. lanaiense, Wikstroemia villosa, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants Alectryon macrococcus, Geranium arboreum, Melicope knudsenii, M. mucronulata, Santalum haleakalae var. lanaiense, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 (and) Palmeria dolei—Unit 24—Subalpine (and) Pseudonestor xanthophrys—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants Bidens micrantha ssp. kalealaha and Geranium arboreum, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Asplenium peruvianum var. insulare, Geranium multiflorum, Phyllostegia bracteata, Schiedea haleakalensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) Palmeria dolei—Unit 25—Subalpine (and) Pseudonestor xanthophrys—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land,

and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Geranium multiflorum, and Schiedea haleakalensis, and by the forest bird, the akohekohe (Palmeria dolei). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants Asplenium peruvianum var. insulare, Bidens micrantha ssp. kalealaha, Geranium arboreum, Phyllostegia bracteata, or Zanthoxylum hawaiiense, or by the forest bird, the kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Geranium arboreum critical habitat consists of three components. Montane mesic (east Maui), Montane dry (east Maui) and Sub-alpine (east Maui) (81 FR 17790-18110):

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: Acacia, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Chamaesyce, Coprosma, Dodonaea, Dubautia, Leptecophylla, Osteomeles, Wikstroemia. Understory: Bidens, Eragrostis, Melanthera, Vaccinium.

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special

management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and

Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Bird pollinators (USFWS, 1997)

Reproduction Narrative

Adult: Geranium arboreum is the only species in its genus that appears to be bird-pollinated. Native honeycreepers appear to be a major pollination vector. (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Damp and partially shaded environments (USFWS, 1997)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1,525 and 2,135 meters (5,000 to 7,000 feet) (USFWS, 1997)

Spatial Arrangements of the Population

Adult: Small isolated populations (USFWS, 1997)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1997)

Habitat Narrative

Adult: Typical habitat of this rare shrub is in moist gulches near the upper limit of native forest growth. The remaining isolated populations of Geranium arboreum grow in steep, narrow canyons on the north and west outer slopes of Haleakala Volcano at 1,525-2,135 meters (5,000-7,000 feet) elevation in a narrow band (0.25 x 14 kilometers [0.16x 8.7 miles]). The environment of these gulches is damp and shaded part of the day and often in clouds, as a result of the coincidence of this band with the layer just below the trade-wind inversion, an important meteorological phenomenon in the Hawaiian Islands. Fog drip is frequent. The climate zone just above is substantially drier and supports native shrubland, not forest. Geranium arboreum plants appear to obtain a significant portion of their water requirement by "combing" moisture out of the drifting fog (Funk 1982). Currently, vegetation in the ravines is often quite dense and consists mainly of mostly medium-sized woody shrubs, alien grasses and weeds, and mixed ferns (Funk 1982). Associated native species include Sophora chrysophylla, Vaccinium reticulatum, Dodonaea, Styphelia, Rubus hawaiiensis, Dryopteris wallichiana, Metrosideros, Myrsine lessertiana, and Coprosma (HPCC 1994). Associated alien species include Ageratina adenophora, Holcus lanatus, redwood, and pines (HPCC 1994; A.C. Medeiros, personal observation 1994). Geranium arboreum is a minor component of the vegetation occurring in small isolated populations in the gulches. (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

4 wild populations (USFWS, 2023)

Population Size:

<65 (USFWS, 2023)

Population Narrative:

As of 2010, the total number of individuals of Geranium arboreum is less than 50 individuals in perhaps five populations on East Maui (USFWS, 2011). In 2011, the 5-year review reported about five populations of Geranium arboreum totaling fewer than 50 individuals on east Maui. In 2012, PEPP reported three populations totaling 42 individuals; and in 2014, seven populations totaling 48 individuals (PEPP 2012, 2014). In 2015, Chau et al. reported eight subpopulations totaling 40 individuals. Currently, there are wild populations in five locations on east Maui consisting of the following reported individuals: Kanaio (1), Waiohuli (48), Pōhakuokala (5), Waikamoi Gulch (2), and Waiakoa (4) (HBMP 2010; Oppenheimer 2018, in litt.; PEPP 2016,

2017a, 2018). Haleakalā National Park reports two occurrences of two individual clumps (Robertson 2016, in litt.). In 2016, four critical habitat units were designated in three ecosystems (montane mesic, montane dry, and subalpine) on east Maui for Geranium arboreum (40,358 ac; 16,333 ha) (81 FR 17790, March 30, 2016) (USFWS 2018). • Haleakalā National Park (HALE NP) reported two wild individuals present on the west slope of the park last observed in 2021 (Waikamoi Gulch) (HALE NP 2019, p. 293; Gates 2021, pers. comm.). Currently, there are four wild populations at Kanaio, Waiakoa, Waikamoi Gulch (including HALE NP), and Waiohuli, totaling fewer than 65 individuals (PEPP 2022; Maui Plant Extinction Prevention Program [Maui PEPP] 2016-2022). There are five translocated or augmented populations at Honomanu, Waiakoa, Waiopai, Waikamoi Gulch, and Waiohuli totaling approximately 118 individuals and 189 translocated individuals in subpopulations within HALE NP (PEPP 2022; Maui PEPP 2016-2022; Gates 2021, pers. comm.). No single population totals more than 50 individuals and natural seedling recruitment is rarely observed (HALE NP 2019, p. 301). • Currently, there are approximately 14 founders (wild plants) from five populations represented in ex situ storage and propagation (USFWS, 2023).

Threats and Stressors

Stressor: Alien plants (USFWS, 1997; USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Displacement by alien plant species, primarily grasses and trees, poses the current primary threat to the long-term survival of Geranium arboreum. Mats of alien grasses cover ground that would otherwise be available to Geranium seedlings. Alien tree species (e.g., Acacia mearnsii and Myricafaya) eventually form such dense stands that they virtually exclude native species, including Geranium arboreum. In the Polipoli Springs area at certain times of the year, pollen from alien pine trees completely covers the stigmas of G. arboreum and precludes any fertilization by its own species. Geranium arboreum does, however, have a longer flowering period than do the alien pines (Funk 1982, 1988; USFWS 1992b). Invasive introduced plant species such as Ageratina adenophora (sticky snakeroot), A. riparia (billy goat weed), Bidens pilosa (beggartick), Epilobium billardierianum (willow herb), Geranium homeanum (NCN), Holcus lanatus (common velvet grass), Lythrum maritimum (loosestrife), Oenothera stricta (evening primrose), Passiflora tarminiana (banana poka), Pennisetum clandestinum (Kikuyu grass), Rubus niveus (Mysore raspberry), R. argutus (blackberry), Senecio madagascariensis (fireweed), and Sporobolus indicus (West Indian dropseed) which alter the habitat and compete for resources (Oppenheimer 2009; Perlman 2009; Wood 2009). (USFWS, 1997; USFWS, 2011)

Stressor: Impacts of feral pigs, cattle, and goats (USFWS, 1997; USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Feral animals continue to exert negative impacts on Geranium arboreum. On East Maui where Geranium arboreum is found, the threats include feral ungulates such as pigs (Sus scrofa), deer (Axis axis), goats (Capra hircus), and cattle (Bos taurus) which disturb the ground and uproot plants. (USFWS, 1997; USFWS, 2011)

Stressor: Fire (USFWS, 1997)

Exposure:
Response:
Consequence:
Narrative: Fires in the habitat of Geranium arboreum continue to be of concern. (USFWS, 1997)

Stressor: Limited gene pool (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: The scattered distribution of the species has the positive effect of reducing the chance that a single natural or human-caused environmental disturbance could affect all populations. However, since the approximately 300 extant individuals occur in about 21 sites (grouped into four populations), each with only 1 to 25 plants, the limited local gene pools may depress reproductive vigor. (USFWS, 1997)

Stressor: Human impacts (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Illegal collecting for scientific or horticultural purposes or excessive visits by individuals interested in seeing rare plants could result from increased publicity, and could seriously impact Geranium arboreum. The species is attractive and could become the subject of increased collection in the future (USFWS 1992b). (USFWS, 1997)

Stressor: Rabbits (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Rabbits almost became established on East Maui within Haleakala National Park in 1990 as a result of release of pet rabbits by a careless pet owner. Rapid response by Park management to the problem is apparently all that prevented a catastrophe. The site where the incipient rabbit population existed was adjacent to habitat of Geranium arboreum. It is almost certain that similar incidents will occur in the future. If rabbits were to establish, they would pose a severe threat to the survival of this species. (USFWS, 1997)

Stressor: Herbivory or predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Insect-bored holes were observed in the flowers of Geranium arboreum observed near Puu Nianiau (Perlman 2009). Slugs (unidentified species), rats (Rattus spp.), and ants (unidentified species) also threaten these plants by eating plant parts and seeds (Perlman 2009). A loss of native pollinators may also be a problem preventing reproduction of this species (Perlman 2009). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:

Consequence:
Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: In addition to all of the other threats, species like Geranium arboreum that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1992). (USFWS, 2011)

Stressor: Drought degradation of habitat (USFWS 2018).
Exposure:
Response:
Consequence:
Narrative: Drought is reported to be a threat to populations of Geranium arboreum at Pōhakuokala, Waikamoi Gulch, and Waiakoa (PEPP 2011, 2013, 2017a). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS 2018).

Stressor: Lack of adequate hunting regulations (USFWS 2018).
Exposure:
Response:
Consequence:
Narrative: Two of the five populations of Geranium arboreum occur in State hunting areas on east Maui. Habitat destruction and modification, and predation by pigs, goats, axis deer, and cattle have been noted as threats to the species. A few individuals in these areas are fenced; however, fences must be continually monitored and repaired. In addition, public hunting areas are not fenced and game mammals have unrestricted access to most areas across the landscape, regardless of underlying land use designation; therefore, any unfenced populations are at risk (DLNR 2010). (USFWS 2018).

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Recovery Priority Number: 2 (USFWS, 2023)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:
- Protect extant populations of this species by constructing a series of five to eight exclosures from leeward Haleakalato Puu Koolau, northwestern Haleakala. (USFWS, 1997)
- Conduct/encourage work on pollinators and reproductive biology. (USFWS, 1997)
- Surveys and population monitoring (USFWS 2018).
- Invasive plant monitoring and control (USFWS 2018).
- Ungulate, predator, and herbivore monitoring and control (USFWS 2018).
- Captive propagation for genetic storage and reintroduction (USFWS 2018).
- Fire monitoring and control (USFWS 2018).
- Reintroduction and translocation (USFWS 2018).
- Population biology research (USFWS 2018).
- Climate change adaptation strategy (USFWS 2018).
- Alliance and partnership development (USFWS 2018).
- Further studies are needed to clarify by what mechanisms predators of this species are affecting its ability to regenerate in the wild, and to mitigate these threats. (USFWS, 2011)
- Monitor known populations and collect any available seed for genetic storage and reintroduction. (USFWS, 2011)
- Fence all known populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)

- Develop and implement methods to control ants and slugs. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Develop and implement a wildfire management plan. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2023. • Surveys and population monitoring—Continue to monitor the wild and translocated individuals and survey for additional populations of Geranium arboreum in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to construct and maintain fencing to protect individuals from the negative impacts of feral ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species within and around populations of G. arboreum. • Fire prevention and management—Continue to implement fire management plans for areas managed by the East Maui Watershed Partnership where G. arboreum occurs. • Climate change adaptation strategy—Research suitability of habitat for translocation of this species in the future due to the impacts of climate change. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents within the vicinity of all individuals of G. arboreum. o Develop and implement effective control methods for slugs at accessible individuals of G. arboreum. • Captive propagation for genetic storage and translocation—Continue collection of genetic resources for storage, propagation, and translocation. • Translocation and augmentation—Continue to augment the population and translocate individuals into suitable habitat that is managed for known threats. • Build resiliency, redundancy, and representation—Continue to augment populations and translocate individuals into suitable habitat that is being managed for known threats to this species to reduce impacts of drought, fires, predation and herbivory, and loss of mutualists. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2023).

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SPECIES ACCOUNT: *Geranium hillebrandii* (Nohoanu)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Decumbent subshrubs, with stems 5-10 dm long, often rooting at the nodes. (Other recently found plants on leeward West Maui are erect shrubs up to about 0.75 m tall.) Cymes terminal, projecting beyond the leaves. Petals white, apparently always with purple veins. (NatureServe, 2015)

Taxonomy

Originally described as Geranium humile. Aedo and Garmendia (1997), found that this name was illegitimate and published the change to Geranium hillebrandii. The U.S. Fish and Wildlife Service used the name G. humile in the candidate list of the Oct. 25, 1999 Notice of Review, but switched to G. hillebrandii in the Oct. 30, 2001 Notice. Wagner and Herbst (1999) accept the change to G. hillebrandii. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from the west Maui mountains, state of Hawaii. Extent of occurrence is approximately 10 sq km (EO data in the NatureServe central database as of November 2010). (NatureServe, 2015). Location: Maui (USFWS, 2021)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Geranium hillebrandii (Nohoanu) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Geranium hillebrandii includes three CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Wet—Unit 7 (and) Palmeria dolei—Unit 16—Montane Wet (and) Pseudonestor xanthophrys—Unit 16— Montane Wet This area consists of 80 ac (32 ha) of State land near Hanaula and Pohakea Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants Cyrtandra oxybapha and Platanthera holochila, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane

Wet—Unit 7 is not known to be occupied by the plants Acaena exigua, Bidens conjuncta, Calamagrostis hillebrandii, Cyanea kunthiana, Geranium hillebrandii, Huperzia mannii, Myrsine vaccinioides, Phyllostegia bracteata, or Sanicula purpurea, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) Palmeria dolei—Unit 20—Montane Mesic (and) Pseudonestor xanthophrys—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant Geranium hillebrandii, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) Palmeria dolei—Unit 21—Montane Mesic (and) Pseudonestor xanthophrys—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Geranium hillebrandii critical habitat consists of two components. Montane wet (west Maui) and Montane mesic (west Maui). Species- specific physical or biological features: Bogs (81 FR 17790-18110):

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed

plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: Short (USFWS, 2021)

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Unknown (NatureServe, 2015)

Habitat Narrative

Adult: Formerly known only as decumbent subshrub growing in montane bogs in wet forests, in the cloud zone at upper elevations of West Maui. In recent years, however, erect shrubs that have been referred to this species have been found in moist shrublands on steep-sided ridges on leeward West Maui. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2023)

Population Size:

2000-10,000 (USFWS, 2023)

Population Narrative:

Currently, 4 occurrences total over 10,000 individuals, with the largest 2 occurrences in the west Maui bogs, from Puu Kukui to East Bog and Kahoolewa ridge. A third occurrence is at Eke Crater and the surrounding area, and the fourth occurrence is at Lihau (HBMP 2010; Oppenheimer 2010h, in litt.). (USFWS, 2016). There are five populations of Geranium hillebrandii totaling an estimated 2,000 to 10,000 individuals (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by

nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013))
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (pigs, and slugs) is considered an ongoing threat to Geranium hillebrandii throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Recovery Priority Number: 2

Number of Populations: 5. Mature Individuals Per Population: 500 (USFWS, 2023).

Delisting Criteria:
Number of populations and individuals needed for delisting based on population and life history characteristics: Number of Populations: 10. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Actions:
- Not available.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to monitor known populations and conduct surveys for Geranium hillebrandii in historical locations and potentially suitable habitat. Develop survey methodology for assessing populations within sensitive bog habitat. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with G. hillebrandii at all populations. • Predation and herbivory by slugs—Implement effective control measures for slugs at all populations. • Captive

propagation for genetic storage and reintroduction—Collect seeds and other propagative materials for storage and begin propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—If necessary, augment populations and increase numbers of populations and individuals in suitable habitat to reduce the impacts of predation and climate change. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- Current Management Actions: • Surveys and monitoring—PEPP monitors individuals of Geranium hillebrandii on west Maui (Oppenheimer 2019, pers. comm.). In addition, rappelling has occurred on the steep slopes of Līhau, where a population of G. hillebrandii has been confirmed (Oppenheimer 2019, pers. comm.). • Ungulate control—The Mauna Kahālāwai Watershed Partnership (MKWP; formerly known as the west Maui Mountains Watershed Partnership (WMMWP)) works in coordination with landowners to reverse the negative impacts of forest degradation by addressing the numerous threats to the native ecosystems of west Maui (WMMWP 2019). The partnership has constructed 22 miles of exclosure fencing (WMMWP 2019) and removed pigs from the upper summits of the west Maui Mountains. Four of the five known populations of G. hillebrandii are fenced. • Nonnative plant control—The MKWP has also initiated nonnative plant control planning and implementation in areas where G. hillebrandii occurs (WMMP 2013). The partnership manages 47,321 ac (19,150 ha) of watershed that includes the populations of G. hillebrandii at Puʻu Kukui, ʻEke, and Līhau on west Maui (USFWS, 2020).

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SPECIES ACCOUNT: *Gesneria pauciflora* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 3/7/1995; Southeast Region (R4) (USFWS, 2015)

Physical Description

A small gregarious shrub which may reach 30 centimeters in height and 8 millimeters in diameter. Stems may be erect or decumbent and the bark is smooth, gray-brown, and glabrous. The leaves are alternate, and the terets or flattened petioles are from 2 to 7 millimeters long. Leaf blades are shaped like a narrow trowel, 2.8 centimeters long and .9 to 2.3 centimeters wide, membranous, dark green and glossy above, and pilose along the prominent veins. The margin is subentire toward the cuneate base and serrate to sublobate above. The inflorescences are one to few flowered, and the peduncles are from 6.1 to 15.3 centimeters long and slightly curved. The pedicels are 1 to 2 centimeters long, reddish-brown, and pilose to glabrascent. The corolla is tubular, curved, 2 to 2.3 centimeters long, 4 millimeters wide at the base, narrowing to 3 millimeters but widening to 5 millimeters at the middle and again narrowing to 4 millimeters at the mouth. The five-lobed corolla is yellow to yellow-orange and densely pilose outside but glabrous inside. The fruit is a capsule containing numerous small seeds, approximately 4 millimeters long and wide, gray-brown, and glabrescent with 5 to 10 not prominent ridges (Liogier 1994, Proctor 1991) (USFWS, 1998).

Taxonomy

Belongs to the family Gesneriaceae (USFWS, 1998).

Historical Range

Known to occur only on serpentine soils in the western mountains of Puerto Rico (USFWS, 1998).

Current Range

At the time of listing and when the recovery plan was signed, only three populations of this small shrub were known to exist in the western mountains of Maricao and Sabana Grande municipalities. Two of the three known populations are located in the Maricao Commonwealth Forest (MCF). The third locality lies on a Lajas River tributary outside of the MCF boundaries. Herbarium specimens indicate that the species has also been collected in the past from the Yagüez River and from “Cerro Las Mesas” in the Mayagüez municipality, but these sites have not been intensively surveyed (USFWS, 1998).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, self-fertilization (USFWS, 2013)

Breeding Season

Adult: Throughout the year (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Possibly hummingbird pollinators (USFWS, 2013); wet conditions (USFWS, 1998)

Reproduction Narrative

Adult: Preliminary data suggests that this species is not apomictic (incapable of asexual reproduction through flowers) and that instead flowers need to undergo the process of pollination to develop fruits. Hummingbirds are the only flower visitors so far observed but visit rates, however, are very low (e.g. maximum visitation rate was 0.004 flower visited/time observation/flower observed) and so is natural fruit production (32.5% of fruits end up maturing fruits). Flowers seem to be capable of some autogamy (self-fertilization) but the rate of this process is low (10.6%) (USFWS, 2013). Field observations during a 2-year study of the species' phenology indicate that flowering and fruiting occur throughout the year. Nevertheless, there appear to be more abundant flowering and fruiting during the rainy months of August, September, and October. Flowering becomes less frequent and patchy during drier periods (Breckon and Kolterman 1994) (USFWS, 1998).

Habitat Type

Adult: Terrestrial, semi-aquatic (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Riparian; pool; subtropical wet forest, subtropical moist forest, subtropical lower montane wet forest (USFWS, 1998)

Dependencies on Specific Environmental Elements

Adult: Shade (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped, colonial (USFWS, 2013)

Environmental Specificity

Adult: Narrow (USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1998)

Habitat Narrative

Adult: This species is known to occur only on serpentine derived substrates with little or no soil formation and associated with wet habitats. At the Maricao River locality, all colonies observed were associated with wet environments and most were on steep rock faces. G. pauciflora's highly specific habitat where few other species occur, suggests that its restriction to serpentine is due to the combination of tolerance (to low nitrogen and calcium levels, and to high levels of heavy metals) and poor competitive ability (Breckon and Kolterman 1994). It is not clear how many distinct individuals of G. pauciflora occur in one colony. It is uncertain if a large aggregate of G. pauciflora plants contains several different individuals or is simply one individual with lots of offshoots (USFWS, 2013). At all known localities, the plants are associated with wet habitats,

which are on steep rock faces with little or no soil formation. They are within the spray zone of waterfalls or near deep pools. Most are in shady situations where direct sun is not received. Most individuals are found within 1 meter of water and may actually be submerged for brief periods of time. At each locality, a number of clusters or colonies grow appressed to the wet rocks. The plant appears to be tolerant of low nitrogen and calcium and to toxicity of high levels of heavy metals found in serpentine (Breckon and Kolterman 1994). The Maricao Forest falls within three life zones: subtropical wet forest, subtropical moist forest, and subtropical lower montane wet forest (Ewel and Whitmore 1973) (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2013)

Number of Populations:

8 (USFWS, 2024)

Population Size:

~7,853 (USFWS, 2024)

Population Narrative:

The species is only known from three localities in Puerto Rico. Each locality is considered one population. The species status is stable; no new threats have been identified for the species. The Service recorded between 800 to 1,500 individuals in the two visited populations. The number of individuals in the remaining two known populations is unknown (USFWS, 2013). Gesneria pauciflora is a perennial small shrub restricted to the southwest of Puerto Rico, within and around the MCF. The most recent survey (2018) reports that there are now approximately 7,853 known individuals within 8 known populations, including an additional indetermined small number of individuals at a new population discovered in 2020, along Río Cain in the Municipality of San German (USFWS, 2024)

Threats and Stressors

Stressor: Recreation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Two of the twelve colonies of G. pauciflora at the Maricao River watershed were found off an unmarked trail that runs almost parallel to the river. If that trail is improved without implementing protective measures, it can adversely affect these colonies. The dirt road leading

up to the Lajas River tributary is open to the public and the Service observed five all-terrain vehicles heading up the road, possibly contributing to erosion on that locality. This locality is adjacent to a highly visited waterfall and natural pool area known as “Salto Curet”. The human activities in the area may contribute to erosion of the small tributary and may modify the habitat conditions needed by the species. If the access to the “Salto Curet” area is expanded, or amenities are developed, these activities may affect the individuals at this locality (USFWS, 2013).

Stressor: Stochastic weather events (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Landslides, storm damage, and floods are natural occurrences that may affect the steep, unstable slopes associated with G. pauciflora habitat and may result in loss of individuals, as they may be smothered, washed or simply ripped off their substrate and rock faces. These effects are further aggravated by tropical storms and hurricanes in Puerto Rico. After the last known G. pauciflora investigation report (Breckon and Kolterman 1996), two hurricanes have affected the island. Hurricane Hortense passed in September 1996 and Hurricane Georges in September 1998 significantly affecting the islands landscape. On November 2012, one of the colonies in the Maricao River watershed was observed to have been almost completely extirpated because of a natural landslide that occurred in that area. This demonstrates the vulnerability of the species to such natural events, as most of the remaining colonies seem to be susceptible to landslides (USFWS, 2013).

Recovery

Reclassification Criteria:
Recovery Priority Number: 11

Delisting Criteria:
1. The existing six (6) populations of G. pauciflora within the Maricao Commonwealth Forests and adjacent private lands exhibit a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (USFWS, 2024).

2. Of the six (6) currently known natural populations, the three (3) populations extending onto private lands adjacent to the Maricao Commonwealth Forest are protected through a long-term conservation mechanism (USFWS, 2024).

3. Threats due to forest management activities (e.g., trail and dirt roads maintenance and improvements in areas adjacent drainage crossings) have been addressed and/or managed to the extent that the species will remain viable for the foreseeable future (USFWS, 2024).

Recovery Actions:
- Protect the existing population and its habitat through the development and implementation of a management plan for the Maricao Commonwealth Forest (USFWS, 2013).
- Monitor known populations (USFWS, 1998).

- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1998).
- Educate the public on conservation values and regulations (USFWS, 1998).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1998).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 2013). 2019 Refinement: In collaboration with partners (e.g., UPRRP, KEW, Fairchild Tropical Botanic Garden and PRDNER), implement a project to propagate and reintroduce G. pauciflora to re-establish populations after Hurricane Maria. The project should address the feasibility of seed banking this species, and if deemed necessary, seed material should be stored at authorized institutions (e.g., Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation (NLGRP) in Ft. Collins). (USFWS, 2019).
- New in 2019 - 2: Refine and validate an existing GIS-based habitat predictability model to identify and further explore additional areas to locate more reintroduction sites for the species. (USFWS, 2019).
- New in 2019 - 3: Continue post hurricane monitoring of the eleven (11) colonies studied within the MCF, and expand it to other colonies in order to assess potential long-term effects of canopy cover loss on plant mortality, the potential effect of co-existing fast growing and exotic invasive species, and the colony recovery rates following canopy regeneration. (USFWS, 2019).
- New in 2019 - 4: Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, to provide baseline information for a sound management of G. pauciflora actions (e.g., need for enhancement of populations with material from different watersheds). (USFWS, 2019).
- Establish the number of populations and number of individuals per population needed in order to consider delisting the species (USFWS, 2013).
- Develop propagation techniques, establish ex situ populations in botanical gardens, and introduce individuals in protected areas (USFWS, 2013).
- Model potential suitable habitat using GIS tools to search for new populations and continue searching within known localities for new colonies (USFWS, 2013).
- Mark and protect colonies 11 and 12 located at the Maricao River watershed to minimize possible effects, if the trail is improved (USFWS, 2013).
- Establish a once a year monitoring schedule for known populations and after any significant weather event (i.e. hurricanes) (USFWS, 2013).
- Conduct studies of the known populations to determine intra- and inter-population genetic diversity (USFWS, 2013).
- Investigate pollination and seed dispersal mechanisms to determine the species strategies for dispersal (USFWS, 2013).
- Evaluate seed viability and germination and growth requirements (USFWS, 2013).
- Conduct studies to evaluate the degree of threat that flower predation in G. pauciflora represents a potential risk for this species (limiting fruit production) (USFWS, 2013).
- Conduct studies to evaluate if common pioneer species of riparian areas are potential habitat competitors for G. pauciflora (USFWS, 2013).
- Select appropriate sites for population introduction (USFWS, 2013).
- Explore the opportunity to enter into a Service Partner’s for Fish and Wildlife Agreement with the landowner to conserve the area and restore suitable habitat for the species

(USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Develop propagation techniques, establish ex situ populations in botanical gardens, and introduce individuals in protected areas. Establish a once a year monitoring schedule for known populations and after any significant weather event (i.e. hurricanes). Conduct studies of the known populations to determine intra- and inter-population genetic diversity. Conduct studies to evaluate the degree of threat that flower predation in G. pauciflora represents a potential risk for this species (limiting fruit production). Conduct studies to evaluate if common pioneer species of riparian areas are potential habitat competitors for G. pauciflora. Select appropriate sites for population reintroduction in areas that exhibit the serpentine habitat requirements outside the MCF. Explore the opportunity to enter into a Service Partner's for Fish and Wildlife Agreement with the landowner to conserve the area and restore suitable habitat for the species (e.g. Indieras Ward site). (USFWS, 2019a)
- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions is presented in the Recovery Plan (Service 1998) and past 5-year reviews (Service 2013, 2019a). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Assess and develop a protocol to relocate individuals to augment, reestablish, or introduce populations. o Prioritize identification of sites for population enhancement or species introduction. • Development and refine propagation techniques for the species. • Outreach with private landowners and communities to inform them about the presence of the plant and discuss options to protect the species' known locations. Monitoring / Research Activities • Monitoring of known sites for this species after heavy disturbance events to identify whether there are any delayed mortality events. • Conducting research on the genetic diversity of the species, both within and among populations. • Continue surveying suitable habitat to identify new localities or populations, and to identify potential reintroduction sites. • Assess how flower predation by the plume moth influences the species reproductive output and viability (USFWS, 2024).

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SPECIES ACCOUNT: *Geum radiatum* (Spreading avens)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/5/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb with stems that grow up to 5 dm tall from a large basal rosette of leaves. The stems are topped with showy, bright yellow flowers during most of the summer. There is no other Geum in the southeastern U.S. that remotely resembles this species. It is taxonomically closest to G. peckii, a species whose southernmost range is in the White Mountains of New Hampshire - about 900 km north of G. radiatum's range (NatureServe, 2015).

Taxonomy

Geum radiatum is a distinct species, sibling to Geum peckii of New England and Nova Scotia, or may be conspecific with that (in which case the older name Geum radiatum would apply to the collective species) (NatureServe, 2015).

Historical Range

This species is endemic to a few scattered mountaintops in western North Carolina and eastern Tennessee (USFWS, 1993).

Current Range

The range of G. radiatum consists of populations distributed across Ashe, Avery, Buncombe, Mitchell, Transylvania, Watauga and Yancey counties, North Carolina and Carter and Sever counties, Tennessee (USFWS, 2013)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, asexual (USFWS, 1993)

Breeding Season

Adult: June - September (USFWS, 1993)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1993)

Reproduction Narrative

Adult: Flowering occurs from June through September; fruiting occurs from August through October. New plants can be produced through sexual or asexual means. Morgan (1980) reported observing many insects visiting the flowers, but these were not identified. Massey et al. (1980) also reported observations of Hymenoptera visiting the flowers. F. Brackley (Keene

State College, personal communication, 1992; Brackley and Burger 1980) has observed flies on this species (USFWS, 1993). This species as low rates of seedling recruitment (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliffs, talus slopes, heath balds (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Consistent moisture (USFWS, 1993)

Geographic or Habitat Restraints or Barriers

Adult: Does not occur < 1310 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very Narrow (NatureServe, 2015)

Habitat Narrative

Adult: A pioneer species. Occurs on exposed, high elevation situations in the southern Appalachians. Primarily in the crevices of northwest-facing cliffs. Also at the bases of talus slopes, or, rarely, in openings in heath balds. Found only at elevations over 1310 m (NatureServe, 2015). These rocky summits and cliffs usually appear as smaller-scale, patchy habitats embedded within a larger forested landscape consisting of spruce-fir or northern hardwood forest, or occasionally high elevation red oak forest (USFWS, 2013). The soils on which spreading avens grows (typic haplumbrepts, udorthents, and entisols) are generally shallow and acidic (pH 4-5), uniform, dark brown, and coarse-loamy. Consistent moisture may be one of the most important habitat requirements of this species (USFWS, 1993).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Stable (USFWS, 2020)

Species Trends:

Stable (USFWS, 2020)

Number of Populations:

15 (USFWS, 2020)

Population Narrative:

Spreading avens should remain classified as endangered. The distribution of this narrow-ranging endemic has not changed since the last 5-year review. Eight of the 15 populations have readily accessible public access, impacts from recreational use remain a threat, and a newly proposed trail may provide access to previously inaccessible sites. Despite nearly stable demography, spreading avens' persistence into the future is uncertain if predicted changes in climate occur. Successful management strategies that significantly reduce or eliminate these threats have yet to be determined. Data and information outlined in this review highlight the need for continued management and monitoring throughout the range and show spreading avens continues to meet the definition of an endangered species under the Endangered Species Act. (USFWS, 2020)

Threats and Stressors

Stressor: Recreation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: protection through public ownership can have unintended adverse consequences, in that areas can become subject to increased visitation by the recreating public. Trampling when recreating, rock climbing and rappelling is a significant threat to G. radiatum, having resulted or contributed to declines at portions of four populations (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Accelerated global climate change is likely to disrupt patterns of climate variability to which G. radiatum has become adapted, and as such is likely to exacerbate threats already mentioned. However, the current scale of most global models of climate change offers little insight into the changes that will likely occur on southern Appalachian high peaks. While a net warming trend could exceed the tolerances of species adapted to cool, moist conditions, the current range of G. radiatum spans a range of conditions which vary widely in their degree of overall sun exposure, humidity, precipitation and soil moisture. Thus most available data suggest that climatic disruptions significantly affecting the availability of soil moisture or above-ground seepage are likely to further threaten the long term viability of this high elevation rock outcrop endemic (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
There are at least 16 self-sustaining populations that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (USFWS, 1993).

Recovery Actions:
- Survey suitable habitat for additional populations (USFWS, 1993).
- Monitor and protect existing populations (USFWS, 1993).

- Conduct research on the biology of the species (USFWS, 1993).
- Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining (USFWS, 1993).
- Investigate and conduct necessary management activities at all key sites (USFWS, 1993).
- Continue annual demographic monitoring at as many sites as possible, including (but not limited to) those nine populations already included in ongoing monitoring efforts (Recovery Tasks 2.1, 2.3 and 2.5) (USFWS, 2013).
- Work with NCNHP and TNNHP to satisfactorily incorporate results from prior survey efforts into their respective databases (Recovery Task 1.2) (USFWS, 2013).
- Conduct reconnaissance surveys to verify population sizes at exceptionally large sites (e.g., Phoenix Mountain, Three Top, The Peak) and to verify apparent or suspected declines at other sites (e.g., Cliff Top, Potato Hill, Grassy Ridge east of Carvers Gap (Big Roan Ridge subpopulation)) (USFWS, 2013).
- Work with TNC and other appropriate partners to evaluate protection alternatives at remaining unprotected sites (e.g., Hanging Rock, Phoenix Mountain, Potato Hill, Yellow Mountain (Raven Cliffs)), including the use of voluntary landowner agreements (Recovery Task 1.4) (USFWS, 2013).
- Compile quantitative data summarizing transplant survivorship across all previously attempted introduction or augmentation efforts involving this species, and evaluate causes for success/failure (Recovery Task 2.7) (USFWS, 2013).
- Work with appropriate partners to place representative genetic material in long-term storage, and to evaluate long-term storage requirements for this species (Recovery Task 3) (USFWS, 2013).
- Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for G. radiatum (Recovery Task 1.4) (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The 2013 5-year review included a list of recommendations to improve recovery of the species. These actions (7), listed below, remain applicable to species recovery. Continue annual demographic monitoring at as many sites as possible, including (but not limited to) those nine populations already included in ongoing monitoring. Work with NCNHP and TNHP to satisfactorily incorporate results from prior survey efforts into their respective databases. Conduct reconnaissance surveys to verify population sizes at exceptionally large sites and to verify apparent or suspected declines at other sites. Work with TNC and other appropriate partners to evaluate protection alternatives at remaining unprotected sites including the use of voluntary landowner agreements. Compile quantitative data summarizing transplant survivorship across all previously attempted introduction or augmentation efforts involving this species, and evaluate causes for success/failure. Work with appropriate partners to place representative genetic material in long-term storage, and to evaluate long-term storage requirements for this species. Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for spreading avens. Additional future actions, in light of new information, are recommended below. Work with partners to investigate/research potential outbreeding depression at Roan Mountain populations. Continue working with and supporting partners to

quantify visitor use and identify visitor use patterns to prioritize management that would minimize recreational impacts to the species. Continue working with and supporting North Carolina State University to identify rare species using UAS (drone). Formalize an agreement (Memorandum of Understanding or other appropriate agreement) to continue demographic monitoring at spreading avens survey sites. Develop a plan for conserving the species in ex-situ collections – either through conservation gardens or seed banking. Spreading avens co-occurs with other federally listed species. Impacts from monitoring could inadvertently occur if field staff conducting monitoring are unaware of other species present or how to identify them. Tailgate meetings should occur prior to each monitoring event when species co-occur. Field staff should be briefed on species present, how to identify them, and strategies for avoidance. (USFWS, 2020)

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SPECIES ACCOUNT: *Gilia tenuiflora ssp. arenaria* (Monterey gilia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/22/1992; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An erect, densely pubescent herb with basal rosette leaves and funnel-shaped purple flowers (NatureServe, 2015).

Taxonomy

A member of the phlox family (Polemoniaceae). It has been observed that in the more inland areas of its distribution, Gilia tenuiflora ssp. arenaria has morphological characteristics that intergrade with G. t. ssp. tenuiflora (Dorrell-Canepa, 1994) (USFWS, 2008).

Historical Range

This subspecies is endemic to the Monterey Bay and Peninsula dune complexes (USFWS, 2008).

Current Range

Restricted to isolated sites within two coastal dune scrub communities along Monterey Bay and the Monterey Peninsula (NatureServe, 2015). Occurrences are distributed in discontinuous populations from Spanish Bay on the Monterey Peninsula north to Moss Landing in Monterey County, CA (USFWS 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015); self-pollination (USFWS, 1998)

Lifespan

Adult: 1 year (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Insect pollinators (NatureServe, 2015); soils seed bank, semi-open areas (USFWS, 2008)

Reproduction Narrative

Adult: Entirely animal pollinated; mixture of bees, butterflies, moths, long-tongued flies, hummingbirds (NatureServe, 2015). It is an annual plant. A recent study has shown that Gilia tenuiflora ssp. arenaria may have long-lived seeds which create a relatively persistent soil seed bank (Fox et al. 2005). Gilia t. ssp. arenaria requires semi-open areas of sandy soil to germinate and to thrive (L. Madison, pers. comm. 2006; B. Collins, pers. comm. 2006; B. Delgado, pers. comm. 2006) (USFWS, 2008). The species is thought to be primarily self-pollinating based on its stamens not protruding from the flower, no observations of pollinators, and very viable seed

(Dorrell-Canepa, in litt., 1995) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal strand (NatureServe, 2015); dune scrub, coastal sage scrub, maritime chaparral (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Dense vegetation (USFWS, 2008); occurs at or below 100 ft. elevation (USFWS, 1998)

Environmental Specificity

Adult: Narrow (USFWS, 2008)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 1998)

Habitat Narrative

Adult: Inhabits coastal strand (sandy beaches and dunes) (NatureServe, 2015). Gilia t. ssp. arenaria is typically associated with sandy soils of dune scrub, coastal sage scrub, and maritime chaparral vegetation types. The taxon is generally found in sparse scrub communities, and does not compete well in the denser vegetation structure often exhibited by many non-native species. (USFWS, 2008). The species occurs at elevations no higher than 30 meters (100 feet). The species is usually tolerant of small amounts of drifting sand, but tends to occur in stable sites with minimal sand accretion or deflation (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dust-like seeds in many desert species, assumed to be wind dispersed (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

3 populations extirpated since listing (USFWS, 2008)

Number of Populations:

24 (USFWS, 2008)

Population Size:

Variable from year to year; 1,665 - 25,000 depending on location (USFWS, 2008)

Population Narrative:

There are likely 24 currently extant occurrences of Gilia tenuiflora ssp. arenaria. Three coastal populations have likely been extirpated since the time of listing. As an annual plant, Gilia tenuiflora ssp. arenaria can go through large changes in number of individuals from year to year, and late-season rainfall can markedly affect germination and growth (Dorrell-Canepa 1994; Fox et al. 2005). Population censuses that span at least 10 years have been conducted at only a few locations. The number of individuals at Marina State Beach has fluctuated from a low of 5,000 individuals in 1987 to a high of 25,000 individuals in 1993; the number of individuals at Salinas River State Beach has fluctuated from a low of 1,665 individuals in 1987 to a high of 13,500 individuals in 1993 (CNDDB 2006) (USFWS, 2008).

Threats and Stressors

Stressor: Development (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: One of the greatest current threats to this subspecies is continuing destruction of habitat due to development. While future development will be precluded at some sites by virtue of being transferred to entities that will manage for their conservation (e.g., Big Sur Land Trust, University of California, and BLM at former Fort Ord), other sites are slated for future development. The western areas of former Fort Ord that are to be developed are relatively small in acreage, but contain a high density of individuals. Six of 11 inland occurrences (55%) on public lands are under threat of at least partial development (USFWS, 2008).

Stressor: Herbivory (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Herbivory has been observed by individuals conducting surveys and research on this subspecies (L. Fox in litt. 2006; T. Hyland pers. com. 2006). This poses a potentially serious threat to this subspecies (Service 1998), but actual effects are currently unknown. Herbivory has been found to increase with an increase in cover for small herbivorous species such as rabbits (McGraw 2004) (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: One of the main threats to this taxon is competition from invasive, non-native species (57 FR 27848). These species are typically able to colonize disturbed habitats and quickly reach high densities. In coastal areas, iceplant (Carpobrotus ssp.) and exotic annual grasses are the most problematic invasive species for Gilia tenuiflora ssp. arenaria. In inland areas, jubata grass (Cortaderia jubata), iceplant, and annual grasses (Festuca spp., Avena spp., and others) are the most problematic invasive species for G. t. ssp. arenaria (Mactec Engineering and Consulting Incorporated 2002, 2003, and 2004). Annual grasses are particularly difficult to remove once they have colonized an area. Non-native grasses decrease the suitability of habitat for G. t. ssp. arenaria due to excessive soil stabilization and litter accumulation (Pickart 1997, Russo et al. 1988) (USFWS, 2008).

Stressor: Inadequate vegetation management (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Other human-caused factors that could affect the inland occurrences at former Fort Ord, aside from those previously mentioned, are vegetation management activities that fail to create or maintain the open, sandy conditions necessary for continued survival and colonization by Gilia tenuiflora ssp. arenaria. These include the elimination of fire from chaparral communities, poorly timed (e.g., wet season) prescribed fires, the use of pre-fire treatments that result in increases in non-native species, and the use of mechanical vegetation clearing that leaves the chipped vegetation on the soil surface (Zander and Associates 2007) (USFWS, 2008).

Recovery

Reclassification Criteria:
1. Habitat occupied by the taxon that is needed to allow delisting has been secured with long-term commitments and, if possible, endowments to fund conservation of the native vegetation (USFWS, 2008).

2. Management measures are being implemented to address the threats of invasive species and other problems, including grazing, pedestrians, and off-road vehicles at some sites (USFWS, 2008).

3. Monitoring indicates that management actions are successful in reducing threats of invasive non-native species (USFWS, 2008).

4. Additional restored habitat has been secured, with evidence of either natural or artificial long-term establishment of additional populations, and long-term commitments (and endowments, where possible) to fund conservation of the native vegetation (USFWS, 2008).

Delisting Criteria:
1. Habitat throughout this taxon's range is protected from encroachment of non-native species, recreational activity (including off-road vehicles [ORVs] and horses), and development (USFWS, 2008).

2. Habitat throughout this taxon's range is restored to native vegetation at proper densities to allow natural colonization by this plant (USFWS, 2008).

3. Habitat throughout this taxon's range is monitored sufficiently to assure that local threats are spotted promptly (USFWS, 2008).

4. Enough plants are at enough locations throughout this taxon's range and within the protected vegetation to reasonably assure the viability of the taxon (USFWS, 2008).

5. (Re)introduced populations should be naturally reproducing in vegetation that also appears to be persisting without excessive maintenance or "gardening" (USFWS, 2008).

6. The determination that delisting is possible must be based on at least 15 years of monitoring for the endangered taxa, to include wet and drought years (USFWS, 2008).

Recovery Actions:

- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plant (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).
- Develop and implement an outreach program (USFWS, 1998).
- A reworking of the recovery criteria listed in the recovery plan should be undertaken. The specific population sizes recommended in delisting criteria #4 are difficult to correlate with the observed distribution of occurrences in the field. Using specific numbers for annual species with persistent seed banks, as previously discussed, is not necessarily valuable as an indicator of species status. A more useful indicator should be identified to indicate the quality and status of the habitat that is supporting the various populations (USFWS, 2008).
- Improved coordination between State and Federal agencies and local landowners would increase information sharing and maximize conservation and recovery efforts. Aside from the work being done for the re-use of former Fort Ord properties, very little communication is currently occurring between different parties involved with the management of this subspecies. Little or no information was available for many of the privately owned parcels of land believed to support occurrences of this subspecies. Attempts to establish conservation easements or acquire properties containing coastal dune habitat that supports this and other rare and endangered species should be made. Conducting surveys of these lands to determine whether or not extant populations still exist would be valuable. Directed oversight through coordination of information, overall strategies, and implementation of uniform methodologies would allow for implementation of much more powerful adaptive management techniques (USFWS, 2008).
- Long-term monitoring programs at more known occurrences of Gilia tenuiflora ssp. arenaria should be undertaken. Due to the strong influence of annual precipitation on observable population size, this monitoring should be habitat-based or in another way address the issue of dormant soil seed banks. This monitoring should include monitoring of pre-fire vegetation and herbivory rates on portions of former Fort Ord that will be burned under the prescribed burn plan in the Fort Ord draft HCP. Information regarding control of non-native plants, community structure, herbivory, and germination of G. t. ssp. arenaria from persisting seed banks or new colonization in cleared areas may provide invaluable information for future management efforts (USFWS, 2008).
- Initiate surveys to locate suitable habitat for out-planting sites in areas that are managed for conservation and that could support Gilia tenuiflora ssp. arenaria. For instance, outplantings to areas such as Salinas River National Wildlife Refuge could complement recovery efforts elsewhere. If populations were to become established in such areas, they could also function as seed bank sources or reserves for other populations that are at risk of extirpation (USFWS, 2008).
- Seed collection should be initiated where populations are at risk of extirpation, including at former Fort Ord. Seeds should be stored at appropriate facilities, such as the Rancho Santa

Ana Botanic Garden, for future greenhouse seed production, genetic analyses, or direct recovery plantings. In conjunction with this, genetic analyses should be initiated to determine the geographic boundaries of Gilia tenuiflora ssp. arenaria and G. t. ssp. tenuiflora and the level of interbreeding, if any, occurring in the wild populations. This should be done prior to out-plantings from questionable populations in order to maintain genetic distinctiveness and accurately assess habitat requirements for each taxon (USFWS, 2008).

- Initiate controlled burn studies on former Fort Ord to determine the recovery potential of inland populations lost to unnaturally dense shrub communities. This should be undertaken to determine the conservation value of potential reserve areas prior to the finalization of proposed HCPs (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-year review: 1. Use the recently completed range-wide surveys to establish and implement a series of monitoring areas to evaluate population trends throughout the range. 2. Convene a working group of land managers to discuss funding for invasive species control, monitoring, restoration, and best management practices for Monterey gilia. 3. Expand invasive species control programs throughout the coastal occurrences of Monterey gilia. 4. Establish ex situ seed banks for long term preservation of Monterey gilia. 5. Conduct genetic analyses and collect morphological data where overlap between closely related subspecies occur. (USFWS, 2020)

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SPECIES ACCOUNT: *Gilia tenuiflora ssp. hoffmannii* (Hoffmann's slender-flowered gilia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, 6-12 cm tall. Flowers (April) are purplish and funnel-shaped, the top of the "funnel" widening to flat, pink lobes (NatureServe, 2015).

Taxonomy

A member of the phlox family (Polemoniaceae) (USFWS, 2009). In 1959, Munz included the varieties of tenuflora as subspecies, including ssp. hoffmannii, as per a 1956 treatment by the Grants (Munz and Keck 1973). This nomenclature was used in the latest treatment of the genus (Day 1993). Of the four subspecies of G. tenuiflora, the subspecies hoffmannii is the only one that occurs in southern California (USFWS, 2000).

Historical Range

Known from three locations on Santa Rosa Island of the northern Channel Islands. A collection was made by Reid Moran from the “arroyo between Ranch and Carrington Point” in 1941 (Rutherford and Thomas 1994). In 1994, Kathy Rindlaub located a population of 88 individuals covering 2 square meters (m) (21 square feet (ft.)) that reasonably corresponded to Moran’s site, and was grazed by cattle (Rindlaub 1994). The other historical location is at the type locality near East Point, where the species is still found today. It was not until 1994 surveys that Rindlaub discovered a third population that was 5 comprised of three colonies at Skunk Point on Santa Rosa Island. This population was comprised of approximately 3,000 to 3,500 individuals in 1994 and had been cropped by cattle (Rindlaub 1994) (USFWS, 2009).

Current Range

It is restricted to Santa Rosa Island off the coast of southern California. A third population was discovered in 1994 at Skunk Point (Rindlaub 1994) (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2009)

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: April - May (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Winter and spring rains (USFWS, 2009); insect pollinators (USFWS, 2000)

Reproduction Narrative

Adult: This is an annual plant. Plants germinate with winter or spring rains, primarily in January or February, and flowers and produces seed by late April or early May. An individual can produce from 200 to several hundred seeds (Faulkner and Chaney 2007) (USFWS, 2009). A small beefly (Otigodranes spp., Bombyliidae) was observed to be the most numerous and effective pollinator, and a soft-winged flower beetle (Melyridae) was observed as a casual visitor in a pollination study on south coast range Gilia tenuflora populations (Grant and Grant 1965). It is unknown if these species or their counterparts occur on Santa Rosa Island (USFWS, 2000).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dune scrub (NatureServe, 2015); lupine scrub (USFWS, 2000)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2000)

Habitat Narrative

Adult: Inhabits sandy soils with dune scrub vegetation. (NatureServe, 2015). Gilia tenuiflora ssp. hoffmannii thrives in open patches of habitat where bare ground ranges from about 50 to 95 percent (Faulkner and Chaney 2007). Gilia tenuiflora ssp. hoffmannii can be found growing on ancient stabilized sand dunes on the northeastern side of Santa Rosa Island where soil textures are characterized by loamy sand. The species prefers open habitat among other low herbaceous vegetation where competition for resources is low (Faulkner and Chaney 2007) (USFWS, 2009). Hoffmann's slender-flowered gilia is also a component of lupine scrub vegetation (USFWS, 2000).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (USFWS, 2009)

Number of Populations:

3 (USFWS, 2022)

Population Size:

Variable depending on year; East Point: 20,000 - 256,000; Skunk Point: 3,000 - 3,500 (USFWS, 2009).

Population Narrative:

At the time of listing, three populations of Gilia tenuiflora ssp. hoffmannii were known on Santa Rosa Island; currently there are two known populations. Gilia tenuiflora ssp. hoffmannii populations exhibit large inter-annual fluctuations. The East Point and Skunk Point populations appear to be relatively stable since the time of listing (USFWS, 2009).

Threats and Stressors

Stressor: Grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In response to browsing, Gilia forms multiple side branches, and although a branched plant may produce a greater number of flowers, this does not necessarily increase the fecundity of the plant (Painter and Belsky 1993). Flowers produced later in the season out of synchrony with pollinator activity results in lower seed productivity (Painter in litt. 1997 as referenced in Service 1997). In the step-down narrative portion of the recovery plan, effective elimination of habitat damage from nonnative animals, particularly the deer and elk on Santa Rosa Island, was considered one of the most important management tasks needed for recovery of this species and other listed plant taxa (Service 2000). Some progress has been made toward eliminating nonnative animals from Santa Rosa Island since the time of listing. Although habitat conditions on Santa Rosa Island show the effects of long-term grazing, the USGS believes that at the landscape level, conditions are improving (McEachern in litt. 2007) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Gilia tenuiflora ssp. hoffmannii is threatened by the risk of stochastic extinction due to small population size and limited distribution (Service 2000). In particular, the small size of each population makes it difficult for this species to persist while sustaining the impacts of soil damage and habitat alteration from nonnative species. The species remains vulnerable to extirpation due to its small population size, high inter-annual variability in plant numbers, and limited distribution (USFWS, 2009).

Stressor: Nonnative species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Competition from nonnative grasses currently threatens the existence of Gilia tenuiflora ssp. hoffmannii and its habitat. An invasive annual grass, false brome (Brachypodium distachyon), was recently discovered within Gilia tenuiflora ssp. hoffmannii habitat on East Point on Santa Rosa Island. Both false brome and Gilia tenuiflora ssp. hoffmannii prefer open patches

of habitat. The invasive grass has the potential to displace Gilia as it fills in the open areas of habitat (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Gilia tenuiflora ssp. hoffmannii may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap regions that would be climatically favorable in the future (Levine et al. 2008). This potential threat is particularly acute for species on islands because they are unable to disperse to more favorable habitat as the environment changes. Sea level rise as a result of climate change has the potential to adversely affect Gilia tenuiflora ssp. hoffmannii and its habitat. In particular, ocean bluffs along the coast will be subject to greater and more frequent wave attack, resulting in erosion and shoreline retreat (CCC 2001). In addition, Gilia tenuiflora ssp. hoffmannii may also be threatened by climate change because of its germination cues. According to the study conducted by Levine et al. (2008), Gilia tenuiflora ssp. hoffmannii exhibited the highest germination rates in the years of the coldest germination-inducing storms (USFWS, 2009).

Recovery

Reclassification Criteria:
Establish 10 populations on Santa Rosa Island that are stable or increasing for a period of 15 years that includes the normal precipitation cycle. A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000) (USFWS, 2009).

Recovery Priority Number: 6

Delisting Criteria:
1. Discover or establish five additional populations (USFWS, 2009).

2. No decline after downlisting for 10 years (USFWS, 2009).

Recovery Actions:
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species in this recovery plan and should be referred to as a supporting document (USFWS, 2000).
- Restore habitats and control competitive weeds for long-term management of the species and its habitats (USFWS, 2000).
- Conduct thorough surveys for the species (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species (USFWS, 2000).

- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).
- The USGS and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine the generalized downlisting criteria to take into consideration new information. Attaining the recovery criteria outlined in the recovery plan is unrealistic for this species (USFWS, 2009).
- The Service should work cooperatively with NPS and USGS to refine delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines in the species (USFWS, 2009).
- The USGS and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends of the species (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue monitoring the East Point population of Gilia tenuiflora ssp. hoffmannii. 2. Better define suitable germination and growth microhabitat for Gilia tenuiflora ssp. hoffmannii, especially in relationship to non-native grass Brachpodium distachyon competition. 3. Control and strive for eradication of Brachypodium distachyon at the East Point occurrence. 4. Establish a regular survey monitoring schedule for Gilia tenuiflora ssp. hoffmannii at the Skunk Point and Carrington Point populations. 5. Collect seed, especially from the Skunk Point and Carrington Point populations, for restoration seed bulking, and augment these populations with population-specific seed to boost population sizes. 6. Improve the completeness of coverage of Gilia tenuiflora ssp. hoffmannii in conservation seed banks, with all populations over a wider range of years (USFWS, 2022).

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SPECIES ACCOUNT: *Goetzea elegans* (Beautiful goetzea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/19/1985; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree reaching 30 feet (9 meters) in height with a stem diameter of 5 inches (13 centimeters). The leaves are simple, alternate, and elliptic, with entire margins and shiny dark green upper surfaces. The species generally flowers and sets fruit between April and August. The perfect (bisexual) funnel-shaped flowers are yellow-orange in color, and borne singly on curved stalks arising from the leaf axils. The fruit is an orange, one-seeded berry up to 1 inch (2.5 centimeters) in diameter, and is reputed to be poisonous (USFWS, 1987).

Taxonomy

Matabuey is a member of the nightshade family Solanaceae. The genus Goetzea comprises two species, one endemic to Hispaniola and the other endemic to Puerto Rico (USFWS, 2013).

Historical Range

Historically known from Quebradillas (type locality), the foothills of the Luquillo Mountains in Río Grande and Canóvanas, and from the Cambalache Commonwealth Forest in Arecibo (Vivaldi et al. 1981, USFWS 1987) (USFWS, 2013).

Current Range

The species is present in ten localities within the municipalities of Isabela and Quebradillas, one locality in Fajardo, and five localities in the island of Vieques (USFWS, 2013).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily sexual but capable of self-fertilization (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Probably the bananaquit (USFWS, 2013)

Breeding Season

Adult: Year round, especially February and July (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Shaded, moist conditions, followed by adequate sunlight for growth; bird and insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Matabuey is a canopy species that requires an intact understory for successful recruitment of seeds and saplings. Matabuey is mainly self-incompatible (mechanism that prevents self-fertilization) and requires outcrossing (pollination required between two different flowers) for successful seeding and fruiting. Germination and establishment of matabuey were better in shaded and mesic environments, and seeds do not tolerate high light incidence and dry conditions, such as open pastures, and seed dormancy is absent (Santiago-Valentín 1995). Maturity is achieved when the plant reaches the canopy with higher light levels. Santiago-Valentín (1995) reported that trees produce flowers throughout the year, but most frequently in February and in July. Fruits were found mainly between March and August, showing a maximum number of fruits in July. Santiago-Valentín (1995) found that the bananaquit or reinita común (Coereba flaveola) was the most frequent bird visitor to the flowers, and the European honeybee (Apis mellifera) was the most frequent insect visiting matabuey. The bananaquit is the most frequent visitor with 94.7% of the flower visits (USFWS, 2013).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical moist forest (USFWS, 2013); foothills, mogotes (USFWS, 1987)

Geographic or Habitat Restraints or Barriers

Adult: Occurs below 660 ft. elevation (USFWS, 1987)

Habitat Narrative

Adult: In Isabela and Quebradillas populations occur in the Subtropical Moist Forest Life Zone as described by Ewel and Whitmore (1973). The plants were growing in a semi-evergreen seasonal forest with an almost continuous upper canopy, having few emergent trees, and vines and lianas were frequent. All locations were on the Aymamón limestone formation; hence, plants were growing on limestone-derived upland soil association (Santiago-Valentín 1995) (USFWS, 2013). It has been found only below 660 ft. elevation in foothills and mogotes (USFWS, 1987).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Santiago-Valentín (1995) observed the stripe-headed tanager or reina mora (Spindalis zena) was the only animal he observed manipulating the fruits of matabuey, picking the fruits from the canopy, not from the forest floor. it has been observed that rats occasionally consumed immature fruits in Quebrada Bellaca in Quebradillas, especially when the tree had many fruits (M. Caraballo-Ortiz, pers. comm., 2013). In addition, there is some evidence that livestock probably predate on small trees (M. Caraballo-Ortiz pers. comm., 2013) (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2013)

Number of Populations:
16 (USFWS, 2015)

Population Size:
1,700 (USFWS, 2013)

Population Narrative:
The species status is increasing; there is evidence of recruitment in the localities where the species occurs. Currently, there are 16 populations in Quebradillas, Isabela, Fajardo, and the Island of Vieques. The most recent estimate of at least 1,200 individuals in Vieques, added to the known individuals from other sites in Puerto Rico, result in about 1,700 naturally occurring matabueys in Puerto Rico (USFWS, 2013). In general, conservation efforts completed and discussed above have resulted in approximately 900 individuals being planted between 2014 and 2018. However, their current status is unknown. Moreover, the species is mainly self-incompatible, populations show limited dispersal, and the majority of the populations are fragmented and have limited or no recruitment. Thus, based on the information received since the 2013 5-year status review, and that the species continues to be threatened by the same factors indicated in 2013 (Factors A, D, and E), we still consider matabuey to be endangered. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: All known populations in mainland Puerto Rico are located in privately owned lands or rights-of-way of existing roads periodically maintained by the local government. Although these areas may have limited use, all of them are privately-owned and human activities, such as harvesting of tubers and selective cutting of matabuey for fence posts, firewood and pathways were documented. Cattle grazing farms surround the majority of the areas and sometimes cattle are present within the habitat. Cattle grazing activities may modify the habitat, affecting the possibility of successful recruitment of seedlings. The Puerto Rico Highway and Transportation Authority is proposing the expansion of the highway PR 22 from Aguadilla to Hatillo, and two of the proposed alternative routes may affect an undetermined number of matabuey in locality 9 and 10 of Figure 2. In addition, indirect effects related to commercial, residential and tourist development associated with the expansion of the highway may affect the species and its habitat. In Vieques, the species is located along creeks in the western portion of the Island and in one locality in the Monte Pirata area within the Vieques National Wildlife Refuge. The populations located along creeks are outside of the refuge. This land was transferred by the Navy to the municipality for residential and tourism development (USFWS, 2013).

Stressor: Small isolated populations (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Research has demonstrated this species is mainly self-incompatible, and that pollinator visits and fruit set and seed germination is adversely affected by low blooming intensity and high distances to nearest reproductive neighbors. Furthermore, the frequency of sterile adults is high (about 53%). Low fecundity and isolation may affect genetic diversity of the species. The currently known populations also face dispersal limitation and fragmentation. Since the majority of the currently known populations are surrounded by pasturelands, small residential areas and existing roads, the chances for these populations to be expanding are very limited (USFWS, 2013).

Recovery

Reclassification Criteria:

1. The principal population in Quebrada Bellaca (Isabela) is placed under protective status (USFWS, 2013).

2. At least three new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest System in the karst region (e.g., Cambalache or Guajataca), or on Federal land within the Caribbean National Forest, if suitable habitat exists (USFWS, 2013).

Delisting Criteria:

1. The three (3) existing populations on privately owned lands (Guajataca Gorge, Fajardo, and Vieques) are protected through a conservation mechanisms (addresses Factor A). (USFWS, 2019).

2. The three (3) existing populations in Guajataca Gorge, Fajardo, and Vieques show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

3. Establish three (3) new populations in areas protected through a conservation mechanisms within the known geographical range that demonstrate a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Prevent further habitat loss and population decline (USFWS, 1987).
- Continue to gather information on distribution and abundance of Goetza elegans in norther Puerto Rico (USFWS, 1987).
- Research (USFWS, 1987).
- Refine recovery goals (USFWS, 1987).
- New in 2019: Current propagation efforts of matabuey should be re-evaluated to ensure those efforts are consistent with the biological and ecological limiting factors of the species, and to ensure establishment of self-sustaining populations in protected areas as recommended by SantiagoValentin (1995). Trees should be planted approximately 4.5 m (15 ft) apart to obtain a high germination rate (Santiago-Valentin 1995). This recovery action

should be coordinated with the Puerto Rico Department of Natural and Environmental Resources and be included within Tasks 33 and 34: Evaluate feasibility of artificial propagation, and Select appropriate sites for population enhancement, reintroduction, or introduction using artificially propagated material, respectively, of the approved recovery plan. (USFWS, 2019).

- The recovery plan should be revised to establish measurable reclassification criteria and develop delisting recovery criteria as more information is learned on this plant (USFWS, 2013).
- Further studies on pollination and seed dispersal are needed to determine the pollination and seed dispersal strategies in Vieques Island. We should assess if any of these dispersal mechanisms are limiting population growth and distribution expansion (USFWS, 2013).
- Isolated populations may require conservation efforts to augment number of individuals and ensuring interchange of genetic representation from other localities (USFWS, 2013).
- The Quebrada Bellaca area in Isabela should be acquired and a buffer zone established to reduce the impacts of the adjacent and upstream activities to the integrity of the system (USFWS, 2013).
- The Service needs to work with the municipality of Vieques to implement conservation measures on creeks and ravines, including the protection of watersheds by zoning. A private-lands initiative is needed to further protect the adjacent land and streams (USFWS, 2013).
- Both DNER and the Service should re-evaluate propagation efforts and introduction requirements for the species. Current efforts should be carefully evaluated to ensure that these efforts are consistent with the biological and ecological limiting factors of the species, and to ensure establishment of viable populations in protected areas. Santiago-Valentín recommended that reintroductions efforts for the recovery of the species must target the establishment of new populations on protected lands following reproductively functional spatial patterns of planting. Based on his study, trees could maintain up to 100% germination (in the case of few-flowered trees) if they are separated by 4.5 m (15 ft.) or less. Other considerations should include the presence and abundance of the bananaquit and the striped-headed tanager as the main pollinator and the seed dispersers, respectively. An interesting research project would be to determine seed shadows (an area on the ground where seeds do not fall due to canopy for example), time of gut passage, and viability of seeds (USFWS, 2013).
- Isolated populations should be enhanced with propagated material with genetic representation from other localities (USFWS, 2013).
- Efforts should continue to protect privately-owned populations (USFWS, 2013).

References

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USFWS. 2019. Beautiful Goetzea (Goetzea elegans) Recovery Plan, Amendment 1. USFWS, Atlanta, Georgia. 5 pp.

USFWS 2013. Matabuey (Goetzea elegans) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region. Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Gonocalyx concolor* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/9/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A small evergreen shrub, mainly epiphytic (grows on the trunks of trees) or clambering (uses other vegetation as support), which may reach 15 ft. (4.7 m) in length (Acevedo 2005, p. 227) (USFWS, 2014a). The stems are highly branched, slender, cylindrical, and dark brown in color. The twigs are pubescent (covered with fine short hairs). Young leaves and branches are brilliantly rose-colored, but become green with age. Flowers are bisexual, 5-merous (floral part in multiples of 5 in each whorl), regular, and uniformly vivid red. Fruit is a bright red berry with many seeds inside (Lioger 1995, p. 105) (USFWS, 2013).

Taxonomy

Gonocalyx concolor was described in 1970, as a new species of the genus Gonocalyx, family Ericaceae, for Puerto Rico (Nevling 1970, p. 221). G. concolor is similar to G. portoricensis, differences in distribution and flower morphology indicate that they are well-differentiated species (Nevling 1970, p. 224) (USFWS, 2014a).

Historical Range

Gonocalyx concolor is a Puerto Rican endemic plant species that has been found growing only in the elfin and ausubo (Manilkara bidentata) forests within the Carite Commonwealth Forest, which lies within the municipalities of Cayey, Patillas, and San Lorenzo in east-central Puerto Rico (USFWS, 2014b).

Current Range

It currently occurs at Cerro La Santa and Charco Azul, both in the Carite Commonwealth Forest (Pacheco and Monsegur, Service, unpubl. report, 2013, p. 2) (USFWS, 2013).

Critical Habitat Designated

Yes; 9/9/2014.

Legal Description

On September 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Gonocalyx concolor under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Puerto Rico (79 FR 53315-53344).

Critical Habitat Designation

The critical habitat designation for Gonocalyx concolor includes two CHUs in Espino Ward, between the Municipalities of Cayey and San Lorenzo, and Espino Ward, between the Municipalities of Cayey and San Lorenzo, Puerto Rico. This species critical habitat encompasses approximately 198 acres (ac) (80.1 hectares (ha)) (79 FR 53315-53344).

Unit 1: Cerro La Santa: Unit 1 consists of 18.8 ac (7.6 ha) of elfin forest located on exposed peaks and ridges of Cerro La Santa, above 2,890 ft (880 m) in elevation from sea level. This unit is

located in the Sierra de Cayey on Road PR 184, Km 27.1 in Espino Ward, between the Municipalities of Cayey and San Lorenzo. This unit is within the geographical area occupied by the species at the time of listing. This unit contains all PCEs. The PCEs in this unit may require special considerations to address threats of habitat modification resulting from maintenance and potential expansion of existing telecommunication facilities, humaninduced fires, invasive species, and degradation of forest quality.

Unit 2: Charco Azul: Unit 2 consists of 179.2 ac (72.5 ha) of ausubo forest located along the Rio Grande de Patillas River basin between 2,030 ft (620 m) and 2,330 ft (720 m) in elevation from sea level. This unit is approximately 2.0 mi (3.2 km) southeast of Unit 1. This unit is within the geographical area occupied by the species at the time of listing. This unit contains all PCEs. The PCEs in this unit may require special considerations and protection to address threats of habitat modification resulting from humaninduced fires, invasive species, and degradation of forest quality.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Gonocalyx concolor critical habitat consists of three components (79 FR 53315-53344):

(1) Elfin forest at elevations over 2,900 ft (880 m) in Cerro La Santa, Puerto Rico, which includes: (a) Forest with single canopy layer with trees seldom exceeding 22 ft (7 m) in height. (b) Associated native vegetation dominated by species such as Tabebuia schumanniana, Tabebuia rigida, Ocotea spathulata, Eugenia borinquensis, Clusia minor, and Prestoea acuminata var. montana, native ferns, and dense cover with epiphytes, including bromeliads and mosses.

(2) Ausubo forest at elevations between 2,000 to 2,300 ft (620 to 720 m) in the Charco Azul, which includes: (a) Forest with single canopy layer with trees exceeding 22 ft (7 m) in height. (b) Plant association comprised by few species of native trees and associated native vegetation (e.g., Manilkara bidentata, Dacryodes excelsa, Guarea guidonia, and Cyrilla racemiflora), native ferns, and dense cover with epiphytes, including bromeliads and mosses.

(3) The type locations described in PCEs (1) and (2), above, for this species should have mean annual precipitation of 88.7 in (225.3 cm), mean annual temperature of 72.3 °F (22.7 °C), and Los Guineos type of soil (i.e., very deep, acidic, clayey, well-drained soils on side slopes of mountains).

Special Management Considerations or Protections

The primary threats to the PBFs that G. concolor depends on include: (1) Habitat destruction and modification by development of telecommunication towers and associated facilities on the mountain top of Cerro La Santa; (2) vegetation management; (3) hurricanes and tropical storms; (4) landslides; (5) invasive species; and (6) humaninduced fire. The majority of these threats can be addressed by special management considerations or protection while others (e.g., hurricanes, landslides, and climate change) are beyond the control of land owners and managers. Management activities that could ameliorate these threats include, but are not limited to, implementation of conservation measures with DNER to reduce threats to the species in the Carite Commonwealth Forest; minimization of habitat disturbance, fragmentation, and destruction resulting from maintenance of telecommunication facilities; prevention of fires; and

controlling invasive plant species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily sexual; self-pollination (USFWS, 2013)

Breeding Season

Adult: December - January, April (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Possibly hummingbird pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Gonocalyx concolor has been observed flowering in December, January, February, and April (Nevling 1970, p. 224). Preliminary studies of the species' reproductive biology indicate that the plant is predominantly outcrossed, and that outcrossed flowers produce twice the number of seeds than self-pollinated flowers (S. Flores, Universidad del Turabo, pers. comm. 1996). The low number of individuals per population may suggest that Gonocalyx concolor has highly specialized ecological requirements to grow and that production of viable seeds rarely occurs (C. Pacheco, Service, pers. obs., 2013). Gonocalyx concolor has vivid red, semipendent flowers, which apparently are hummingbird pollinated (USFWS, 2013).

Habitat Type

Adult: Terrestrial (USFWS 2014a)

Habitat Vegetation or Surface Water Classification

Adult: Lower montane wet forest: elfin forest, ausubo forest (USFWS, 2014a)

Dependencies on Specific Environmental Elements

Adult: mean annual precipitation of 88.7 in, mean annual temperature of 72.3 °F (USFWS, 2014b)

Habitat Narrative

Adult: It has been described as endemic from the elfin forest type at Cerro La Santa and from the ausubo (Manilkara bidentata) forest type at Charco Azul, both within the lower montane (an altitudinal zone in mountainous region characterized by distinctive flora and forest structure) very wet forest life zone in the Carite Commonwealth Forest (Ewel and Whitmore 1973, p. 41) (USFWS, 2014a). The Service identifies mean annual precipitation of 88.7 in (225.3 cm), mean annual temperature of 72.3 °F (22.7 °C), and Los Guineos type of soil (i.e., very deep, acidic, clayey, well-drained soils on side slopes of mountains) to be physical or biological features for this species. The Service identifies the remnants and late successional vegetation of elfin and ausubo forests with a single canopy layer of about 22 ft. (7 m) in height to be physical or biological features for this species (USFWS, 2014b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

2 (USFWS, 2021)

Population Size:

62 (USFWS, 2021)

Population Narrative:

Currently, Gonocalyx concolor is known from three populations. The species shows a limited distribution in its habitat, occupying only 0.75 ac (0.3 ha) at Cerro La Santa (Pacheco and Monsegur Service, unpubl. report, 2013, p. 3) and approximately 0.12 ac (0.05 ha) at Charco Azul (O. Monsegur, UPRM, unpubl. report, 2006, p.2) (USFWS, 2013). Gonocalyx concolor is an endemic shrub known only from two small populations within the CCF, a public land managed by PRDNER for conservation. Currently, the overall species abundance throughout its range is 62 individuals, persisting in two types of forest (i.e., elfin forest and ausubo forest) within the subtropical lower montane very wet forest life zone. Both forest types have similar climate conditions (temperature and humidity). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014a)
Exposure:
Response:
Consequence:
Narrative: George Proctor (1992, p. 3) stated that the construction of a paved road and gigantic telecommunication towers on the summit ridge of Cerro La Santa destroyed much of the natural population of this species. Currently, the telecommunication tower and its associated facilities (i.e., access roads, security fences, guy wires) occupy approximately 6.1 acres (ac) (2.5 hectares (ha)) of the elfin forest in Cerro La Santa. Although the populations at Cerro La Santa are located within a Commonwealth forest, this area is subjected to development for expansion of telecommunication infrastructure because permits to build new communication facilities or expand currently existing ones within or near Commonwealth forests are prevalent (DNER 2004a, p. 2). Expansion of the existing telecommunication facilities may result in loss of 27 individuals of G. concolor and their habitat. In Puerto Rico, towers for cellular communication, radio, television, and military and governmental purposes have represented a threat to those plant species that happen to occur only on mountaintops. Construction of a new access road and improvement of the existing access road to the existing communication facilities have been identified as a factor that could directly (destruction of individuals) or indirectly (slope instability and habitat degradation) reduce the number Gonocalyx concolor and its habitat at Cerro La Santa (Proctor 1992, p. 3; C. Pacheco and O. Monsegur, Service, unpubl. report, 2013, p. 3). Additionally,

clearing the native vegetation along the road may facilitate and accelerate colonization of invasive vegetation towards G. concolor habitat. Vegetation management around the existing telecommunication towers and associated facilities and along the existing power lines that energize these facilities is a threat to Gonocalyx concolor and its habitat (C. Pacheco and O. Monsegur, Service, unpubl. report, 2013, p. 3) (USFWS, 2014a).

Stressor: Invasive plant species (USFWS, 2014a)
Exposure:
Response:
Consequence:
Narrative: Invasive native plants, such as the ferns Gleichenella pectinata and Sticherus bifidus, may invade and alter diverse native communities, often resulting in plant monocultures that support few wildlife species (Walker et al. 2010, p. 627). These ferns can colonize disturbed areas faster than other native plants and may grow into dense mats, thereby excluding native plants (Walker et al. 2010, p. 634). Additionally, the mats formed by these species serve as fuel for fires and, in fact, seems to be fire-tolerant. The invasive, nonnative grass Pennisetum purpureum (elephant grass) is a fire adapted species that, in dense growth, can suppress most grasses, herbs, and tree seedlings (J. K. Francis, ITF, internet data, 2013). These invasive ferns and grass are currently found occupying areas disturbed by fire, landslides, and road construction in Cerro La Santa, and have the potential to affect Gonocalyx concolor by increasing fire incidences, microclimate, and nutrient cycling of the habitat on which this species depends (USFWS, 2014a).

Stressor: Fire (USFWS, 2014a)
Exposure:
Response:
Consequence:
Narrative: Human-induced fire is a current threat to Gonocalyx concolor at Cerro La Santa. Areas adjacent to (less than 33 ft. (10 m) from) a population of this species have been affected by such fires (O. Monsegur, UPRM, unpubl. data, 2006). Fire effects could accelerate the colonization of invasive plants and change the vegetation composition of Cerro La Santa (see discussion under Factor A, above). Currently, Pennisetum purpureum, a nonnative grass, is occupying these areas, making them vulnerable to human-induced fires. During the dry season (March through May), the fern Gleichenella pectinata, and other fern species that have colonized landslides and roadsides, form dense mats of dry material that serve as fuel for fires. Although Cerro La Santa is located in the wet forest, fires still occur in the area, particularly along roads, during the dry season (C. Pacheco, USFWS, pers. obs. 2013) (USFWS, 2014a).

Stressor: Small isolated populations (USFWS, 2014a)
Exposure:
Response:
Consequence:
Narrative: The limited distribution and low number of populations (3) and individuals (172 historically reported) of Gonocalyx concolor may exacerbate its vulnerability to natural events such as hurricanes and landslides, and compromise its continued existence. Damage to higher elevation forested habitat is usually greater during hurricane events (Weaver 2008, p. 150). Gonocalyx concolor is extremely vulnerable due to its habitat requirements and the fact that it is usually found growing on the canopy of the tallest trees in Cerro La Santa and Charco Azul. Therefore, damage to the forest canopy may result in a direct impact to individuals of G. concolor

that may fall to the ground and probably be outcompeted by pioneer plant species that get established during early successional stages after hurricanes. Small and isolated populations of rare plants often display reduced fitness as reduced reproductive output, seedling performance, or pollen viability (Holmes et al. 2008, p. 1031). Additionally, given the extremely limited geographic distribution of G. concolor, it is likely that its genetic variability is low (USFWS, 2014a).

Stressor: Climate change, coupled with the species highly specialized ecological requirements (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The Service considers climate change, coupled with the species highly specialized ecological requirements, as a threat to Gononcalyx concolor. Climate change can have both direct and indirect impacts on the species and can exacerbate the effects of other threats, especially those related to habitat modification such as fires and invasive species. Climate change is one of the most challenging threats to address since climate change scenarios for Puerto Rico predict a gradual trend toward a drier and hotter climate (Khalyani et al. 2016). (USFWS, 2021)

Recovery

Reclassification Criteria:
Recovery Priority Number: 5C (USFWS, 2023)

Delisting Criteria:
(1) Threat reduction and management activities (e.g., loss of individuals and habitat by vegetation clearance around the telecommunication facilities and access road, wildfires and control of invasive species) have been implemented to a degree that the species is viable (addresses Factor A, Factor D and Factor E); (USFWS, 2023)

(2) The two existing natural populations of Gonocalyx concolor in the Carite Commonwealth Forest reach at least 200 individuals per population1 , show a stable or increasing trend, evidenced by natural recruitment[2] and multiple age classes, sufficient to ensure selfperpetuation (addresses Factor E). The minimum number of 200 individuals per population may be reached as a result of natural recruitment or by introduction of controlled propagated individuals: and (USFWS, 2023)

(3) At least two new additional viable populations[3] are established or discovered in protected suitable habitat outside (ex-situ) the Carite Commonwealth Forest and maintain and demonstrate natural recruitment over 5 generations (address Factor A and E). The minimum number of individuals per ex-situ population should also be at least 200 (USFWS, 2023).

Recovery Actions:
- 1. Prevent further habitat loss (including habitat enhancement and restoration) and population decline (USFWS, 2023).
- 2. Continue to gather information on the biology, ecology, distribution and abundance of Gonocalyx concolor in the Carite Commonwealth Forest (USFWS, 2023).
- 3. Develop a habitat suitability model to predict spatial distribution of the species (USFWS, 2023).

- 4. Evaluate feasibility of artificial propagation and introduction (USFWS, 2023).
- 5. Facilitate recovery and protection of the Gonocalyx concolor through public awareness and education (USFWS, 2023).
- 6. Refine recovery criteria and determine what additional actions are necessary to achieve recovery criteria for downlisting/delisting the Gonocalyx concolor (USFWS, 2023).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Finalize the recovery plan for Gonocalyx concolor. • Prevent further habitat loss and population decline by implementing habitat management and other conservation strategies. • Continue working with stakeholders to avoid and reduce impacts of the telecommunication facilities (particularly expansion and maintenance) to Gonocalyx concolor and its habitat. • Continue gathering information on the biology, ecology, distribution and abundance of Gonocalyx conclor. o Develop and validate a habitat suitability model to predict spatial distribution of the species and its habitat in Puerto Rico • Evaluate the species resilience to climate change and other factors. • Evaluate feasibility of a controlled propagation program for Gonocalyx concolor. o Evaluate feasibility of vegetative plant propagation and germination from seed. • Facilitate recovery and protection of Gonocalyx concolor through public awareness and education. (USFWS, 2021)

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016

USFWS 2014a. Endangered and Threatened Wildlife and Plants

Endangered Species Status for Agave eggersiana and Gonocalyx concolor, and Threatened Species Status for Varronia rupicola. 79 Federal Register 174. September 9, 2014. Pages 53303 - 53315

USFWS 2014b. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Agave eggersiana, Gonocalyx concolor, and Varronia rupicola. 79 Federal Register 174. September 9, 2014. Pages 53315 - 53344

USFWS 2013. Endangered and Threatened Wildlife and Plants

Endangered Status for Agave eggersiana and Gonocalyx concolor, and Threatened Status for Varronia rupicola. 78 Federal Register 204. October 22, 2013. Pages 62560 - 62579.

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USFWS. 2023. Recovery Plan for Gonocalyx concolor (no common name). Southeast Region. Caribbean Ecological Service Field Office. Puerto Rico. 8 pages.

SPECIES ACCOUNT: *Gouania meyenii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

An erect to spreading shrub with stems 0.5-2.2 m long. Flowers are small and white. (NatureServe, 2015). A short-lived, erect to spreading shrub in the Rhamnaceae family. (USFWS, 2017).

Historical Range

Historically, Gouania meyenii was known from central and southern areas of the Waianae Mountains, from Kamaileunu Ridge to Honouliuli (USFWS 1995, Wagneret al. 1990).

Current Range

Gouania meyenii is found in Northern Waianae Mountains, Oahu and Kalalau Valley, Kauai. (NatureServe, 2015). As of 2017, there are no known individuals remaining on Kauai (Ching Harbin 2017, pers. comm.). (USFWS, 2017). Island Distribution: Found on Oahu. Possibly extirpated on Kauai (USFWS, 2021c)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Gouania meyenii under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Gouania meyenii (77 FR 57648-57862). The critical habitat designation includes 18 critical habitat units, which encompass approximately 8,109 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Gouania meyenii includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Gouania meyenii under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat desisgnation for Gouania meyenii includes 18 critical habitat units, covering three ecosystem types, which encompass approximately 8,109 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 6, 8, 9, 10, 11; Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to

Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 6 [287 ac (116 ha)]. This area consists of 287 ac (116 ha) of State land in the lowland dry ecosystem, on the outer rim of Leahi (Diamond Head) Crater within Diamond Head State Monument. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for Gouania meyenii includes three CHUs in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—Gouania meyenii—a: This unit is critical habitat for Gouania meyenii and is 442 ha (1,094 ac) on State land (Kuia NAR), and containing portions of Mahanaloa Valley. This unit provides habitat for one population of 300 mature, reproducing individuals of the shortlived perennial Gouania meyenii and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges, cliff faces, and ridge-tops in dry shrubland or Metrosideros polymorpha lowland diverse mesic forest. This unit provides for one population within this multi-island species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—Gouania meyenii—b: This unit is critical habitat for Gouania meyenii and is 128 ha (316 ac) on State land (Na Pali Coast State Park) within Kalalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Gouania meyenii and is currently occupied with eight plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges, cliff faces, and ridge-tops in dry shrubland or Metrosideros polymorpha lowland diverse mesic forest. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—Gouania meyenii—c: This unit is critical habitat for Gouania meyenii and is 215 ha (532 ac) on State land, and containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Gouania meyenii and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, rocky ledges, cliff faces, and ridge-tops in dry shrubland or Metrosideros polymorpha lowland diverse mesic forest. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Gouania meyenii critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Gouania meyenii occurs within the Lowland dry, Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland dry ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 6, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (E) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Gouania meyenii critical habitat consists of two components (68 FR 9116-9479):

(i) Rocky ledges, cliff faces, and ridge tops in dry shrubland or Metrosideros polymorpha lowland diverse mesic forest and containing one or more of the following native plant species: Bidens spp., Carex meyenii, Chamaesyce spp., Dodonaea viscosa, Diospyros spp., Eragrostis variabilis, Euphorbia haeleeleana, Hedyotis spp., Hibiscadelphus spp., Lysimachia spp., Melicope pallida, Neraudia kauaiensis, Nestegis sandwicensis, Nototrichium divaricatum, Panicum lineale, Poa mannii, Psychotria spp., Senna gaudichaudii, or Wilkesia gymnoxiphium; and

(ii) Elevations between 375 and 1,179 m (1,231 and 3,867 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Gouania meyenii to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and

equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 10 to 18 years (USFWS, 1998)

Breeding Season

Adult: March to May (USFWS, 1998)

Reproduction Narrative

Adult: Guoania meyenii is known to sexually reproduce. Gouania meyenii flowers from March to May. Seed capsules develop in about 6 to 8 weeks. Plants appear to live about 10 to 18 years in the wild (USFWS 1995). (USFWS, 1998; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral, woodland- hardwood (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 17 and 1,179 meters (USFWS, 1998)

Habitat Narrative

Adult: Gouania meyenii typically grows on rocky ledges, cliff faces, gulch slopes, and ridge tops in dry or moist shrubland or ohia lowland mesic forest at an elevation of 580 to 820 meters (1,900 to 2,700 feet) (USFWS 1995). In Oahu, Gouania meyenii typically grows on moderate to steep slopes in dry or mesic shrubland and lowland forest at elevations between 17 to 930 meters (56 to 3,050 feet). On Kauai, this species typically grows on rocky ledges, cliff faces, and ridge tops in dry shrubland or in Metrosideros polymorpha lowland diverse mesic forest at elevations between 375 and 1,179 meters (1,231 and 3,867 feet). Associated plants include aalii, akoko, kopiko, manono, alani, olopua, kookoolau, Carex meyenii, lama, kolokolo kuahiwi, and Senna gaudichaudii (kolomona) (USFWS 1995). (USFWS, 1998; USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2021c). 2 (USFWS, 2021b)

Population Size:

15 (USFWS, 2021c). Currently there are approximately 14 wild individuals of Gouania meyenii on O‘ahu and 12 wild individuals on Kaua‘i. (USFWS, 2021b)

Adaptability:

Unknown (NatureServe, 2015)

Additional Population-level Information:

In 2016, Keir et al. reported occurrences of this species on Oahu at two locations totaling32 individuals. Currently, there is one wild occurrence of Gouania meyenii on Oahu(Makaha), totaling 15 individuals, and two nearby outplantings, one with five individualsand another with one individual (Ching Harbin 2017, pers. comm.). There are 135 seedsin storage at Lyon Arboretum and two plants at the Pahole Rare Plant Facility. Efforts togerminate a few of the stored seeds for propagation are currently underway. There are noknown individuals remaining on Kauai (Ching Harbin 2017, pers. comm.). There is a2013 record of four seeds collected from up to four individuals in 1992 at the last knownpopulation at Kalalau (NTBG 2013, 2014). Seed viability is uncertain. (USFWS, 2017).

Population Narrative:

Currently, this species is found on Oahu and Kauai in seven occurrences. There were three populations of Gouania meyenii on Kauai. Currently, the total number of individuals on Kauai is estimated between 18 and 23, and the overall total number of individuals between 38 and 63. On Oahu, it is found on the Makaha Waianae Kai Ridge on State, private, and City and County lands. USFWS estimated 63 individuals in these four known populations on Oahu in 2003 (USFWS 2003b). Population numbers for Oahu appear to be based on surveys that have not been repeated for as much as ten years, and may not reflect the current status of the species. The actual number of individuals on Oahu is more likely between 20 and 40 individuals. (USFWS, 2010; NatureServe, 2015)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The major threats to Gouania meyenii on Oahu are competition from invasive introduced plant species such as Ageratina riparia (spreading mist flower), Blechnum

appendiculatum (NCN), Grevillea robusta (silk oak), Bryophyllum pinnatum (airplant), Lantana camara (lantana), Leucaena leucocephala (haole koa), Lythrum maritimum (loosestrife), Melinis minutiflora (molasses grass), Oplismenus hirtellus (basketgrass), Pimenta dioica (allspice), Psidium cattleianum (strawberry guava), Psidium guajava (common guava), Rubus sp. (blackberry), and Schinus terebinthifolius (Christmas berry) (National Tropical Botanical Garden 2009a; USFWS 2003b). On Kauai, threats to Gouania meyenii include competition from invasive introduced plant species such as Melinis minutiflora, Psidium cattleianum, and Schinus terebinthifolius (USFWS, 2010)

Stressor: Fire, pigs, and goats (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Other threats include fire; habitat degradation by feral pigs (Sus scofa) and goats (National Tropical Botanical Garden 2009a; USFWS 2003b). (USFWS, 2010)

Stressor: Small population size (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The small number of extant populations and individuals is also a threat to Gouania meyenii on Kauai and Oahu (National Tropical Botanical Garden 2009a; USFWS 2003a). There is a risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of remaining occurrences and individuals. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to Gouania meyenii. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Stressor: Drought loss or degradation of habitat (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: Drought is reported to be a threat to the Makahapopulation of Gouania meyenii (PEPP 2011, 2014, 2015). Over the past 100 years, theHawaiian Islands have experienced an annual decline in precipitation from just over 9percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008;Chu and Chen 2005; Diaz 2005). The increase in drought frequency and intensity leadsto a self-perpetuating cycle of increasing cover of nonnative plants, increasing numbersof fires, and an increasing amount of erosion (D'Antonio and Vitousek 1992;Giambelluca et al. 1991; US-GCRP 2009; Warren 2011). (USFWS, 2017).

Stressor: Landslides and flooding destruction or degradation of habitat (USFWS, 2017).
Exposure:
Response:

Consequence:
Narrative: Landslides are reported tobe a threat to the Makaha population of Gouania meyenii (Keir et al. 2016; PEPP 2010).Landslides and erosion due to ungulate disturbance and natural weathering destabilizessubstrates, damages and destroys individual plants, and alters hydrological patterns (Stearns 1985). (USFWS, 2017).

Stressor: Rodent predation or herbivory (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: Herbivory by rats is noted to be a threat to Gouaniameyenii at the Makaha population (Keir et al. 2016; PEPP 2010). Rats eat virtually everypart of plants and at every stage: fleshy fruits, seeds, flowers, stems, leaves, shoot,seedlings, and roots (Russell 1980; Cuddihy and Stone 1990). The effects on plantsrange from reduced vigor and decreased reproduction to mortality of individuals andcomplete lack of recruitment. (USFWS, 2017).

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:
- Enclosures should be constructed around the known populations of Gouania meyenii to reduce impacts from feral ungulates. Subsequent control or removal of ungulates from these areas will alleviate their impact on native ecosystems. Specific efforts should be made to immediately fence and protect populations that have only a few remaining individuals, such as within the Waianae Kai Forest Reserve on Oahu and those in the Na Pali-Kona Forest Reserve on Kauai. A commitment should be developed for long-term stewardship and

conservation of these areas once they have been enclosed. (USFWS, 1998)

- Populations that have only a few remaining individuals should be immediately weeded and protected. (USFWS, 1998)
- A coordinated fire protection plan needs to be developed for endangered plant species on State forest reserves (Waianae Kai on Oahu and Na Pali-Kona on Kauai) and Federal lands. (USFWS, 1998)
- New in 2017 - 1: Surveys and inventories—Survey historical populations on Oahu and Kauai to determine current status. (USFWS, 2017).
- 2017 - 2: Ungulate monitoring and control—Maintain fences to protect populations from negative impacts of feral ungulates to prevent imminent extinction. (USFWS, 2017).
- 2017 - 3: Invasive plant monitoring and control—Remove ecosystem-altering invasive plant species from the immediate vicinity of populations. (USFWS, 2017).
- 2017 - 4: Captive propagation for genetic storage and reintroduction— o Study limiting factor to viable seed production. o Continue to collect material for genetic storage and propagation for reintroduction, as well as research to determine storage protocols if needed. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 6: Predator and herbivore monitoring and control—Implement effective control methods for rodents. (USFWS, 2017).
- 2017 - 7: Fire monitoring and control—Develop and implement fire management plans for each population. (USFWS, 2017).
- 2017 - 8: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from drought and landslides and storms. (USFWS, 2017).
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2010)
- Construct exclosures to protect populations from negative impacts of feral ungulates. (USFWS, 2010)
- Control competing invasive introduced plant species within exclosures. (USFWS, 2010)
- Develop and implement fire management plans for each population. (USFWS, 2010)
- Survey current and historical populations on Oahu to determine current species status. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021. • Surveys and inventories—Continue to survey geographical and historical range for a current assessment of the species' status and that of possible additional populations. • Ungulate monitoring and control—Continue to construct ungulate exclosures or strategic fencing where possible to protect all occurrences from the impacts of feral ungulates, including browsing. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species at all wild and reintroduced populations. • Fire monitoring and control—Continue to implement fire

management plans for O‘ahu and develop and implement fire management plans for occurrences on Kaua‘i. • Predator and herbivore monitoring and control—Implement effective rat control methods at populations to improve viable seed production. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources into long-term storage due to the species’ vulnerability to climate change. • Reintroduction and translocation— o Continue reintroduction into suitable habitat within historical range in areas that are managed for known threats. o Increase numbers of populations and individuals to build resiliency within populations and species redundancy to reduce impacts from low numbers of individuals, as well as landslides, drought, fire, and hurricanes. • Population viability monitoring and research—Study and determine factors that impede viable seed production. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to impacts of climate change. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2021b)

- New Management Actions: • Surveys and inventories—PEPP continues to survey and monitor all wild and reintroduced populations (PEPP 2017, 2018, 2019, 2020). • Nonnative plant control—PEPP worked in collaboration with the State’s Native Ecosystems Protection & Management (NEPM) program to conduct nonnative plant control at two reintroduction sites on O‘ahu (Pahole and Mākaha) (PEPP 2018). • Collection and propagation— o The Lyon Arboretum Seed Conservation Laboratory reported 184 seeds in storage representing at least nine founders from populations at Mākaha on O‘ahu (Lyon Arboretum 2020). o In 2018, PEPP took cuttings of an individual in Mākaha for propagation and reported collection and contribution of 13 seeds representing two founders from Mākaha to Lyon Arboretum in 2018 (PEPP 2018). • Reintroduction—The last living individual of an outplanting of six plants at Mākaha died in 2019. Four of five plants at another reintroduction site at Mākaha survive as of 2019. Four plants (representing one founder) reintroduced at Pahole survive as of 2019 (PEPP 2017, 2019; Pahole Rare Plant Facility [PRPF] 2019). (USFWS, 2021b)

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SPECIES ACCOUNT: *Graptopetalum bartramii* (Bartram stonecrop)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

Graptopetalum bartramii is a small, succulent (fleshy), acaulescent (without a stem) perennial plant (Phillips et al. 1982, p. 2; Figure 2.1). Graptopetalum bartramii has a basal rosette that is 7 to 16 centimeters (cm) (2.75 to 6.3 inches (in)) wide comprised of 20 or more flat to concave, smooth, blue-green leaves (Rose 1926, p. 2; Phillips et al. 1982, p. 2; Moran 1994, p. 192). One to seven showy inflorescences (includes stems, stalks, bracts, and flowers) up to 30.5 cm (12 in) in height are produced in equilateral panicles (pyramidal loosely branched flower cluster) (Figure 2.2). The branches of the panicles produce one to six (usually three) flowers each (Rose 1926, p. 2). Based on the size of the plant and the number of inflorescences and flowers produced, an individual plant can have up to 214 yellow-petaled with brown-to-red spotted flowers that are 2.54 cm (1.0 in) or more across (Rose 1926, p. 2; Phillips et al. 1982, p. 3; Moran 1994, p. 3; Shohet 1999, p. 36; Ferguson 2017b, tables). The five-petaled flowers contain stamens that are reflexed (bent or turned backward) after pollen is shed (Rose 1926, p. 2; Moran 1994, p. 192). Flower petals close following anthesis (the flowering period of a plant). The fruits are follicles (capsule that splits along one side to release seeds), with minute seeds (0.5 to 0.9 mm (0.02 to 0.04 in) in length) having little or no endosperm (tissue surrounding the embryo that provides nutrition; Shohet 1999, pp. 3, 48). Although we do not know how many seeds are produced per follicle or per plant on average, in 2016 seeds from 249 individual G. bartramii were collected for conservation. Over 50,000 seeds were collected, or roughly 200 seeds per plant, and they were reported to resemble dust. Conservation rules were applied to seed collection with no more than one third of available seeds collected (USFWS, 2018).

Taxonomy

Graptopetalum bartramii is a succulent plant of the Crassulaceae or stonecrop family (Moran 1994, p. 192). Graptopetalum bartramii was first presumed to be a form of G. rusbyi due to similar appearance (though G. rusbyi has clustered rosettes and flowers in the spring, rather than the fall) and similar, but not overlapping, habitat. Edwin Bartram, however, felt his 1920 and 1923 collections represented a different species and sent live specimens to Dr. J. N. Rose who, in 1926, recognized G. bartramii to be distinct and named it after Mr. Bartram (Phillips et al. 1982, p. 1). Later, in 1939, T. Kearney and R. Peebles changed the name of all Arizona species in the genera Graptopetalum and Dudleya to the genus Echeveria (Kearney and Peebles 1951, pp. 358–362; Phillips et al. 1982, p. 1). Phillips et al. (1982, p. 2) noted that most botanists recently concerned with this family separate the genera Graptopetalum and Dudleya. Acevedo et al. (2004, entire) investigated the phylogenetic relationship of Graptopetalum and other genera of Crassulaceae. Their work clearly separates G. bartramii from other species (Acevedo et al. 2004, p.1101). The Flora of North America (2008, p. 227) recognizes Graptopetalum and Dudleya as distinct and recognizes this species as G. bartramii in the genus Graptopetalum. Based on this information as the best available scientific and commercial data, the FWS accepts this taxonomy. Genetic analysis of G. bartramii specifically, has not been conducted. However, due to the large distance between populations, the often small numbers of individuals within populations, and the unlikelihood of pollination between populations, it is possible that genetic variability within populations may be low. However, there may be genetic diversity between

populations. For this SSA we assume that there is low diversity of genetics within a population, but that different populations have some level of genetic diversity (USFWS, 2018).

Current Range

We have no information regarding historical populations that would indicate a different historical range than the current range. However, there have been many changes in the southeastern Arizona landscape since the 1890s with intensive cattle grazing, water development, and fire suppression (e.g. Bahre 1991, entire). These impacts may have reduced the range or number of populations and individuals, but we have no specific information indicating this. The current range of G. bartramii includes 12 mountain ranges with 29 populations in Cochise, Pima, and Santa Cruz Counties of southern Arizona, as well as 3 mountain ranges with one population each in Sonora and Chihuahua, Mexico (Figure 3.1; Table 3.1). The populations range in elevation from 1,067 to 2,042 m (3,500 to 6,700 feet (ft)) (USFWS, 2018).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Cross pollination

Lifespan

Adult: The lifespan of G. bartramii is thought to be approximately 5 years (USFWS, 2018)

Breeding Season

Adult: Flowering (September – November) and seed dispersal (November – December) (USFWS, 2018)

Reproduction Narrative

Adult: The inflorescence stalks of G. bartramii grow for 30 to 40 days, around July and August, before coming to their full height, with the flowers then opening primarily between September and November (Kearney and Peebles 1951, p. 361; Phillips et al. 1982, pp. 2, 7; Shohet 1999, p. 25). Individual flowers produce both male and female parts, but the timing of male and female flower stages differs. Individual flowers open in succession, such that the length of time each flower remains open overlaps, allowing for various stages of flowering and fruiting to be simultaneous within an individual plant for a month or more. Each individual flower remains open for approximately 5.5 days in the wild and as much as 9 days in the greenhouse (Shohet 1999, pp. 33, 35, 54) with plants going from bud to follicle within 15 days (Ferguson 2014, p. 39). Approximately the first two days are a staminate (male) stage of anthesis in which pollen is produced. The next three days are the pistillate (female) stage, in which the stamens (male part of the flower that produces pollen) are reflexed and the stigmas (female part of the flower that receives the pollen) are fully extended with the pistils (female part of the flower) receptive to the pollen (Rose, 1926, p. 2; Shohet 1999, p. 33). The two stages of floral growth may reduce the probability of self-pollination, though it likely does still occur (Ferguson, pers. comm. May

19, 2017). Graptopetalum bartramii requires pollination for reproduction. The major pollinators of G. bartramii are Sarcophaga spp. (true flies) and Musca spp. (house flies), though Apis mellifera (honey bee) may also play a role in pollination. Other species that have been noted on G. bartramii include wasps, butterflies, and Tachinidae and Bombyllidae flies (Shohet 1999, p. 41; Ferguson2014, p. 26; Ferguson 2017b, p. 13). Fertilization success is greatest in earliest opening flowers, possibly due to more pollinators being available earlier in the season, though having a long period of flowering increases overall chance of pollination (Shohet 1999, p. 57). Of the seeds produced, approximately 20 percent are viable under optimal conditions (Shohet 1999, p. 48). Because seedlings (plants less than 1.5 cm [0.6 in] in diameter) have been located in most populations, we assume pollinator availability is not a limiting factor for this species. Given their geographic location in the landscape (i.e. in canyons with springs and streams), it is possible that seeds are transported by water and that populations may have been founded by a single individual plant or seed (Shohet 1999, p. 58). Seeds may also be dispersed via gravity and wind. Although Shohet (1999, p. 50) suggested vegetative reproduction may occur in this species, Ferguson (2015, p. 2) stated that plants rarely branch or re-root following dislodging. The Flora of North America (2008, p. 227) states the genus is not viviparous (does not reproduce from buds that form plantlets), but that G. bartramii may have solitary or rarely multiple rosettes. It is more likely rosettes are solitary, a characteristic so common that it is a feature which separates G. bartramii from G. rusbyi, a similar southern Arizona occurring species, in most floristic keys. Therefore, G. bartramii is dependent on pollinators and seed production for reproduction. Populations within and between sky island mountain ranges are very isolated, and it is unlikely that pollen is dispersed between populations or sky islands (USFWS, 2018).

Habitat Type

Adult: canyons/woodlands (USFWS, 2018)

Habitat Narrative

Adult: Graptopetalum bartramii have been found within 10 sky island mountain ranges of southern Arizona and 3 mountain ranges in northern Mexico (SEINet). The species is typically found in deep, narrow, heavily shaded canyons with erodible soils within Madrean woodlands at elevations ranging from 1,067 to 2,042 m (3,500 to 6,700 feet (ft)). Madrean woodlands are a forested community dominated by evergreen oaks, but also containing junipers and pine trees, and characterized by mild winters and warm wet summers (Brown 1982, p. 59). Madrean evergreen woodland species include evergreen oaks with sclerophyllous (hard) leaves, such as Quercus emoryi (Emory oak), Q. arizonica (Arizona white oak), and Q. oblongifolia (Mexican blue oak). Pinus discolor (border pinyon pine) and Juniperus deppeana (alligator juniper) are also common species. Madrean evergreen woodland is typically bounded by semi-desert grasslands and savanna at warmer, drier sites in the lower-elevations, and by evergreen and broadleaf forests on more mesic and cooler sites at higher elevation, north aspect, or near riparian areas. Graptopetalum bartramii are almost always located near water sources (springs, seeps, or intermittent streams), but above the floodline (Phillips et al. 1982, p. 4; Shohet 1999, p.22; NPS 2014, p. 2). Proximity to water may provide humidity for the plant's microclimate. Plants are typically within 10 m (32.8 ft) from a streambed in the bottom of canyons on rocky outcrops, though can be much farther on occasion (Shohet 1999, p. 5; Ferguson 2014, p. 41; NPS 2014, p. 2; Ferguson 2016a, p. 14). The deep, narrow canyons and associated overstory species provide shade during a portion of the day, creating a cooler temperature and aiding in maintaining a humid microenvironment (Figure 2.4). In addition, the vegetation litter provides retention of

soil moisture, further promoting the humid microenvironment. From a study of 12 G. bartramii subpopulations, associated species and their frequency of occurrence follow: Agave palmeri (Palmer agave; 88%), J. deppeana (81%), mosses (73%), Nolina microcarpa (sacahuista; 69%), Dasylirion wheeleri (sotol; 65%), Garrya wrightii (Wright's silktassel; 65%), Myriopteris (=Cheilanthes) spp. (cloak fern; 58%), Q. emoryi (54%), Muhlenbergia emersleyi (bullgrass; 54%), Quercus arizonica (Arizona white oak; 42%), Pinus discolor (border pinyon; 38%), and Rhus virens (evergreen sumac; 46%; Ferguson 2014, p. 41). In addition, Cheilanthes lindheimeri (fairyswords fern) and Selaginella rupincola (rockloving spikemoss) (Figure 2.5) have been determined to be commonly associated with good G. bartramii habitat (Buckley pers. comm. December 17, 2013). Graptopetalum bartramii root into crevices on rock ledges and cliffs on slopes of various aspect (Shohet 1999, p.22; Ferguson 2014, p. 41; NPS 2016, p. 7; Figure 2.4). Due to the location of plants in crevices or shallow soil pockets in steep canyons, adherence to substrate or soil is tenuous, and plants can be easily dislodged due to flooding, foot traffic, eroding soil, or falling rocks. Crevices provide shade, shelter, and soil moisture retention, and they offer protection from burning due to a lack of surrounding vegetation for fuel in the rocky terrain (Ferguson 2014, p. 41; Figure 2.4). Crevices above floodline offer protection from typical flood events. Graptopetalum bartramii occur on a variety of substrates (Malusa 2001, p. 39), including volcanic (Van Devender 1981, p. 4), granitic (Phillips et al. 1982, p. 5), igneous (granite or granitoid porphyries, dacite or rhyolite, all with high content of quartz, usually as phenocrysts; Ferguson 2014, p. 41), sedimentary (sandstones and conglomerate sedimentary rocks with a high quartz content; Ferguson 2014, p. 41), and metamorphic substrates (quartzite, marble with high calcite content; Ferguson 2014, p. 41). Based on microhabitats in which the species is typically found, species needs include crevices (with or without soil) for seeds to lodge and germinate, shade and deep leaf litter to help maintain soil moisture, and a humid microhabitat in this arid environment. The specific substrate component does not seem to be critical. In addition, for reestablishment in suitable habitat, soil seedbank may be important for this species following extended periods of drought (USFWS, 2018).

Dispersal/Migration

Dispersal

Adult: Possible wind, gravity or water dispersal (USFWS, 2018)

Dispersal/Migration Narrative

Adult: Given their geographic location in the landscape (i.e. in canyons with springs and streams), it is possible that seeds are transported by water and that populations may have been founded by a single individual plant or seed (Shohet 1999, p. 58). Seeds may also be dispersed via gravity and wind (USFWS, 2018).

Population Information and Trends

Number of Populations:

12 subpopulations (USFWS, 2021)

Population Size:

1,122 individuals found (USFWS, 2021)

Population Narrative:

Among 12 subpopulations surveyed between October 2013 and July 2014 in the Baboquivari, Dragoon, Mule, Pajarito-Atascosa, Patagonia, Santa Rita, and Whetstone Mountains in Arizona, seedlings were noted in many, but not all subpopulations. A total of 131 seedlings were counted in these surveys; seedlings were typically concentrated near a mature plant (Ferguson 2014, p.6). There was 20 percent mortality among the 1,122 individuals found; in most instances, mortality outweighed seedling production (Ferguson 2014, pp 6–39). Because of this, the stressor of small population size is considered in our analysis of future species viability (USFWS, 2021).

Threats and Stressors

Stressor: Loss of Water (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Dewatering of streams from mining operations may lead to overstory canopy losses and subsequent loss of shade, as well as reductions in spring and stream flow and humidity in nearby Bartram's stonecrop populations. The Rosemont Mine Final Environmental Impact Statement (Statement) notes that no Bartram's stonecrop individuals were found in the project area or the footprint of the associated actions; however, individuals growing in the analysis area could experience indirect impacts from groundwater drawdown (USFS 2013a, p. 676). According to the Statement, the proposed mine pit would create a permanent drawdown of the water table, and groundwater would flow toward the pit and be lost to evaporation (USFS 2013a, p. 339). The Bartram's stonecrop plants growing just southwest of the proposed Rosemont Mine were analyzed in the Rosemont Final Environmental Impact Statement (USFS 2013a, pp. 346–350). The predicted groundwater drawdown in the affected population at the end of active mining is 0.1–5 feet, depending on the site assessed and the model used. At 20 years from the mine closure, the predicted drawdown increases to a maximum of 15–20 feet. The water would be perpetually replenished in part by groundwater from the regional aquifer, and the pit would act as a hydraulic sink. Given that Bartram's stonecrop is consistently found in locations with nearby springs or other water sources, the loss of groundwater and changes in soil moisture and humidity are expected to negatively affect the plant. For example, loss of groundwater in the unmapped spring in Box Canyon/Sycamore Canyon confluence, between Ruelas Spring and the Singing Valley Road residences, could substantially impact Bartram's stonecrop plants growing nearby (just southwest of the proposed Rosemont Mine). Mining claims, trenching and exploration drilling activities, and a few active and proposed mines are present in Bartram's stonecrop's range. Many currently undeveloped areas of locatable mineral deposits may be explored and/ or mined in the future. We do not know the full extent of future mine activity within the range of Bartram's stonecrop; however, a number of proposed mines are identified for development within Bartram's stonecrop habitat. The range of current and projected mining activities varies from 1 to 10 per sky island mountain range with Bartram's stonecrop occurrences (USFS 2012, entire). The loss or reduction of groundwater, stream flow, or spring flow in or near a Bartram's stonecrop population due to mining-related activities could lead to extirpation of that population (USFWS, 2021).

Stressor: Altered Fire Regime (USFWS, 2021)
Exposure:
Response:

Consequence:
Narrative: Wildfire frequency in western forests from the mid-1980s to the present has nearly quadrupled compared to 1970– 1985. The timing, frequency, extent, and destructiveness of wildfires are expected to continue to increase (Westerling et al. 2006, p. 943), given historical land management actions, an increase in fire starts from cross-border human activity and recreationists (e.g., from campfires, cigarettes, target shooting), nonnative plant invasion, and continuing drought conditions (Westerling et al. 2006, p. 940; FireScape 2016, entire; Fire Management Information System 2016, p. 2). Direct impacts of fire include burning of Bartram's stonecrop individuals, resulting in injury, reduction in reproductive structures, or plant mortality. Indirect impacts of fire on Bartram's stonecrop may include increased runoff of floodwaters, postfire flooding, deposition of debris and sediment originating in the burned area, erosion, changes in vegetation community composition and structure, increased presence of nonnative plants, alterations in the hydrologic and nutrient cycles, and loss of overstory canopy shade essential to maintaining Bartram's stonecrop microhabitat (Griffis et al. 2000, p. 243; Crawford et al. 2001, p. 265; Hart et al. 2005, p. 167; Smithwick et al. 2005, p. 165; Stephens et al. 2014, p. 42; Ferguson 2014, p. 43; Ferguson 2016a, p. 26). Fire primarily alters hydrology and erosion processes by consumption of the protective canopy, ground cover, and organic matter. When plants and litter are removed by fire, ground surface protection is decreased, less rainfall is intercepted, and less infiltration occurs (Pierson et al. 2011, p. 443). The exposed bare soil becomes susceptible to increased runoff generation and sediment detachment and transport (Pierson et al. 2011, p. 444). Amplified runoff post-fire carries sediment (Pierson et al. 2011, p. 443), causing erosion or burial of Bartram's stonecrop plants. (USFWS, 2021).

Stressor: Altered Precipitation, Drought, Flooding, and Freezing Regimes (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The southwestern United States is warming and experiencing severe droughts of extended duration, changes in amount of snowpack and timing of snowmelt, and changes in timing and severity of precipitation and flooding (Garfin et al. 2014, entire). The effects of a changing climate are important considerations in the analysis of the stressors to Bartram's stonecrop, including increased nonnative competition (described above) and altered fire regimes during times of altered precipitation and drought. To analyze the effects of a changing climate to Bartram's stonecrop, we relied on the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment (IPCC 2014, entire) and IPCC Climate Change 2013—The Physical Science Basis (IPCC 2013, entire). Four emission scenarios, referred to as Representative Concentration Pathways (RCPs), were developed for the IPCC report (IPCC 2014, p. 57). We evaluated the effects of climate change on Bartram's stonecrop using RCP 4.5 and RCP 8.5 to bracket the range of environmental variability. The IPCC report (2014) expresses confidence that emissions will fall within the RCP 4.5–8.5 range (USFWS, 2021).

Stressor: Erosion, Sedimentation, and Burial (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Bartram's stonecrop typically occurs on steep slopes with erodible soils and in areas susceptible to rock fall, making the plant particularly vulnerable to physical damage to its environment (Phillips et al. 1982, p. 10; Shohet 1999, p. 50; Ferguson 2014, p. 42; Ferguson

2016a, pp. 15, 26). Soil erosion can result in the burial of individual plants, loss of soil where the plant is rooted, or dislodgment of plants. While displaced plants may re-root (Shohet 1999, pp. 50–51, 60), it is more likely that these plants will not survive (Ferguson 2015, p. 2). Soil disturbance and erosion within or above Bartram's stonecrop habitat may occur from a variety of activities, including livestock and wildlife movement; the placement and maintenance of infrastructure, trails, and roads; and recreationists or other individuals traveling along established trails or cross country (Phillips et al. 1982, p. 10; Shohet 1999, p. 60; Ferguson 2014, p. 42; NPS 2015, p. 4; Ferguson 2016a, p. 26) (USFWS, 2021).

Stressor: Trampling (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The trampling of individual Bartram's stonecrop plants may occur from a variety of activities, including livestock and wildlife movement; the placement and maintenance of infrastructure, trails, and roads; and recreationists or other individuals traveling along established trails or cross country (Phillips et al. 1982, p. 10; Shohet 1999, p. 60; Ferguson 2014, p. 42; NPS 2015, p. 4; Ferguson 2016a, p. 26). Populations may be particularly impacted during periods of unusual recreational use. We considered trampling as a stressor in our analysis of future viability only when it may impact a population with fewer than 50 individuals, as more minor stressors are exacerbated in small populations (USFWS, 2021).

Stressor: Illegal Collection (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The illegal collection of succulents is known to occur, and is often difficult to detect. Illegal collection of Bartram's stonecrop individuals has been reported, and the effect of collection is more pronounced in small populations. More than half (58 percent) of Bartram's stonecrop populations contain fewer than 50 individuals. The lifespan of Bartram's stonecrop plants has been estimated at 5–10 years, allowing sufficient time for discovery and collection (USFWS, 2021).

Stressor: Small Populations (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Small population size affects Bartram's stonecrop population resiliency, as all stressors are exacerbated in populations with only a small number of individuals (fewer than 50). Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000, pp. 308–310), such as fluctuations in reproduction (demographic stochasticity), variations in rainfall (environmental stochasticity), or changes in the frequency or severity of disturbances, such as wildfires. Twenty-nine of the 50 extant Bartram's stonecrop populations in the United States contain fewer than 50 individuals. Losses due to mining, erosion, trampling, collection, herbivory, fire, severe frost, or other stressors mentioned above are exacerbated in small populations and have the potential to seriously damage or completely remove these small populations (USFWS, 2021).

Recovery

Conservation Measures and Best Management Practices:

- Action Plan: 1. Protect extant populations through minimizing adverse effects to habitat and populations by: (a) working with stakeholders and partners to control and reduce the spread of nonnative plant species that outcompete native plants and contribute to unnatural fire regimes; (b) working with stakeholders and partners to restore natural fire regimes, including reducing the impacts of recreationists and cross border violators that may spread nonnatives or start wildfires; and (c) working with stakeholders and partners to reduce groundwater withdrawal and promote water conservation. (d) working with stakeholders and partners to encourage land stewardship. 2. Augment existing and establish additional populations through working with nonprofits, researchers, stakeholders and partners to develop and implement propagation, outplanting, and monitoring strategies to: (a) augment existing small Bartram's stonecrop populations, and (b) introduce the species to other suitable native-dominated locations within the historical range of the species to increase connectivity and redundancy. 3. Survey and monitor the status of the species by: (a) maintaining existing and adding additional long-term Bartram's stonecrop and habitat monitoring. These plots would be re-measured on a regular basis to determine trends across the range of the species and across management scenarios and allow adjustment of management practices to increase Bartram's stonecrop population viability; (b) maintaining regular census counts from populations for which full census population structure, reproduction, and habitat parameters have been determined; (c) conducting surveys in remote areas of Bartram's stonecrop historical range, including in Mexico, to determine presence, absence, and status; and (d) conducting surveys to identify suitable moist, shady canyons within evergreen woodlands that support high native biodiversity and could be locations for future Bartram's stonecrop introduction. 4. Conduct research in areas that will inform conservation of the Bartram's stonecrop and its pollinators by: (a) determining specific habitat needs of the species such as humidity, shade, slope and aspect, mycorrhizae, and moisture requirements; (b) determining genetic uniqueness of Bartram's stonecrop populations and subpopulations, as well as genetic structure, geneflow patterns, and adaptive differentiation to local site characteristics; (c) studying Bartram's stonecrop life history to better understand pollination and pollinator needs, reproduction, growth, life span, and seed bank viability; and (d) studying the threats and management action responses of Bartram's stonecrop and its habitat. 5. Maintain a collection of seed and plants representing the geographical, morphological, and genetic diversity of Bartram's stonecrop at multiple Center for Plant Conservation approved botanical institutions and seed banks. 6. Develop and improve upon Bartram's stonecrop propagation and outplanting techniques including genetics management, outplanting methodologies, and post-introduction monitoring strategies. 7. Promote Bartram's stonecrop conservation education and outreach by: (a) working with State and Federal agencies, private organizations, and private land owners to promote good stewardship of Bartram's stonecrop and its habitat; and (b) developing programs and materials to inform the public on the need and benefits of nativedominated habitat management.

Additional Threshold Information:

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References

USFWS. 2021. Endangered and Threatened Wildlife and Plants

Threatened Species Status for Bartram's Stonecrop With a Section 4(d) Rule. Final Rule. FR Vol. 86, No. 166. Pages 48545-48569. United States Fish and Wildlife Service. 2018. Species status assessment report for Graptopetalum bartramii (Bartram's stonecrop). United States Fish and Wildlife Service Arizona Ecological Services Office, Tucson, Arizona. 117 pp. + 2 appendices.

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Threatened Species Status for Bartram's Stonecrop With a Section 4(d) Rule. Final Rule. FR Vol. 86, No. 166. Pages 48545-48569.

USFWS. 2021a. Recovery Outline for Graptopetalum bartramii (Bartram's stonecrop). 10 pp.

SPECIES ACCOUNT: *Grindelia fraxinipratensis* (Ash Meadows gumplant)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/20/1985; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

It is an erect biennial or more commonly a perennial herb, reaching 25 to 40 inches in height and has yellow flowers with heads measuring 0.3 to 0.4 inches in diameter (Mozingo and Williams 1980). The gumplant genus is so named because of their very sticky (gummy) flower heads (USFWS, 2007).

Taxonomy

Kartesz (1999) used the spelling 'fraxinopratensis'. According to comments in the Index to California Plant Names (part of the Jepson Interchange for California Floristics, April 2012) "fraxinipratensis" is the correct spelling. It is a member of the Asteraceae (sunflower family) (NatureServe, 2015).

Historical Range

It is endemic to the greater Ash Meadows region in Nye Co., Nevada and Inyo Co., California. (NatureServe, 2015). Cochrane (1981) believes that its distribution was continuous prior to perturbation for agriculture (USFWS, 1990).

Current Range

Most of its distribution is within the Ash Meadows National Wildlife Refuge (Refuge). One population occurs outside the Refuge boundary in the Carson Slough, primarily within the Ash Meadows Area of Critical Environmental Concern (ACEC) managed by Bureau of Land Management (BLM) in Nevada. Based on anecdotal observations and assessments of biologists, it appears Ash Meadows gumplant distribution has likely increased since the species was listed (Service 2001) (USFWS, 2008).

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Grindelia fraxinipratensis (Ash Meadows gumplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California and Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Grindelia fraxinipratensis includes two CHUs in Inyo County, California and Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

California, Inyo County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Grindelia fraxinipratensis critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include saltgrass meadows along streams and pools or drier areas with alkali clay soils.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: Summer - fall (USFWS, 1990)

Reproduction Narrative

Adult: It is a biennial or more commonly a perennial plant (NatureServe, 2015). In a good year, each plant may produce several hundred seeds (Lane 1993) (USFWS, 2008). It flowers during the summer and autumn (USFWS, 1990).

Habitat Type

Adult: Terrestrial, riparian, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Saltgrass meadows (NatureServe, 2015); ash-screwbean mesquite woodlands, desert shadscale scrub, clay barrens (USFWS, 2008)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits saltgrass meadows along streams and pools; occasionally occurs in alkali clay soils in drier areas. Dependent on moisture available from streams (NatureServe, 2015). Ash Meadows gumplant is found primarily in the vicinity of ash-screwbean mesquite woodlands and desert shadscale scrub vegetation. It occasionally occurs sparsely in drier shadscale habitats or in the unique clay barrens. Over 30 percent of the Refuge has been mapped as wet meadow and is dependent on flows from several dozen springs and seeps (Otis Bay 2006). These springs and seeps are fed by an extensive groundwater system (USFWS, 2008). Extant populations are scattered throughout the area at sites that have not been disturbed or have been allowed to restabilized from disturbance for extended periods (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal of the small seed is most likely accomplished by strong winds because they could be blown for some distance. Those seeds which fall within close proximity of the parent plant could be further transported by water during the winter rainy season or during summer flash floods. Mammals and birds may also be responsible for dispersal of seeds (Cochrane 1981) (USFWS, 2008).

Population Information and Trends

Number of Populations:

2 Population Services (USFWS, 2020)

Population Size:

~ 898,404 (USFWS, 2020)

Population Narrative:

The Ash Meadows gumplant is concentrated in three main populations and several smaller ones over an area of approximately 2,260 acres (BLM and Service 2000). There is little quantitative population or demographic data to describe trends for the Ash Meadows gumplant. The 2000 Environmental Assessment to withdraw lands from mineral entry estimated the entire Ash Meadows gumplant population to contain 81,000 plants within 2,260 acres (BLM and Service 2000). This number, based on visual estimates, is a serious underestimate of the total number of plants because a 2002 survey of the California population, which used transects to develop a population estimate, estimated 241,514 ± 69,660 plants within 88 acres (Soil Ecology and Restoration Group 2004) (USFWS, 2008).

Threats and Stressors

Stressor: Groundwater pumping (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Groundwater availability is a regional phenomenon; thus groundwater pumping in the vicinity would impact the entire Ash Meadows ecosystem, including habitat that supports the Ash Meadows gumplant. Groundwater rights in Nevada are regulated by the State Engineer. In theory, the water rights owned by the Refuge are protected. However, in recent hearings, the National Park Service testified the number of water rights issued by the State of Nevada for the Amargosa Valley has grossly exceeded sustainable withdrawal levels and the resource is over-allocated (Baldino 2006a). It is important that current groundwater monitoring continues to ensure regional extractions do not affect the species (USFWS, 2008).

Stressor: Nonnative species (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: As in the case of noxious agricultural weeds present on the Refuge, many invasive species have adaptations that allow them to outcompete native vegetation and colonize previously undisturbed habitat. The wet meadows that support Ash Meadows gumplant provide an especially favorable environment for invasive species that would not otherwise be able to survive in the desert. On the Refuge, there are an estimated 4,460 acres of former agricultural fields previously used for crop production and livestock grazing (Service, 2006). These fields, situated adjacent to two of the largest Ash Meadows gumplant populations, are now largely monocultures of Russian knapweed, bassia and Malta star thistle. In many parts of the Refuge, these non-native species are expanding beyond the fields into surrounding Ash Meadows gumplant habitat (Service 2006). Fire facilitated by non-native species is a new threat to Ash Meadows gumplant not identified in the original listing. Non-native species are known to alter fire regimes and are a threat to biodiversity (Brooks et al. 2004). In some areas of the Refuge, non-native salt cedar trees (Tamarix sp.) and red brome grass (Bromus madritensis) increase the ease with which fire spreads through riparian corridors and along the spring channels that comprise Ash Meadows gumplant habitat. In the past two years, three major fires (the Meadows Fire, Longstreet Fire, and Ash Fire) have burned 144 acres (roughly 6%) of Ash Meadows gumplant habitat. Following the Meadows Fire, Russian knapweed populations exploded to create monocultures that now likely prevent regrowth and colonization of native vegetation, including the Ash Meadows gumplant (Baldino 2006a). Ash Meadows gumplant habitat is extremely vulnerable to being altered by non-native species. If left untreated the consequences would likely be decreases in the population of Ash Meadows gumplant, both due to competitive exclusion, and additional population reductions resulting from increased fire frequencies (USFWS, 2008).

Stressor: Surface mining (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Active mineral claims within Ash Meadows could cause direct loss of habitat, as well as indirect impacts to the species by diverting or draining water away from habitat during mining activities. There are 29 active mining claims on BLM lands in and near the Refuge and critical habitat for the species (BLM 2007). Approximately 45 percent of the occupied Ash Meadows gumplant habitat within the Refuge boundary is on BLM and Service lands with a high mineral potential and are open to public minerals (BLM and Service 2000) (USFWS, 2008).

Stressor: Off-highway vehicles (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Illegal OHV activity has recently become a problem again on the Refuge, possibly due to a fence in need of repair (Baldino 2006b). Repairs to the fence and monitoring of OHV activity will be an ongoing necessity at the Refuge (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: Small populations have an inherent risk of extinction due to stochastic and natural catastrophic events. Fire and flooding are natural catastrophic events that occur within Ash Meadows gumplant range. Given the species' distribution on the Refuge, fire is the catastrophic event most likely to affect the Ash Meadows gumplant. Although possible, it is unlikely that any one fire could affect a major portion of the Ash Meadow gumplant distribution throughout its entire range. However, increased fuel loads from non-native species can lead to more frequent fires in the Mojave Desert (Brooks and Pyke 2001) (USFWS, 2008).

Stressor: Feral Horses (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: We received a correspondence from Rancho Santa Ana Botanic Garden (2019). They state results are preliminary and not yet available for surveys of the Ash Meadows gumplant in California. They also reported that feral horses have been documented in occupied Ash Meadows gumplant habitat in lower Carson Slough in 2018 and 2019, and thus remain a threat. We received a recent monitoring report from Ash Meadows NWR (Pyramid Botanical Consultants, 2019). The results indicate the species is still present at all previously known populations within the refuge, and species distribution remains the same as described in our most recent 5-year review (Service, 2008). (USFWS, 2020)

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Secure, protect, and maintain the species in natural vegetation corridors and adjacent buffer areas for gene flow and dispersal of the species within essential habitat (USFWS, 2008).

2. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 2008).

3. The species is present in all the sites that it has historically occupied (USFWS, 2008).

4. The listed plant has a frequency value equal to or greater than the frequency value determined by comparison with unaltered reference sites as an indicator of a self-sustaining plant populations (USFWS, 2008).

Recovery Actions:
- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new & existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).
- The population monitoring described in the Recovery Plan should be carried out (USFWS, 2008).

- The Refuge is implementing many restoration projects that could benefit the Ash Meadows gumplant. To document recovery of the Ash Meadows gumplant, these projects should include pre- and post-site sampling to verify and quantify that restoration actions are benefiting the species (USFWS, 2008).
- Non-native weeds are a major threat to the Ash Meadows gumplant, and the IPM Plan is an important step towards addressing this problem. Long-term funding should be secured for non-native species control on the Refuge (USFWS, 2008).
- Interactions between fire and non-native weeds within Ash Meadows gumplant habitat and effects on the Ash Meadows gumplant need to be studied (USFWS, 2008).
- Surface mining remains a threat to the Ash Meadows gumplant. Service and BLM lands with a high mineral potential must be withdrawn from future mineral entry. In addition, existing mining claims should be acquired when possible. Unless these mineral rights are purchased or transferred to the Service, a program needs to be put in place to renew existing mineral withdrawals every 20 years (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); and III. Support Ash Meadows gumplant research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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SPECIES ACCOUNT: *Hackelia venusta* (Showy stickseed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/08/2002; Pacific Region (Region 1)

Physical Description

Hackelia venusta is a moderately stout perennial plant, 20-40 cm (8-16 inches) tall, with numerous flowering stems arising from a slender taproot. Large showy flowers are white or white washed with blue, with five lobes topping the end of a short corolla tube. Flowering occurs in April or May. Leaves are basal and numerous on the flowering stem. The fruit consists of four prickly nutlets which drop near the plant but the spurred fruit can be dispersed by clinging to the hair of passing animals (USFWS 2007). (NatureServe, 2015)

Taxonomy

This species was first described within the genus Lappula (annual plants) but later transferred to the genus Hackelia (perennial plants). Carr (1974) undertook a taxonomic study of the genus in western North America and recognized Hackelia venusta as a morphologically uniform, distinct species that exhibited little variability. A further taxonomic review (Harrod et al 1999) indicated that certain high elevation populations previously assigned to H. venusta were a distinct undescribed species, Hackelia taylori (Harrod et al. in review). Harrod and his colleagues (1999) further outline that no affinities exist between the low and high elevation taxon, nor with nearby populations of H. diffusa var. arida. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

This species is known from one location only in Chelan County, Washington. (USFWS, 2011)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) (USFWS, 2007)

Lifespan

Adult: >10 years (USFWS, 2007)

Dependency on Other Individuals or Species

Adult: Insect pollinators (USFWS, 2007)

Breeding Season

Adult: April to June (USFWS, 2007)

Reproduction Narrative

Adult: Hackelia venusta is perennial, and individual plants can live for at least 10 years. Flowers begin to open in late April, and new flowers are continuously added to each inflorescence until late June. By mid-June, the lowest flowers have nearly mature fruits. Dispersal begins with the lowest flowers and continues for several weeks into early July (Gamon 1997). It is possible that H. venusta could be pollinated by moths; however, this is unlikely because the relatively long tongues of moths are an apparent mismatch with the short corolla tube length of H. venusta. If the species is insect pollinated, bee and fly species appear to be the most likely candidates, as they have shorter tongues that better match the corolla tube length of H. venusta. In the past, H. venusta has been assumed to be an obligate outcrosser (Harrod 1999). Three pollinators were verified on the H. venusta plants: two bees, Andrena nigrocaerulea and Protosmia rubifloris, and one fly, Eulonchus sp. This work has indicated H. venusta is primarily outcrossing, with the possibility of geitonogamous selfing (pollination by other flowers on the same plant); autogamous selfing (pollination within a single flower) is possible since the stigma and anthers do appear to be in close proximity with one another at anthesis, but is unlikely to be a major contributor because most of a flower's pollen is produced before its stigma is receptive (J. Taylor, pers. comm. 2005, 2007). (USFWS, 2007)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, cliff, forest- conifer, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 472 meters (1,550 feet) to 823 meters (2,700 feet); prefers open, sparsely vegetated areas (shade intolerant) (USFWS, 2007)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2007)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Hackelia venusta is shade-intolerant (R. Carr, pers. comm. 1998) and grows in openings within Pinus ponderosa (ponderosa pine) and Pseudotsuga menziesii (Douglas-fir) forest types. This vegetation type is described as the Douglas-fir zone by Franklin and Dyrness (1973). Common associates include Penstemon subserratus (finetooth beardtongue), Phacelia hastata (silverleaf phacelia), Lomatium triternatum (nineleaf biscuitroot), Lupinus wyethii (Wyeth's lupine), Eriogonum compositum (arrowleaf buckwheat), Eriogonum umbellatum var. hypoleium (sulphur-flower buckwheat), Hieracium cynoglossoides (houndstongue hawkweed), and Pseudoroegneria spicata (bluebunch wheatgrass). Hackelia venusta is found on open, steep slopes (minimum 80 percent inclination) of loose, well-drained, granitic weathered and broken rock fragmented soils, and on ledges and cracks on granitic cliff faces, at elevations between 472 meters (1,550 feet) to 823 meters (2,700 feet). Aspect ranges from 192 degrees (south-southwest [SSW]) to 310 degrees (west-northwest [WNW]), with most plants at an aspect of 265

degrees (west [W]). Plants are found on concave, convex, or flat slopes. The primary subpopulation is on an area of slope between drainages, but a number of the smaller subpopulations occur along the steep south-facing sides of dry drainages or on vertical cliff faces. Hackelia venusta appears to be somewhat adapted to natural and possibly human-caused substrate disturbance (R. Carr, pers. comm. 1998), and occurs within the right of way along both sides of Highway 2. Although potential habitat for this species exists elsewhere in Tumwater Canyon, and occasionally single plants are seen elsewhere along Highway 2, no other populations have yet been found. Wildfires play a role in maintaining open, sparsely vegetated sites as suitable habitat for Hackelia venusta, a requirement of this shade-intolerant plant (R. Carr, pers. comm. 1998, in litt. 2000). The range of Hackelia venusta has been reduced to a small single population occurring in a scattered distribution across roughly 16 hectares (40 acres) in Tumwater Canyon. (USFWS, 2007)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Most nutlets seem to fall directly to the ground around the parent plant, but the topography is so steep and unstable that many nutlets are carried downslope. Small concave areas near parent plants often have seedlings (L. Malmquist, pers. comm. 2003). The prickly nutlets are also well adapted for dispersal by adhesion to the coats of passing animals (Gamon 1997). (USFWS, 2007)

Population Information and Trends

Number of Populations:

1 core pop, 5 outplanted with limited success (USFWS, 2020)

Population Size:

~477 at core pop and an unknown number of reintroduced (USFWS, 2011)

Population Narrative:

The core population was last surveyed in 2012 when 477 plants were documented (Fertig 2019, p. 36-37). Since 2012 only outplanting plots have been surveyed. The core population has not been surveyed since 2012 due to concerns about the potential for on foot surveys to damage seedlings and decrease the stability of the granitic sandy soils where the plants occur in unstable, steep slopes. Visual surveys indicate the species is still present at the core population without noticeable change, but no quantitative assessment of the core population has occurred since 2012. Implementation of recovery actions since 2011 include seed collection, growing plants from seed at the UW Rare Care Program and conducting outplantings in Tumwater Canyon and Icicle Creek Canyon in 2015 and 2019. A total of 228 individuals were planted at four sites in Tumwater Canyon adjacent to the core population in 2015 and another 39 were reintroduced to a former outplanting site near Icicle Creek (Arnett and Goldner 2017). According to the most recent surveys in May of 2020 by the UW Rare Plant Care Program the overall survival rate of the 2015 outplantings is 22 percent (with only three plants remaining at the Icicle Creek site) (Gibble 2020). In 2019 seedlings were observed at the outplanting sites and in 2020 two, second year plants were observed in the Tumwater Canyon outplanting site. In October of 2019, approximately 200 plants were planted at three plots adjacent to the core population and between the 2015 outplanting plots in Tumwater Canyon. The first year survival

rate of these outplantings was 61 percent, which was much lower than the first year survival rate of the 2015 outplantings (80 percent survival rate). Evidence indicated 85 percent of the plants survived the winter, and most of the loss occurred in April, which was much drier than normal. Highest mortality occurred at the sites with the most sun exposure and least shade. (Gibble 2020). One new outplanted population was also planted in October of 2019 approximately 1.5 miles north from the core population in Tumwater Canyon on an area of Forest Service land with similar soils and aspect to the core population. The new outplanted population consisted of approximately 100 individuals. When surveyed in May of 2020, the plants at the new population north of the core population had an overall survival rate of 37 percent, with approximately half of the mortality occurring over the winter and half in the spring. (Gibble 2020). (USFWS, 2020)

Threats and Stressors

Stressor: Plant succession (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The primary loss of habitat for Hackelia venusta has resulted from changes in habitat due to plant succession in the absence of fire. Fire suppression has been a factor in reducing the extent of the Tumwater Canyon population (Gamon 1988a, b; D. Werntz, in litt. 2000), and most likely the few hundred acres of occupied habitat recorded in 1968 (Gentry and Carr 1976) represented a population that had already been reduced in both numbers and range due to fire suppression activities that had been ongoing for many years. Historically, fuels in the forest type where H. venusta is found were rarely at high levels because of the frequent fires that consumed forest floor fuels and pruned residual trees (Agee 1993). In the past, fires suppressed the encroachment of woody vegetation and maintained open areas presumably more conducive to H. venusta reproduction and growth. As described above, wildfires play a role in maintaining open, sparsely vegetated sites as suitable habitat for this shade-intolerant species (R. Carr, pers. comm. 1998; D. Werntz, in litt. 2000). (USFWS, 2007)

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Two nonnative, Washington State-listed noxious weeds (Washington Administrative Code Chapter 16-750 and Revised Code of Washington Chapter 17-10) occur within the habitat of Hackelia venusta in Tumwater Canyon. Linaria dalmatica (dalmatian toadflax) and Centaurea diffusa (diffuse knapweed) are present along the roadside, and the former also occurs above the main portion of the population (F. Caplow, pers. obs. 2004). During visits to the H. venusta population in 1995 through 1998, U.S. Fish and Wildlife Service staff noted that the cover and distribution of the noxious weeds had increased over this time period (T. Thomas, pers. obs. 1998). Both of these noxious weeds outcompete many native plant species through uptake of water and nutrients, interference with photosynthesis and respiration of associated species, and production of compounds that may directly affect seed germination and seedling growth and development. Without intervention, these species have the ability to outcompete H. venusta and replace native vegetation, and eventually dominate the site (J. Wentworth, King County Noxious Weed Control Board, in litt. 2001). (USFWS, 2007)

Stressor: Highway maintenance (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Highway maintenance activities are an ongoing threat to the population of Hackelia venusta. The highway is sanded during winter months, and de-icers are also occasionally applied, affecting the immediate roadside habitat where H. venusta is found. Since 1998, the Washington Department of Transportation has been using de-icers on the roadway during winter months. The de-icer used by the Department is called CalBan, a formulation of calcium chloride, which is a salt. Solutions of the salts accumulate in the soil and are retained on soil particles. The decline of H. venusta along the roadcut and right of way corresponds to an increase in noxious weeds and the Washington Department of Transportation's use of de-icers starting in 1998. De-icers may be associated with the decline of individual plants in the right-of-way and it is now considered a threat to the species. A study of the effect of de-icers used by the Washington Department of Transportation on surrogate species found deleterious effects on survival and biomass at concentrations above 1:100 (Chalker-Scott and Brickey 2004), although the authors do not believe concentrations this high occur at the H. venusta site. The Washington Department of Transportation is aware of the potential threat to H. venusta, and has been actively cooperating with the U.S. Fish and Wildlife Service, U.S. Forest Service, and the Washington Department of Natural Resources to plan and manage their maintenance activities so as to minimize impacts on the rare plant species of Tumwater Canyon (Washington Department of Transportation [WDOT] 2000; see Section G, Conservation Measures, for further details). (USFWS, 2007)

Stressor: Herbicides (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Although the roadsides have not been sprayed with herbicides in recent years by the Washington Department of Transportation, spraying did occur for a considerable period of time prior to 1980. The residual effect of herbicide spraying on Hackelia venusta is unknown. Some herbicides are known to reside in the soil for long periods of time, affecting the plants that persist there. In 1999 and 2000, the application of herbicides by U.S. Forest Service personnel was used as a method for reducing the amount and distribution of nonnative, noxious weeds (L. Malmquist, pers. comm. 2003). Although they were used with great caution by U.S. Forest Service staff with knowledge of H. venusta's presence, the threat from herbicide drift and residue remains. (USFWS, 2007)

Stressor: Erosion and landslides (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Small surface erosion events and large landslides on the unstable slope where the Hackelia venusta population is located are a continuing threat to the species. The steepness of the slope exceeds 100 percent (45 degree) inclination in many places, and the slope's instability constitutes a significant threat as a major landslide could bury most of the population (Gamon 1997). The last time a large landslide occurred, in 1992, the road was closed for emergency

repairs by the Washington Department of Transportation. The repairs undercut the slope and at least 50 H. venusta plants were destroyed (R. Harrod, pers. comm. 2001). The population census numbers continued to decrease for several years after the landslide. (USFWS, 2007)

Stressor: Burying, trampling, or dislodging of plants by soil releases (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The threat of soil being dislodged and the burying, trampling, or dislodging of plants below these soil releases has been witnessed as more people visit the habitat to photograph or collect Hackelia venusta (S. Ballinger, Biologist in litt. 2000; P. Camp, Bureau of Land Management, in litt. 2000; F. Caplow, in litt. 2000; J. Frazee, U.S. Forest Service, in litt. 2000; K. Robson, Cowlitz and Wahkiakum Conservation Districts, in litt. 2001). The potential for slumping (deep-seated mass movement) at the site has increased since 1994, when wildfires burned through the forest in Tumwater Canyon where the species is located. The increased potential for landslides occurs when water uptake by trees and other vegetation that were killed by the 1994 fire is reduced, along with transpiration, so there is more soil water, which increases instability. This is a case where the response to fire may have negative consequences. Another contributing factor is that when tree roots decompose, their ability to bind soil particles and water is decreased. When this happens, the potential for landslides increases. A large landslide in the location of the Tumwater Canyon population of H. venusta would severely degrade the habitat and reduce the plant population. (USFWS, 2007)

Stressor: Automobile emissions (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Although there are no data regarding the effects of automobile emissions on Hackelia venusta specifically, such emissions should be considered a potential threat, given the proximity of the road to the population. The highway is heavily used, with between 3,900 to 5,200 automobiles traveling daily through Tumwater Canyon, which is very narrow (WDOT 1996). Automobile emissions are likely to increase along this heavily traveled corridor. These emissions, containing ozone and sulphur and nitrate oxides, are known to negatively affect photosynthesis of coniferous and herbaceous plants (Bega 1979), and may increase nitrogen in the soil, thereby increasing the cover and vigor of competing vegetation. (USFWS, 2007)

Stressor: Collection pressure
Exposure:
Response:
Consequence:
Narrative: There is a long history of collection pressure on Hackelia venusta. (R. Carr, in litt. 2000; L. Malmquist, in litt. 2000; J. Brickey, University of Washington, in litt. 2001; R. Crawford, Washington Department of Natural Resources, in litt. 2001; E. Guerrant, in litt. 2001; K. Robson, in litt. 2001). H. venusta is very showy and has been collected by scientists, amateur wildflower enthusiasts, and other visitors to the population for more than 30 years. The availability of highway turnouts, and a general increase in knowledge and interest in the species are likely to have increased collecting pressure. Collecting activities may have reduced the number of plants in the population and have also degraded the habitat (Gamon 1997; R. Carr, in litt. 2000; R.

Crawford, in litt. 2000, 2001; R. Harrod, in litt. 2000; G. Hoffman, U.S. Forest Service, in litt. 2000; F. Caplow, in litt. 2001). (USFWS, 2007)

Stressor: Human activities (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: An associated and serious threat is physical disturbance to the habitat and the individual plants from people trampling the slope to collect or see plants, photograph the plants, and monitor the population. Physical disturbance to the substrate increases instability, may damage the root systems of adult plants, and may also cause higher mortality of germinants (F. Caplow, pers. obs. 2003). (USFWS, 2007)

Stressor: Biocontrol agent (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: However, there is a potential threat from a new biocontrol agent. Mogulones cruciger is a weevil that attacks the nonnative hound's-tongue, Cynoglossum officinale (gypsyflower), which is also in the borage family. Cynoglossum officinale is known from Chelan County. The biocontrol agent has not been formally released in the United States, but has been released in Canada. (USFWS, 2007)

Stressor: Predation by weevils (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: A laboratory-based study, using tissue-culture clones of H. venusta, found that M. cruciger was able to develop and feed to a limited extent on H. venusta. However, in both laboratory and field experiments M. cruciger demonstrated a strong preference for Cynoglossum (J. Andreas, University of Idaho, in litt. 2004). The investigator concluded that M. cruciger could pose some risks to native species of Boraginaceae and recommended that the weevil not be released in the United States. However, the weevil may spread from Canada and has been identified in the Okanagan Region of British Columbia (S. Reichard, pers. comm. 2003). (USFWS, 2007)

Stressor: Low seed production (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Low seed production is a factor in the decline of Hackelia venusta. At the Tumwater Canyon site, an estimated high proportion (60 to 70 percent) of H. venusta seeds did not develop in 1984 (Barrett et al. 1985). Fruit development was poor on many plants; only a few individuals exhibited mature fruit development. Low fruit production has been observed in other years as well (L. Malmquist, pers. comm. 2002). This low or variable reproductive potential may be a major factor in the small number of plants at the type locality. The age structure of the extant population at Tumwater Canyon, poor seed production and germination of new seedlings, and historical estimates of population size indicate that the population has been in decline (Barrett et

al. 1985; Gamon 1997), although recent monitoring of the population shows that the population has increased during the period from 1995 to 2004. The increase in population size can likely be attributed to the improved habitat conditions brought on by restoration activities and the effects of a wildfire that burned through Tumwater Canyon in 1994. (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The small size of the only known population of Hackelia venusta is a major problem for recovery. Seedling establishment is most critical, and trampling may significantly affect the germination of seedlings (R. Carr, pers. comm. 1998, in litt. 2000; K. Robson, in litt. 2001). The small number of individuals (roughly 600 plants) remaining in the sole population located in Tumwater Canyon makes H. venusta vulnerable to extinction due to random events such as slope failure (mass wasting or surface erosion) or drought. A single random environmental event could extirpate a substantial portion or all of the remaining individuals of this species, leading to extinction. Also, changes in gene frequencies within small, isolated populations can lead to a loss of genetic variability and a reduced likelihood of long-term viability (Franklin 1980; Soulé 1980; Lande and Barrowclough 1987; R. Carr, in litt. 2000). (USFWS, 2007)

Recovery

Reclassification Criteria:
Hackelia venusta may be considered for downlisting to threatened status when all of the following conditions have been met to address the threats to the species: (USFWS, 2019)

1. Listing/Recovery Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range. In order to ensure the long-term recovery needs of Hackelia venusta, threats to the species habitat must be reduced or removed. This will have been accomplished if the following have occurred: (a) Tree and shrub cover in all populations is maintained at a level equal to or more open than that present in 2007 in the original population, through manual removal or controlled burns. (b) Noxious weed populations are not present within any populations or close enough to them to pose a significant threat of invasion, or are annually removed. (c) Herbicide and de-icer use continues to be minimized within all populations or close enough to them that individuals may be affected. (d) All population sites have been evaluated for mass wasting potential and plans have been developed and implemented to minimize the effects of landslides on H. venusta. (USFWS, 2019)

2. Listing/Recovery Factor B: Overutilization for commercial, scientific, or educational purposes. Hackelia venusta is vulnerable to overcollecting of seeds or plants, and to habitat damage through substrate disturbance. In order to ensure the long-term recovery of H. venusta, threats to the species through collecting and visitation must be reduced or removed. This will have been accomplished if the following have occurred: (a) Seed collection guidelines are established. (b) A guideline of not sharing specific site information with the public or the press has been accepted by the U.S. Forest Service. * The quantitative measure of tree and shrub cover must be determined (Recovery Action 1.7.1). (c) The pullout across the highway from the population has been modified or removed to discourage the public from stopping their vehicles and crossing the highway. (d) The U.S. Forest Service has an entry log in place and all permitted entries into

the population are logged. (e) All research within the population is approved by the U.S. Fish and Wildlife Service and the U.S. Forest Service after review by the recovery team. (USFWS, 2019)

3. Listing/Recovery Factor C: Disease or predation. The viability of Hackelia venusta could be compromised by the presence of the borage-specific biocontrol weevil, Mogulones cruciger. In order to ensure the long-term recovery needs of H. venusta, threats to the species through predation by the biocontrol agent must be reduced or removed. This will have been accomplished if the following have occurred: (a) A monitoring program is in place to inspect H. venusta and identified populations of Cynoglossum officinale (gypsyflower) in Chelan County on an annual basis for the presence of the biocontrol weevil, Mogulones cruciger. (b) A written plan is in place for actions to undertake if the weevil is found and determined to have negative effects on H. venusta. (USFWS, 2019)

4. Listing/Recovery Factor D: Inadequacy of existing regulatory mechanisms. In order to ensure the long-term recovery needs of Hackelia venusta, regulatory mechanisms need to be strengthened. This will have been accomplished if the following have occurred: (a) Habitat management plans have been developed and implemented by the U.S. Forest Service. Management plans will include provisions, as appropriate, for habitat maintenance and restoration, noxious weed control, fire management, recreational activities, monitoring, and research. (b) A revised management plan has been developed and implemented by the Washington Department of Transportation. The management plan will include provisions, as appropriate, for habitat maintenance and restoration, noxious weed control, and highway maintenance activities. (c) All H. venusta populations on public lands are within management areas where maintenance of the species is a primary management goal. (USFWS, 2019)

5. Listing/Recovery Factor E: Other natural or manmade factors affecting its continued existence. The long-term recovery needs of Hackelia venusta require more populations that are stable and self-sustaining. The genetic resources of the species must also be adequately protected through seed storage, in case of catastrophic events in Tumwater Canyon. This will have been accomplished if the following have occurred: (a). At least three stable, self-sustaining populations are present within Tumwater Canyon on protected sites (owned or managed by a government agency or private conservation organization that identifies maintenance of H. venusta as the primary management objective for the site), separated by at least 2 kilometers (1.2 miles) or by the Wenatchee River. These populations could be the result of identification through further inventory, or through reintroduction or augmentation. If a new population is discovered outside of Tumwater Canyon, it may contribute to meeting this criterion. To be deemed stable and self-sustaining, a population must maintain a 5-year average of at least 1,000 adult plants, must show evidence of positive or neutral population growth over the same 5-year period, and must show evidence of natural reproduction and establishment. b. Genetic material, in the form of seeds adequately representing the geographic distribution and genetic diversity within the species, is stored in at least one facility approved by the Center for Plant Conservation. (USFWS, 2019)

6. Monitoring. In order to ensure the efficacy of recovery actions and allow for adaptive management, as necessary, population and habitat monitoring will have been established for all populations of the taxon at appropriate intervals. Habitat monitoring should include census, monitoring of Hackelia venusta, and of shrub and tree cover and nonnative species. Monitoring

must be planned and conducted to minimize the potential negative impacts on the species and its habitat. Written agreements to continue monitoring after downlisting must be in place. (USFWS, 2019)

Delisting Criteria:
Delisting of Hackelia venusta may be considered when all of the following conditions, in addition to the downlisting criteria set in the Recovery Plan (USFWS 2007), have been met to address threats to the species: (USFWS, 2019)

Criterion A/1: The primary threats are removed or adequately managed in all five populations counted toward recovery in delisting criteria (see also Criterion E/1). (USFWS, 2019)

Criterion B/1: Threats to the species through visitation should be removed. (USFWS, 2019)

Criterion E/1: There are at least five stable, self-sustaining populations typically separated by 1.5 miles or by a geographical barrier such as the Wenatchee River on protected sites where protection of the species is a priority. (USFWS, 2019)

Criterion E/2: To be deemed stable and self-sustaining, a population should maintain a 20- year running average of at least 2,000 adult plants, show evidence of positive or neutral population growth over the same 20-year period, and be sustained through natural regeneration. (USFWS, 2019)

Recovery Actions:
- Maintain the current geographic distribution of the species through maintaining habitat integrity. There is only 1 known native population of Hackelia venusta, of about 572 to 772 plants, covering approximately 16 hectares (40 acres). Because there are threats from the presence of the nearby State highway, continuing and increasing coordination between the U.S. Forest Service and the Washington Department of Transportation will be necessary. Planning for the future maintenance of this habitat is essential to facilitate the timely implementation of recovery actions. (USFWS, 2007)
- Continue surveys in Tumwater Canyon and other appropriate areas; identify potential habitat for reintroductions. Although considerable inventory work has been undertaken for this species, the discovery in the last few years of previously unknown sites, and the highly convoluted terrain of the Wenatchee Mountains, suggests that other populations may yet be discovered. (USFWS, 2007)
- Establish if necessary, new populations of H. venusta within the estimated historical range of the species. Further field inventory may reveal previously unknown populations which meet the criteria for recovery. If so, reintroduction efforts will not be necessary. However, if no other large populations are found through further inventory work, reintroduction may be necessary to ensure the viability of the taxon into the foreseeable future. A carefully prepared reintroduction plan and propagation and reintroduction research will be necessary before reintroduction is undertaken. Reintroduction may only take place in the Tumwater Canyon watershed, which is the only watershed known to have supported populations of the species, based on historical collections. Based on habitat surveys to date, there appear to be few locations suitable for reintroduction having all habitat attributes necessary to support H. venusta. (USFWS, 2007)

- Collect seed adequately representing the genetic diversity within the species and store in a Center for Plant Conservation approved facility. The single known population, small number of individuals, and extremely restricted distribution of Hackelia venusta make this species highly vulnerable to random environmental and human-caused events. As a hedge against the loss of significant genetic material, seed representing the diversity within the taxon should be collected and stored in at least one Center for Plant Conservation approved facility. The stored seed could also be used in efforts to establish new populations. Periodic testing will be necessary to estimate the rate of viability loss of stored seed. This will help estimate the correct interval and adequate quantity of seed to recollect for storage. (USFWS, 2007)
- Establish a technical working group to periodically review the status of the species and assess the effectiveness of management plans and other recovery actions. Annual review of all progress toward recovery and all ongoing research and monitoring is critical for successful implementation of this plan and for modifications to the plan that may be needed in future. (USFWS, 2007)
- Determine the suitability for establishing appropriate delisting criteria (Priority 3). As more information becomes available over time, the conditions necessary for delisting Hackelia venusta should become apparent. (USFWS, 2007)
- Recommendation for Future Actions from 2011 5-Year Review: Continue efforts for establishing additional populations of H. venusta. This work will require refining propagation and reintroduction methods, and continuing to search for potential sites for outplanting the species. This includes continuing to collect and store genetically representative samples of seeds and determining optimal germination requirements. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Dr. Darlene Zabowski, Soil Science Professor at the University of Washington, has proposed a study of soil requirements for H. venusta. This study may help to clarify the substrate requirements of this species. As researchers have shown with other species, the success or failure of small outplantings in different sites may also provide a useful indicator of habitat requirements for the species (Dunwiddie 2010, Lawrence and Kaye 2009), Taylor 2008, WNHP 2007). (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: As the next step in monitoring, it would be useful to establish a yearly record of temperature, rainfall, and soil moisture. Together with annual pollinator censuses and assessments of the general condition of plants, it might then be possible to find patterns of pollinator abundance or scarcity, and relate them to seed set on H. venusta in the context of environmental conditions. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue the examination of life history: reproductive/pollination biology, seed production, germination requirements, seedling establishment, life span. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Investigate the natural history of H. venusta - What was its potential historic range? Could the white-flowered population have been at higher elevations at one time? (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue to study the effects road de-icer formulas have on H. venusta. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Resolve the taxonomy of H. venusta and H. “taylori” and provide an appropriate name for these high elevation plant populations of conservation concern. (USFWS, 2011)

- Recommendation for Future Actions from 2011 5-Year Review: Continue work to improve the existing population and reduce the threats to the species sufficient to accomplish increases in population size and geographic distribution across its presumed historical range so that the species is no longer in danger of extinction. (USFWS, 2011)
- Recommendation for Future Actions from 2011 5-Year Review: Continue investigations for potential suitable habitat for H. venusta to find potential reintroduction sites, with emphasis on studying sites that have been found to be promising such as Icicle Canyon, and other sites within a two miles radius of the extant site. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future research and management recommendations include: (1) Develop an improved monitoring plan for the core population and outplantings that is replicable and minimizes impacts. (2) Research potential outplanting sites, and potential sites where undiscovered populations may occur. (3) Establish additional populations to meet downlisting and delisting criteria. (4) Monitor for the threat of invasive Mogulones cruciger in Washington and near Hackelia venusta sites. (5) Continue to supplement core and outplanting sites with plants until populations are self-sustaining (USFWS, 2020)

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SPECIES ACCOUNT: *Harrisia (=Cereus) aboriginum (=gracilis)* (Aboriginal Prickly-apple)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/25/2013; Southeast Region (R4) (USFWS, 2015)

Physical Description

Harrisia aboriginum is a sprawling cactus, usually with multiple stems arising from a single base. The stems are erect, slender, and cylindrical. They possess 9 to 11 longitudinal ribs, and may reach 6 m (20 ft) in height. Spines are 1.0 cm (0.4 in) long and originate in clusters of 7 to 9 spines, with up to 20 spines in a cluster at the base of the stem. Flowers are funnel-shaped, white, up to 18 cm (7.1 in) long; have a slight scent; and are nocturnal, lasting only one night. The bracts on the outside of the flower has sparse white hairs. Fruits are yellow, round in shape, and 6.1 to 7.6 cm (2.4 to 3.0 in) in diameter. (USFWS, 2013)

Taxonomy

Harrisia aboriginum (Family: Cactaceae) was described by John Kunkel Small, after he discovered it in Manatee County in 1919. The most recent revision of the genus Harrisia supports H. aboriginum as a morphologically and genetically distinct species endemic to the west coast of Florida (USFWS, 2013).

Historical Range

Harrisia aboriginum was known historically from coastal areas of southwest Florida along the Gulf coast in Manatee, Charlotte, Sarasota, and Lee Counties. The species was documented on six keys along approximately 125 km (78 mi) of Gulf of Mexico coastline (USFWS, 2013).

Current Range

Currently occurs along the Gulf Coast of Florida, in Sarasota, Lee, and Charlotte Counties (NatureServe, 2015).

Critical Habitat Designated

Yes; 2/22/2016.

Legal Description

On January 22, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 22, 2016) for Harrisia aboriginum (Aboriginal Prickly-apple) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Florida (81 FR 3866-3925).

Critical Habitat Designation

The critical habitat designation for Harrisia aboriginum includes eleven CHUs in Manatee, Charlotte, Sarasota, and Lee Counties, Florida. This species' critical habitat encompasses approximately 3,444 acres (ac) (1,394 hectares (ha)). Nine of these units (approximately 44 percent of the area) were occupied by the species at the time of listing; the remaining two units (approximately 56 percent of the area) were unoccupied. The critical habitat includes lands under Federal (11 percent), State (48 percent), county (15 percent), and private or other (26

percent) ownership. General descriptions are presented below. Maps depicting the CH units are available in the Final Rule (81 FR 3866-3925).

Unit APA1: Terra Ceia, Manatee County, Florida: Unit APA1 consists of approximately 222 ac (90 ha) in Manatee County, Florida. This unit is composed of State lands within Madira Bickel Mound State Historical Park, Terra Ceia Preserve State Park, Cockroach Bay State Buffer Preserve, and the Tampa Bay Estuarine System (66 ac (27 ha)); Manatee County lands at Emerson Point Preserve and parcels owned by the Manatee County Port Authority (70 ac (28 ha)); and parcels in private or other ownership (87 ac (35 ha)). This unit includes lands west of Highway 41 extending from just south of South Dock Street south to Snead Island. The unit also includes areas of Harbor Key, Mariposa Key, Horseshoe Key, Joe Island, Skeet Key, Paradise Island, Ed's Key, and Rattlesnake Key.

Unit APA2: Longboat Key, Sarasota County, Florida: Unit APA2 consists of approximately 54 ac (22 ha) in Sarasota County, Florida. This unit is composed entirely of parcels in private or other ownership. This unit includes lands west of Gulf of Mexico Drive, extending from 0.40 mi (0.6 km) south of the intersection of Bay Isles Parkway and Gulf of Mexico Drive, to the southern tip of Longboat Key. It also includes lands on the north side of Gulf of Mexico Drive, east of Longboat Club Key Drive, on the northwest tip of Longboat Key.

Unit APA3: Osprey, Sarasota County, Florida: Unit APA3 consists of approximately 116 ac (47 ha) in Sarasota County, Florida. This unit is composed of Sarasota County lands within Palmer Point County Park (50 ac (20 ha)) and parcels in private or other ownership (66 ac (27 ha)). This unit extends along the barrier island (Casey Key) from the south terminus of Blind Pass Road, south for approximately 1.2 mi (1.9 km) along North Casey Key Road. On the mainland, the unit includes lands bordered on the north by Vamo Way, to the east by Highway 41, and to the south by Palmetto Avenue.

Unit APA4: Manasota Key, Sarasota and Charlotte Counties, Florida: Unit APA4 consists of approximately 415 ac (168 ha) in Sarasota and Charlotte Counties, Florida. This unit is composed of State lands within Stump Pass Beach State Park (58 ac (23 ha)); County lands within Blind Pass Park, Brohard Beach and Paw Park, Manasota Beach Park, Casperson Beach Park, and Service Club Park (111 ac (45 ha)); and parcels in private or other ownership (245 ac (99 ha)). This unit extends from Beach Road in the City of Venice, south along Manasota Key to the barrier islands southern tip, including a portion of Peterson Island.

Unit APA5: Charlotte Harbor, Charlotte County, Florida: Unit APA5 consists of 51 ac (21 ha) in Charlotte County, Florida. This unit is composed entirely of State lands within the Charlotte Harbor Preserve State Park. This unit includes the Big Mound, Boggess Ridge, and a shell mound located on the east side of Charlotte Harbor, south of the City of Charlotte Park.

Unit APA6: Gasparilla North, Charlotte and Lee Counties, Florida: Unit APA6 consists of approximately 98 ac (40 ha) in Charlotte and Lee Counties, Florida. This unit is composed of State land (0.006 ac (0.02 ha)), county land (22 ac (9 ha)), and parcels in private or other ownership (77 ac (31 ha)). This unit includes most of Kitchen Key (Live Oak Key) and the area east of Gasparilla Road, from the intersection of Grouper Hole Road and Grouper Hole Court, south to 0.15 mi (0.24 km) north of Snail Island Court, from approximately 0.10 mi (0.21 km) south of 35th Street to 23rd Street, including the small island separated from Gasparilla Island by a canal; and from

22nd Street to 20th Street.

Unit APA7: Gasparilla South, Lee County, Florida: Unit APA7 consists of approximately 92 ac (37 ha) in Lee County, Florida. This unit is composed of Federal land owned by the Service and Bureau of Land Management (3 ac (1 ha)), State lands within Gasparilla Island State Park (69 ac (28 ha)), Lee County lands (12 ac (5 ha), and parcels in private or other ownership (8 ac (3 ha)). This unit includes lands located from south of 1st Street to the southern tip of Gasparilla Island.

Unit APA8: Cayo Pelau, Charlotte and Lee Counties, Florida: Unit APA8 consists of approximately 25 ac (10 ha) in Charlotte and Lee Counties, Florida. This unit is composed of Lee County lands within Cayo Pelau Preserve, and parcels in private or other ownership (0.6 ac (0.2 ha)). This unit includes lands located from 0.13 mi (0.21 km) south of the northern tip of Cayo Pelau, extending south to the southeastern tip of Cayo Pelau.

Unit APA9: Cayo Costa, Lee County, Florida: Unit APA9 consists of approximately 1,702 ac (689 ha) in Lee County, Florida. This unit is composed of State lands within Cayo Costa State Park (1,379 ac (558 ha)), lands owned by Lee County (94 ac (38 ha)), and parcels in private or other ownership (230 ac (93 ha)). This unit includes lands located from the northern tip to the southern tip of Cayo Costa.

Unit APA10: Bocilla, Lee County, Florida: Unit APA10 consists of approximately 33 ac (13 ha) in Lee County, Florida. This unit is composed of Lee County lands within the Bocilla Preserve (32 ac (13 ha)) and parcels in private or other ownership (0.7 ac (0.3 ha)). This unit includes lands located on the undeveloped portion of Bokeelia Island from 0.02 mi (0.03 km) west of the terminus of Ebbtide Way, extending south and west to the northwestern and southeastern corners of Bokeelia Island.

Unit APA11: Sanibel Island and Buck Key, Lee County, Florida: Unit APA11 consists of approximately 635 ac (257 ha) in Lee County, Florida. This unit is composed of Federal lands owned by the Bureau of Land Management, and Service lands within the J.N. `Ding' Darling National Wildlife Refuge (NWR) (373 ac (151 ha)), State lands (47 ac (19 ha)), lands owned by Lee County (90 ac (36 ha)), and parcels in private or other ownership (126 ac (51 ha)). This unit includes lands on Buck Key, Runyan Key, and Sanibel Island. On Sanibel Island, the unit includes a portion of Bowman's Beach, from just south of Silver Key to the western terminus of Water's Edge Lane; uplands within J.N. `Ding' Darling NWR; and a shell mound located near the northern terminus of Tarpon Bay Road.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Harrisia aboriginum critical habitat consists of the following components (81 FR 3866-3925):

(i) Areas of upland habitats consisting of coastal berm, rockland hammocks, and buttonwood forest. (A) Coastal berm habitat that contains: (1) Open to semi-open canopy, subcanopy, and understory; and (2) Substrate of coarse, calcareous, and storm-deposited sediment. (B) Rockland hammock habitat that contains: (1) Canopy gaps and edges with an open to semi-open canopy, subcanopy, and understory; and (2) Substrate with a thin layer of highly organic soil covering limestone or organic matter that accumulates on top of the limestone. (C) Buttonwood forest

habitat that contains: (1) Open to semi-open canopy and understory; and (2) Substrate with calcareous marl muds, calcareous sands, or limestone rock.

(ii) A plant community of predominately native vegetation with no invasive, nonnative animal or plant species or such species in quantities low enough to have minimal effect on survival of Consolea corallicola.

(iii) A disturbance regime, due to the effects of strong winds or saltwater inundation from storm surge or infrequent tidal inundation, that creates canopy openings in coastal berm, rockland hammocks, and buttonwood forest.

(iv) Habitats that are connected and of sufficient size to sustain viable populations in coastal berm, rockland hammocks, and buttonwood forest.

(v) Habitats that provide populations of the generalist pollinators that visit the flowers of Consolea corallicola.

Special Management Considerations or Protections

Management considerations or protection are necessary throughout the critical habitat units to avoid further degradation or destruction of the habitat that provides those features essential to the species' conservation. The primary threats to the physical or biological features that Harrisia aboriginum depends on include: (1) Habitat destruction and modification by development and sea level rise; (2) Competition with nonnative, invasive plant species; (3) Herbivorous nonnative animal species; (4) Wildfire; and (5) Hurricanes and storm surge. Some of these threats can be addressed by special management considerations or protection while others (e.g., sea level rise, hurricanes, storm surge) are beyond the control of landowners and managers. However, even when landowners or land managers may not be able to control all the threats, they may be able to address the results of the threats. Management activities that could ameliorate these threats include the monitoring and minimization of impacts from recreational activities, nonnative species control, and protection from development. Precautions are needed to avoid the inadvertent trampling of Harrisia aboriginum in the course of management activities and public use. Development of recreational facilities or programs should avoid impacting these habitats directly or indirectly. Ditching should be avoided because it alters the hydrology and species composition of these habitats. Sites that have shown increasing encroachment of woody species over time may require efforts to maintain the open nature of the habitat, which favors these species. Nonnative species control programs are needed to reduce competition, predation, and prevent habitat degradation. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All critical habitat units require active management to address the ongoing threats above and those presented in the Summary of Factors Affecting the Species sections in the proposed and final listing rules. The Service, State of Florida, and Manatee, Sarasota, Charlotte, and Lee Counties own and manage conservation lands within the historical range of Harrisia aboriginum. The CCP for J.N. 'Ding' Darling National Wildlife Refuge (JDDNWR) promotes the enhancement of wildlife populations by maintaining and enhancing a diversity and abundance of habitats for native plants and animals, especially imperiled species. This CCP provides specifically for maintaining populations of H. aboriginum. The State Management Plans for Charlotte Harbor Preserve, Cayo Costa, Stump Pass Beach, DelnorWiggins Pass, and Gasparilla Island State Parks and Bocilla Preserve promote the protection of habitats and native species. The Service, State of

Florida, and Manatee, Sarasota, Charlotte, and Lee Counties conduct nonnative species control efforts on sites that support, or have suitable habitat for, H. aboriginum. The Service monitors the population of H. aboriginum at JDDNWR. FDEP monitors the H. aboriginum population at Charlotte Harbor Preserve State Park. Nonnative species control is currently lacking at Manasota Beach Park and Kitchen Key in areas that support H. aboriginum. Poaching, vandalism, and wildfire have been observed at Manasota Beach Park. Most populations are at elevations close to sea level and may require assisted migration as sea level rise continues to drive the transition toward salt-tolerant plant species in these areas. Reintroduction is needed to restore the species' historical distribution on Cayo Costa and Madira Bickell Mound State Historical Park. Augmentation of small populations at Longboat Key, Terra Ceia, Lemon Bay Preserve, Kitchen Key, Gasparilla Island, and Cayo Pelau would reduce the risk of population loss to hurricanes, storm surge, or wildfire. Harrisia aboriginum is listed on the Regulated Plant Index as endangered under chapter 5B–40, Florida Administrative Code. Florida Statutes 581.185 sections (3)(a) and (b) prohibit any person from willfully destroying or harvesting any species listed as endangered or threatened on the Regulated Plant Index, or growing such a plant on the private land of another, or on any public land, without first obtaining the written permission of the landowner and a permit from the Florida Department of Plant Industry.

Life History

Food/Nutrient Resources

Breeding Season

Adult: May - September (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: Insect visitors recorded on other species of Harrisia include hawk moths (Nitidulidae), stingless bees (Meliponidae), and several types of beetles. Flowers are produced May through September. Ripe fruits have been observed from June through October (USFWS, 2013). Generalist pollinators (e.g., bees, butterflies, and beetles) pollinate H. aboriginum (USFWS, 2016).

Habitat Type

Adult: Terretrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal hammocks, shell middens (NatureServe, 2015); tropical savanna: berm, grassland (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: High sunlight exposure, disturbance regime (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Dense canopy cover, elevations significantly above sea level (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Linear (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Open coastal hammocks and shell middens at low elevations. This species has a narrow environmental specificity (NatureServe, 2015). The climate of south Florida where Harrisia aboriginum occurs is classified as tropical savanna. Harrisia aboriginum occurs in coastal berm, coastal strand, coastal grassland, and maritime hammock. It also occurs on shell mounds with a calcareous shell substrate (Bradley et al. 2004, pp. 4, 14) (USFWS, 2013). Harrisia aboriginum requires adequate rainfall and does not tolerate freezing temperatures. Substrates supporting Harrisia aboriginum include sand and calcareous shell material (Bradley et al. 2004, pp. 4, 14). Harrisia aboriginum requires upland habitats that occur above the daily tidal range, but are potentially subject to flooding by seawater during extreme tides and storm surge. H. aboriginum will not tolerate hydric or saline soils. The species occurs in habitats that have a vegetation composition and structure that allows for adequate sunlight. Disturbance regimes, including hurricanes, and infrequent inundation events that maintain the habitat suitability for H. aboriginum (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Studies on the pollination biology of Harrisia aboriginum are unknown. Insect visitors recorded on other species of Harrisia include hawk moths (Nitidulidae), stingless bees (Meliponidae), and several types of beetles. Harrisia fruits are sweet and fleshy, suggesting that seed dispersal by birds may be important. (USFWS, 2013)

Population Information and Trends

Population Trends:

Decline of <30% to increase of 25% (NatureServe, 2015)

Species Trends:

Relatively stable (NatureServe, 2015)

Number of Populations:

12 (USFWS, 2013)

Population Size:

300 - 500 (USFWS, 2015)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

The long-term population trend is a decline of <30% to an increase of 25%. Recently the species appears to be relatively stable (NatureServe, 2015). In total, the species was represented by an estimated 300 to 500 individuals in 2007, when population sizes were last estimated. The current range of Harrisia aboriginum spans a small geographic area (100-km (62-mi) stretch of coastline north to south). Of 12 extant populations, all but 2 have fewer than 100 plants (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Destruction and modification of habitat from development throughout the species' range continue to be a threat to Harrisia aboriginum. The coastal habitats of this species have been heavily impacted by development over the past 50 years. Despite the recent downturn in residential construction, coastal development is ongoing in the habitat of H. aboriginum. Populations on private land or non-conservation public land are most vulnerable to habitat loss. Threats include residential development, road widening, and landscape maintenance . Suitable habitat within the species' range was recently destroyed by encroachment from a private development onto State land (FNAI 2011, pp. 207–208). The threats of habitat loss, modification, and degradation are expected to increase with increased human population, development pressure, and infrastructure needs. Sarasota, Charlotte, and Lee Counties, where this plant currently occurs, are expected to build out before 2060, placing further pressure on remaining natural areas. Populations located on public lands are better protected than those on private land, but still may face the threat of habitat loss through development of park facilities such as new buildings, parking lots, and trails (USFWS, 2013).

Stressor: Poaching (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Overutilization (collection by hobbyists, also known as poaching) is a major threat to Harrisia aboriginum. The rarity of H. aboriginum, coupled with its showy flowers, makes this cacti particularly desirable to collectors. Evidence of poaching was recently observed at a site in Sarasota County that has high public visitation (USFWS, 2013).

Stressor: Disease and predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: An as yet unidentified pathogen can attack Harrisia aboriginum and cause stems to rot and die within about a week. However, no signs of this disease were observed at several sites visited in 2011. Herbivory of flowers by iguanas (Iguana sp.) and stems by gopher tortoises (Gopherus polyphemus) has been noted. Scale insects have been observed in some H. aboriginum populations, occasionally causing severe damage to plants. Overall, evidence indicates disease and predation are relatively minor stressors to H. aboriginum at present, but could become threats in the future if they become more prevalent in the cacti populations

(USFWS, 2013).

Stressor: Fire (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: At a site in Sarasota County, a large illegal bonfire pit is located within the habitat that supports one of the larger populations of H. aboriginum. The bonfires occur just a few yards from the plants (Bender 2011, pp. 5–6). At least one plant was killed by an escaped fire that affected part of this site in 2006 (Woodmansee et al. 2007, p. 108), and should another fire escape into occupied habitat in the future, it is reasonable to conclude this could result in the loss of individuals or extirpation of populations (USFWS, 2013).

Stressor: Nonnative plant species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Schinus terebinthifolius can dramatically change the structure of rockland hammocks, coastal berms, and shell mounds, making habitat conditions unsuitable for Harrisia aboriginum, which prefer moderate to full sun exposure. For example, at more than one site, numerous H. aboriginum plants occurring in the shade of S. terebinthifolius were observed to have died. Casuarina equisetifolia forms dense stands that exclude all other species through dense shade and a thick layer of needles that contain substances that leach out and suppress the growth of other plants. Coastal strand habitat that once supported Harrisia aboriginum has experienced dramatic increases in C. equisetifolia over the past 30 years. Other invasive plant species that are a threat to Harrisia aboriginum include Scaevola taccada (beach naupaka), Neyraudia reynaudiana (Burma reed), Cupaniopsis anacardioides (carrotwood), Thespesia populnea (Portia tree), Manilkara zapota (sapodilla), Hibiscus tiliaceus (hau), and Hylocereus undatus (night blooming cactus). (USFWS, 2013)

Stressor: Vandalism and recreation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Vandalism is a threat to Harrisia aboriginum, and has caused population declines in both species. At a Sarasota County site, the Service has documented numerous H. aboriginum plants that have been uprooted, trampled, and hacked with sharp implements. This population is impacted by people who use the coastal berm and hammock interface to engage in a variety of recreational (including unauthorized) activities as evidenced by a very large bonfire site and vast quantities of garbage, bottles, and discarded clothing.Due to their historic significance and possible presence of artifacts, shell mounds are susceptible to vandalism by artifact hunters. Despite regulations that protect these sites on State lands (Florida Statute 267.13), there is a long history of artifact hunters conducting unauthorized excavation of shell mounds in Florida, including some mounds where Harrisia aboriginum has been found, causing erosion and opening areas for invasion by nonnative plants (USFWS, 2013).

Stressor: Small population size and limited distribution (USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: The current range of Harrisia aboriginum spans such a small geographic area that all populations could be affected by a single event (e.g., hurricane). Six of the 12 remaining populations have 10 or fewer individual plants. Threats exacerbated by small population size include hurricanes, storm surges, freezing temperatures, recreation impacts, wildfires, and poaching. Due to ongoing and pervasive threats, the number and size of existing populations of this species are probably not sufficient to sustain it into the future (USFWS, 2013).

Stressor: Sea level rise (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Downscaled projections suggest that sea level rise is the largest climate-driven challenge to low-lying coastal areas and refuges in the subtropical ecoregion of southern Florida. The current occurrences of Harrisia aboriginum at Live Oak Key (1), Gasparilla Island (2), Bokeelia Island (1), Cayo Pelau (1), Lemon Bay Preserve (1), and Buck Key (1) would be inundated by a 1.8-m (5.9-ft) sea level rise, leading to the loss of these populations. Occurrences at Longboat Key (1), North Manasota Key (2–3), and on a coastal berm in Charlotte Harbor Preserve (1) would not be completely inundated, but would experience significant loss and modification of habitat, and what remains would be highly susceptible to further losses to storm surge and salinization (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- The Service; National Park Service (NPS); State of Florida; Manatee, Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments own and manage conservation lands within the range of Harrisia aboriginum (USFWS, 2013).
- The Service; NPS; State of Florida; Sarasota, Charlotte, Lee, Miami-Dade, and Monroe Counties; and several local governments conduct nonnative species control efforts on sites that support Harrisia aboriginum (USFWS, 2013).

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Determination of Endangered Status for Chromolaena frustrata (Cape Sable Thoroughwort), Consolea corallicola (Florida Semaphore Cactus), and Harrisia aboriginum (Aboriginal Prickly-Apple)

Final Rule. 78 Federal Register 206. October 24, 2013. Pages 63795 - 63821.

U.S. Fish and Wildlife Service. 2016. Designation of Critical Habitat for Consolea corallicola (Florida Semaphore Cactus) and Harrisia aboriginum (Aboriginal Prickly-Apple). Final Rule. 81 FR 3866-3925 (January 22, 2016).

Final Rule. 78 FR 63795 - 63821 (October 24, 2013).

USFWS. 2016. Endangered and Threatened Wildlife and Plants

Designation of Critical Habitat for Consolea corallicola (Florida Semaphore Cactus) and Harrisia aboriginum (Aboriginal Prickly-Apple)

Final Rule. 81 Federal Register 14. January 22, 2016. Pages 3865 - 3925.

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USFWS. 2013. Endangered and Threatened Wildlife and Plants

SPECIES ACCOUNT: *Hedeoma todsenii* (Todsen's pennyroyal)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/18/1981; Southwest Region (R2)

Physical Description

Todsen's pennyroyal is a perennial rhizomatous herb 10- 20 centimeters (cm) (4 to 8 inches (in)) tall and somewhat woody at the base. The rhizomes are slender and unbranched. The leaves are opposite, 0.8 to 1.5 cm (0.3 to 0.6 in) long, 0.25 to 0.5 cm (0.1 to 0.2 in) wide, lance-shaped, margins smooth, tip rounded to acute, and the lower surface glandular-dotted. The flowers occur singly in the axils of the upper stem leaves. The calyx is 1 .3 cm (0.5 in) long and two-lipped; the five calyx teeth are lance-shaped. The corolla is of five united petals, two-lipped, 3.6 cm (1.4 in) long, and orange-red to yellow. Yellow-flowered plants are less common, but have been seen at several places in the Sacramento Mountains. The corollas of the San Andres Mountains plants are slightly longer than those of the Sacramento Mountains plants (New Mexico Forestry and Resources Conservation Division [NMFRCD] 1991). There are two stamens. The fruits are of four nutlets; usually one or two develop to maturity, but all four may reach maturity (NMFRCD 1992; Huenneke 1993). The oblonglanceolate leaves and long, bright red-orange corolla easily distinguish Todsen's pennyroyal from other members of the genus (Irving 1979). (USFWS, 2001)

Taxonomy

Dr. Thomas Todsen discovered the first Todsen's pennyroyal population on August 18, 1978. Dr. Todsen and Dr. Robert Irving found a second population in the San Andres Mountains later in 1978. Todseri's pennyroyal was described as a new species in 1979; Dr. Todsen collected the type specimen, "2 miles south of Hardin Ranch, 2000 m" (collection #SA 1-78). The holotype is deposited at the New York Botanical Garden Herbarium; isotypes are deposited in herbaria at New Mexico State University, the University of Texas, and the U.S. National Herbarium (Irving 1979). Todsen's pennyroyal is a member of the mint family (Lamiaceae). Within its genus, it is placed in the subgenus Cifatum, a group of morphologically distinct, restricted endemics of southern New Mexico, western Texas, and Nuevo Leon, Mexico (Irving 1979). (USFWS, 2001)

Historical Range

Endemic mint that occurs in the San Andres Mountains of Sierra County, and the Sacramento Mountains in Otero County in south-central New Mexico. (USFWS, 2011)

Current Range

Endemic mint that occurs in the San Andres Mountains of Sierra County, and the Sacramento Mountains in Otero County in south-central New Mexico. (USFWS, 2011)

Critical Habitat Designated

Yes; 1/19/1981.

Legal Description

On January 19, 1981, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective February 18, 1981) for Hedeoma todsenii (Todsen's pennyroyal) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one

critical habitat unit (CHU), in New Mexico (46 FR 5730-5733; USFWS, 1981).

Critical Habitat Designation

The critical habitat designation for Hedeoma todsenii includes one CHU in Sierra County, New Mexico. A description is provided below; the Final Rule contains a map depicting the location of the CHU (46 FR 5730-5733).

In New Mexico: Sierra County; the Critical Habitat of Hedeuma todsenii is best defined by two one-square kilometer sections on the 1000 m2 Universal Transverse Mercator Grid, Zone 13. The more northern critical habitat lies between 76,000 and 77,006 m N and 39,000 and 40,000 m E. The southern area lies between 74,000 and 75,000 m N and 40,000 and 41,000 m E.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Hedeoma todsenii critical habitat are explicitly defined in the Final Rule, but are thought to be the following (46 FR 5730-5733):

Gypsum limestone soils.

Special Management Considerations or Protections

Any activities which would result in increased trampling or disturbance of the extremely fragile areas where Hedeoma todsenii occurs would probably adversely modify the Critical Habitat. The long-term solution on how to best protect Hedeoma todsenii may be to greatly reduce all traffic in the area where this plant occurs. In this respect, Critical Habitat designation may affect Federal activities within the 2 square kilometer area of Hedeoma todsenii's Critical Habitat, which is administered by the Department of the Army. (USFWS, 1981)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative, sexual: self-fertilization (USFWS, 2011); sexual: cross-pollination (USFWS, 2001)

Lifespan

Adult: 2+ years (inferred from NatureServe, 2015; see physical description)

Dependency on Other Individuals or Species

Adult: broad-tailed hummingbirds (Selasphorus platycercus) (USFWS, 2011/USFWS, 2022)

Breeding Season

Adult: June - September (USFWS, 2001)

Key Resources Needed for Breeding

Adult: High rainfall (USFWS, 2001)

Reproduction Narrative

Adult: Nutlets remain inside the calyx which has a mucilaginous surface when wet. Plants typically have a low seed set which seems to be a genetic characteristic of the species (USFWS 2011h; NatureServe, 2015). Recent efforts to study pollination and reproductive success in the populations in the San Andres Mountains found that broad-tailed hummingbirds (Selasphorus platycercus) were using the flowers of H. todsenii and were relatively frequent visitors (Sikula 2009, Tonne 2009). Tonne (2009) also observed broad-tailed hummingbirds as the primary visitors of H. todsenii flowers in the Sacramento Mountains. Tonne (2009) noted two other wasp visitors (Sphecidae) were observed. The distribution of age classes indicates a normally aging group of long-lived perennial plants that are actively recruiting new individuals to the population. The plant perpetuates patches of stems by asexual reproduction and sexual inbreeding (USFWS, 2011). Field observations of seed set per fertile flower have been 1.6 nutlets/flower (Irving 1979), 1.8 nutlets/flower (NMFRCD 1991), 2.3 nutlets/flower (NMFRCD 1 992), and 2.3 nutlets/flower (Ulaszek 1 993). Todsen's pennyroyal flowers from June to September. Most flowers are produced from late August to early September, concurrent with the period of highest rainfall. Although the sample sizes were small, self-pollination, pollination between flowers in a patch, and pollination between patches of a population all resulted in some seed production (Huenneke, 1993) (USFWS, 2001). .1 New information on the species' biology and life history: Hedeoma todsenii exhibit two periods of reproduction, both in the summer, and both are influenced by precipitation (Britt 2017). The first reproductive period occurs in early summer, especially in years with favorable winter and spring precipitation, and the second occurs in late summer, coinciding with summer monsoons. While conducting phenological monitoring in 2017, Britt observed the first flower on May 9th, during the first reproductive period, and the last flower on September 20th, during the second reproductive period. While monitoring populations in the Sacramento Mountains in 2017 and 2020, reproductive effort was observed to occur during both reproductive periods, but most reproductive effort occurred in the early reproductive period (Britt 2021). Funding from the Department of Defense was allocated in 2009 to initiate a pollinator study of Todsen's pennyroyal populations on White Sands Missile Range, Lincoln National Forest, and Bureau of Land Management lands in both the San Andres Mountains and the Sacramento Mountains ranges. The study was designed to assess the structure and function of the pollinator community and evaluate Todsen's pennyroyal's breeding success. Tonne (2009) only completed the first year of this pollinator study but found that broad-tailed hummingbirds are the likely pollinator and primary visitor to Todsen's pennyroyal in all areas. (USFWS, 2022)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinyon-juniper woodland (NatureServe, 2015); ponderosa pine and Douglas fir woodlands (USFWS, 2011)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~2,000 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2001)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015

Habitat Narrative

Adult: Inhabits steep gravelly north- and east-facing slopes with loose, gypseous-limestone soils at about 2000 m elevation. The surrounding plant community is an open pinyon-juniper woodland (USFWS 2001d, NMNP PAC 1984) (NatureServe, 2015). It also occurs in scattered ponderosa pine and Douglas fir woodlands in the Sacramento Mountains. All habitats occur on the Permian-age Yeso Formation and are associated with strata that produce gypseous, sandy loam soils, often with loose limestone gravel and cobble (USFWS 2001). Populations have hundreds to thousands of separate clumps of plants (USFWS, 2001).

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: The sticky calyx sticks to surfaces, therefore limiting long distance dispersal (USFWS 2001d; NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

47 (USFWS, 2022)

Population Size:

Unknown (USFWS, 2011)

Population Narrative:

The plant was known from only two populations at the time of listing in 1981. Between the time of listing and completion of the second Recovery Plan revision in 2001, 16 additional populations had been discovered, forming a total of three populations in the San Andres Mountains on White Sands Missile Range, and 15 sites in the Sacramento Mountains on Bureau of Land Management and Lincoln National Forest lands. The Sacramento Mountains are situated 75 kilometers (45 miles) to the east of the San Andres Mountains, and both ranges have an overall north to south orientation that straddles the lower and drier Tularosa Basin. As of 2022, 47 Todsen's pennyroyal populations have been documented: 32 populations in the Sacramento Mountains and 15 populations in the San Andres Mountains. Nearly all known populations occur on Federal lands, with 19 populations on Bureau of Land Management lands; 5 populations on Bureau of Land Management and the Lincoln National Forest lands; 7 populations on the Lincoln National Forest; and 15 populations on White Sands Missile Range. One population occurs on land administered by the New Mexico State Land Office, and one population on Bureau of Land Management land crosses over into private land (Britt 2020). Populations in the San Andres Mountains are numbered P16 to P30, and populations in the Sacramento Mountains are numbered P1 through P15 and P31 through P49 (USFWS, 2022).

Threats and Stressors

Stressor: Low reproduction (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Inbreeding depression in this species could be a contributing factor to the very low level of seed set observed throughout all populations of H. todsenii. If inbreeding and long-term asexual reproduction have caused an accumulation of lethal alleles in a population, many embryos would fail to survive and would be aborted. The possibility of increasing genetic variability by purposely out crossing distant populations with pollen or seed transfers would run the risk of breaking up co-adapted gene complexes that confer adaptation to local environmental conditions, i.e. out breeding depression. Purposeful transfer of gene complexes between populations may further reduce embryo survival in ways that have not yet been identified. Huenneke (1993) showed that self-pollination and transfers of pollen between individuals within a patch and between nearby patches produced at least a few seeds. However, her hand-pollen transfers between two distant populations in canyons 1.2 km apart failed to produce any seeds. Infrequent seed set likely may be a genetic characteristic of the species as a whole and probably cannot be modified by a few attempts to purposely transfer gene complexes between the various inbred populations. The continuing inability of H. todsenii to produce an abundance of seeds will severely limit its ability to recolonize habitats where populations may be extirpated or to migrate to new habitats if climate change renders current habitats unsuitable (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Hedeoma todsenii is a relict species persisting as small, scattered patches of plants in a few places where gypseous soils and topographic aspect create cooler, moister microclimates in a relatively hot and arid region. These microclimate habitats and the H. todsenii populations they contain would probably expand if the regional climate became cooler or wetter. Conversely, a climatic change that made these microclimate habitats drier could shrink or eliminate H. todsenii populations. Localities in the San Andres Mountains may be vestiges of relict populations and incapable of spreading: whereas, colonies in the Sacramento Mountains inhabiting more mesic areas could hold more promise for the species' persistence, making their protection all the more imperative (P. Tonne 2011, pers. comm.). If predicted warming is accompanied by less precipitation over the longer term, or no increase in precipitation, it is possible that H. todsenii populations could be diminished (USFWS, 2011).

Stressor: Fire (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Most H. todsenii populations occur within piñon-juniper woodlands that are becoming more dense due to a history of fire prevention, and more susceptible to wildfire due to current drought conditions. The proximity of H. todsenii populations to each other increases the chances that any given fire could affect multiple populations. However, the ground cover in more arid

habitats, particularly in the San Andres Mountains, might not be dense enough to carry a fire a great distance. The underground rhizomes of H. todsenii would probably survive a moderate fire, but the suitability of burned habitat for this species is not known because woodland canopy removal by fire might actually increase H. todsenii vigor, but could also result in hotter and drier habitat with eliminated colonies (depending on fire severity and on climatic conditions) or a smaller overall population (USFWS, 2011).

Stressor: Human disturbance (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: All Todsen's pennyroyal populations occur in rugged and remote areas that have no vehicle entry and receive very little land use by the managing agencies or the public. Additionally, White Sands Missile Range is closed to the public. Any human disturbance would likely be the result of monitoring and surveying activities (USFWS, 2022).

Stressor: Erosion (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Erosion was noted as a potential human threat in the 2001 Recovery Plan. Erosion, as a natural disturbance, may occur within habitat occupied by Todsen's pennyroyal as a result of steep topography and loose, gravelly substrates. However, the very limited use of these sites by the public, outside of monitoring, does not appear to be exacerbating erosional impacts at this time (USFWS, 2022).

Stressor: Grazing (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Livestock grazing was listed as a potential threat to Todsen's pennyroyal, though related more to the trampling of plants and exacerbation of erosion in fragile habitat than from direct herbivory (USFWS 2001). Populations on the Lincoln National Forest in the Sacramento Mountains are closed to grazing by livestock (Britt 2015). Heavy ground disturbance was observed at one population (P15) in 2017, though the cause of the disturbance is not clear (Britt 2018b). Habitats on Bureau of Land Management land in the Sacramento Mountains are open to entry by cattle but are rarely used because of steep topography and lack of water (M. Howard 2010, pers. comm.; Britt 2015). White Sands Missile Range is not open to cattle grazing, but trespass (feral) cattle were reported grazing in and around the San Andres populations in 1982 (USFWS 2001) and trespass cattle are occasionally reported grazing on or near some of the populations (Sikula et al. 2007). Two populations (P22 and P23) are located outside of the fence that restricts grazing on White Sands Missile Range. Grazing has been observed downslope of these populations, although they are likely protected from grazing by the steep gradient. Mule deer and elk occur throughout the range of Todsen's pennyroyal, but these native species are not believed to concentrate around or threaten the plant through grazing. Oryx and feral hogs, two non-native species, have been noted near occupied habitat, but there is currently no data on how these species may impact Todsen's pennyroyal (USFWS, 2022).

Stressor: Tree encroachment (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Substantial increases in cover and extent of piñon-juniper woodlands in New Mexico have taken place within the last 150 years because of a warming climate, a period of heavy use by livestock, and a decrease in wildfire frequency (Laycock 1999). Most Todsen's pennyroyal populations occur within piñonjuniper woodlands that were probably less dense in the past and could continue to expand in the future. Todsen's pennyroyal grows and flowers under piñonjuniper woodland canopy and in open areas without canopy. Increased canopy cover can contribute to increased asexual recruitment, but it has also been suggested to impair flowering (Sikula et al. 2007, 2009; Britt 2015). However, clumps located beneath cover have been observed flowering (Britt 2015). More information is needed to understand the relationship between canopy cover and reproductive effort. Canopy cover is higher in the Sacramento Mountains (70%) than in the San Andres Mountains (50%) due to a higher density of trees and shrubs, potentially contributing to populations in the Sacramento Mountains being more susceptible to catastrophic wildfires (USFWS, 2022).

Recovery

Reclassification Criteria:
1. Plans are developed and implemented to permanently protect occupied Hedeoma todsenii habitat from human degradation or destruction (USFWS, 2001).

2. The responsible land management agencies verify through monitoring that protective management is successful (USFWS, 2001).

Recovery Priority Number: 8 (USFWS, 2022)

Delisting Criteria:
1. Research identifies the factors responsible for the low sexual reproduction and restricted distribution of H. todsenii (USFWS, 2001).

2. Measures are taken to correct any factors within management control (USFWS, 2001).

3. Monitoring and further research demonstrate H. todsenii can sustain itself indefinitely at present or higher population levels (USFWS, 2001).

Recovery Actions:
- Remove any threats to existing Todsen's oennyroyal populations. Protection of Todsen's pennyroyal will require enforcement of existing laws, prevention of habitat disturbance, control of land use impacts through implementation of management plans, and monitoring to verify management effectiveness. (USFWS, 2001)
- Study populations and natural habitat. Past studies have revealed much about the biology of Todsen's pennyroyal. Further investigations are needed, however, to determine if extant populations are self-sustaining, and to develop sound management practices for the species. The land management agencies may be able to use their research divisions for some studies and contract with independent researchers for others. (USFWS, 2001).

- Use information from previous studies to identify potential habitat and search these areas for Todsen's pennyroyal. The discovery of new populations has reduced the vulnerability of the species. The discovery of any more populations will further decrease the chance that Todsen's pennyroyal will become more endangered. (USFWS, 2001).
- Establish a working group to help coordination and communication between the various agencies, organizations, and interested citizens playing a role in recovery of Todsen's pennyroyal. Recovery will go more smoothly if everyone communicates about recovery activities. Public support will be enhanced if elected officials, county public land users groups, conservation groups, and other interested citizens are included. (USFWS, 2001).
- Recommended Action from 2011 5-Year Review; There are additional suitable habitats in the northern San Andres Mountains in and around the Gyp Hills and Chalk Hills that still need to be surveyed on both WSMR and adjacent BLM lands. There are also potential habitats on the Mescalero Apache Reservation in the Sacramento Mountains that have not been surveyed. A partnership with the Mescalero Apache Tribe should be established to survey and manage any extant populations in a manner consistent with their sovereign authorities (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; Permanent monitoring plots have been established in two canyons in the Sacramento Mountains on LNF and BLM lands and at five H. todsenii locations on WSMR in the San Andres Mountains. However, monitoring has not occurred at the LNF or BLM locations since the plots were established in the 1990s. Additional plots should be established and monitored in the Sacramento Mountains to assess differences in plant density and vigor under varying degrees of piñon-juniper woodland canopy closure. To achieve recovery criteria for downlisting, standardized monitoring should occur at approximately five year intervals to detect any trends. Population trends need to be compared with climatic data obtained from the nearest permanent weather stations to investigate relationships to climate change. Monitoring dates should coincide with flower maturation (September) for an assessment of sexual reproduction success (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; At least one patch of H. todsenii should be burned by prescribed fire to determine the effects of fire on plant density and vigor. This population should occur in woodlands of sufficient density to carry a fire of at least moderate intensity. Permanent monitoring plots should be established and assessed prior to the fire and for at least five years after being burned. Additionally, any permanent monitoring plots that are unexpectedly burned by wildfire should be monitored annually for five years to determine the effects of the fire (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; Low sexual reproduction, poor seed viability, and limited seed dispersal are considered to be inherent threats to this species. The only pollinators documented for this plant are broad-tailed hummingbirds, a mating system supported by the red, tubular flowers of this plant species. Other, undocumented pollinators could be important to reproduction or simply absent due to pollinator limitation or an overall lack of conspicuous flowering plants in the community. Field studies in each mountain range documenting pollinator species and activities should be undertaken with the goal of improving pollination, fertilization, and seed set (USFWS, 2011).
- Recommended Action from 2011 5-Year Review; The Federal permitting and consultation requirements and oversight under the Endangered Species Act, along with NEPA are adequate to protect known Todsen's pennyroyal habitats from serious land use impacts. Monitoring plans that are specific to this species need to be adopted by all three Federal

agencies with H. todsenii populations. These plans should commit agency time and personnel to establishing and monitoring permanent monitoring plots and at least one agency should prescribe a fire across monitoring plots in H. todsenii habitat. If monitoring data indicate a need for active woodland treatments specific to H. todsenii habitats, plans for woodland thinning or prescribed fire could be implemented by these agencies (USFWS, 2011).

- Recommended Action from 2011 5-Year Review; To ensure that the recovery plan for H. todsenii continues to be a current, living document, the recovery criteria should be updated to reflect the current number of colonies, upcoming results from genetic studies, and the recent status of threats to provide measurable standards by which the species can be quantified in the San Andres and Sacramento Mountains populations (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Field Surveys: Recovery Action 3.0 in the Recovery Plan recommends using information from previous studies to identify potential habitat and search these areas (USFWS 2001). Suitable habitat in the San Andres Mountains has been extensively searched since 2001. The only areas that remain to be searched in the White Sands Missile Range vicinity include portions of the Chupadera Mesa north of highway 380. This area is shared between White Sands Missile Range and the Bureau of Land Management. In the Sacramento Mountains, there are potential habitats on private lands, the Mescalero Apache lands, and on other areas within the Lincoln National Forest. Additional searches in the Lincoln National Forest should occur within La Luz Canyon, Fresnal Canyon, and their associated tributaries. The Mescalero Apache Tribe should be engaged to assess the tribe's interest in a partnership to survey and manage any extant populations in a manner consistent with their sovereign authorities. Long-term Monitoring: Recovery Action 1.7 prescribes establishing long-term monitoring (USFWS 2001). Long-term monitoring of all populations in the San Andres Mountains was established in 2006, and has subsequently been performed in 2007, 2009, 2012, 2014, 2015, 2016, 2017, 2018, and 2019. Long-term monitoring of most populations in the Sacramento Mountains was established in 2017, and has subsequently been conducted in 2020 and 2021. Long-term monitoring plots have not been established in the four (P46-P49) populations discovered in 2020. Additional plots should be established and monitored at these populations, and any new populations. To achieve recovery criteria for downlisting, standardized monitoring should occur at regular intervals to detect any trends. Population trends need to be compared with climatic data obtained from the nearest permanent weather stations to investigate relationships to climate change. Monitoring dates should continue to coincide with flower maturation, for an assessment of sexual reproduction success. Research and monitoring should assess differences in plant density and vigor under varying degrees of piñon-juniper woodland canopy closure. These periodic assessments of canopy cover influences are prescribed by Recovery Actions 2.1.2 and 2.2.2 (USFWS 2001). Fire Effects: Recovery Action 2.2.4 prescribes studying the effects of fire on Todsen's pennyroyal (USFWS 2001). At least one patch of Todsen's pennyroyal should be burned by prescribed fire to determine the effects of fire on plant density and vigor. This population should occur in woodlands of sufficient density to carry a fire of at least moderate intensity. Permanent monitoring plots should be established and assessed prior to the fire and for at least five years after being burned. Additionally, any permanent monitoring plots that are unexpectedly burned by wildfire should be monitored annually for five years to determine the effects of the fire. At least one agency should prescribe a fire across monitoring plots in Todsen's pennyroyal habitat. If monitoring data indicate a need for active woodland treatments specific to Todsen's pennyroyal habitats, plans for woodland thinning or prescribed fire could be implemented by these agencies. Reproductive Biology Studies: Recovery Action 2.1.1 recommends conducting

studies on the reproductive biology of Todsen's pennyroyal including pollination, seed development, and seed dispersal. Low sexual reproduction, poor seed viability, and limited seed dispersal are considered to be inherent threats to this species. The only pollinators documented for this plant are broad-tailed hummingbirds. Other undocumented pollinators could be important to reproduction or simply absent due to pollinator limitation or an overall lack of conspicuous flowering plants in the community. Field studies in each mountain range documenting pollinator species and activities should be undertaken with the goal of improving pollination, fertilization, and seed set. Planning: Recovery Action 1.2 prescribes the development and implementation of management plans for Todsen's pennyroyal (USFWS 2001). The Federal permitting and consultation processes under the Endangered Species Act, along with NEPA, are adequate to protect known Todsen's pennyroyal habitats from significant land use impacts. Monitoring plans that are specific to this species need to be adopted by all three Federal agencies with Todsen's pennyroyal populations, these plans should commit agency time and personnel to establishing and monitoring permanent monitoring plots. Recovery Plan: When workloads permit, a Species Status Assessment could be conducted to guide the development of a revised recovery plan to reflect the current number of populations, and status of threats (USFWS, 2022).

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SPECIES ACCOUNT: *Hedyotis megalantha* (Paudedo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb (USFWS, 2015).

Taxonomy

A member of the coffee family (Rubiaceae) (USFWS, 2015).

Historical Range

Historically, H. megalantha was reported solely from Guam. Between 1911 and 1966, this species ranged from the mid-central mountains and west coast of Guam, south to Mt. Lamlam (Bishop Museum 2013—Online Herbarium Database) (USFWS, 2015).

Current Range

It currently occurs on southern Guam (USFWS, 2015). Guam (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Savanna (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Scattered individuals (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the savanna ecosystem. Hedyotis megalantha typically occurs as lone individuals rather than in patches or groups (Gutierrez 2013, in litt.) (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Not available

Species Trends:
Decreasing (USFWS, 2015)

Number of Populations:
Unknown (USFWS, 2023)

Population Size:
< 800 (USFWS, 2023)

Population Narrative:
Currently, H. megalantha is known from one large scattered occurrence totaling fewer than 1,000 individuals on southern Guam (Costion and Lorence 2012, pp. 54, 86; Gutierrez 2012, in litt.; Bishop Museum 2013—Online Herbarium Database; Gutierrez 2013, in litt.). In sum, the single known occurrence of H. megalantha, a single island endemic, is decreasing from initial numbers observed on Guam (USFWS, 2015). Hedyotis megalantha is endemic to the savanna habitat of southern Guam. This endangered perennial herb is often found growing in the Dimeria community and erosion scar community within the savanna habitat, frequently in patches with the native fern Dicranopteris linearis (Gawel et al. 2013, in litt.; Demeulenaere, 2020, in litt.). An estimated 800 individuals of this endangered plant remain in the wild (Demeulenaere 2020 in litt.). Because surveys of the distribution and abundance of H. megalantha are incomplete, the number of populations of H. megalantha and total population sizes are unknown (Demeulenaere 2020 in litt.). The Guam Plant Extinction Prevention Program has found it difficult to propagate the plant (GPEPP 2018). (USFWS, 2020). Number of Known Populations: Unknown. Number of Individuals in the Wild in the Marianas: <800 (USFWS, 2023)

Threats and Stressors

Stressor: Urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: On Guam, a housing development is proposed for the Sigua highlands, where this species occurs (USFWS, 2015).

Stressor: Feral pigs (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The destruction or degradation of habitat due to nonnative feral pigs is currently a threat to this species. Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly impact native plants by disturbing and destroying vegetative cover, and trampling plants and seedlings (USFWS, 2015).

Stressor: Fire (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Fire is a human-exacerbated threat to native species and native ecosystems throughout the Mariana Islands, particularly on the island of Guam. Fire can destroy dormant seeds of native species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to those favorable to alien plants (USFWS, 2015).

Stressor: Recreational vehicles (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The savanna areas of Guam are popular for use of recreational vehicles. Damage and destruction caused by these vehicles are a direct threat to this species and its habitat. This species is particularly at risk, as the only known individuals are scattered on the savanna and local biologists have observed recreational vehicle tracks directly adjacent to these individuals (Gutierrez 2013, in litt.; Guam DAWR 2013, pers. comm.) (USFWS, 2015).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 8

Minimum Number of Stable Populations: 5. Reproducing Individuals / Population: 200 (USFWS, 2023)

Delisting Criteria:
Not available - this species does not have a recovery plan.

Minimum Number of Stable Populations: 10. Reproducing Individuals / Population: 500 (USFWS, 2023)

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Threat and Recovery Potential: Full species with a moderate degree of threat and a high recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine population status and current distribution—Determine the distribution and number of all individuals on each island. Identify priority sites for species conservation. Assess the status and threats to each population to inform prioritization of conservation effort. • Conduct research to clarify life history information and

threats to the populations and their habitat—Conduct research to determine the best way to control the brown treesnake, rodents, and invasive invertebrates. Assess development and land designation and zoning threats to conservation of habitat needed for recovery. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control ecosystem-altering nonnative invasive plant species and those that compete with H. megalantha at all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction. • Reintroduction and translocation—Augment populations and increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of predation and typhoons, and climate change. • Reduce human disturbance from military activities mortality and reduced viability— increase population resiliency by mitigating threats from military activities. • Fire prevention and control—Implement more effective fuel load control. • Develop regulations and policy essential to recover the species and their habitats— Encourage the development of legislation to ensure protection of the listed species under Commonwealth or Territorial law. Develop and support the implementation of biosecurity plans to prevent the influx of new pests and invasive species into the Territory and inter-island movement of pests and invasive species. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2020)

- Current Management Actions: • Surveys and inventories – • The University of Guam's Center for Island Sustainability & Guam Plant Extinction Prevetnion Program surveys for Hedyotis megalantha in savanna habitat (Demeulenaere 2020, in litt.). • Captive propagation for genetic storage and reintroduction • The Guam Plant Extinction Protection Program (GPEPP) is an island-wide program to prevent the extinction of Guam's native and rarest plants, such as Hedyotois megalantha. With the help of conservation partners, GPEPP helps to protect extant species, propagate species to preserve seeds and genetic material, and reintroduce propagated individuals to their native habitats. This program has attempted to propagate H. megalantha in the nursery; however, they found H. megalantha difficult to grow and that the seedlings grow slowly (McConnell 2020, in litt.). • Habitat protection – • A major biosecurity focus within the Mariana Islands is on controlling the brown treesnake on Guam. Federal agencies support local capacity. The U.S. Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of InteriorOffice of Insular Affairs (U.S. Geological Survey, USFWS), are developing methods to suppress the snake on the landscape scale (Dorr, et al. 2016, in litt.; Phillips 2014, in litt; BTSTWG 2015, entire; (Siers, et al. 2018, in litt.). • Researchers and students at the University of Guam's Center for Island Sustainability (CIS) conduct biological monitoring in the savanna habitat and are currently exploring optimal restoration methods to restore degraded savanna habitat. The biologists at CIS monitor the watersheds throughout the savanna focusing on sedimentation, erosion, and runoff. There are several graduate student projects focused on savanna ecology and restoration (e.g., seed balls, plant propagation and outplanting) to reduce erosion and runoff. One of these student projects includes Hedyotis megalantha. • In 2018, public outreach/awareness efforts to protect Hedyotis megalantha and the savanna habitat were initiated by NOAA Fisheries Pacific Island Regional Office. As part of this effort, NOAA created outreach materials to warn the public about the impacts of erosion on reef ecosystems and to prevent any damage to native savanna species. Cards with pictures and details about H. megalantha and other savanna species are being given to individuals before outplanting efforts in the savanna so extant individuals can be marked and buffers put in place. Although the cards are only currently provided to volunteers as part of

outplanting trees, they may be made available to hikers or off-road bikers. • In 2002, a community effort known as the "Humåtak Project" was created to revive the watershed that is affecting Fouha Bay on southern Guam. Sediment traps to control erosion are improving habitat suitability for native plants in the savanna. Swordgrass is very opportunistic and commonly the first plant to colonize an open area possibly limiting or prohibiting recolonization by Hedyotis megalantha and other native herbs. • A fire management plan to reduce wildfire potential, protect and enhance natural and cultural resources, integrate applicable permit and reporting requirements and implement ecosystem management goals, sustainable training, and objectives is being drafted (JRM 2019). • Other Natural or Manmade Factors - Recreation – The Guam's Department of Agriculture, Division of Aquatic Wildlife Resources (DWAR) has the authority to enforce laws (5 GCA, Chapter 63, PL-6-85) to protect native flora and fauna. Their Conservation Land areas include Cotal with 552 acres (223 ha) and Bolanos area with 2,830 acres (1145 ha). Cotal is primarily savanna, badlands, and some secondary forests and Bolanos consists of both savanna and forest. The Bolanos Conservation area is dominated by swordgrass and efforts are being made to rehabilitate the area by enforcing public use permits. (USFWS, 2020)

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SPECIES ACCOUNT: *Hedyotis purpurea var. montana* (Roan Mountain bluet)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/07/1990; Southeast Region (R4)

Physical Description

A cespitose perennial herb with erect or ascending, unbranched or weakly terminally branched stems to 21 centimeters (cm) tall from a basal winter rosette. Cauline leaves are opposite, sessile, and typically ovate, 0.8 to 3.0 cm long and 0.6 to 1.3 cm wide. Flowers are reddish purple and funnel-shaped; the corolla has four lobes that are shorter than the 8- to 12-millimeter (mm)-long tube. Like other bluets, this species is heterostylous with two flower morphs. In the pin form, the pistil style is longer than the stamen filaments; whereas, in the thrum form, the style is shorter than the filaments. The inflorescence is few-flowered, consisting of a terminal simple cyme, and sometimes having from one to four lateral simple cymes arising from the uppermost stem nodes. Flowering occurs from late May through August or September, with peak flowering usually in June and July. The mature fruits are subglobose capsules, 2.0 to 4.0 mm long and 2.0 to 4.0 mm wide, semi-inferior and bilocular, with axial placentae bearing as many as 24 ovules. Capsules dehisce along a single apical suture in late August through September (Terrell 1959; Fosberg 1954; Kral 1983; Radford et al. 1968; Boyer 1990; B. Saunders, personal observations). This variety is easily distinguished from other bluets by its relatively large reddish purple flowers, relatively small sessile ovate leaves, compact stature and clump-forming growth habit, and its exposed mountaintop habitat. (USFWS, 1996)

Taxonomy

The recovery plan discusses the taxonomy of this taxon at length. It acknowledges numerous disagreements ranging From the generic name (Hedyotis or Haustonia) to the issue of whether the taxon should be recognized as a full species or as a variety of purpurea. The USFWS listed the taxon as Iledyotis purpurea (L.) Torrey & Gray var. montana (Small) Fosberg, but the recovery plan acknowledged that the emerging consensus favoring treatment as a full species, Houslonia montana Small. Weakley (2008) treats the taxon as Housionia montana Small. Glennon et al. (2011) conclude that the patterns of genetic variation, morphological differences, and distribution along an elevational gradient (with H. purpurea occurring lower than 4,40011 and H. montana higher than 4,800 ft in their sampled populations) support recognition of H. montana as a distinct species. The USFWS submitted a technical revision to the list of Endangered and Threatened Species to the Regional Office in 2008 (Currie 2008, pers. comm.) proposing to recognize this taxon as a full species (Houstonia montana Small). To date, this change has not been published in the Federal Register and has not taken effect. (USFWS, 2017)

Historical Range

Endemic to a few scattered mountaintops north of the Asheville Basin in North Carolina and, formerly, Tennessee (USFWS, 1996).

Current Range

The current county distribution of H. montana includes Ashe, Avery, Mitchell, Watauga, and Yancey Counties, North Carolina; Carter County, Tennessee; and Grayson County, Virginia.

(USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 1996)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1996)

Other Reproductive Information

Adult: On grassy slopes, growth began earlier in the season and led to taller plants occupying greater ground area, but neither reproductive output, number of leaves, or patterns of mychorhizal associations differed consistently between these habitat types. H. montana emerged at least eight weeks earlier than all other species except Solidago glomerata,. which suggests a strategy for minimizing light competition (S. glomerate was not co-dominant with H. montana in any plots examined for this study). However, the study confounds differences in habitat with large geographic distances between populations: the two grassy slope sites were at Roan Mountain (Mitchell and Avery Counties, NC), whereas the rock outcrop sites were at Grandfather Mountain (Avery and Watauga Counties, NC) and Bluff Mountain (Ashe County, NC). Thus, it is quite possible that the differences observed in growth pattern and life-history traits are the result, at least in part, of factors other than differences in grassy slope or rock outcrop habitat conditions. This study raises many interesting observations and bears repeating using subpopulations within populations in which grassy slope and rocky outcrop conditions can be directly compared. (USFWS, 2017)

Reproduction Narrative

Adult: The four main flower visitors, listed in decreasing order of probable pollination effectiveness (based on field observations of frequency, pollen loads, and movement distances), were small staphylinid beetles, bumblebees, syrphid flies, and ants. A hand pollination study suggested that this population of Roan Mountain bluet is self-incompatible, as is expected in a heterostylous breeding system. Moreover, plants that were hand-pollinated, using neighboring pollen donors, set seeds just as well as naturally pollinated plants and just as well as plants that were hand-pollinated using distant, presumably unrelated, pollen donors. Asexual propagation occurs in late summer when Roan Mountain bluets begin to produce basal rosettes from rhizome buds (USFWS, 1996).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, talus (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Low sunlight exposure (USFWS, 1996)

Geographic or Habitat Restraints or Barriers

Adult: Occurs > 1370 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Very Narow (inferred from USFWS, 2017)

Habitat Narrative

Adult: H. montana occupies high elevation (over 5,011 above sea level) rocky summits and cliffs in the southern Appalachian mountains of western North Carolina, extreme eastern Tennessee, and southwestern Virginia. These rocky summits and cliffs usually appear as smaller-scale, patchy habitats usually embedded within a larger forested landscape consisting of spruce-fir or northern hardwood forest (occasionally high elevation red oak forest). But, they can also appear as smaller outcrops; or over patches of talus or scree embedded within a grassy or heath bald habitat. (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

See narrative.

Number of Populations:

16 (USFWS, 202023)

Additional Population-level Information:

Hedyolis purpurea var. montana is an herbaceous, cespitose (growing in tufts or clumps) perennial that grows in clumps of one to several hundred stems (TNC 1996). The taxon is known to spread by horizontal rhizomes up to 5cm long; therefore, a stem does not usually, or is not likely, to represent a genetically distinct individual. Site observations and accompanying estimates of abundance in this taxon are widely inconsistent. Some observers estimate abundance in terms of stems, others in terms of clumps or patches, and still others counting or estimating "plants" without defining whether they were counting sterns or clumps (NCNHP 2009, TNNHP 2009). Saunders (1992) offered two definitions for defining an individual in this taxon: a "stem bundle", defined as a bundle of stems radiating from a single crown < 5cm in diameter, and a "bounded clump", defined as a circumscribed cluster of stem bases. The Nature Conservancy (TNC, 1996) later proposed a single, common definition for clumps, which adopted Saunder's "bounded clump" accompanied by a categorical assessment of stern density (classes of 1-10, 1 I - 25, 25-50,51-100, and > 100 stems). Donaldson (assisted early on by Smith)

followed a slightly modified version of TNC monitoring protocols during a multi-year monitoring project involving several populations (Donaldson I 999a, I 999b, 2002a, 2002b). However, Donaldson does not consistently provide stem counts (or stem classes) and occasionally forgoes clump estimates altogether in areas where he found H. montana to be especially dense. In this situation, observations were reported in terms of percent cover (within quadrats). (USFWS, 2017)

Population Narrative:

By 2021, known extant populations had declined from 17 to 16 (Appendix A). One population in Yancey, North Carolina was removed in 2017 after survey efforts failed to find the species (NCNHP 2021; Table A). Population numbers in Tennessee and Virginia have remained the same since 2017 at one population each. Of the 16 current populations, 12 consist of a single occurrence with no subpopulations, and the remaining 4 populations are comprised of subpopulations totaling 37 spatially discrete sublocations in which the bluet is known to occur or has historically occurred (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The principal source of habitat destruction affecting H. montana is the recreating public, who seek out high elevation views, adventurous rock climbing, boulder-hopping, or even just a flat and sparsely vegetated picnic spot. Trampling compacts the plant's rhizome and can shear plants from the rocks in which they are anchored. In the process, soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites (by this or other taxa) exceedingly difficult. Trampling is a significant threat to H. montana, having contributed to significant declines at one subpopulation' and continues to threaten the long-term viability of several others. A related concern stems from the construction of facilities intended to control or direct visitor use. These facilities must be sited and constructed appropriately in order to avoid impacts to H. montana. (USFWS, 2017)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: This factor was mentioned in the listing rule as a potential threat. A poaching incident was documented for this species in the summer of 2014 (Estep 2014, pers. comm.). Ten to 20 percent (two clumps) of USE= WS population number eight (Table A.1) in Watauga County was dug and removed in July of 2014. The USFWS has no additional information to suggest overutilization has become a significant threat to the continued existence of H. montana. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017)
Exposure:
Response:

Consequence:
Narrative: This factor was acknowledged as a threat in the listing rule and recovery plan, and remains a threat to the taxon. State laws protecting rare plant species have limited authorities, and neither North Carolina, Tennessee, nor Virginia rare plant statutes protect the species from habitat destruction from recreational use of federal lands (where four populations occur and remain vulnerable to this threat). (USFWS, 2017)

Stressor: Other natural or manmade factors affecting its continued existence (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The listing rule identified woody succession and natural rock slides as additional threats to the taxon. In reality, natural rock slides may also serve to open up additional areas of newly available habitat for an early successional taxa like H. montana. Thus, as with many factors, the frequency and severity of these disturbance events needs to be better understood for a meaningful evaluation of their effects upon the continued existence of this taxon. Accelerated global climate change is likely to disrupt patterns of climate variability to which H montana has become adapted and as such is likely to exacerbate threats already mentioned. However, the current scale of most global models of climate change offers little insight into the specific changes that will likely occur on southern Appalachian high peaks. (USFWS, 2017)

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Climate change is expected to increase temperatures, create more intense droughts, increased rates of soil moisture loss, and increase intensity of storms and rainfall associated with hurricanes (Frankson et al. 2022, Runkle et al. 2022a, b). In addition, research suggests that climate change could create a phenological mismatch between blooming periods and common pollinators known to Roan Mountain bluet such as bees, flies, and ants (USFWS, 2023)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
At least nine self-sustaining populations are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act. A self-sustaining population is self-regenerating and maintains sufficient genetic variation to enable it to survive and respond to natural habitat changes. A population will be considered adequately protected when landowners and cooperating agencies have implemented the management actions necessary for population persistence and when the population is protected from present or foreseeable natural and human-related threats that might jeopardize its persistence. (USFWS, 1996)

Recovery Actions:

- Protect existing populations and essential habitat. Because of increasing threats to Roan Mountain bluet and its highly fragmented distribution at all sites, all eight extant

populations should be protected. A careful census of each population is needed in order to establish interim protection, monitoring, and management priorities. (USFWS, 1996)

- Determine and implement necessary management for long-term reproduction, establishment, maintenance, and vigor. New subpopulations may need to be established periodically in order to replace any that may eventually die out. For all populations, plant numbers, reproduction, and electrophoretic variation should be monitored. Within selected population units, the following management efforts should occur: (1) census the life-cycle stages and follow individual plants to estimate population size and rates of vegetative survival, reproduction, and recruitment; (2) test for reproductive or recruitment limitations that jeopardize local persistence; (3) characterize buffering or compensatory processes that reduce the long-term impact of short-term reductions in survival, reproduction, or recruitment; and, (4) identify habitat and seed characteristics that permit colonization, germination, and establishment in new habitat. (USFWS, 1996)
- Maintain and expand cultivated sources for the species and provide for the lone-term maintenance of selected populations in cultivation. Horticultural studies can contribute to recovery efforts in three ways. First, they provide valuable insight into the developmental patterns and growth habits of individual plants--difficult observations to obtain from field populations in natural habitats. Second, horticultural studies test the true environmental requirements of a species and help distinguish habitat preferences from habitat requirements. Third, horticultural studies eventually generate plant material that can be used directly to replenish or reintroduce the species into native habitat. The same material may also be used to establish experimental populations in natural habitat for perturbation studies of novel threats or natural factors. (USFWS, 1996)
- Establish new populations in former habitat or rehabilitate marginal populations to the point where they are self-sustaining (USFWS, 1996).
- Enforce laws protecting the species and/or its habitat. Federal and State enforcement agents whose jurisdiction includes the known range of Hedyotis purpurea var. montana should be made aware of the threats to the species and be able to identify specimens. Wherever collecting is a potential problem, signs should be posted explaining the prohibitions against taking of these plants (without specifying the species, so as not to draw undesirable attention). (USFWS, 1996)
- 5. Develop materials to inform the public about the status of the species and the recovery plan objectives. Public support for the conservation of Roan Mountain bluet could greatly encourage landowner assistance in conservation efforts, particularly at those sites that may be adversely affected by the creation or expansion of resorts and recreation facilities. However, informational material should not identify the plant's precise locations in order to discourage vandalism to, or collection of wild populations. (USFWS, 1996)
- Recommendations for Future Actions from 2017 5-Year Review: 1. Work with appropriate partners to evaluate protection alternatives at unprotected populations, including the use of voluntary landowner agreements. - 2. Develop interim research and management plans in conjunction with cooperative landowners, especially the U.S. Forest Service (in affirmation of their Section 7(a)(1) and 7(a)(2) responsibilities as a federal agency under the Act). - 3. Implement monitoring at a representative number of populations and subpopulations, for purposes of assessing status and trends and acquiring life-history information needed to inform future recovery efforts. - 4. Use monitoring data to define criteria for self-sustaining populations and implement appropriate management techniques. - 5. Develop techniques to reestablish populations within suitable habitat and provide for long-term maintenance of

selected populations in cultivation (long-term seed storage). - 6. Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for H. montana. (USFWS, 2017)

- In North Carolina, the Natural Heritage Program, the North Carolina chapter of The Nature Conservancy (TNC), and the Service are working with landowners to protect and manage Roan Mountain bluet sites. The TNC owns part of one cliff-side site and is monitoring and protecting its populations by limiting public visitation. The U.S. Forest Service owns the Roan Mountain site (and the historic Big Bald site) and is trying to protect the species by placing new recreational facilities away from known locations and by creating innocuous natural barriers to discourage access and trampling at heavily used locations (USFWS, 1996).
- The North Carolina Arboretum in Asheville recently became an allied facility of the Center for Plant Conservation. They have proposed to serve as the seed-storage and plant-propagation facility for Roan Mountain bluet and have established a collection of specimens in cooperation with the North Carolina Plant Conservation Program (USFWS, 1996).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The 2017 5-year review included a list of recommendations to improve recovery of the species. These activities, listed below, remain applicable to species recovery. 1. Work with appropriate partners to evaluate protection alternatives at unprotected populations, including the use of voluntary landowner agreements (Recovery Task 1.4). 2. Develop interim research and management plans in conjunction with cooperative landowners, especially the U.S. Forest Service (in affirmation of their Section 7(a)(1) and 7(a)(2) responsibilities as a federal agency under the Act). (Recovery Task 1.1). 3. Implement monitoring at a representative number of populations and subpopulations, for purposes of assessing status and trends and acquiring life-history information needed to inform future recovery efforts (Recovery Tasks 2, 2.1, 2.2, 2.3, and 2.4). 4. Use monitoring data to define criteria for self-sustaining populations (Recovery Task 2.5) and implement appropriate management techniques (Recovery Task 2.6). 5. Develop techniques to reestablish populations within suitable habitat (Recovery Task 2.7) and provide for long-term maintenance of selected populations in cultivation (long term seed storage) (Recovery Task 3). 6. Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high elevation southern Appalachian rocky summits and cliffs. Devise and evaluate potential adaptation scenarios for H. montana (Recovery Tasks 1.3 and 1.4). Based on current scientific data, additional measures are recommended below: 1. Support research to determine hybrid vigor and determine ploidy of all populations. 2. Support research to determine ploidy of H. purpurea when cooccurring with Roan Mountain bluet. 3. Support additional microsatellite loci studies or support development of AFLP loci span the entire genome to evaluate hybridization patterns (USFWS, 2023).

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SPECIES ACCOUNT: *Helenium virginicum* (Virginia sneezeweed)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/03/1998; Northeast Region (R5) (USFWS, 2015)

Physical Description

A perennial herb, 7-11 dm tall. Some Missouri plants reach 17 dm in height (Tim Smith, Missouri Dept. of Conservation, pers. comm. 2006). Basal leaves form a rosette and may be broad in the middle tapering toward the ends, but otherwise may appear oblong. Stem leaves are lanceolate and become progressively smaller from the base to the tip of the stem. Stems are winged, wings being continuous with the base of the stem leaves. Flower ray petals are yellow and wedge shaped with three lobes at the ends. Central disk is nearly ball-shaped. Clusters of golden-yellow flower heads bloom from July to September (NatureServe, 2015).

Taxonomy

A member of the Ateraceae (Aster family) (USFWS, 2000). Knox et al. (1995) determined that H. virginicum is distinct from H. autumnale morphologically and ecologically. Genetic work by Simurda and Knox (2000) supported treating H. virginicum and a Pomona, Missouri, Helenium sp. as a monophyletic group. Additional genetic work with a larger number of Helenium populations over a broader geographic range strengthened this conclusion and determined a narrow-leaved Helenium autumnale population from the Bruce Peninsula in Ontario, Canada, to be a sister group to the Virginicum group (Simurda et al. 2005) (NatureServe, 2015).

Historical Range

It was first found in Augusta County, Virginia, in 1935 (Blake 1936) and the known range was expanded to Rockingham County by C. E. Stevens in 1967 (Roe 1977) (USFWS, 2000).

Current Range

As of 2000, 23 populations have been documented in Augusta county and 7 in Rockingham County. Recent studies from a sinkhole pond in southern Missouri suggest that it may represent a disjunct population, but further studies are needed to resolve this (USFWS, 2000).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative; sexual: cross-pollination (USFWS, 2000)

Lifespan

Adult: 5 years (USFWS, 2000)

Breeding Season

Adult: July - October (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, abundant soil moisture, seed bank (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers from early July to October, with peak flowering occurring in late July to early August at most sites. The pollination biology has not been studied in detail; however, cursory observations conducted at Kennedy Mountain Meadow suggest that the primary insect pollinators are bees, wasps (Hymenoptera: Apidae, Halictidae, Sphecidae), butterflies (Lepidoptera: Hesperiidae and Lycaenidae, among others), and hoverflies (Diptera: Syrphidae) (C. Williams, pers. obs.). During favorable years at Kennedy Mountain Meadow, approximately one quarter of the population may flower (Knox and Williams 1988). Flowering appears to correlate with water availability during late spring and early summer, a critical period for bolting and flower formation (Knox et al. 1987). Seasonal water fluctuation, particularly inundation, is probably a key factor affecting recruitment and maintenance of populations (J. Knox, unpubl.). For example, extensive periods of inundation during the growing season may greatly limit recruitment and result in high levels of mortality in established plants. Reestablishment of inundation-depleted populations may be facilitated by a soil seed bank; viable seeds can persist in the soil for at least two years (J. Knox, pers. obs.). Thus H. virginicum appears to be a "boom-bust" species in which recruitment is keyed by water fluctuations: population peaks occur in years of abundant soil moisture and troughs in years of excessive and persistent inundation. In addition, seasonal water fluctuations may also modulate populations of co-occurring plants that compete with H. virginicum for space and resources. (NatureServe, 2015). In a nine year demographic field study at one population, plants were found to live up to five years and flower two to three times (Knox 1997). Individual plants identified in the field are nearly always genets (Knox 1997). Research by Messmore and Knox (1997) determined that plants from at least one site have a self-incompatible breeding system (USFWS, 2000).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ephemeral pond, wet meadow (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seasonal inundation (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Shade (USFWS, 2000)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: In Virginia, Helenium virginicum is a wetland plant restricted to shallow, seasonally inundated ponds (which are in or near sinkholes) in Augusta and Rockingham Counties, Virginia (Blake 1936; Roe 1977; Harvill et al. 1986). The pond basins in which this species occurs are usually flooded from January to July. The substrate at most H. virginicum sites consists of poorly

drained, acidic, low fertility Purdy silt loams (USDA 1979) underlain by gray clays and dolomitic bedrock (Werner 1966; Rader 1967). The level of disturbance present at the sinkhole ponds includes relatively undisturbed ponds surrounded by forest, more meadow-like habitats around farm ponds actively used by cattle, a backyard seasonal wetland maintained in an open state by the landowner, a seasonally wet mowed lawn, and a seasonal wetland degraded by severe cattle trampling and an ongoing attempt to fill the site. In Missouri it is found on sinkhole pond margins and wet meadows in the Ozark Highlands (Rimer and McCue 2005). The plant has been found to prefer open growing conditions and is found in a variety of sites in addition to the less disturbed sinkholes and wet meadows including rural airports, roadside ditches, and cattle ranches (R. Rimer and J. Summers, pers. comm. 2005). It appears to be less confined to discrete wetlands in Missouri and can occur in a temporarily wet portion of a hayfield or in roadside ditches (Tim Smith pers. comm.) (NatureServe, 2015). Data from one site indicate that H. virginicum is shade intolerant (USFWS, 2000).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

Resiliency - In VA, 42 percent of the EOs are classified as having excellent to good viability, 32 percent as fair viability, and 26 percent as poor viability. In MO, 43 percent of the EOs are classified as having excellent to good viability, 43 percent as fair viability, and 14 percent as poor viability. Across the species range, 43 percent are classified as excellent to good, 39 percent as fair, and 17 percent as poor. Viability is currently estimated based on the persistence of above-ground plants over time, among other factors like habitat condition and evident threats. However, we now know that populations of adult plants can fluctuate significantly between observations due to the highly variable hydrology of their preferred habitat. In addition, seeds retain high germinability in the seed bank for at least 11 years providing the ability for the species to re-establish populations of flowering plants at sites following periods of unfavorable conditions. The combination of a self-incompatibility reproductive strategy and low gene flow between neighboring populations is cause for some concern regarding reproductive failure if individual populations get so small that there are only a limited number of compatible mates; however, there is no evidence of this occurring thus far in populations that have been observed over the course of 10 to 15 years, including those that have declined due to habitat disturbances. (USFWS, 2020)

Representation:

Representation - The species shows a high level of genetic diversity and structuring, while there is evidence of low diversity within populations and low gene flow among populations. In VA, populations in close proximity have been demographically asynchronous in the same year, despite experiencing similar climates and hydrology (Knox 1997, Adams et al. 2005) possibly indicating metapopulation structure. Populations in MO and VA show significant genetic

differences indicating high representation for the species. The species has specific habitat requirements like variable hydrology and acidic soils; however, there are multiple circumstances under which those conditions occur including natural sinkhole ponds as well as human made features like roadside ditches, farm ponds, and other depressions or areas that act as seasonal wetlands. The species occurs in three states and four physiographic provinces, adding to its representation. (USFWS, 2020)

Redundancy:

Redundancy - At the time of listing (1998), there were 25 known populations in VA and one suspected occurrence in MO. Through additional survey work (and a revision of how EOs are defined), there are currently 76 EOs in 3 states spanning 4 physiographic provinces: 19 EOs in VA, 56 EOs in MO, and 1 EO in IN. Several recovery criteria are no longer relevant due to the increased distribution and number of occurrences. There has been no range contraction among the originally identified populations in VA, and significant range expansion in MO with the discovery of 55 additional EOs. Currently, a large number of populations occur across a broad geographic range, increasing the species' ability to withstand catastrophic events. Redundancy has therefore increased significantly since listing. (USFWS, 2020)

Number of Populations:

26 - 30 (USFWS, 2000)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015); 1 - 500,000 per occurrence (USFWS, 2000)

Population Narrative:

Species exhibits high tolerance to mechanical disturbance. Surprisingly, it appears to benefit from grazing. The stems and leaves of this species are extremely bitter in taste and apparently unpalatable, thus selective grazing by cattle may eliminate competing plants (John Knox, pers. obs.). Moreover, the largest (100,000 - 1,000,000 plants) and densest H. virginicum population (> 400 plants/m2) grows at a site that is mowed yearly. The estimated population size in Virginia is 2500-10,000; in Missouri over 10,000. Widely fluctuating population numbers have been taken into consideration: a population of 10,000 one year may be reduced to a handful in years of drought or prolonged inundation. The long term population trend is unknown (NatureServe, 2015). As of 2000, 30 populations have been documented, four of which have not been seen since the late 1970's and may be locally extirpated. Population sizes documented among the different occurrences range from one individual to 500,000 (USFWS, 2000). In summary, the best available information currently indicates the existence of 76 EOs of H. virginicum across 3 states; this represents a significant increase in spatial distribution (redundancy, representation) and abundance (resilience) from the 25 known populations in 2 counties in VA at the time of listing. As discussed in more detail below in section 2.3.1.3, it also represents a significant increase in genetic diversity (representation) since Knox (2016) reported all sampled populations as being genetically distinct. The following sections provide more detailed information on abundance estimates in each state. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and modification (NatureServe, 2015)
Exposure:

Response:
Consequence:
Narrative: In Virginia the long-term viability of existing populations is primarily threatened by human-induced disruptions of hydrologic regimes, particularly by encroaching agriculture, residential land development, and logging (Van Alstine 1991; J. Knox, C. Williams pers. obs.). In addition, a private site and adjacent sites on the George Washington National Forest are sporadically impacted by off road vehicles (e.g., during summer 1991 on the private land; J. Knox, C. Williams, pers. obs.). The following paragraphs are taken, with modifications, from U.S. Fish and Wildlife Service (2000): The most serious threat to H. virginicum appears to be habitat loss, most often arising from changes in the natural hydrological regime of the sinkhole pond habitat. Four of the sites, three of which are grazed by cattle, have had a portion of the wetland deepened to create a permanent pond; prior to being excavated, much of this section once undoubtedly supported H. virginicum and so loss of some habitat has occurred. Input from groundwater sources may be decreased by withdrawals for wells for adjacent developments such as subdivisions. Overland surface water flow may be altered by activities such as timber harvesting or road building in upslope areas. A variety of site-specific threats to H. virginicum from habitat loss have appeared over the last ten years. The Virginia Department of Transportation (VDOT) has proposed to widen to four lanes Route 340, a currently two lane north-south corridor on the east side of the Shenandoah Valley. A portion of one site in Augusta County is immediately east of Route 340. Another H. virginicum population is near the site of silos built in the early 1990's that are used to store septic waste. Mowing occurs in at least 3 of the Virginia sites. Repeated mowing before seed is set and the seed bank is replenished, may lead to local extinction as vegetative plants die out and the seed bank ultimately becomes depleted. As the soils of the H. virginicum sites have been found to be nutrient-limiting (Knox 1997), long-term nutrient enrichment from cattle could ultimately create more favorable habitat for other plant species (NatureServe, 2015).

Stressor: Nonnative species (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Exotic organisms may pose threats to H. virginicum populations in the near future. Purple loosestrife, L. salicaria, is slowly spreading through Virginia and may eventually invade some H. virginicum sites, especially following disturbances to hydrologic regime and/or substrate. The gypsy moth, L. dispar, is currently defoliating large areas of the George Washington National Forest and adjacent lands but it is unclear whether the gypsy moth will negatively impact H. virginicum populations. For example, as H. virginicum is shade-intolerant, defoliation of trees and shrubs that grow on the periphery of sinkholes may increase light availability and allow H. virginicum to expand into areas from which it was formerly excluded (NatureServe, 2015).

Stressor: Stochastic events (USFWS, 2000)
Exposure:
Response:
Consequence:
Narrative: Extremes in the fluctuating hydroperiod of the ponds could, when preceded by a low investment in the seed bank, result in local extirpations of populations. The self-incompatible breeding system may eventually lead to local extinction at sites with low population numbers

(Messmore and Knox 1997) (USFWS, 2000).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Twenty self-sustaining populations and their habitats have received permanent protection across the species' Virginia range (USFWS, 2000).

2. Monitoring over a 15-year period indicates that populations in the 20 sites are viable (USFWS, 2000).

3. Life history and ecological requirements are understood sufficiently to allow for effective protection, monitoring, and, as needed, management (USFWS, 2000).

4. Seeds representing the range of genetic diversity in H. virginicum are placed in long-term storage to provide a source of genetic material in the event of extinction (USFWS, 2000).

5. If determined to be H. virginicum, the Missouri population and its habitat are permanently protected and seeds placed in long-term storage (USFWS, 2000).

Recovery Actions:
- Protect the extant populations and their habitat (USFWS, 2000).
- Monitor extant populations (USFWS, 2000).
- Definitively identify the range and distribution of the species (USFWS, 2000).
- Continue investigations into the life history and ecology of Helenium virginicum (USFWS, 2000).
- Maintain seed sources for the species (USFWS, 2000).
- Develop informational materials to create more awareness of H. virginicum and its status (USFWS, 2000).
- H. virginicum has been listed as endangered by the Commonwealth of virginia since 1989 under the Endangered Plant and Insect Species Act. This law protects listed plant and insect species from take in the form of collection or translocation, except by the landowner (USFWS, 2000).
- Site-specific conservation planning, funded by the U.S. fish and Wildlife Service and the Virginia Department of Agriculture and Consumer Services, was conducted by the Virginia Department of conservation and Recreation's Division of Natural Heritage at five privately-owned sites (Erdle 1996, Erdle 1997) (USFWS, 2000).
- If the Missouri Helenium sp. is confirmed to be H. virginicum, sinkhole pond habitat in Missouri, intervening states, and other areas of virginia will need to be targeted for surveys to determine the distribution of this species (USFWS, 2000).
- A fact sheet on H. virginicum was developed by the Virginia Department of Conservation and Recreation's Division of Natural Heritage in 1995 (USFWS, 2000).
- Six of the sites that have been documented to support populations of H. virginicum are on land managed by the U.S. Forest Service (USFWS, 2000).

- A number of studies are underway or planned for the near future by J.S. Knox and associates at Washington and Lee University (USFWS, 2000).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Because we have determined that H. virginicum no longer meets the definition of T or E, the following recommendations are not required to achieve or maintain recovery. They reflect the need for post-delisting monitoring and highlight actions that have already been proposed but not yet carried out and would contribute to our understanding of population genetics for this geographically disjunct species. 1. Develop a post-delisting monitoring plan and continue monitoring EOs for viability over time. a. Develop and implement methodology to survey and monitor the seed bank instead of relying on observations of above ground plants for improved viability estimates. 2. Conduct surveys in IN in suitable habitat near the EO in Hamilton County. In addition, complete genetic analysis of the IN EO to help determine whether it is a natural or introduced occurrence. 3. Opportunistically collect seeds from VA populations,additional MO populations, and IN populations if more are discovered, representing adequate genetic diversity and place them in long-term storage. 4. Conduct additional genetic analysis with larger sample sizes from VA and MO populations using both contemporary plants and seed bank samples. (USFWS, 2020)

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SPECIES ACCOUNT: *Helianthemum greenei* (Island rush-rose)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/31/1997; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Island rush-rose (Helianthemum greenei) is a short-lived perennial subshrub in the rockrose family (Cistaceae). The currently accepted scientific name is Crocanthemum greenei, but the change is not yet recognized in Service documents, and we continue to use the genus Helianthemum. The plant grows to about 30 centimeters (1 foot) tall and wide, and it is distinguished from the closely related Crocanthemum scoparium (with which it may co-occur and hybridize) by reddish glandular herbage and a wider corolla diameter (USFWS, 2024).

Taxonomy

Combination in Crocanthemum published by Sorrie (2011) (NatureServe, 2015). A member of the rock rose family (Cistaceae) (USFWS, 2010).

Historical Range

At the time of listing, Helianthemum greenei had been reported from four of the Channel Islands off the coast of southern California: San Miguel (McMinn 1932; Thorne 1967), Santa Rosa (Wallace 1985), Santa Cruz (Hochberg et al. 1980; McEachern and Wilken 1996), and Santa Catalina (Thorne 1967; Takara, Catalina Island Conservancy, pers. comm. in Service 1994). The species was believed to be extirpated on Santa Rosa Island and San Miguel Island by the time of listing; the known historical occurrences could not be relocated. Helianthemum greenei was extant in at least 10 occurrences on Santa Cruz Island and at least 1 occurrence on Santa Catalina (USFWS, 2010).

Current Range

Island rush-rose is found on the California Channel Islands on Santa Catalina Island (Los Angeles County), and Santa Cruz and Santa Rosa islands (Santa Barbara County). It has been collected once from San Miguel Island (Santa Barbara County), in 1932. Santa Catalina Island plants are all on land owned by the Catalina Island Conservancy (CIC), Santa Cruz Island is owned by Channel Islands National Park (CINP, the eastern 24%) and The Nature Conservancy (TNC, the western 76%), Santa Rosa Island is owned by CINP, and Santa Miguel Island is owned by the U.S. Navy but is administered by CINP. (USFWS, 2024).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (USFWS, 2010)

Breeding Season

Adult: March - May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Fire/disturbance (USFWS, 2010)

Reproduction Narrative

Adult: Flowers from March to May (NatureServe, 2015). When the flowers are insect pollinated, the plant produces a maximum of 12 seeds per fruit; seed production is reduced when the plants are self-pollinated (Service 2000). Helianthemum greenei has been known to germinate in open space in the absence of fire; however, researchers have documented large increases in the number and size of occurrences after fires where occurrences were thought to be small or non-existent (McEachern and Wilken 1996; Knapp 2005; Ratay in litt. 2009) and no new germination several years after the fire event. This suggests that the species may not require fire for germination, but fire appears to increase germination efficiency (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral (NatureServe, 2015); coastal sage scrub, cismontane woodland, island pine forest (USFWS, 2010)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 0 - 1,608 ft. elevation (USFWS, 2010)

Environmental Specificity

Adult: Broad (inferred from USFWS, 2010)

Habitat Narrative

Adult: Inhabits dry, open, rocky areas, mostly in chaparral vegetation. (NatureServe, 2015). The species is found in open, exposed areas in chaparral, coastal sage scrub, cismontane woodland, and island pine forest, up to 1,608 ft. elevation (California Native Plant Society (CNPS) 2009). Helianthemum greenei is likely fire-dependent, as the number and size of occurrences increased dramatically soon after fire events, with little to no recruitment observed absent of fire (McEachern and Wilken 1996, Service 2000). Helianthemum greenei can grow in a variety of dry, rocky substrates including fine-grained shales, rocky volcanic soils, and alluvial deposits in ephemeral stream channels (Junak 1995; Center for Plant Conservation 2009). (USFWS, 2010).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2010)

Number of Populations:

86 (USFWS, 2024)

Population Size:

~7,400 (USFWS, 2010)

Population Narrative:

Island rush-rose is found on Santa Catalina, Santa Cruz, and Santa Rosa islands, and has historically been found on San Miguel Island. There is not a single spatial database that accurately reflects current location information. We collated data from the California Natural Diversity Database (CNDDB 2023), SBBG (Schneider and Carson, 2022), TNC (John Knapp in litt.), CIC (Aaron Kreisberg in litt.), and USGS (McEachern et al. 2022). CNDDB defines an element occurrence (EO) as being a group of plants that is at least one quarter mile (400 m) away from the any other group of plants of the same species (CNDDB 2018, entire). However, there are reports of groups of plants that fit the definition of an EO but are not currently in the CNDDB records. For discussion within this document, we use the term occurrence to refer to both EOs and to other groups of plants that match that definition. There are 86 mapped occurrences of island rush-rose across its range (Figure 1, Table 1), compared to the 15 reported when listed (USFWS< 2024)

Threats and Stressors

Stressor: Nonnative mammals (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The large-scale loss of topsoil caused by non-native mammal activity was the primary cause for the decline of Helianthemum greenei. Although feral pigs have been removed from Santa Catalina island, soil loss is still a threat on Santa Catalina Island, as deer and bison continue to disturb the soil. On Santa Catalina Island, H. greenei is still threatened by consumption by deer. Bison are not considered predators of H. greenei, but they affect the habitat of the species through trampling. Deer and elk remain on Santa Rosa Island as part of a private hunting operation, and they impact Helianthemum greenei in a similar manner to the ungulates on Santa Catalina Island (USFWS, 2010).

Stressor: Nonnative plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Non-native plants have the potential to disrupt native habitats and displace native species (Service 1997). The listing rule included Helianthemum greenei as one of the species most susceptible to lack of recruitment and habitat displacement by non-native plants. The removal of non-native ungulates released predation pressure on both native and nonnative plants. Without management, non-native plants that have a competitive advantage could increasingly affect the distribution and recruitment of H. greenei (USFWS, 2010).

Stressor: Stochastic events (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The few occurrences on Santa Rosa Island could be extirpated by any number of circumstances, including low genetic diversity and demographic imbalance, and unforeseen events such as climatic phenomena (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Predictions of climatic conditions for small sub-regions such as the California Channel Islands remain uncertain. Given the narrow geographic range of Helianthemum greenei, the species will have limited ability to disperse in response to climate change. Helianthemum greenei may be able to take advantage of significant altitudinal gradients on Santa Catalina Island, Santa Rosa Island, and Santa Cruz Island, and an increased frequency of wildfires may actually benefit the species (USFWS, 2010).

Recovery

Reclassification Criteria:
Recovery Priority Number: 14

Delisting Criteria:
1. Maintain existing stable populations on Santa Cruz and Santa Catalina Islands for a period of 15 years that includes the normal precipitation cycle (USFWS, 2024)

2. Seed stored in CPC cooperating facilities (USFWS, 2024).

3. Seed germination and propagation techniques understood (USFWS, 2024).

4. Successful outplanting techniques developed (USFWS, 2024).

5. Life history research conducted (USFWS, 2024).

6. Experimental use of fire for population enhancement researched and applied (USFWS, 2024).

Recovery Actions:
- Support and intensify active control programs where herbivory or habitat alteration by alien animals exists (USFWS, 2000).
- Develop and implement a plan to achieve the goals and standards of the Conservation Strategy. The Conservation Strategy is a draft strategy for conservation of island resources prepared by biologists from the National Park Service, U.S. Fish and Wildlife Service, and the U.S. Geological Survey, Biological Resources Division. This Strategy is essentially a primer or guide that provides the basis for the recovery of the species and should be referred to as a supporting document (USFWS, 2000).

- Restore habitats and control competitive weeds for long-term management of the species and its habitats (USFWS, 2000).
- Conduct thorough surveys for the species (USFWS, 2000).
- Conduct research that aids in the conservation and recovery of the species (USFWS, 2000).
- Store seeds at facilities certified by the Center for Plant Conservation and develop successful seed germination and propagation techniques (USFWS, 2000).
- Develop successful outplanting techniques (USFWS, 2000).
- Revise the recovery criterion to include maintenance of existing occurrences on Santa Rosa Island. Because the historic distribution and abundance of the species is unknown on Santa Rosa Island, the first need is to establish a baseline for the species over the first 10 years after non-native mammal removal (USFWS, 2010).
- Manage the habitat throughout the geographic range of Helianthemum greenei to conserve and replenish topsoil. This should include (1) removal of bison, deer, and elk, and (2) revegetation efforts (USFWS, 2010).
- Eliminating non-native predation pressure on Helianthemum greenei. Ideally this means removing all non-native herbivorous mammals from Santa Catalina and Santa Rosa Islands. In the interim, reinforced fencing may serve to maintain existing occurrences that can repopulate the islands as predation pressure is reduced (USFWS, 2010).
- Land managers should expand the distribution of the species by establishing fence-protected occurrences on the west end of Santa Catalina Island, by establishing occurrences inside any other currently fenced Arctostaphylos confertiflora occurrences on Santa Rosa Island, and by reestablishing the species on San Miguel Island (USFWS, 2010).
- Land managers should experiment with controlled burns as a means of increasing the size and number of occurrences of the species, within a framework of restoring ecosystem health (USFWS, 2010).
- Land managers should continue monitoring all known occurrences of Helianthemum greenei (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Manage the habitat throughout the geographic range of island rush-rose to provide suitable habitat for the species to complete its life cycle. This should include removal of deer and bison from Santa Catalina Island, and appropriate landscape recovery efforts. 2. Eliminate non-native ungulate herbivore pressure on island rush-rose by removing deer and bison from Catalina Island. In the interim, maintain reinforced fencing around existing occurrences so that they can serve as a source to repopulate the island as herbivory pressure is reduced. 3. Expand the distribution of the species by establishing fence-protected occurrences on the west end of Santa Catalina Island. Additionally, the number of occurrences on Santa Rosa Island could be increased, and the species reestablished on San Miguel Island. Population genomics indicate that seed from Santa Cruz or Santa Rosa islands could be used to reestablish the species on San Miguel Island. 4. Experiment with controlled burns and other disturbances in the field to evaluate their effectiveness as a means of increasing the number and size of occurrences of the species. 5. Establish a uniform protocol of regular repeat monitoring of known occurrences of island rush-rose, especially after land disturbance events (e.g., fire), to document the number of plants present and the extent of occurrences. Additional directed surveys in identified potential habitat should occur, especially on Santa Rosa Island and San Miguel Island. 6. Evaluate existing genomic data and genetic management frameworks to assess the potential threat of hybridization where island rush-rose and Crocanthemum scoparium co-occur. As needed, conduct

additional studies of hybridization extent and develop management strategies. 7. Continue addition of seed to conservation seed banks, especially from Santa Catalina and Santa Rosa islands (USFWS, 2024).

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SPECIES ACCOUNT: *Helianthus paradoxus* (Pecos (=puzzle, =paradox) sunflower)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/20/1999; Southwest Region (R2) (USFWS, 2016)

Physical Description

An annual herb with stems 1-2 m tall. Flower heads have yellow rays and are 3-5 cm across (NatureServe, 2015).

Taxonomy

Puzzle sunflower is a species of hybrid origin (Rieseberg et al. 1990; Rieseberg 1991). The parental species are the common sunflower and the prairie sunflower, H. petiolaris. These two species occupy different habitats from puzzle sunflower (NatureServe, 2015).

Historical Range

Historically there were six other locations within Pecos and Reeves Counties; however all except one of these sites have not been relocated due to imprecise locality data and the lack of access to private land. The relocated site was heavily invaded by salt cedar and had little water left. No puzzle sunflowers were found, although the entire site was not searched (NatureServe, 2015).

Current Range

At present puzzle sunflower occurs in two general areas in Pecos and Reeves Counties in west Texas and four general areas in New Mexico (NatureServe, 2015). Pecos sunflower populations occur at alkaline wetlands in the arid regions of west Texas, lower Pecos River of eastern New Mexico, and the Rio Grande and Rio San Jose of west-central New Mexico (USFWS, 2015).

Critical Habitat Designated

Yes; 4/1/2008.

Legal Description

On April 1, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Helianthus paradoxus (Pecos (=puzzle, =paradox) sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes five critical habitat units (CHUs), in New Mexico and Texas (73 FR 17762-17807).

Critical Habitat Designation

The critical habitat designation for Helianthus paradoxus includes five CHUs (ten sub-units) in Chaves, Cibola, and Guadalupe counties, New Mexico, and in Pecos County, Texas. This species critical habitat encompasses approximately 1,305 acres (ac) (528 hectares (ha)) (73 FR 17762-17807).

Unit 1: West-Central New Mexico: Subunit 1a is located at Rancho del Padre Spring Cienega. This subunit is 26 ac (10 ha) in Cibola County, New Mexico. The subunit consists of an area of Rancho del Padre Spring Cienega from the spring on the south side of I– 40 then northeast approximately 0.5 mi (0.8 km) to the Rio San Jose. This population consists of large patches of several thousand

plants on areas owned by two private landowners (23 ac (9 ha)) and the Pueblo of Acoma (3 ac (1 ha)). This site was known to be occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by H. paradoxus on every visit (Sivinski 2007a, p. 3). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during H. paradoxus's growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Subunit 1b is located at Grants Salt Flat Wetland. This subunit is 63 ac (25 ha) of private land in Cibola County, New Mexico. The subunit consists of an area of wet alkaline playa (i.e., a seasonal, shallow desert lake) between railroad tracks and I–40 and west of Hwy 122 (Road from Interstate to downtown Grants). Playas are nearly level areas at the bottom of undrained desert basins that are sometimes covered in water. This population consists of large patches of several thousand plants mostly on private property. This site was occupied at the time of listing and has been visited or observed from a public right-of-way by species experts during four or more seasons. These experts have found the site occupied by Helianthus paradoxus on every visit (Sivinski 2007). This unit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by wetland filling and development, encroachment by nonnative vegetation, and livestock management not compatible with H. paradoxus physiology. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Subunit 1c is located at the Pueblo of Laguna. This subunit's acreage is undefined in Valencia County, New Mexico. The subunit consists of an area along the Rio San Jose, South Garcia, New Mexico. At this site, Helianthus paradoxus plants are located in patches at springs along the Rio San Jose. Each patch consists of several hundred to several thousand plants, and a few scattered plants grow along the river (Sivinski 1995, p. 4). The entire site belongs to the Pueblo of Laguna. This site was occupied at the time of listing, is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, encroachment by nonnative vegetation, and livestock grazing during H. paradoxus' growing and flowering season. The Pueblo has developed a management plan for H. paradoxus. On the basis of this plan and our partnership with the Pueblo of Laguna, we are excluding this area from the final critical habitat designation pursuant to section 4(b)(2) of the Act (see ''Application of Section 4(b)(2) of the Act'' section below for additional information).

Unit 2: La Joya Wildlife Management Area: Unit 2 is located in the La Joya Wildlife Management Area. This unit is 854 ac (346 ha) in Socorro County, New Mexico. This population is located about 7 mi (11 km) south of Bernardo within Socorro County near the confluence of the Rio Grande and the Rio Puerco. The La Joya population is bounded to the west by I–25 and to the east by the Unit 7 Drain. The north boundary is adjacent to River Mile 126 of the Rio Grande and the south boundary is adjacent to River Mile 123. One of the largest populations of Helianthus paradoxus occurs adjacent to the Rio Grande at La Joya. This Rio Grande population consists of 100,000 to 1,000,000 plants and occurs on the La Joya Wildlife Management Area (Service 2005, p. 4). It is within the La Joya Unit of the Ladd S. Gordon Waterfowl Complex. This property is owned by the New Mexico State Game Commission. It is managed by the NMDGF for migratory waterfowl habitat, which is compatible with preservation of wetlands for H. paradoxus. We believe this area was not occupied at the time of listing. It was discovered in 2004. This site has been found to be occupied every year since then and represents one of the largest populations of Helianthus paradoxus in the range of the species (Hirsch 2006, p. 1). This unit is currently

occupied by a stable population (Blue Earth Ecological Consultants, Inc. 2007c, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, very large population of Helianthus paradoxus, and is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event because it is the sole representative located in an area distinct from any other population in the range of the species. As such, it may contain genetic variation not found anywhere else in the range of the species. Because the water source for this population is stable, this population can be expected to persist in very large numbers every year. As described below, we are excluding Unit 2, the La Joya Wildlife Management Area, from the critical habitat designation for Helianthus paradoxus (see ''Exclusions Under Section 4(b)(2)'' section).

Unit 3: Santa Rosa: Subunit 3a is located at Blue Hole Cienega/Blue Hole Fish Hatchery Ponds. This subunit is 134 ac (54 ha) in Guadalupe County, New Mexico. The Blue Hole Fish Hatchery Ponds population of Helianthus paradoxus is part of the same population as and nearly contiguous with the Blue Hole Cienega in Santa Rosa, New Mexico. The Blue Hole Fish Hatchery Ponds population is immediately north of Blue Hole Road and the Blue Hole Cienega is immediately south. This subunit was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the subunit to be occupied by Helianthus paradoxus on every visit (Sivinski 2007a, p. 2). This subunit is currently occupied (Blue Earth Ecological Consultants, Inc. 2006, p.1), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. The part of this population at Blue Hole Cienega consists of 100,000 to 1,000,000 plants and is the largest population of Helianthus paradoxus in the upper Pecos River basin. A nontraditional section 6 grant was awarded to the State of New Mexico in 2004 for acquisition of the Blue Hole Cienega, which was finalized in July 2005. At this site, shallow ground water seeps to the surface to create cienega communities. This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment by nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. The part of this population at the Blue Hole Fish Hatchery Ponds is owned and administered by the City of Santa Rosa and consists of approximately 1,000 plants. This site is maintained as a recreational area. City of Santa Rosa park maintenance staff have voluntarily stopped mowing and cutting Helianthus paradoxus during the months of August and September. An information kiosk on endangered wetland plants is being planned for the bike/foot path along the creek at Blue Hole Park. This subunit was confirmed to be occupied in 2006 (Blue Earth Ecological Consultants, Inc. 2006, p. 4), contains all of the PCEs, and is threatened by encroachment from nonnative vegetation, wetland filling, and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address Helianthus paradoxus in this area. Subunit 3b is located at Westside Spring. This subunit is 6 ac (3 ha) of private land in Santa Rosa, Guadalupe County, New Mexico. The subunit consists of an area along an unnamed spring on the west side of the Pecos River, located to the west of River

Road and 1 mi (1.6 km) east of Highway 54. We believe this area was not occupied at the time of listing. It was discovered in 2005, and contained thousands of plants. This site was found to be occupied again in 2006 by a species expert observing from a public right-ofway (Sivinski 2007). This subunit is currently occupied by a stable population, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and encroachment of nonnative vegetation. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address Helianthus paradoxus in this area. We have determined this site to be essential to the conservation of the species because it is currently occupied by a stable, large population of Helianthus paradoxus, and is one of only two stable, large populations in Unit 3. This subunit is sufficiently distant (over 40 mi (64 km)) from other populations to serve as an additional locality that contributes to the conservation of genetic variation. This population may prevent extirpation of the species resulting from encroachment of nonnative species, degradation of habitat, or a catastrophic event that could occur to the other subunit in Unit 3. It may also contain genetic variation specific to this Unit. Because the water source for this population is stable and not anticipated to be subject to any known future water withdrawals, this population can be expected to persist in large numbers every year.

Unit 4: Roswell/Dexter: Subunit 4a includes 576 ac (233 ha) of Bitter Lake National Wildlife Refuge and City of Roswell land located in Chaves County, New Mexico. This subunit is located approximately 5 mi (8 km) northeast of the city of Roswell. One of the largest Helianthus paradoxus populations occurs on the Bitter Lake National Wildlife Refuge in New Mexico on Federal lands managed by the Service. Several hundred thousand to a few million plants occur nearly continuously along the shores and small islands of all the artificial lakes in the southern unit of the refuge. Also, a few small patches of plants occur on the west side of Bitter Lake Playa and adjacent springs on the Lost River. This area was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by Helianthus paradoxus on every visit (Ulibarri 2006a, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This area is currently occupied, contains all of the PCEs essential to the conservation of the species, and is threatened by water withdrawal and encroachment of nonnative vegetation. Additional threats occurring on the City of Roswell lands include wetland filling and development, and incompatible livestock management. Therefore, special management or protections may be required to minimize these threats. Subunit 4b includes 96 ac (39 ha) of land within the Bitter Lake National Wildlife Refuge Farm (Refuge Farm). This subunit is located in Chaves County, New Mexico, approximately 5 mi (8 km) east of Roswell on the west side of the Pecos River. Subunit 4b consists of a few large patches with several thousand plants on alkaline seeps behind the dikes on the western edge of the Refuge Farm south of Highway 380. This land is owned and managed by the Service as a grain farm and feeding area for migratory birds. The eastern portion of the Refuge Farm is a marshy spring-seep area that contains a large population of Helianthus paradoxus. The wet soils in this population are not cultivated. This area was known to be occupied at the time of listing and has been visited by species experts during four or more seasons. The experts found the site occupied by Helianthus paradoxus on every visit (Ulibarri 2006b, p. 1; Sivinski 2007a, p. 2; Blue Earth Ecological Consultants, Inc. 2007a, p. 3). This subunit is currently occupied and contains all of the PCEs in the appropriate spatial arrangement and quantity essential to the conservation of the species. Subunit 4c is located at the Oasis Dairy. This subunit is 104 ac (42 ha) of private land in Chaves County, New Mexico. The subunit is located on the east side of Roswell, west side of Pecos River Valley, approximately 4 mi (7 km) southeast of the Hwy 380 bridge, and beside an

unnamed spring approximately 0.6 mi (1 km) west of the Pecos River and 6 mi (9 km) south of Highway 380. This site contains a very large, dense patch of several thousand Helianthus paradoxus in a low alkaline sink area approximately 0.5 mi (0.8 km) west of the Pecos River on private land. It also contains a large patch with many thousands of H. paradoxus in a low area below a spring, also on private land. This site was occupied at the time of listing and has been visited by species experts during at least three seasons. These experts found the site occupied by H. paradoxus on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by livestock grazing during H. paradoxus' growing and flowering season, water withdrawal, and wetland filling and development. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Subunit 4d is located at Lea Lake at Bottomless Lakes State Park. This subunit is 20 ac (8 ha) in Chaves County, New Mexico. It includes the wet margins of Lea Lake. This site contains a few thousand plants on the riparian margins of Lea Lake. This land belongs to the State of New Mexico and is managed by the New Mexico Parks and Recreation Division. The lands adjacent to Lea Lake are used as a picnic area and campground for the State Park. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by Helianthus paradoxus on every visit (Sivinski 2007a, p. 3). This subunit is currently occupied (Sivinski 2007a, p. 3; Blue Earth Ecological Consultants, Inc. 2007a, p. 3), contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by encroachment of nonnative vegetation, and recreational and park maintenance activities. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area. Cienega. This subunit is 41 ac (17 ha) of private land in Chaves County, New Mexico. The subunit is located in a small valley west of the Pecos River, east of the Hagerman Irrigation Canal, and 3 mi (5 km) north of Dexter. This site consists of several thousand plants on private land along a wide, boggy drainage bottom. This site was known to be occupied at the time of listing based upon observations from a public right-of-way by species experts during at least three seasons (Sivinski 2007a, p. 2). This subunit is currently occupied, contains all of the PCEs in the appropriate spatial arrangement and quantity, and is threatened by water withdrawal, wetland filling and development, and livestock grazing during Helianthus paradoxus' growing and flowering season. Therefore, special management or protections may be required to minimize these threats. At this time, we are not aware of any management plans that address H. paradoxus in this area.

Unit 5: West Texas Unit 5 includes 240 ac (97 ha) of private land located on Diamond Y Spring in Pecos County, Texas. The unit is located approximately 12 mi (20 km) north-northwest of Fort Stockton, Texas. Unit 5 consists of several hundred thousand to one million plants found on The Nature Conservancy's Diamond Y Spring Preserve and a contiguous parcel of private land. This site was occupied at the time of listing and has been visited by species experts during four or more seasons. These experts found the site occupied by Helianthus paradoxus on every visit (Poole 2006, p. 2). This unit is currently occupied (Blue Earth Ecological Consultants, Inc. 2007b, p. 3) and contains all of the PCEs essential to the conservation of the species. The land within The Nature Conservancy's Diamond Y Spring Preserve was purchased to protect Diamond Y Spring Preserve and other rare or endangered aquatic species in the Diamond Y Spring system. This habitat is managed for the conservation of such species (Service 2005, p. 12). Diamond Y Spring Preserve has recently expanded from 1,500 ac (607 ha) to 4,000 ac (1,618 ha). However, Helianthus paradoxus on the Preserve is threatened by water withdrawal occurring outside the

Preserve. On the adjacent private land, H. paradoxus is also threatened by water withdrawal, wetland filling and development, and livestock grazing during the growing and flowering season. As a result, special management or protections may be required to minimize these threats. At this time, we are not aware of any completed management plans that address H. paradoxus in this area.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Helianthus paradoxus critical habitat consists of two components (73 FR 17762-17807):

(i) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone (top 50 cm (19.7 in) of the soil profile), and have salinity levels ranging from 10 to 40 parts per thousand; and

(ii) A low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas occupied by the species at the time of listing contain the physical and biological features essential to the conservation of the species, and whether these features may require special management consideration or protections. As stated in the final listing rule (64 FR 56582), threats to Helianthus paradoxus and its physical and biological features include drying of wetlands from groundwater depletion, alteration of wetlands (e.g., wetland fills, draining, impoundment, and development), competition from nonnative plant species, overgrazing by livestock during H. paradoxus' flowering season, impacts from recreational activities, mowing, and highway maintenance. The loss or alteration of wetland habitat continues to be the main threat to Helianthus paradoxus. The scattered distribution of cienegas makes them aquatic islands of unique habitat in an arid-land matrix (Hendrickson and Minckley 1984, p. 169). There is evidence these habitats have been historically, and are presently being, reduced or eliminated by aquifer depletion, and severely impacted by agricultural activities and encroachment by exotic plants (Poole 1992, pp. 1–2; Sivinski 1995, p. 11). The lowering of water tables through aquifer withdrawals for irrigation and municipal use, diversion of water from wetlands for agriculture and recreational uses, and wetland filling for conversion to dry land uses destroy or degrade desert wetlands. In Grants, New Mexico, Helianthus paradoxus has been observed in close proximity to building sites that may have contained suitable wetland habitat prior to filling (Service 2005, p. 8). A cienega containing H. paradoxus near Dexter, New Mexico, was dried when a wellhead was placed on the spring and the water diverted for other uses (Service 2005, p. 8). Springs that have fed H. paradoxus habitats have been converted to swimming pools and fishing ponds in the towns of Roswell and Santa Rosa, New Mexico (Service 2005, p. 8). Groundwater withdrawals for agriculture in Pecos and Reeves counties in Texas have had an especially severe impact on desert springs (Service 2005, p. 8). Of the 61 historical desert springs in these two counties, only 13 were still flowing in 1980 (Brune 1981 in Poole 1992, p. 5). Beginning around 1946, groundwater levels fell as much as 400 feet (ft) (120 meters (m)) in Pecos County and 500 ft (150 m) in Reeves County. Groundwater pumping has lessened in more recent years due to the higher cost of removing water from deeper aquifers, but rising water tables and resumption of spring flows are not expected (Poole 1992, p. 5). We are not aware of any protections afforded by Texas water

law for the remaining springs that support H. paradoxus populations on The Nature Conservancy properties, which limits options for addressing this threat. Livestock will eat Helianthus paradoxus when other green forage is scarce, and when the buds are developing and abundant (Service 1999, p. 56587). Cattle and horses tend to pull off the flower heads, which can reduce seed production (Bush and Van Auken 1997, p. 416). However, well-managed grazing during non-flowering months may have a beneficial effect on H. paradoxus populations by decreasing the density and biomass of potentially competing plant species in these habitats. This sunflower germinates earlier than most associated plants and grows vigorously on wet, bare, highly insolated soils (Service 2005, p. 9). Actions that remove shading grass cover, such as grazing, appear to enhance growth and reproduction of sunflower plants that are later protected from grazing while they are reproductively maturing. Therefore, properly managed livestock grazing can be compatible with H. paradoxus conservation. Livestock grazing operations that are not managed to protect H. paradoxus occur in populations in the Grants and Roswell areas of New Mexico (Service 2005, p. 9). Although water contamination is a significant threat for the Roswell springsnail, Koster's springsnail, Noel's amphipod, and the Pecos assiminea found on Bitter Lake National Wildlife Refuge (70 FR 46304), we have no information on whether contamination of water would affect Helianthus paradoxus. We did not find that reduced water quality was a threat to the species when it was listed in 1999 (64 FR 56582). Moreover, we are not aware of any research or information that documents the species' response to elevated nutrients or contaminants. For these reasons, we do not believe that water contamination is a significant threat to H. paradoxus at this time. We have determined that each area included in this designation meets the definition of critical habitat for the reasons described in our unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (inferred from NatureServe, 2015)

Lifespan

Adult: 1 year (inferred from USFWS, 2015)

Breeding Season

Adult: August - October (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Possibly ground disturbance (inferred from NatureServe, 2015); pollinators unknown - likely various insects (USFWS, 2005)

Reproduction Narrative

Adult: No specific research has been conducted on the reproduction of this species. The reproductive biology is likely to be very similar to that of the common sunflower, H. annuus. Cattle disturbance of the surrounding vegetation may supply puzzle sunflower with light gaps for germination and growth, and lessen competition (Bush and Van Auken 1997). Numerous experiments have been conducted both in and ex situ on competition between puzzle sunflower and its associates (Van Auken and Bush 1993, 1994, 1995). With competitors removed, puzzle

sunflower exhibited greater basal stem diameter, more flower heads, and greater flower head, leaf, and stem dry mass (Bush and Van Auken 1997). Annual species of sunflowers hybridize in cultivation, but have reduced pollen viability and seed fertility (Heiser 1965, 1969). Hybrids of puzzle and common sunflower have been observed at Diamond Y Preserve in west Texas and in the Santa Rosa area of New Mexico (NatureServe, 2015). The Pecos sunflower is an annual plant that must re-establish each population by seeds produced during preceding years. It is annual plant that germinates in the spring, and flowers and makes seed from late August through October (USFWS, 2015). Pollination vectors for the Pecos sunflower have not been studied. However, most radiate-headed plants in the aster family are generalists in attracting a variety of insect pollinators (USFWS, 2005).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cienega (NatureServe, 2015), wet meadow, spring seeps (USFWS, 2015)

Dependencies on Specific Environmental Elements

Adult: Disturbance regime, 10 - 40 ppt soil salinity, < 10% canopy cover (USFWS, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 3,280 - 6,561 ft. elevation (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Patches of dozens to thousands (USFWS, 2005)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2015)

Habitat Narrative

Adult: Helianthus paradoxus is the only sunflower in the Southwest United States that requires permanent wetlands for its survival. Puzzle sunflowers grow in saline soils that are permanently saturated. Areas that maintain these conditions are commonly called cienegas (desert wetlands) associated with springs. However, the required conditions may also be found at stream margins and at the margins of impoundments. Where plants are associated with the latter the impoundments have replaced the natural cienegas. Van Auken and Bush (1995) tested puzzle sunflower to determine if it was mycorrhizal. The greenhouse experiments, done with non-native soil, indicated that puzzle sunflower was an obligate mycorrhizal species (NatureServe, 2015). This species is associated with spring seeps and desert cienegas, or wet meadows, which are very rare in the dry regions of New Mexico and Texas. The cienega climax community has been described as mid-elevation, 3280.84 to 6561.68 feet (ft.). Disturbance regimes, such as fire or tillage, which eliminate vegetation thatch and expose bare ground surface tend to increase Pecos sunflower cover and productivity (Van Auken and Bush 2004; New Mexico Forestry Division 2008). Based on knowledge of the life history, biology, and ecology of the Pecos sunflower and the habitat requirements for sustaining the essential life history functions of the

species, the PBFs for Pecos sunflower are the desert wetland or riparian habitat components that provide: (1) Silty clay or fine sand soils that contain high organic content, are saline or alkaline, are permanently saturated within the root zone in the top 19.69 inches (in) (50 centimeters (cm)) of the soil profile, and have salinity levels ranging from 10 to 40 parts per thousand; and (2) low proportion (less than 10 percent) of woody shrub or canopy cover directly around the plant (U.S. Fish and Wildlife Service 2008b). The Pecos sunflower is intolerant of habitats that are too wet at the surface and prefers soils that are relatively dry at the surface and wet in the lower root zone (Bush 2006) (USFWS, 2015). Populations tend to grow in crowded patches of dozens or even thousands of individuals (USFWS, 2005).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2015)

Dispersal/Migration Narrative

Adult: Limited seed mobility restricts the ability of the Pecos sunflower to disperse to other suitable habitats or away from habitat that becomes unsuitable (USFWS, 2015).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

7 (USFWS, 2005)

Population Size:

< 100 to > 200,000 per site, fluctuates yearly (USFWS, 2015)

Adaptability:

Low (inferred from USFWS, 2015)

Population Narrative:

At some occurrences it is locally abundant - maybe > 3000 individuals in total - but some New Mexico occurrences are small and nonviable. At present there are six general areas where the species occurs: four in New Mexico and two in Texas. There are between 1 and 11 sites at each of these six general locations for a total of 25 sites. Ten of the 11 Pecos River sites occur within a 22 mile (36 km) stretch of the Pecos River Valley. All eight observations in the Santa Rosa area occur within a four square-mile area. The two sites in Grants are near the San Jose River and separated from the Laguna population by approximately 44 miles (73 km). The two Diamond Y sites are within three miles of each other. The Diamond Y and East Sandia Springs Preserves are within 50 miles (80 km) of each other. The Texas sites are approximately 150 miles (241 km) south of the most southerly New Mexico site. The overall trend for the species is unclear as the historical distribution, with few exceptions, is unknown (NatureServe, 2015). The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations. The number of sunflowers per site varies from less than 100 to several hundred

thousand. Because Pecos sunflower is an annual, the number of plants per site can fluctuate greatly from year to year with changes in precipitation and depth to ground water. The Pecos sunflower has a small, localized range, such that either a natural (e.g., drought) or anthropogenic (e.g., water withdrawal) perturbation can eliminate many or all of the existing populations (USFWS, 2015). Pecos sunflower occurs in seven populations; two occur in west Texas and five are located in New Mexico (USFWS, 2005). The Pecos sunflower is a wetland plant that was known from only a single population near Fort Stockton, Pecos County, Texas, when it was proposed as a candidate for listing as endangered under the Act on December 15, 1980 (45 FR 82480). Subsequent field surveys for this species found additional populations in New Mexico and Texas. At the time of listing, Pecos sunflower was known from 25 sites that occurred in five general areas. These areas were Pecos and Reeves counties, Texas, in the vicinity of Fort Stockton and Balmorhea; Chaves County, New Mexico, from Dexter to just north of Roswell; Guadalupe County, New Mexico, in the vicinity of Santa Rosa; Valencia County, New Mexico, along the lower part of the Rio San Jose; and Cibola County, New Mexico, in the vicinity of Grants. There were three sites in the Fort Stockton to Balmorhea area, eleven in the Dexter/Roswell area, eight in the Santa Rosa area, one along the lower Rio San Jose, and two in the Grants area (Service 1999). In addition, since listing, two new sites on the middle Rio Grande have been added, additional sites at the Ladd S. Gordon Waterfowl Complex, population expansion on BLM land in the Dexter/Roswell area, several new sites in the Santa Rosa area, and expansion of a site in Texas. There are occurrences of Pecos sunflower on State, Federal, tribal land, and several private land holdings (USFWS, 2023).

Threats and Stressors

Stressor: Reduction of water in springs (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Loss or alteration of spring habitat continues to be the main threat to Pecos sunflower. Lowering water tables from aquifer withdrawals for irrigation and municipal use has degraded many desert spring habitats. The primary threat to the Pecos sunflower in west Texas is the potential failure of spring flow due to excessive groundwater pumping or drought or both, which would result in total habitat loss for the species. There is evidence that spring habitats have been historically reduced or eliminated by aquifer depletion on the Bitter Lake NWR (Jones and Balleau 1996). In addition, recent drought years may have impacted the size of Pecos sunflower populations on La Joya WMA (Hirsch 2012). Here, the total number of acres occupied by Pecos sunflower fell from 261 ac (105.622 ha) in 2010, to 224 ac (90.65 ha) in 2011, to 200 ac (80.94 ha) in 2012, as the drought in New Mexico intensified (USFWS, 2015).

Stressor: Nonnative plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Exotic plants have potential to seriously impact the native plant community composition and ecological integrity of arid land springs and cienegas. Exotic trees, especially salt cedar and Russian olive can almost completely convert a treeless cienega to a dense woodland with little understory vegetation. Aggressive, rhizomatous non-native grasses and forbs compete with, and replace, native cienega plants, especially in areas of soil disturbance. Herbaceous

exotics that are currently degrading some arid land springs and cienegas include Persoon (Johnsongrass) (Sorghum halepense), Hudson meadow fescue and perennial pepperweed (USFWS, 2015).

Stressor: Water contamination (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Water contamination, particularly from oil and gas operations, could be a potential threat for Pecos sunflower, but the effects on this species have not been studied. In order to assess the potential for contamination, a study was completed in September 1999 to delineate the area that serves as sources of water for the springs on Bitter Lake NWR (Balleau Groundwater, Inc. 1999). This study reported that the sources of water that will reach Bitter Lake NWR's springs include a broad area beginning west of Roswell near Eightmile Draw, extending to the northeast to Salt Creek, and southeast to Bitter Lake NWR. This area represents possible pathways from which contaminants may enter the groundwater that feeds the springs on the Refuge. This broad area is located within a portion of the Roswell Basin and contains a mosaic of Federal, State, City, and private lands with multiple land uses, including expanding urban development. There are 378 natural gas and oil wells in the 12-township area encompassing the source-water capture zone for the Middle Tract of Bitter Lake NWR that are potential sources of contamination (Go-Tech 2010). The Diamond Y Springs Complex is within an active oil and gas extraction field. At this time, there are still many active wells and pipelines located within approximately 330 ft. (100 m) of the surface waters at the springs. In addition, a natural gas refinery is located within 0.5 mi (0.8 km) upstream of Diamond Y Spring (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Increased air temperatures lead to higher evaporation rates, which may reduce the amount of runoff, groundwater recharge, and consequently spring discharge. Increased temperatures across the Southwest may also increase the extent of area influenced by drought (Lenart 2003), decreasing groundwater recharge regionally, and thereby reducing spring discharge. Prolonged drought leading to diminishment or drying of springs would have a negative impact on Pecos sunflower. Springs would not have to dry out completely to have an adverse effect. In addition, as water becomes increasingly scarce, conflict over its use becomes more intense. The proportion of human and livestock consumption of water would be expected to increase during drought. Any of these factors, alone or in combination, could lead to either the reduction or extirpation of Pecos sunflower populations. Therefore, climate change is a significant threat to the Pecos sunflower into the foreseeable future (USFWS, 2015).

Stressor: excessive livestock grazing (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: excessive livestock grazing (USFWS, 2023)

Stressor: Highway maintenance (USFWS, 2023)

Exposure:
Response:
Consequence:
Narrative: mowing, and highway maintenance (USFWS, 2023)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
1. Identify and establish at least one core conservation area for Pecos sunflower in each of the four distinct recovery regions that would collectively, if protected, ensure the long-term survival of the species. Each core habitat must occur on wetlands that are not threatened by depletion of the contributing aquifer and have demonstrated a self-perpetuating stand of Pecos sunflowers of greater than 5,000 individuals for a minimum of 7 out of 10 years. In addition to the core conservation area, each region should have at minimum one isolated stand of protected Pecos sunflowers with greater than 1,600 individuals for at least 7 out of 10 years to protect against catastrophic loss of the regional population (USFWS, 2015).

2. Assure long-term protection of designated core conservation areas and designated isolated stands in perpetuity through the implementation of appropriate management plans, conservation easements, or land acquisitions (USFWS, 2015).

Recovery Actions:
- Identify and establish core conservation areas and isolated stands (USFWS, 2005).
- Identify and address information gaps, compatible uses, and management actions regarding Pecos sunflower distribution, biology and aquifer stability (USFWS, 2005).
- Protect core conservation areas and isolated stands through landowner education, implementation of management plans, conservation easements, and land acquisition (USFWS, 2005).
- Monitor Pecos sunflower conservation areas and management actions as needed to satisfy delisting criteria (USFWS, 2005).
- Habitat protection through land acquisition or conservation agreements with landowners is the most important remaining recovery task. The development of management plans for the different agencies, as outlined in the recovery plan, should continue to be pursued. Government programs that acquire cienegas or assist landowners with their management are greatly needed (USFWS, 2015).
- Non-native tree species and thatch should continue to be removed in occupied and potential Pecos sunflower habitats. Pecos sunflowers should be re-seeded in suitable areas with willing land owners or managers within the range of the species to expand occupied habitats. The Pecos sunflower would also make an excellent focal species for public education and awareness of the importance of wetlands and the recovery of listed species. These opportunities should be explored and implemented where appropriate (USFWS, 2015).
- The recovery criteria in the Pecos Sunflower Recovery Plan (U.S. Fish and Wildlife Service 2005) should be collectively re-evaluated to determine if they constitute the most effective

strategy for conservation and recovery of the species. Of most significance, the actual size of existing core populations is between 50 and 100 times, or even higher multiples in some years of, the minimum number required in the recovery plan. The current recovery criteria may not have considered this much higher number of plants extant throughout the range of the species (USFWS, 2015).

- Survey efforts in occupied and potential habitats should be increased and improved, and surveys should employ an agreed-upon standardized protocol. Surveys should cover the entire range of the species and be repeated at least every 3 years. Existing populations should be monitored to document population trends in response to habitat restoration and maintenance (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Continue management actions and encourage partnerships and agreements in the conservation areas of the Recovery Regions with an emphasis on minimization or elimination of threats to core populations, isolated stands, and aquifer security. Research water contamination potential and point and nonpoint source pollutants relative to core and isolated populations. Continue monitoring of the populations in their respective Recovery Regions. This may include analysis of core area mapping for changes in density, continued monitoring on the Overflow wetlands and surrounding BLM lands, the population on the Bernardo Unit of the Ladd S. Gordon Complex, the effects of fire, the water table at Blue Hole Ciénega with a prioritization of the mechanisms regulating groundwater availability, and consider similar monitoring efforts for water availability for populations in Texas. Study the impacts of different types of grazing in the isolated populations of the Recovery Units, and monitor the impacts of feral hogs in the West Texas recovery unit. There is opportunity for cooperation with NMDOT's plans to restore, create or enhance wetlands to benefit Pecos sunflower with excavation, plantings, fencing, natural channel design modifications, and follow-up monitoring (NMDOT 2023) (USFWS, 2023).

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SPECIES ACCOUNT: *Helianthus schweinitzii* (Schweinitz's sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/7/1991; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb that produces solitary stems, up to 2 m tall and bears yellow flower heads in late summer and early autumn (NatureServe, 2015).

Taxonomy

Heiser et al. (1969), in the most recent monograph of the genus Helianthus, placed H. schweinitzii in Section Divaricati, Series Gigantel. Its closest relatives include other members of the Gigantei series, such as H. giganteus Linnaeus. H. maximiliani Schrader, H. resinosus Small, and H. grosseserratus Martens. The small heads, however, make H. schweinitzii anomalous in the Gigantei (USFWS, 1994).

Historical Range

Endemic to Piedmont (and central Plateau) of North Carolina and South Carolina (NatureServe, 2015). Past reports known from other parts of North and South Carolina, including Columbus County. North Carolina, and Horry County, South Carolina (both in the outer Coastal Plain), and Stokes County, North Carolina (in the upper Piedmont of North Carolina near the Virginia border) (USFWS, 1994).

Current Range

The species' distribution includes 13 NC counties (the original five plus Anson, Davidson, Gaston, Montgomery, Randolph, Richmond, Stokes, Surry) and two SC counties (Lancaster and York) (USFWS, 2010).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, vegetative (USFWS, 1994)

Lifespan

Adult: > 10 years (USFWS, 1994)

Breeding Season

Adult: August - first frost (USFWS, 1994)

Reproduction Narrative

Adult: It is a long-lived perennial with individuals probably living for decades. The species blooms from late August to frost. The relative importance of sexual (by seed) and asexual (by

rhizome) reproduction is not known in this species. Schweinitz's sunflower can also be propagated from pieces of the tubers. New plants readily sprout from entire or partial tubers (Creel, personal communication, 1992) (USFWS, 1994).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Oak-pine-hickory woods, piedmont longleaf pine forests (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial sun (NatureServe, 2015); periodic fire (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: Dense vegetation (USFWS, 1994)

Spatial Arrangements of the Population

Adult: Clumped (see population narrative)

Environmental Specificity

Adult: Broad (inferred from USFWS, 1994)

Habitat Narrative

Adult: Clearings in, and edges of, upland oak-pine-hickory woods and piedmont longleaf pine forests in moist to dryish sandy loams. Requires the full to partial sun of an open habitat, which was formerly maintained over the species' range by wildfires and grazing by herds of bison and elk. Now most occurrences are confined to roadsides and powerline clearings. (NatureServe, 2015). Although H. schweinitzii substrates in the Carolina Slate Belt are primarily mafic rocks (of either volcanic, plutonic, or sedimentary origin), the species also appears to occur on intermediate and even felsic rocks. With fire operating in the landscape to maintain open and semi-open habitats (Piedmont prairies and oak barrens or oak savannas), it is possible that Schweinitz's sunflower had a wider ecological amplitude than is apparent to us in the modern landscape. They also appear to be detrimentally affected by growing in dense competing vegetation, even if the other vegetation does not shade them (Bradford-Clebsch. personal communication. 1992) (USFWS, 1994).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

90 (USFWS, 2019)

Population Narrative:

Although monitoring for all 90 populations (278 extant EOs) is mostly infrequent and inconsistent, available data does suggest an increase in abundance in populations with potential to provide recovery (24 populations in NC and SC); however, only five populations in NC (representing four counties) and possibly one population in SC (representing one county) are currently of good to excellent viability. Threats identified in the 1990 listing rule and the 2010 5-year review are still current threats. Development pressure remains a significant threat to Schweinitz's sunflower and a TaILS database search yielded 380 consultations associated with the species range-wide since the 2010 5-year review. The Metrolina MSA, which includes York and Lancaster Counties in SC, continues to urbanize. While deer browse is known to be a threat to the species, small mammal and weevil herbivory has also been identified as impacting the species. Populations that are stable or increasing have maintained that status only through active land management to maintain suitable habitat conditions. Accidental herbicide spraying and lack of ROW maintenance impacts the species range-wide. Data and information outlined in this review highlight the need for continued management and consistent monitoring of abundance and threats throughout the range. Schweinitz's sunflower continues to meet the definition of an endangered species under the Endangered Species Act. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction and degradation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Threats to the species continue to escalate with rapid urbanization and suburban sprawl in the greater Charlotte area. Throughout the species' range, over 90% of known sites occur in managed ROW, where vegetation management practices occasionally mimic patterns of natural disturbance (from fire or native grazers) now largely absent from the present day landscape. However, these same vegetation management practices pose a threat to these occurrences, in that inappropriately timed mowing (e.g., during the growing season, prior to seed set) or excessive herbicide application have adversely impacted the species at several of these locations. Many of these ROW occurrences are along existing roads which are subject to widening and improvement projects which disturb or eliminate the existing adjacent ROW. The NCDOT has a program in which roadside occurrences of federally listed plant species are posted with signs prohibiting growing season mowing or herbicide application. Despite these efforts, 28 of 63 NCDOT sites containing H. schweinitzii were reportedly adversely impacted at least once as of 2003 (USFWS, 2010).

Stressor: Herbicides (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The two most recent accidental herbicide spraying events involving Schweinitz's sunflower occurred in York County, SC in 2015 and Mecklenburg County, NC in 2018. As a result of these, and similar incidents, Duke Energy is implementing several precautionary measures (Fletcher 2019, Duke, pers. comm.). They are developing an "on-board" Geographic Information System to aid employees and contractors in identifying locations of sensitive habitats and

species. In-field employees and contractors, as well as machinery, will be equipped with mobile tablets and mapping software that identifies “red zones” that should not be sprayed or that have specific management requirements. This technology should be in use by spring of 2020. Additionally, in 2018, recovery biologists with the Asheville and Raleigh field offices provided comments and recommendations for updated signage on Duke Energy powerline ROWs and species fact sheets. Installation of updated and new signs, at the sensitive habitat areas, began in the spring of 2019 (a total of 650 signs) and fact sheets are distributed to employees and contractors prior to ROW maintenance activities. The updated signs are in both English and Spanish, and are posted at eye-level. (USFWS, 2019)

Stressor: Invasives (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Mowing (wrong season or excessive) (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Native Competition (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Road Construction (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Utility Construction (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Woody Succession (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
1. 10 geographically distinct, self-sustaining populations are protected in at least 4 counties in North Carolina and one in South Carolina (USFWS, 2010).

2. Managers have been designated for each population (USFWS, 2010).

3. Management plans have been developed and implemented (USFWS, 2010).

4. Populations have been maintained for 5 years (USFWS, 2010).

Delisting Criteria:
1. 15 geographically distinct, self-sustaining populations are protected in at least 4 counties in North Carolina and one in South Carolina (USFWS, 2010).

2. Management plans have been implemented (USFWS, 2010).

3. Populations (as measured by number of adult plants) have been stable or increasing for 10 years (USFWS, 2010).

4. Permanent conservation ownership and management of at least 10 populations are assured by legally binding agreements (USFWS, 2010).

Recovery Actions:
- Implement emergency protective management of known remnant populations (USFWS, 1994).
- Survey suitable habitat for additional populations and potential reintroduction sites (USFWS, 1994).
- Protect viable populations through a range of protection tools (management agreements, acquisition, registry, cooperative agreements, etc.) (USFWS, 1994).
- Monitor existing populations (USFWS, 1994).
- Conduct research on the biology of the species and on suitable management tools for maintaining the natural ecosystem in which it occurred (USFWS, 1994).
- Implement management on protected populations (USFWS, 1994).
- For sites with the potential to contribute toward the species' recovery (Appendix B, Tables B.1 and B.2), work with appropriate owners/managers to implement monitoring capable of producing reliable trend data at each site. Range-wide standardized monitoring protocol are generally not regarded as feasible for this species, due to the widely varying sizes of populations and the resources available to monitor them. However, site-specific protocol could be implemented such that counts or estimates provided at a given site are directly comparable from one monitoring period to the next (USFWS, 2010).
- For sites with the potential to contribute toward the species' recovery (Appendix B, Tables B.1 and B.2), characterize existing vegetation using standardized community classification methods (e.g., NatureServe's community classification systems and Schafale and Weakley (1990)). Use this information to inform restoration objectives and direct future site protection efforts toward the highest quality habitats (USFWS, 2010).
- Devise recovery criteria which balance the availability of suitable habitat with opportunities for restoration, management, and protection as dictated by landowner willingness and

resource availability. These criteria should emphasize the role of prescribed fire in site restoration and management, but allow for those instances in which sites cannot be managed with fire (USFWS, 2010).

- Work with Dr. Richard Houk (Winthrop University, retired) to find successors to continue his monitoring efforts in South Carolina (USFWS, 2010).
- Clarify the role of controlled propagation, rescue and relocation, and public demonstration gardens in the species' recovery, so that sites supporting native populations in conjunction with remnants of native plant communities are prioritized for protection (above sites characterized by rescued and introduced plant material) (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTION The 2010 5-year review included a list of recommendations to improve recovery of the species. These actions, listed below, remain applicable to species recovery. For sites with the potential to contribute toward the species' recovery, work with appropriate owners/managers to implement monitoring capable of producing reliable trend data at each site. Range-wide standardized monitoring protocol are generally not regarded as feasible for this species, due to the widely varying sizes of populations and the resources available to monitor them. However, site-specific protocol could be implemented such that counts or estimates provided at a given site are directly comparable from one monitoring period to the next. For sites with the potential to contribute toward the species' recovery, characterize existing vegetation using standardized community classification methods (e.g., NatureServe's community classification systems and Schafale and Weakley (1990)). Use this information to inform restoration objectives and direct future site protection efforts toward the highest quality habitats. Devise recovery criteria which balance the availability of suitable habitat with opportunities for restoration, management, and protection as dictated by landowner willingness and resource availability. These criteria should emphasize the role of prescribed fire in site restoration and management, but allow for those instances in which sites cannot be managed with fire. Work with Dr. Richard Houk (Winthrop University, retired) to find successors to continue his monitoring efforts in South Carolina. Clarify the role of controlled propagation, rescue and relocation, and public demonstration gardens in the species' recovery, so that sites supporting native populations in conjunction with remnants of native plant communities are prioritized for protection (above sites characterized by rescued and introduced plant material). In light of new information, additional future actions are recommended below: Convene a working group of species experts to focus on species recovery. The working group would concentrate on, but not be limited to: o Defining populations, identifying populations on which to focus recovery, and assigning a responsible party for each identified population. o Determining what constitutes a "self-sustaining" population and determining the appropriateness of the criterion for a species dependent on active management. o Developing a standardized, tiered monitoring protocol that could be used on many different types of Schweinitz's sunflower sites. o Determining what constitutes a "natural" habitat considering the species' current relationship to the landscape (i.e. primarily in ROWs). o Clarifying the role of controlled propagation and relocation in recovery o Providing support and, if feasible, pooling resources for management and monitoring. o Prioritizing unprotected sites that are critical for recovery and working towards permanent protection. o Having a regularly scheduled meeting to share resources and information. Support research to determine the geographical extent of Smicronyx pinguis (weevil) and level of threat to Schweinitz's sunflower. Support research to determine if Schweinitz's sunflower is hybridizing with other Helianthus species and to what extent. Encourage Departments of Transportation and utility companies to maintain ROWs in a manner that is beneficial to Schweinitz's sunflower. (USFWS, 2019)

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SPECIES ACCOUNT: *Helianthus verticillatus* (Whorled Sunflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/1/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

A tall, perennial, herbaceous sunflower 1-2 meters in height with flower heads about 1 cm wide (Matthews et al. 2002). Flowers from August into October (NatureServe, 2015).

Taxonomy

The U.S. Fish and Wildlife Service (Call 2009) accepts this taxon as a species in considering it a candidate for federal listing; Matthews et al. (2002) and Flora of North America Editorial Committee (2006) also treat it as a species. Two supporting studies are cited by the USFWS: (1) morphological studies and root-tip chromosome counts which showed it to be a distinct, fertile diploid (Matthews et al. 2002); and (2) comparative genetic studies with its putative parents (H. grosserratus and H. angustifolius), which showed that it does not exhibit a mixture of parental alleles at nuclear loci and does not share chloroplast DNA haplotype with either of its putative parents (Ellis et al. 2006). In contrast, the Kartesz checklists (1994 and 1999) treat this taxon as a hybrid between Helianthus angustifolius and H. grosseserratus, following earlier treatments written when it was known from only the type specimen (NatureServe, 2015).

Historical Range

The species is known from Cherokee County, Alabama; Floyd County, Georgia; and McNairy and Madison Counties, Tennessee (USFWS, 2013).

Current Range

This species occurs in remnant prairie habitats found in uplands and swales of headwater streams in the Coosa River watershed in Georgia and Alabama and in the East Fork Forked Deer and Tuscumbia Rivers' watersheds in Tennessee (USFWS, 2014).

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Helianthus verticillatus (Whorled Sunflower) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Indiana, Alabama, Georgia and Tennessee (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for Helianthus verticillatus includes four CHUs in Cherokee County, Alabama; Floyd County, Georgia; and Madison and McNairy Counties, Tennessee. This species critical habitat encompasses approximately 1,542.3 acres (ac) (624.2 hectares (ha)) (79 FR 50990-51039).

Unit 1: Mud Creek: Unit 1 consists of 210.6 ha (520.4 ac) of privately owned lands in Cherokee County, Alabama, located approximately 11.6 km (7.2 mi) southeast of the city limits of Cedar

Bluff. The unit begins approximately 0.06 km (0.04 mi) north of the junction of CR–164 and CR–29 and extends in a northerly direction to encompass much of the drainage area of an unnamed tributary to Mud Creek and to the northeast to encompass much of the drainage area of a second unnamed tributary to Mud Creek. The easternmost boundary of this unit is adjacent to CR– 101, from approximately 1.0 km (0.6 mi) to 1.4 km (0.9 mi) north of its junction with CR–164. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses; and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 2: Coosa Valley Prairie: Unit 2 consists of 366.9 ha (906.5 ac) of privately owned lands in Floyd County, Georgia, located approximately 4.5 km (2.8 mi) northwest of the city limits of Cave Spring. This unit corresponds to the boundary of The Nature Conservancy's conservation easement on lands formerly owned by The Campbell Group and now owned by Plum Creek, a site commonly referred to as the Coosa Valley Prairie. The northern boundary of this unit follows Jefferson Road for approximately 1.4 km (0.9 mi) in a southeasterly direction, beginning approximately 1.7 km (1.0 mi) east of the Alabama-Georgia State line. From the eastern extent on Jefferson Road, the unit boundary follows an unnamed dirt road south for a distance of approximately 1.5 km (0.9 mi), where the boundary turns to the west and south before turning back to the north and again to the west, reaching the Alabama–Georgia State line. Here, the unit follows the State line in a northwest direction for approximately 0.8 km (0.5 mi) before turning east and following an unnamed dirt road in a northeasterly direction for approximately 2.7 km (1.7 mi) and reuniting with the northern boundary on Jefferson Road. Silt loam and silty clay loam soils are present throughout the unit, spanning broad uplands, depressions, and terraces and flood plains of headwater streams in the Coosa River watershed (PCE 1). Prairie openings and woodlands with low levels of canopy cover (PCE 2) are present throughout much of the unit. While Ellis and McCauley (2009, pp. 1837–1838) found very few viable achenes and low germination rates at this site, whorled sunflower has responded favorably to habitat management efforts by increasing in numbers, and there likely are now a sufficient number of compatible mates for production of viable achenes (PCE 3) at this site. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to silvicultural site preparation or timber harvest; indiscriminate herbicide use or mowing for silvicultural purposes or road right-of-way maintenance; conversion of remnant prairie habitat to agricultural or industrial forestry uses, and excessive shading or competition from native woody species or invasive, nonnative plants.

Unit 3: Prairie Branch: Unit 3 consists of 6.0 ha (14.9 ac) of privately owned land in McNairy County, Tennessee, and is located approximately 0.6 km (0.5 mi) south of the easternmost city limit of Ramer. This unit is located along Prairie Branch, a tributary to Muddy Creek, beginning approximately 0.42 km (0.26 mi) upstream of the point where it passes under Mt. Vernon Road and extending downstream for approximately 2.0 km (1.2 mi). Within this reach, the critical habitat unit forms a buffer extending 15 m (50 ft) upslope from the tops of the banks on both sides of Prairie Branch. Sandy loam soils (PCE 1) are present throughout the unit, as are small patches of vegetation containing whorled sunflower and other wet prairie species (PCE 2). The

features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing for road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and competition from invasive, nonnative plants.

Unit 4: Pinson: Unit 4 consists of 40.7 ha (100.5 ac) of privately owned land in Madison County, Tennessee, and is located approximately 4.1 km (2.5 mi) northwest of the city limits of Henderson, Tennessee. Beginning approximately 0.7 km southeast of the junction of U.S.–45 and Bear Creek Road, this unit extends approximately 0.08 km (0.05 mi) northeast of U.S.–45, crossing a railroad track, and then turns in a southeasterly direction, paralleling the track for a distance of approximately 0.5 km (0.3 mi). From this corner, the unit boundary turns southwest for a distance of approximately 0.79 km (0.49 mi), and then turns to the northwest for a distance of approximately 0.65 km (0.4 mi). From this corner, the unit boundary turns to the northeast for a distance of approximately 0.63 km (0.39 mi). Silt loam soils (PCE 1) are present throughout the unit, small patches of vegetation containing whorled sunflower and wet prairie species (PCE 2) are present, and a sufficient number of compatible mates are present for the production of a limited number of viable achenes (PCE 3) (Ellis and McCauley 2009, p. 1838). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of soil disturbance due to agricultural practices; indiscriminate herbicide use or mowing road or railroad right-of-way maintenance; conversion of remnant prairie habitat to agricultural uses; and excessive shading or competition from native woody species or invasive, nonnative plants. Much of the land within this unit has been converted to agricultural uses, but is included because of the potential for decreasing fragmentation among the subpopulations that are present in this unit by restoring suitable vegetation within previously converted lands.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Helianthus verticillatus critical habitat consists of three components (79 FR 50990-51039):

(i) Silt loam, silty clay loam, or fine sandy loam soils on land forms including broad uplands, depressions, stream terraces, and floodplains within the headwaters of the Coosa River in Alabama and Georgia and the East Fork Forked Deer and Tuscumbia rivers in Tennessee.

(ii) Sites in which forest canopy is absent, or where woody vegetation is present at sufficiently low densities to provide full or partial sunlight to whorled sunflower plants for most of the day, and which support vegetation characteristic of moist prairie communities. Invasive, nonnative plants must be absent or present in sufficiently low numbers to not inhibit growth or reproduction of whorled sunflower.

(iii) Occupied sites in which a sufficient number of compatible mates are present for outcrossing and production of viable achenes to occur.

Special Management Considerations or Protections

The features essential to the conservation of whorled sunflower may require special management considerations or protection to reduce the following threats: (1) Soil disturbance

due to silvicultural site preparation, timber harvest, or cultivation of row crops; (2) indiscriminate herbicide use or mowing; (3) conversion of remnant prairie habitat to agricultural or industrial forestry uses; and (4) excessive shading or competition from native woody species or invasive, nonnative plants. Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production; (2) ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season; (3) locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible; (4) managing, including prescribed burning, mowing, and bushhogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation; (5) reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat; and (6) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (NatureServe, 2015); sexual (inferred from USFWS, 2014)

Breeding Season

Adult: August - October (USFWS, 2013)

Reproduction Narrative

Adult: The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009) (NatureServe, 2015). This species is self-incompatible (USFWS, 2014). It produces flowers from August into October (Matthews et al. 2002, pp. 17–20; Ellis and McCauley 2008, p. 1837) (USFWS, 2013).

Habitat Type

Adult: Terrestrial, wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet prairie, calcareous barrens, riparian (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full to partial sunlight (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: Succession (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: A narrow habitat specialist occurring in remnant wet prairie areas and calcareous barrens, in moist, prairie-like openings in woodlands and along adjacent creeks. Soils are sandy clays which are alkaline, high in organic matter, and seasonally wet. Some associated plant species, including Schizachyrium scoparium, Sorghastrum nutans, Andropogon gerardii, and Panicum virgatum, suggest a strong prairie affinity. Other associates include Carex cherokeensis, Sporobolus heterolepis, Physostegia virginiana, Silphium terebinthinaceum, Pycnanthemum virginianum, Symphyotrichum novae-angliae, Hypericum sphaerocarpum, H. angustifolius, Helenium autumnale, and Marshallia mohrii. Most remaining wet prairies are remnants along rights-of-way where succession is artificially impeded (Call 2009) (NatureServe, 2015). The soil types are silt loams, silty clay loams, and fine sandy loams at the sites where whorled sunflower occurs. These soils share the characteristics of being strongly to extremely acidic and having low to moderate natural fertility and low to medium organic matter content (USDA 1997, pp. 73–76; USDA 1978a, pp. 24–54; USDA 1978b, p. 20; USDA 1978c, p. 44). Full or partial sunlight for most of the day is an essential feature for this species (USFWS, 2014). Initial efforts to estimate population sizes of whorled sunflower relied on counting individual stems (Allison 2002, pp. 3–8; Schotz 2001, pp. 8–10); however, due to the species' clonal growth habit, stem counts overestimate the true number of genetically distinct individuals (genets) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

Unknown (NatureServe, 2015)

Number of Populations:

8 extant (USFWS, 2023)

Population Size:

250 - 10,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Whorled sunflower, a perennial member of the aster (or sunflower) family, is known from nine natural populations in Alabama, Georgia, Mississippi, Tennessee, and Virginia, of which eight are extant. In addition, there is one established population in Tennessee. Natural populations are threatened by mechanical and chemical vegetation management for industrial forestry, right-ofway maintenance, and agriculture; shading and competition resulting from vegetation succession; and limited distribution and small population sizes (USFWS, 2023).

Population Narrative:

The low number of populations in the wild may be due to poor in situ seed germination (Matthews et al. 2002). However, seed germination is high in the laboratory and the species can reproduce rapidly from rhizomes, forming a dense colony (Call 2009). H. verticillatus has a high level of genetic diversity at the population and species level despite its rarity, which may indicate that it was more widespread in the past and perhaps became rare relatively recently (Ellis et al. 2006). Most sites recently discovered. Rarity is due to habitat loss. Its wet prairie habitat was more extensive before European settlement, fire suppression, and conversion to farmland; much of this habitat has been degraded or destroyed due to agricultural, silvicultural, and residential development (Matthews et al. 2002, Call 2009). The Georgia site has hundreds to thousands of stems (Norquist 2005, Call 2009); the number of genetic individuals is believed to be much lower than this, but is not known for certain (Call 2009). One site in Tennessee has about 70 plants (genetic individuals) with 500-1000 stems, the other site, discovered in 2006, has 36 clumps (genetic individuals) with approximately 400 stems (A. Bishop, pers. comm., 2007). One Alabama site contains an estimated 100 genetic individuals, and the second Alabama site contains an estimated 175-200 stems (representing a lower, but unknown, number of genetic individuals) (Call 2009). Five population groups are currently known extant, two in Alabama, one (with three sub-populations) in Georgia, and two in Tennessee (Norquist 2005; A. Bishop, pers. comm., 2007); in addition, there is the historical type collection from Tennessee in 1892, which has not been relocated despite searches. The estimated population size is 250 - 10,000 individuals. Population trends are unknown (NatureServe, 2015). There are four whorled sunflower populations known to be extant (USFWS, 2013). Despite the fact that a new population was discovered after whorled sunflower was listed, only five natural populations are known to be extant. Furthermore, most of these populations are small, consisting of 100 or fewer stems, and isolated, occurring more than 20 miles from their nearest neighbor. Small populations are more susceptible to deleterious stochastic events (such as severe drought, which may be exacerbated by future climate change) and demographic processes (such as reduced fitness due to restricted mate availability). The species' fragmented distribution limits potential gene flow between populations and makes natural reestablishment of a given population unlikely should the population become extirpated. Land conversion has reduced available habitat for this species and continued land conversion could further restrict available habitat. Today, incompatible forestry and agricultural practices, incompatible right-ofway management (e.g., indiscriminate herbicide application), and habitat degradation due to inadequate management (e.g., activities that promote closed canopies and increased competition) are the primary threats to this species. Limited long-term protection (only one population is currently protected) and inconsistent habitat management increase susceptibility of whorled sunflower to these threats. Together, these factors make whorled sunflower extremely vulnerable to local extirpation and overall extinction in the foreseeable future. As such, the species continues to meet the definition of an endangered species. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: The threats to whorled sunflower from habitat destruction and modification are occurring throughout the entire range of the species. These threats include mechanical or chemical vegetation management associated with industrial forestry practices, maintenance of transportation and utility rights-of-way, agricultural practices, and shading and competition. While a conservation easement and suitable habitat management alleviate threats from industrial forestry that otherwise would adversely affect the Georgia population, one of the Alabama whorled sunflower subpopulations currently is threatened by industrial forestry practices. The population-level impacts from these activities are expected to continue into the future (USFWS, 2013).

Stressor: Small, isolated populations (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The whorled sunflower is vulnerable to localized extinction because of its extremely restricted distribution and small population sizes at most known locations, which reduces the resilience of these populations to recover from acute demographic effects of threats to its habitat. the highly fragmented distribution of populations within Tennessee, combined with their disjunct location with respect to those in Georgia and Alabama, presumably precludes gene flow among them and leaves little chance of natural recolonization of these populations in the event of localized extinctions. Small population size could be affecting reproductive fitness of the whorled sunflower. The findings of Ellis and McCauley (2008, entire) suggest that the Madison County, Tennessee, population is reproductively less fit than the Alabama population. Ellis and McCauley (2008, p. 1840) offered two possible explanations for reduced reproductive fitness of the Tennessee population, including limited mate availability due to limited diversity of self-incompatibility alleles, or more extensive inbreeding. Both could be contributing to reduced seed production and viability rates (USFWS, 2013).

Stressor: Industrial Forestry Practices (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Industrial forestry practices have altered much suitable whorled sunflower habitat in Georgia and Alabama and currently threaten one known subpopulation in Alabama. While surveying potential habitat for additional populations, Jim Allison (Botanist, GDNR, pers. comm., March 9, 1999) observed that much of this species' prairie habitat in Georgia had been converted to pine plantations. Nearly all the Georgia subpopulations and one of the Alabama subpopulations of whorled sunflower are located on lands that are currently owned by Weyerhaeuser. The Georgia subpopulations on Weyerhaeuser Company lands are protected from habitat destruction or degradation by their inclusion in the conservation easement area at the Coosa Valley Prairie, which was donated to TNC by a previous landowner. On lands outside of the conservation easement area at the Coosa Valley Prairie, site preparation for planting pine seedlings has included subsoil plowing sites to improve drainage and conditions for tree root development. Mechanical and chemical methods to control competing vegetation have also been employed for site preparation. These site preparation activities may continue under Weyerhaeuser's ownership, depending on site conditions and needs, but buffers and alterations to specific site preparation practices are employed to limit impacts to rare species (Muckenfuss, pers. comm., September 14, 2017), such as whorled sunflower. Without adequate precautions,

these practices could cause direct mortality of whorled sunflower plants at one of the Alabama subpopulations and contribute to habitat degradation due to shading and competition (see "Shading and Competition", below) from planted pines. During timber harvests, either to thin (i.e., reduce density of pine trees to improve growth conditions for remaining trees) or to clear-cut the stand, whorled sunflower plants at this subpopulation could be subjected to indirect adverse effects from soil disturbance or to direct mortality due to movement of harvesting equipment (USFWS, 2023)

Stressor: Right-of-Way Maintenance (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Incompatible maintenance activities in utility and transportation ROWs have adversely affected whorled sunflower in Alabama, Mississippi, and Tennessee, and could affect one subpopulation in Georgia. At one of the Alabama subpopulations, whorled sunflower occurs in a narrow strip of vegetation between a roadside and adjacent pine forest, where it is vulnerable to mortality or reduced vigor and reproductive output due to indiscriminate use of herbicides or mowing for ROW maintenance. Poorly timed mowing of this ROW prevented flowering and seed production in some plants at this site in 2008; however, the Alabama Department of Conservation and Natural Resources (ADCNR), Alabama Department of Transportation, and Cherokee County Highway Department cooperated in placing signs at the site to mark the presence of whorled sunflower and attempt to prevent this in the future (Dr. Wayne Barger, Botanist, ADCNR, pers. comm., February 10, 2009); although, periodic replacement might be needed due to vandalism or removal of the signs (Barger, pers. comm., March 6, 2012). In Mississippi, whorled sunflower plants discovered growing in a road ROW in August 2017 were apparently been sprayed with herbicide during the intervening weeks between the initial discovery and a follow-up visit later in the month, which visibly stressed the plants, but did not apparently kill them (Brandon, pers. comms., August 12, 2017, and August 17, 2017). These plants remained extant into 2018 (Brandon, pers. comm., August 6, 2018); however, follow-up visits in 2020 could not relocate plants within the ROW (Breeden, pers. comm., September 14, 2020). Both of Mississippi's remaining two populations also occur in road ROWs and are vulnerable to similar indiscriminate herbicide application. Similarly, plants extending onto a roadside within a power line ROW at the Madison County, Tennessee population were sprayed with herbicide during roadside and power line maintenance in 2004, causing significant mortality (David Lincicome, Rare Species Protection Program Administrator, TDNA, pers. comm., September 22, 2006; Andrea Bishop, Botanist, TDNA, pers. comm., February 21, 2008). Likewise, plants extending into the railroad ROW at the McNairy County, Tennessee, population are vulnerable to adverse effects from potential indiscriminate herbicide application used for railroad ROW maintenance, but installation of appropriate signage may alleviate this threat. A small cluster of plants in one of Georgia's subpopulations is located on the bank of a road adjacent to the Coosa Valley Prairie easement area and is not protected. These examples indicate that incompatible vegetation management (such as indiscriminate herbicide application or poorly timed mowing) along transportation and utility ROWs could adversely affect whorled sunflower populations in Alabama, Mississippi, and Tennessee, and a small subpopulation in Georgia. Regular coordination with parties responsible for maintenance of these ROWs locations will be necessary to avoid future adverse effects to local whorled sunflower populations from indiscriminate mowing or herbicide application (USFWS, 2023).

Stressor: Agricultural Practices and Land Conversion (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Whorled sunflower has not been rediscovered at the type locality in Tennessee despite intensive surveys of that area (Nordman 1998, pp. 1–2, Nordman 1999, p. 2). This record is from an 1892 collection and locality information is vague (Matthews et al. 2002, p. 13), so it is not possible to determine why this population was lost. In Tennessee, much of this species' suitable habitat has presumably been converted to agricultural use, as substantial proportions of the counties in the state where the species has been found have been in row crop production since 1850 (Table 3) (Waisanen and Bliss 2002, p. 13; geographic information system [GIS] data available at http://landcover.usgs.gov/cropland, accessed January 9, 2013). Because this species was not seen following the initial 1892 collection until it was rediscovered in 1994, and was not seen again in Tennessee until 1998, it is impossible to be certain about the historical distribution and abundance of its habitat. However, the data presented in Table 3 indicate that land conversion to agricultural uses has a long and sustained history in the Tennessee counties where whorled sunflower has been found and has likely contributed to loss of the species' habitat and populations (USFWS, 2023).

Stressor: Shading and Competition (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Absent natural or human-caused disturbance, habitats where whorled sunflower occurs are threatened by succession of vegetation to a shrub-dominated or forested condition. The largest concentration of plants at the Madison County, Tennessee, population is in a successional old field approximately 1 ha (2.5 ac) in size, which has become almost entirely wooded (Lincicome, pers. comm., November 30, 2017), degrading the largest patch of contiguous habitat where most of this population occurs. Woody species present at this site include Acer negundo (box elder), Liquidambar styraciflua (sweetgum), and Salix nigra (black willow) (TDNA 2006, p. 5), all of which can rapidly invade moist old-field habitats if left unmanaged. No conservation agreements or management plans are in place to ensure that this site receives periodic disturbance to maintain open conditions needed for the growth and sexual reproduction of whorled sunflower. Invasive plants, including, Lonicera japonica (Japanese honeysuckle), Microstegium vimineum (Nepalese browntop, Japanese stiltgrass), and Rosa multiflora (multiflora rose), have been noted at both natural populations in Tennessee (Caitlin Elam, Botanist, Division of Natural Areas, Tennessee Department of Environment and Conservation, pers. comm., October 14, 2019). Likewise, the invasive Ligustrum sinense (Chinese privet) is a persistent problem for Georgia's population (USFWS, 2023)

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Since 1970, the average annual temperature across the Southeast has increased by about 2°F, with the greatest increases occurring during winter months. The geographic extent of areas in the Southeast region affected by moderate to severe spring and summer drought has increased over the past three decades by 12 and 14 percent, respectively (Karl et al. 2009, p.

111). These trends are expected to increase. Rates of warming are predicted to more than double in comparison to what the Southeast has experienced since 1975, with the greatest increases projected for summer months. Depending on the emissions scenario used for modeling change, average temperatures are predicted to increase by 4.5°F to 9°F by the 2080s (Karl et al. 2009, p. 111). While there is considerable variability in rainfall predictions throughout the region, increases in evaporation of moisture from soils and loss of water by plants in response to warmer temperatures are expected to contribute to increased frequency, intensity, and duration of drought events (USFWS, 2023)

Recovery

Reclassification Criteria:
CRITERION 1. At least 20 geographically distinct populations—separated by at least 1 mile (1.6 kilometer)—of at least moderate size (at least 100 individuals) are distributed across the species' range, with each of the 4 known ecoregions (Loess Plains, Northern Hilly Gulf Coastal Plain, Southern Crystalline Ridges and Mountains, and Southern Shale Valleys)1 supporting at least 3 such populations, including 1 population within each of the 4 designated critical habitat units. (Addresses Factors A and E.) (USFWS 2023).

CRITERION 2. At least 3 large populations (at least 500 individuals), protected by long-term conservation mechanisms, occur in each of the 4 known ecoregions, for a total of 12 protected populations, and are managed to promote open-canopied habitat, native plant community integrity, and support resilient populations2 of whorled sunflower. (Addresses Factors A, D, and E.) (USFWS, 2023).

CRITERION 3. Monitoring demonstrates that these populations (described in Criteria 1 and 2) are viable, as evidenced by natural recruitment and having stable to increasing populations for at least 10 years (approximately 10 generations). (Addresses Factor E.) (USFWS, 2023).

Recovery Priority Number: 5

Delisting Criteria:
Whorled sunflower may be considered for delisting when the above criteria are met and when:
CRITERION 4. At least 20 additional geographically distinct populations of at least moderate size occur within the species' known range for a total of at least 40 extant populations. (Addresses Factors A and E.) (USFWS, 2023).

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Avoiding areas located in close proximity to whorled sunflower sites when planning for establishing new sites for agriculture or pulpwood and timber production (USFWS, 2014).
- Ensuring that herbicide use or mowing does not occur in whorled sunflower sites during the species' growing season (USFWS, 2014).
- Locating suitable habitat, determining presence or absence of whorled sunflower, and protecting or restoring as many sites or complexes of sites as possible (USFWS, 2014).
- Managing, including prescribed burning, mowing, and bush hogging, to reduce canopy cover, minimize competition from native and invasive, nonnative plants, and maintain characteristic moist prairie vegetation (USFWS, 2014).

- Reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat (USFWS, 2014).
- Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat (USFWS, 2014).
- 1. Work with rights-of-way stakeholders to develop and implement management agreements (USFWS, 2023).
- 2. Work with federal and state agencies, non-governmental conservation organizations, and private landowners to obtain protection for populations on privately owned lands (USFWS, 2023).
- 3. Work with partners and stakeholders to develop and implement management plans for all populations (USFWS, 2023).
- 4. Work with partners and stakeholders to develop and implement a monitoring strategy for all populations (USFWS, 2023).
- 5. Increase the representation and genetic diversity of ex situ (offsite) safeguarding collections of whorled sunflower (USFWS, 2023).
- 6. Facilitate and support surveys to identify new whorled sunflower populations (USFWS, 2023).
- 7. Population augmentation and establishment (USFWS, 2023).
- 8. Conduct research that enhances knowledge of whorled sunflower biology and ecology to facilitate the development of scientifically sound management plans, population viability models, and species/habitat distribution models (USFWS, 2023).
- 9. Coordinate with federal, state, county, and local agencies, and other stakeholders to promote whorled sunflower recovery and identify innovative ways to increase public awareness of the need to protect this species and its habitats (USFWS, 2023).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Finalize the recovery plan. 2. Continue and expand work with federal and state conservation agencies, nongovernmental organizations, right-of-way owners and managers, and private individuals and organizations to protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. 3. Safeguard representative genetic material from all known populations. 4. Search for new populations. 5. Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. 6. Conduct studies into the species' life history, biology, and ecology to improve management of the species and its habitat. 7. Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity and long-term viability. 8. Investigate metapopulation structure and dynamics of the species. (USFWS, 2020)

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Designation of Critical Habitat for Physaria globosa (Short's bladderpod), Helianthus verticillatus (whorled sunflower), and Leavenworthia crassa (fleshy-fruit gladecress)

Final Rule. 79 Federal Register 165. August 26, 2014. Pages 50989 - 51039

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SPECIES ACCOUNT: *Heritiera longipetiolata* (ufa-halomtano)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree (USFWS, 2015).

Taxonomy

A member of the hibiscus family (Malvaceae) (USFWS, 2015).

Historical Range

Historically, Heritiera longipetiolata is reported from Guam, Rota, Saipan, and Tinian (USFWS, 2015).

Current Range

It currently occurs on Guam, Saipan, Tinian, and Rota (Marian Islands) (USFWS, 2015).
Distribution: Guam, Saipan, Rota, Tinian (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: Long (USFWS, 2023)

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the forest ecosystem (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

19 (USFWS, 2023)

Population Size:

> 2,000 (USFWS, 2023)

Population Narrative:

Currently, H. longipetiolata is known from 10 occurrences totaling approximately 200 individuals. On Guam, H. longipetiolata is presently known from 4 occurrences, totaling approximately 90 individuals; on Tinian, there are between 30 and 40 individuals of H. longipetiolata, and possibly more in adjacent forested areas (Spaulding 2013, in litt.; Williams 2013, in litt.; Spaulding 2015, in litt.); on Saipan, H. longipetiolata is known from 3 occurrences, totaling at least 53 individuals, with several hundred seedlings beneath the trees (Camacho and Micronesian Environmental Services (MES) 2002, pp. 38–39); and on Rota, more recent information indicates that there is at least one known individual of H. longipetiolata (Cook 2010, in litt. cited in CNMI–DLNR 2015, in litt.) (USFWS, 2015). There are approximately 15 populations of Heritiera longipetiolata containing 1,838 adult and immature plants and more than 11,000 naturally occurring seedlings distributed on Guam, Rota, Tinian, and Saipan. GPEPP and Rota Forestry have successfully propagated and translocated this species, and efforts are ongoing. One population of H. longipetiolata, with 18 individuals, is within an ungulate-fenced area (Ritidian Point, Andersen Air Force Base, Guam, DoN 2018 in litt), but the majority of populations have no ongoing control of any threats, and no genetic storage collection has been established except for one wild tree from Mangilao in the GPEPP nursery (USFWS, 2020). Number of Known Populations: 19. Number of Individuals in the Wild in the Marianas : > 2,000 (USFWS, 2023).

Threats and Stressors

Stressor: Development, military training, and urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In their 2015 Final SEIS (http:// guambuildupeis.us/) (see ‘‘Historical and Ongoing Human Impacts,’’ above), the U.S. Department of Navy states that approximately 5,000 Marines will be relocated from Okinawa to Guam, accompanied by approximately 1,300 dependents, with a concurrent introduction of support staff and development of infrastructure, and increased use of resources such as water (Berger et al. 2005, p. 347; JGPO– NavFac, Pacific 2015, p. ES–3). The current preferred alternative sites on Guam for cantonment and live-fire training include the Naval Computer and Telecommunications Station Finegayan and Northwest Field on Andersen AFB, where this species occurs. The northern two-thirds of Tinian are leased by the U.S. Department of Defense, and the development of these lands and effects from live-fire training will directly impact this species. In November 2007, the people of Rota voted to legalize casino gambling to increase tourism, and two development projects have been proposed. Development around and within forested areas on Rota will also directly impact the forest habitat and

individuals of this species (USFWS, 2015).

Stressor: Feral ungulates (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Cattle ranching is gaining in popularity, and in the future the number of cattle is expected to double from 1,500 individuals (Bagnol 2014, in litt.; NRCS 2015, in litt.). The number of cattle ranchers on Tinian has risen from 10 or 12 in 2010, to 49 ranchers by 2014 (Bagnol 2014, in litt.). As numbers of cattle and ranchers increase on Tinian, there may be a somewhat greater risk of cattle potentially escaping and becoming feral. Both feral and domestic cattle can drastically alter the landscape (Wiles et al. pp. 176–177), and depending on the location and amount of land designated as pasture land for domestic cattle, negative impacts to the forest ecosystem may be observed in the future. Several herds of Asiatic water buffalo or carabao roam southern Guam and the Naval Magazine area, and cause damage to the forest and savanna ecosystems that support this species. Observations and reports have documented that pigs and deer browse and trample this species (USFWS, 2015).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 5

Minimum Number of Stable Populations: 5. Reproducing Individuals / Population: 200 (USFWS, 2023)

Delisting Criteria:
Not available - this species does not have a recovery plan.

Minimum Number of Stable Populations: 10. Reproducing Individuals / Population: 200 (USFWS, 2023)

Recovery Actions:

- Not available - this species does not have a recovery plan.
- In 2012, the Guam Plant Extinction Prevention Program (GPEPP) was formed to address conservation concerns for a select group of native Mariana Islands plant species, including Heritiera longipetiolata. GPEPP is a partnership between the University of Guam (UOG), multiple Federal agencies (USFWS, DOD, and USDA), Hawaii State DLNR, and the Hawaii Plant Extinction Prevention Program (Hawaii PEPP). The goal of GPEPP is to prevent the extinction of native Mariana Islands plant species that have fewer than 200 individuals remaining in the wild on the island of Guam (GPEPP 2014, in litt.). The program's main objectives are to monitor, collect, survey, manage, and reintroduce native plant species in the Mariana Islands. They plan to work with conservation partners to protect wild populations and preserve genetic material (GPEPP 2014, in litt.) (USFWS, 2015).
- Threat and Recovery Potential: Full species with a high degree of threat and a low degree of recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine population status and current distribution—Determine the distribution and number of all individuals on each island. Assess the status and threats to each population to inform prioritization of conservation effort. • Conduct research to clarify life history information and threats to the populations and their habitat—Conduct research to determine the best way to control the brown treesnake, rodents, and invasive invertebrates. Assess development and land designation and zoning threats to conservation of habitat needed for recovery. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species and those that compete with H. longipetiolata at all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction. • Reintroduction and translocation—Augment population and increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of predation and typhoons, and climate change. • Reduce human disturbance from military activities mortality and reduced viability— increase population resiliency by mitigating threats from military activities. • Develop regulations and policy essential to recover the species and their habitats— Encourage the development of legislation to ensure protection of the listed species under Commonwealth or Territorial law. Develop and support the implementation of biosecurity plans to prevent the influx of new pests and invasive species into the Territory and inter-island movement of pests and invasive species • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and inventories – • The USFWS recommends all sites containing suitable habitat be surveyed for Heritiera longipetiolata prior to implementation of projects entailing vegetation or soil disturbance. • Joint Region Marianas (JRM) surveyed for ESA-listed species, including H. longipetiolata, at the Naval Munitions Site (NMS) and Naval Base Guam Telecommunication Site, Tarague Triangle, MSA Igloos, THAAD, and other projects to document locations and estimate population densities in sites that are proposed for ungulate exclusion and forest restoration (JRM 2019 and 2020). • Captive propagation for genetic storage and reintroduction • The Guam Plant Extinction Prevention Program (GPEPP) has propagated 69 individuals of H. longipetiolata in the GPEPP's nursery and translocated these individuals in various locations: 27 individuals near the University of Guam Marine Lab; 32 individuals in Yigo OP1; 7 individuals in Yigo OP2; and 3 individuals at the Guam National Wildlife Refuge (GPEPP 2015, in litt.; GPEPP 2019, in litt.). In 2018, GPEPP had nine plants in their nursery from the Mangilao population representing a single wild tree that were being grown for translocation (GPEPP 2018). • CNMI Forestry-Rota has been propagating H. longipetiolata, and have been conducting translocations since 2014 (USFWS 2017, p. 118). They currently do not have an ex situ collection of this species (CNMI 2018). • Habitat protection – • A major biosecurity focus within the Mariana Islands is preventing the spread of BTS to the CNMI from Guam. Federal agencies support local capacity both in Guam and the CNMI. Efforts include inspection of all arriving cargo from Guam to the CNMI by BTS detection dogs as well as specialized trapping around all major ports of entry. The Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs (U.S. Geological Survey, USFWS), are using aerial applications of acetaminophen to suppress BTS over forested areas in AAFB (Dorr, et al. 2016, in litt.; Phillips 2014,

in litt; BTSTWG 2015, entire). In addition, repeated and sustained applications could drastically reduce BTS abundance on a landscape scale (Siers, et al. 2018, in litt.). • An island-wide Habitat Conservation Plan for Guam, that would provide a collaborative and comprehensive approach to endangered species conservation on non-federal lands, is beginning to be developed (USFWS 2020). • A 2020 Memorandum of Understanding between JRM and the USFWS outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative (REPI) to address conservation of upland vegetation communities (DON and USFWS 2020). • Plans to exclude deer and pigs from 165 acres of North Haputo Ecological Reserve Area, where Heritiera longipetiolata is known to occur, with ungulate fencing have been developed (USFWS 2017). • Other Natural or Manmade Factors - Ordnance – Range Fire Management Plan for Marine Corps Ranges on Guam. A range fire management plan to reduce range/wildfire potential, protect and enhance natural and cultural resources, integrate applicable permit and reporting requirements and implement ecosystem management goals, sustainable training, and objectives already supported on existing Marine Corps installations is being drafted (JRM 2019). (USFWS, 2020)

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SPECIES ACCOUNT: *Hesperolinon congestum* (Marin dwarf-flax)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/03/1995; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with linear leaves and slender stems, generally 5-15 cm tall but occasionally reaching 40 cm. Flowers (May-July) are white to rose-colored with purple anthers; they are borne in congested clusters. Anthers are purple at time of pollen release. 3 carpels and styles (NatureServe, 2015).

Taxonomy

A member of the flax family (Linaceae) (USFWS, 2011). J. K. Small (1907) established Hesperolinon as a distinct genus in 1907 (USFWS, 1998).

Historical Range

Its historical range has not been established, but likely included all occurrences at the time of listing, as well as extirpated occurrences on former serpentine areas in San Francisco and San Mateo Counties that are now urban development (USFWS, 2011).

Current Range

It is known to occur in serpentine soils in San Mateo, San Francisco, and Marin Counties, typically in association with bunchgrasses, chaparral, or other dry grasslands (USFWS, 2023).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1998)

Lifespan

Adult: 1 year (NatureServe, 2015)

Breeding Season

Adult: May - July (USFWS, 2011)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 1998)

Reproduction Narrative

Adult: This species is an annual (NatureServe, 2015). The species generally flowers from early May through June or July, and is sensitive to the amount and timing of rainfall (USFWS, 2011). The species is pollinated by native insects including bee flies and pollen beetles (Robison and

Morey 1992a) (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grasslands and chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 100 - 1,200 ft. elevation (USFWS, 1998)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from USFWS, 2011)

Habitat Narrative

Adult: Inhabits grasslands and chaparral on serpentine soils. The environmental specificity is very narrow; it is a narrow serpentine endemic only known from serpentine sites in parts of the S. F. Bay area (NatureServe, 2015). Serpentine soils are formed from weathered volcanic rock, with a low calcium-magnesium ratio, lack of soil nitrogen, potassium, or phosphorus, and elevated heavy metals (mineral toxicity). It is believed that Hesperolinon congestum's tolerance for this soil chemistry allows it to grow where most other plant species cannot (USFWS, 2011). Known populations occur between approximately 30 and 370 meters (100 to 1,200 feet) (California Natural Diversity Data Base 1996) (USFWS, 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

23 extant (USFWS, 2023)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Additional Population-level Information:

The final listing rule did not provide abundance estimates for any of the known Marin dwarf-flax occurrences but did note they can fluctuate in size from hundreds to thousands of plants (Robison and Morey 1992, p. 7; Service 1995, p. 6675). In the previous 5-year review we stated abundance estimates for most locations had been occasional and often qualitative, and when recorded would vary greatly among occurrences and between years. Similar to the previous review, we do not have abundance estimates for most locations; however, for the locations we do have data for, abundance varied greatly (Chassé et al. 2019; Williams and O'Herron 2019, p. 68; Diversity Database 2020) (see Appendix, Table B). The widespread variability in Marin dwarfflax abundance is not surprising as numbers are known to be greatly affected by rainfall, with more individuals in years with abundant spring rains (Service 2011, p. 6). Because of this variability, it is difficult to determine population dynamics and trends of each occurrence without multiple years of tracking, and currently only a few occurrences of Marin dwarf-flax are being regularly monitored (see Appendix, Table B). Moreover, for many occurrences the only available information is what was submitted to the Diversity Database, which often includes little quantitative information on the species, making it difficult to analyze abundance trends (USFWS, 2023).

Population Narrative:

Vulnerable due to its fluctuating population numbers based on rainfall and due to its frail, annual habit. The population numbers of this annual fluctuate with rainfall. There may be a few hundred at a site one year and 10's of thousands the next. One recently reported site at Lucasfilms property had 200,000 plants one year. The total estimated population size is 10,000 - 1,000,000. The long term trend for this plant is one of severe decline due to urbanization of its habitat; decline of 50-70%. This species has experienced a short term decline of 10 - 30% due to urbanization. The population numbers of this annual fluctuate with rainfall. There may be a few hundred at a site one year and 10's of thousands the next. One recently reported site at Lucasfilms property had 200,000 plants one year (NatureServe, 2015). At the present time, there are 23 extant occurrences of the species (USFWS, 2011). The 1995 final listing rule stated there were fourteen known occurrences: six from Marin County, one from San Francisco County, and seven from San Mateo County (Service 1995, p. 6679). The previous 5-year review reported 23 extant, 2 unreliable, and 5 extirpated occurrences of the Marin dwarf-flax. Of these extant occurrences, 11 were from Marin County, 2 from San Francisco County, and 10 from San Mateo County (Service 2011, pp. 3–6). Currently, there are 23 extant occurrences, 1 unreliable occurrence, 2 possibly extirpated occurrences, and 1 extirpated occurrence reported in the Diversity Database (2020) (see Appendix, Table A). Although CNDDB labels 23 occurrences as “Presumed Extant,” most of these occurrences have not been seen and/or surveyed in several years and therefore are labeled as “Unknown” in the Appendix, Table A. Since the previous 5-year review, two new occurrences have been reported to the Diversity Database (occurrence #34 and #35) and some of the previous occurrences have been combined (#30 included in #3, #2 included in #1, #15 included in #14, and #10 included in #9) (see Appendix, Table A). New occurrence #34 expands the previously known range further north. New occurrence #35 is within the range known at the time of listing. Of the 23 extant occurrences, 13 are from Marin County, 2 are from San Francisco County, and 8 are from San Mateo County (USFWS, 2023)

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The threat of habitat destruction continues in several forms, and varies both regionally and with specific location. Recent information concerning the Alta Robles development indicates there would be some direct impacts to Hesperolinon congestum, as well as likely indirect impacts due to construction at distances of 25-to-125 feet from the species and/or potential habitat (MCL 2011; MIJ 2010; Town of Tiburon 2010). These distances are far less than the 500-foot buffer recommended in our Recovery Plan for protection of this species (FWS 1998). Not only do such developments result in direct losses of the species and its habitat where the development takes place, but could result in numerous indirect effects on adjacent areas due to runoff, landslides, foot traffic, dogs, and non-native plant competition. These indirect effects may occur on both private and public lands, particularly in areas which lack permanent protections. Such indirect effects are likely to be ongoing to some extent at all of the Tiburon populations due to nearby developments. Based on information provided by the SFPUC and review of Service files, several planned actions may affect the species (E. Natesan, SFPUC, pers. comm. 2011). One such activity is the Crystal Springs/San Andreas Transmission Upgrade project, whose modest effect on Hesperolinon congestum will be mitigated through conservation and enhancement measures addressed in formal consultation (FWS 2010; Table 2). There is also a planned dam improvement project for Crystal Springs Reservoir which could affect Hesperolinon congestum or presently unoccupied serpentine area which is potential habitat over a more widespread area by allowing a higher maximum water level than at the present time. More development, even without actual direct impacts, may indirectly impact Hesperolinon congestum through occasional foot traffic, or local atmospheric pollutants. These effects have not yet been evaluated (USFWS, 2011).

Stressor: Ground disturbance (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Ground disturbance in serpentine areas from unmonitored casual recreational activities continues to be a threat to the species. Hiking and biking activity has been mentioned as a potential or actual threat for at least fourteen occurrences. At Middle Ridge (#8), unleashed dogs are mentioned to be the main cause of ground disturbance (often by professional dog-walkers), and hiking and bike traffic were also noted (Bittman, in litt. 2009a, 2009b; Buxton, in litt. 2010, pers. comm. 2011; LSA 2010) (USFWS, 2011).

Stressor: Succession (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Atmospheric nitrogen deposition derived from combustion sources like motor vehicles and industry in urban areas may be enriching otherwise low-nutrient serpentine soils. This may be allowing other native and nonnative plant species, such as rye grass (Lolium spp.) or wild oats (Avena spp.), to invade some serpentine areas and compete with serpentine specialist species such as Hesperolinon congestum. Over time, thatch and soil buildup from the invading plants can further enrich serpentine soils. Based on the estimated critical load of 4.5-5.0 kg-N/ha/year for

serpentine natives such as Hesperolinon congestum, nitrogen is a potential threat to this species throughout its range with the exception of more rural parts of Marin County (Weiss, in litt. 2011; Fenn et al. 2010). Studies in the south bay suggest that non-natives have had an effect on other native serpentine plants at Edgewood Park (Weiss 1999), although it has not yet been demonstrated for Hesperolinon congestum in particular (USFWS, 2011).

Stressor: Maintenance activities (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Maintenance as a potential threat was noted at a number of locations and in various forms. Maintenance activities identified since listing included access roads, pipeline maintenance, highway maintenance, disking, herbicide spraying, and "other" maintenance. Maintenance can have a direct effect by disturbing the plants and its habitat, or indirect effects by altering the hydrology/runoff or land stability of a site (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Preliminary results indicate an increase in average maximum summer air temperature at Golden Gate National Recreation area, located near the Presidio (near occurrences #16 and 20), and a statewide reduction in fog frequency (Madej et al. 2010; Johnstone and Dawson 2010). Hesperolinon congestum abundance and flowering period is believed to be affected generally by year-to-year variations in rainfall, so it may be sensitive to climate change. However, there is inadequate information to make accurate predictions regarding its effect on this species at this time (USFWS, 2011).

Stressor: Stochastic events (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Low plant number remains a threat to the smaller population size occurrences of Hesperolinon congestum. The small areas of these occurrences render them susceptible to extirpation as a result of localized stochastic events or disturbances from threats already discussed (USFWS, 2011).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Delisting Criteria:
1. Secure and protect specified recovery areas from incompatible uses: Occupied habitat or 21 populations representing the range of the species along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer (USFWS, 2011).

2. Management plan approved and implemented for recovery areas, including survival of the species as an objective; for all populations and any occupied or unoccupied habitat identified as essential to survival (USFWS, 2011).

3. Population monitoring in specified recovery areas shows stable or increasing plant numbers for a period of 20 years that include the normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2011).

Recovery Actions:

- Habitat protection (USFWS, 1998).
- Habitat management and restoration, including removal of invasive non-native species (USFWS, 1998).
- Surveying and monitoring (USFWS, 1998).
- Ex-situ conservation measures such as artificial rearing and seed banking (USFWS, 1998).
- Research (USFWS, 1998).
- Public participation, outreach, and education (USFWS, 1998).
- Secure and protect all occurrences and potential (unoccupied) serpentine grassland habitat necessary for recovery of Hesperolinon congestum on SFPUC lands in the Crystal Springs group (as previously mentioned, our Formal Consultation applies only to a portion of the occurrences, see FWS 2011). The conservation easements, together with a comprehensive and complete management plan, should be sought to permanently protect all occurrences and potential habitat from future habitat loss due to changes in land use. The management plan should include provisions for monitoring, actions as necessary to quantify and address threats of non-native species encroachment, and means to resolve foreseeable potential conflicts created by human use or operations and maintenance activities (USFWS, 2011).
- Secure and protect to the maximum extent practicable, all occurrences and potential (unoccupied) serpentine grassland habitat necessary for recovery of Hesperolinon congestum at the St. Hilary's Church (#6) and Middle Ridge (#8) locations. In addition to recreational and non-native plant threats, portions of these sites are believed to be imminently threatened by potential conversion to housing developments. Avoidance of any loss is the preferred strategy. Permanent conservation easements should be sought to preclude future loss. One venue for Service participation would be during consultations pursuant to issuance of a permit from the Corps under CWA Section 404. Additionally, there need to be assurances that management, including regular monitoring and corrective action, will be timely implemented as needed to address other primary threats of non-native vegetation and human passive use. Reported adverse human impacts from recreational uses (primarily dog-walking; other uses mentioned include hiking, biking, photography, horse-back riding, photography) to this species or its habitat should be investigated, monitored, and prevented by necessary means, including restricted use/entry where other means have proven ineffective (USFWS, 2011).
- Surveys should be conducted at least once (preferably more often) in this next five years at all known locations of Hesperolinon congestum. In order of priority, surveys should be done for the 10 sites for which this review found no observational information at all in the last five years (#17, 5, 1, 30, 3, 21, 22, 31, 23, and 28), the non-CNDDB site (a), and all other sites. A survey protocol should be developed, which will ideally allow detection of the peak flowering period, a reasonable estimate of population area and size, photodocumentation (of entire area, and closeups of plant forma), establishment of reproducible photo points,

and a rapid assessment of the extent of visible threat factors of human-caused ground disturbance, and non-native/native species invasion (USFWS, 2011).

- Assess the effectiveness of one or more weed control measures on Hesperolinon congestum. This may involve comparing weed densities in areas (occurrence area and adjacent buffer) which are controlled for weeds versus those which are not, or evaluating a chronosequence before, during, and after weed control measures; or comparing different measures. For example, where grazing is used, a study might seek to establish empirical relationships between the control measure (e.g., grazing or grazer density) and weed densities, and the response by Hesperolinon congestum (or lack thereof) (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Marin dwarf-flax. Recommendations #2–5 were discussed in the previous 5-year review (Service 2011, pp. 19–20) and remain valid. 1. Work with partners to develop a standardized methodology to delineate Marin dwarf-flax populations to allow the Service and partners to accurately assess population trends. 2. Secure and protect all occurrences and potential habitat (i.e., unoccupied serpentine grasslands) necessary for recovery of Marin dwarf-flax on SFPUC lands in the Crystal Springs group. Conservation easements, together with a comprehensive and complete management plan, should be sought to permanently protect all occurrences and potential habitat from future habitat loss due to changes in land use. The management plan should include provisions for monitoring, actions as necessary to quantify and address threats of non-native species encroachment and means to resolve foreseeable potential conflicts created by human use or operations and maintenance activities. 3. Secure and protect to the maximum extent practicable, all occurrences and potential habitat (i.e., unoccupied serpentine grasslands) necessary for recovery of Marin dwarfflax at the St. Hilary's Church (Diversity Database #6) and Middle Ridge (Diversity Database #8) occurrences. In addition to recreation and non-native plant encroachment, portions of these sites are threatened by potential conversion to housing developments. Avoidance of any loss is the preferred strategy and permanent conservation easements should be sought to preclude future loss. Additionally, there need to be assurances that management, including regular monitoring, will be implemented as needed to address other primary threats of non-native vegetation and recreational use. Reported adverse human impacts from recreational uses (primarily dog-walking; other uses mentioned include hiking, biking, photography, horse-back riding, photography) to this species or its habitat should be investigated, monitored, and prevented by necessary means, including restricted use/entry where other means have proven ineffective. 4. Conduct surveys at least once (preferably more often) over the next five years at all known locations of Marin dwarf-flax. Develop a survey protocol, which will ideally allow detection of the peak flowering period, a reasonable estimate of occupied area and size, photo documentation (of entire area, and closeups of plant forma), establishment of reproduceable photo points, and a rapid assessment of the extent of visible threat factors of human-caused ground disturbance, and non-native/native species encroachment. 5. Assess the effectiveness of one or more weed control measures on promoting Marin dwarf-flax growth. This may involve comparing weed densities in areas (occurrence area and adjacent buffer) which are controlled for weeds versus those which are not, evaluating areas before, during, and after weed control measures, or comparing different measures. For example, where grazing is used, a study might seek to establish empirical relationships between the control measure (e.g., grazing or grazer density) and weed densities, and the response by Marin dwarf-flax (or lack thereof). 6. There are a variety of other key research needs for the recovery of this species mentioned in our recovery plan that should also be conducted, including: (1) studies on the effects of vegetation management

practices (grazing, burning, herbicide), fertilizer, and runoff; (2) demographic studies such as soil seed bank, and other reproductive features (mating system, pollination); and (3) surveys of potential habitat to identify new occurrences. Surveys of potential habitat could also be useful to identify candidate unoccupied serpentine areas for enhancement (i.e., usually tree/scrub removal) and outplanting. Population genetic studies could be done to determine the extent of differentiation throughout the species' range and how this compares to phenotypic variation noted between occurrences (Smith, in litt. 2011a in Service 2011, p. 7, cover photo). These studies may be useful to select outplanting material should unoccupied restoration sites be identified. If such studies are warranted, collection and preservation of material for genetic study could be done at the same time of surveys (recommendation #2, above). As mentioned in the Recovery criteria section above, there is also a need to refine the recovery criteria in order to objectively assess progress towards recovery. These actions and others listed in our recovery plan may be essential for recovery of the species but may require additional information and analysis to prioritize and implement (USFWS, 2023).

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SPECIES ACCOUNT: *Hexastylis naniflora* (Dwarf-flowered heartleaf)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015)

Physical Description

A stemless perennial herb with mottled heart-shaped leaves 4-6 cm wide, supported on thin leaf-stems arising from an underground rhizome. Small dark brown or maroon-splotched flowers are borne near the rhizome tip, sometimes not rising above the leaf litter. Blooms in April and May. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Reported from Cherokee, Greenville and Spartanburg counties, South Carolina; and Cleveland, Catawba, Burke, Rutherford and Lincoln counties, North Carolina. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: This species jug-shaped flowers are usually beige to dark brown in color and appear from mid-March to early June (USFWS, 1988).

Reproduction Narrative

Adult: This species jug-shaped flowers are usually beige to dark brown in color and appear from mid-March to early June. The flowers are small and inconspicuous and are found near the base of the petioles. The fruit matures from mid-May to early July (Blomquist 1957, Gaddy 1980, 1981) (USFWS, 1988).

Habitat Type

Adult: Forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Site Fidelity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits acidic soils on moist to rather dry north-facing slopes of ravines and along bluffs and hillsides in boggy areas next to streams. Vegetation is typically oak-hickory-pine forests of the Piedmont (NatureServe, 2015). Moderate ecological integrity of the community, site fidelity and tolerance ranges are inferred based on the species habitat requirements, number of populations and relatively wide geographical representation (six counties).

Dispersal/Migration

Population Information and Trends

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Two populations with at least 1000 individuals each (1981) are on registered properties. Sixty populations as of 1997. There were 24 known populations in 1989, of which 4 were protected (NatureServe, 2015). Moderate resiliency, representation and redundancy are inferred based on the number of known populations and individuals.

Threats and Stressors

Stressor: Urban development (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urban development is listed as a threat to this species (USFWS, 2011)

Stressor: Trash disposal (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Trash disposal (as a result of urbam development) is listed as a threat to this species (USFWS, 2011).

Stressor: Residential lawns (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Expansion of residential lawns is listed as a threat to this species (USFWS, 2011).

Stressor: Cattle (USFWS, 2011)

Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Cattle (mostly due to trampling) are listed as a threat to this species (USFWS, 2011).

Stressor: Invasive exotic plants (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive exotic plant species are rampantly spreading throughout riparian corridors and ravines across the range of this species. Invasive exotics such as English Ivy (Hedera helix), Chinese privet (Ligustrum spp.), Japanese honeysuckle (Lonicera japonica) and Japanese Nepal grass (Microstegium vimineum) are known to threaten several populations; however, the scope and magnitude of this threat has not been comprehensively assessed. This threat requires active management in order to be successfully abated. At present, the majority of protected populations are secured against habitat conversion, but lack designated managers with the technical expertise and available resources (funding and personnel) to address this threat (USFWS, 2011).

Stressor: Road and bridge improvements (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Road and bridge improvement projects are listed as a threat to this species (USFWS, 2011).

Stressor: ROW maintenance (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individulas
Narrative: Rights-of-way maintenance is listed as a threat to this species (USFWS, 2011).

Stressor: Hydroelectric and drinking water reservoirs (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Hydroelectirc and drinking water reservoir expansion and maintenance are listed as threats to this species (USFWS, 2011).

Stressor: Fire management (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: A final example of habitat modification bears mentioning here, although it is presently unknown whether the long-term effects to H. naniflora will be adverse or beneficial. One of the largest remaining populations of the species occurs at Cowpens National Battlefield in Cherokee County, South Carolina (Tables B.2 and B.3). This population has been estimated to contain over 10,000 rosettes (Rayner, 2006). NPS has begun using prescribed fire as a vegetation management

tool at this site, pursuant to consultations with USFWS due to the presence of H. naniflora within their prescribed burn units (Bimbi, 2010; Stone, 2010; Wells, 2009; Walker et al., 2009). The scope of NPS's prescribed burning activity is increasing to encompass the majority of this H. naniflora population. Preliminary data suggested that burning has had no adverse effects upon growth or flowering (Walker et al., 2009). USFWS has registered concerns over the limited scope of this two-season monitoring effort and has requested a continuation of monitoring to ensure that this large population is not adversely affected by this experimental management approach (Bimbi, 2010; Wells, 2009). There is little information on the response of H. naniflora to fire, although anecdotal observation from a second site in Caldwell County, North Carolina suggests that the species was not appreciably harmed by a dormant season wildfire that spread through a portion of that population in the winter of 2009 (Tompkins, 2010). The continued use of prescribed burning at Cowpens National Battlefield, if accompanied by continued monitoring of the H. naniflora population, has the potential to significantly inform management strategies for this species (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The North Carolina Plant Conservation and Protection Act (NC State Code Article 19B, § 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, this statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. Plant species are afforded even less protection in South Carolina, where they are protected only from disturbance where they occur on those properties owned by the state and specifically managed as South Carolina Heritage Preserves (SC State Code of Regulations Part 123 § 200-204). There are no other federal or state statutes that afford significant protections to H. naniflora (USFWS, 2011).

Stressor: Drought (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In recent years, the southeast has experienced moderate to severe droughts that many observers have implicated in population declines and poor transplant survivorship (NC NHP, 2010; and references throughout this review). A wildfire, presumably brought on or at least exacerbated by drought conditions, burned portions of one of the largest known populations in 2009 (Foothills Landfill in Caldwell County; Golder and Associates, 2009). Accelerated climate change is expected to increase the frequency and extent of drought conditions across the southeast (Karl, et al. 2009). The extent to which these climate changes will significantly affect populations of H. naniflora is currently unknown (USFWS, 2011).

Recovery

Recovery Actions:

- There is no recovery plan for this species.
- 1. Prepare a recovery outline for the species (USFWS, 2011).

- 2. Convene a meeting of partners with significant knowledge and/or involvement (through ownership, monitoring, or management) with populations expected to play a key role in the recovery of the species. At this meeting: a. Seek confirmation of the current size and spatial extent of all populations estimated to contain more than 1,000 rosettes (e.g., all populations listed in Table B.2). If such information is lacking, prioritize and seek partner assistance for the 2011 field season, to obtain a robust estimate of current population size. b. Seek cooperation from partners for the collection of 2-3 years of baseline monitoring data capable of depicting status and trends in H. naniflora at each focal recovery site. These data would also establish a baseline against which post-delisting monitoring data would be compared (USFWS, 2011).
- 3. Obtain written confirmation of the type of protection afforded to all potentially protected populations, with an emphasis upon the larger populations most likely to represent self-sustaining populations of the species (e.g., Table B.2). This documentation should include: i. the full spatial extent of the known H. naniflora population (either fully or partially in protective ownership), ii. the boundaries of the area subject to protective ownership, iii. a description of the nature of protection afforded to the property (e.g., fee title, conservation easement, deed restriction, NCDOT owned right-of-way, or some other registry or agreement), and iv. provisions for management (including identification of responsible parties) v. landowner agreement to continue to uphold existing levels of protection and management even after the species is removed from the federal list of endangered and threatened species (USFWS, 2011).
- 4. In association with the above efforts, specifically work to address lingering uncertainties and/or increased protections at the following H. naniflora populations, expected to play a key role in the recovery of the species and any associated decisions to remove the species from the federal list: a. Cleveland County Landfill, Cleveland County, NC b. Cliffside Stream Station, Cleveland County and Rutherford Counties, NC c. Forest City Industrial Complex, Rutherford County, NC d. Cowpens National Battlefield, Cherokee County, SC e. Blalock Reservoir, Spartanburg County, SC f. Peters Creek, Spartanburg County, SC (USFWS, 2011).

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SPECIES ACCOUNT: *Hibiscadelphus distans* (Kauai hau kuahiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/29/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Hibiscadelphus distans is a shrub or small tree up to 18 feet (5.5 m) tall with smooth bark and a rounded crown. The green, heart-shaped leaves are 1.5 to 4 in (4 to 10 cm) long with numerous whitish hairs on the underside. The narrow, tubular, curved flowers are approximately 1 inch (2.5 cm) long with persistent leaf-like structures below the flowers. The flowers are greenish yellow, turning maroon with age. The seed pods are woody capsules with five sections, each containing two seeds. This species is readily grown from seeds and can be vegetatively propagated from cuttings. (USFWS, 1996)

Taxonomy

Hibiscadelphus distans was discovered on Kauai in June 1972 by L. Earl Bishop and Derral Herbst (1973) in the lower reaches of Waimea Canyon. They named it Hibiscadelphus distans because of its geographic isolation and morphological differences from other known species. Its morphological characters suggest that it represents the earliest evolutionarily divergent lineage for this genus (Hobdy 1984). (USFWS, 1996). In the Malvaceae family (USFWS, 2017).

Historical Range

The original population found by Bishop and Herbst in 1972 was located within the State-owned Na Pali Kona Forest Reserve, Koaie Canyon. (USFWS, 1996)

Current Range

Hibiscadelphus distans is currently found in Koaie Canyon, Kauai. (NatureServe, 2015). Island Distribution: Kauai (USFWS, 2021c)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1996). Narrow extant range and obligate outcrosser (USFWS, 2021c)

Lifespan

Adult: Long lived perennial shrub (USFWS, 2017). Long (USFWS, 2021c)

Dependency on Other Individuals or Species

Adult: Bird pollinators, specifically honey-eaters and honeycreepers (USFWS, 1996)

Reproduction Narrative

Adult: This species is readily grown from seeds and can be vegetatively propagated from cuttings. Trees in cultivation have begun flowering in 3 years, but the age at which trees in the wild begin flowering is unknown. The narrow, curved flowers produce abundant nectar, indicating that they may have had an important pollination-feeding relationship with one native bird family, Meliphagidae (honey-eaters), and one subfamily, Drepanidinae (honeycreepers) (Hobdy 1984). (USFWS, 1996)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Found in areas with full sun in summer, approximate annual rainfall of 60 in, and yearly mean temperatures ranging from 64 to 82 degrees Fahrenheit. (USFWS, 1996)

Environmental Specificity

Adult: Narrow, with several key requirements (USFWS, 1996)

Habitat Narrative

Adult: The naturally occurring Hibiscadelphus distans in Lower Koaje Canyon are found within a highly degraded native mesic forest that receives full sun in summer with no direct sun in winter. Exposure is 320 to 340 degrees NNW. The area receives approximately 60 in (15.2 cm) of rain annually, with yearly mean temperature ranging from 64 to 82 degrees F (18 to 28 degrees C). The substrate is basaltic bedrock overlain by dry, crumbly red-brown soil. Goats have denuded large areas causing severe erosion, and the entire area is prone to frequent rock slides. Several of the downslope plants grow in a small drainage that is dry except during heavy run-off periods. Associated species include Aleurites moluccana, Artemisia kauaiensis, Psydrax odoratum, Diospyros sandwicensis, Lipochaeta connata, Myrsine sp., Nototrichium sandwicense, Pouteria sandwicensis, Triumfetta senitriloba and Sapindus oahuensis. Melia azedarach, an alien species, is now the dominant tree in the area. The ground cover is sparse and consists mainly of exotic grasses and broad-leaved herbaceous plants, including Lantana camara, which presents a major threat to this small population of Hibiscadelphus distans. Associated with the newly discovered cliffside population (upslope) are Artemisia kauaiensis, Bidens sandwicensis, Psydrax odoratum, Carex meyenii, Dodonaea viscosa, Lipochaeta connata, Lobelia niihauensis, and Schiedea spergulina. Melinus minutifolia, Kalanchoe pinnata, and Opuntia sp. are problem species at this location. (USFWS, 1996)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2021c)

Population Size:

10-20 (USFWS, 2021c)

Population Narrative:

Hibiscadelphus distans is critically endangered, with perhaps 20 known wild individuals in two populations. Numbers have been supplemented by propagation and outplantings, with at least 166 reintroductions from three or four population sources in 2006, and a report of over 200 outplants in four subpopulations in Piwa Valley exclosures, with signs of natural reproduction (USFWS 2008). (USFWS, 2009)

Threats and Stressors

Stressor: Browsing and erosion by feral goats (USFWS, 1996; USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The major threats to Hibiscadelphus distans include feral goat (Capra hircus) browsing within the canyon, and associated erosional hazards created by goat traffic in cliff habitat. Goats chew on the foliage and bark of Hibiscadelphus distans and eat any seedlings they can reach. They also cause landslides by dislodging rocks from ledges above the plants, damaging the trees and destroying seedlings. The surrounding vegetation has also been over browsed, causing increased erosion and danger from rock and landslides. (USFWS, 2009; USFWS, 1996)

Stressor: Competition with invasive plants (USFWS, 1996; USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The major threats to Hibiscadelphus distans include competition with invasive introduced plant species such as Lantana camara (lantana) and Melia azedarach (pride of India). Habitat disturbances have favored the introduction and spread of exotic (non-native) plants, which compete with and smother native vegetation, especially seedlings. These exotic plants include Melia azedarach, Lantana camara, Melinus minutifolia, Kalanchoe pinnata, Opuntia sp. and Myrica faya, an extremely aggressive non-native tree species that has overgrown hundreds of acres in exclosure areas (Diane Ragone, Program Coordinator, NTBG, personal observation). (USFWS, 1996; USFWS, 2009)

Stressor: Pink bollworm infestations (USFWS; 1996; USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The major threats to Hibiscadelphus distans include pink bollworm (Pectinophora gossypiella) infestation of seed capsules. The moth lays as many as 100 eggs in the calyx or flower, and the larvae feed on the seeds, destroying them. (USFWS, 1996; USFWS, 2009)

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The major threats to Hibiscadelphus distans include reduced reproductive vigor due to the small number of founder individuals (USFWS 1996; Hawaii Biodiversity and Mapping Program 2007). (USFWS, 2009)

Stressor: Recreation (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: A hiking trail passes below the area where the plants are located, and hikers and hunters can readily reach the plants. The areahas experienced incidents of unauthorized taking and vandalism (Herbst 1986). (USFWS, 1996)

Stressor: Landslides (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: The limited range of this endangered species makes it especially vulnerable to natural disasters. Overgrazing by goats has increased erosion in this area, and heavy rains in 1989 caused an extensive landslide that destroyed the original known colony. (USFWS, 1996)

Stressor: Fire and stochastic events (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: The remaining populations of Hibiscadelphus distans occur in xeric areas, which are prone to fires. High winds may knock down trees and create bridges between microhabitats, allowing fires to spread farther than would be possible in fragmented terrain. The fire danger may increase if alien plant cover increases with reduced ungulate populations. Severe hurricanes occasionally pass through the Hawaiian Islands and produce winds of a magnitude that can be extremely damaging to the vegetation. During Hurricane Iniki in 1992, winds clocked in excess of 200 mph a few miles to the north of Waimea Canyon reduced the number of outplanted individuals to approximately one-half (G. Kawakami, personal communication 1993). Hibiscadelphus distans, reduced to remnant populations, remains under threat from stochastic events. (USFWS, 1996)

Stressor: Genetic problems (USFWS, 1996)
Exposure:
Response:
Consequence:
Narrative: Although Hibiscadelphus distans was not known prior to 1972, the mesic habitat that the genus characteristically inhabited was extensive, which suggests that this species may once have been more widely distributed. If the species has gone through a bottleneck, the genetic diversity of Hibiscadelphus distans may already be severely reduced, possibly leaving the species prone to deleterious effects of inbreeding. (USFWS, 1996)

Stressor: Climate change loss or degradation of habitat (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Hibiscadelphus distans is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.879 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. (USFWS, 2017).

Recovery

Reclassification Criteria:
1. The currently occupied habitat on Kauai remains protected (under the jurisdiction of the Hawaii Division of Forestry and Wildlife) and managed to perpetuate the species (including maintenance of fencing to prevent feral ungulate damage). (USFWS, 1996)

2. At least two additional protected populations are located or established. (USFWS, 1996)

3. Each population contains at least 50 reproductive individuals. (USFWS, 1996)

4) Newly established populations are geographically isolated from the extant populations to ensure that all populations are not eliminated by a single small scale catastrophic event. (USFWS, 1996)

5) The 6 populations are maintained at the level of at least 50 reproductive individuals each for a minimum of 9 years. (USFWS, 1996)

Number of populations and individuals needed to meet Preventing Extinction Stage based on population and life history characteristics. Number of Populations 3. Mature Individuals per Population 50. (USFWS, 2021c) Number of populations and individuals needed to meet Interim Stage based on population and life history characteristics. Number of Populations 3. Mature Individuals per Population 200. (USFWS, 2021c) Number of populations and individuals needed for Downlisting based on population and life history characteristics. Number of Populations 10. Mature Individuals per Population 400. (USFWS, 2021c)

Recovery Priority Number: 2

Delisting Criteria:
1. Threats, especially feral goats, have been sufficiently reduced or eliminated to allow the six populations to reproduce unassisted. (USFWS, 1996)

2. The populations are stable or increasing and contain an adequate number of reproductive, self-regenerating adults to produce a mixture of reproductive stages (e.g. seedlings, juveniles, and adults) sufficient to ensure self-perpetuation. (USFWS, 1996)

3. There is a 10-year average of at least 250 reproductive plants in each of the six populations. (USFWS, 1996)

Number of populations and individuals needed for delisting based on population and life history characteristics. Number of Populations 10. Mature Individuals per Population 400. (USFWS, 2021c)

Recovery Actions:

- Protect and stabilize populations of Hibiscadelphus distans. (USFWS, 1996)
- Develop and implement plans to augment the extant populations, and create new populations, if necessary. (USFWS, 1996)
- Determine factors limiting growth and reproduction. (USFWS, 1996)
- Develop and maintain a detailed monitoring program. (USFWS, 1996)
- Verify or determine the scientific validity of the recovery objectives. (USFWS, 1996)
- 2017 Recommended actions - 1: Surveys and inventories—Conduct searches to better determine whether plants from Hipalau thought to have been extirpated by Hurricane Iniki have actually disappeared and to search for any new populations within suitable habitat. (USFWS, 2017).
- 2017 - 2: Ungulate monitoring and control—Continue to construct larger-scale fencing to allow the existing populations to expand and continue maintenance of existing fenced exclosures. Protect all occurrences against browsing and disturbances from feral ungulates. (USFWS, 2017).
- 2017 - 3: Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. (USFWS, 2017).
- 2017 - 4: Captive propagation for genetic storage and reintroduction—Continue to collect material for complete genetic storage. (USFWS, 2017).
- 2017 - 5: Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. (USFWS, 2017).
- 2017 - 6: Predator and herbivore control research—Determine whether pink bollworm and beetles continue to infest seed capsules of Hibiscadelphus distans and any additional needed recovery actions. (USFWS, 2017).
- 2017 - 7: Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of hikers and trail maintenance. (USFWS, 2017).
- 2017 - 8: Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides and storms. (USFWS, 2017).
- 2017 - 9: Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. (USFWS, 2017).
- 2017 - 10: Population biology research—Summarize available biological information to determine flowering cycles, pollination vectors, seed dispersal agents, longevity, specific

environmental requirements, or limiting factors of Hibiscadelphus distans. (USFWS, 2017).
- Continue collecting for complete genetic storage. (USFWS, 2009)
- Construct larger-scale fencing to allow the existing populations to expand. (USFWS, 2009)
- Work with Hawaii Division of Forestry and Wildlife to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species in Koaie Canyon. (USFWS, 2009)
- Determine sites for establishing additional populations. (USFWS, 2009)
- Conduct searches to better determine whether plants from Hipalau thought to have been extirpated by Hurricane Iniki have actually disappeared and to search for any new populations within suitable habitat. (USFWS, 2009)
- Determine whether pink bollworm continues to infest seed capsules of Hibiscadelphus distans. (USFWS, 2009)
- Summarize available biological information to determine if anything has been learned in recent years about Hibiscadelphus distans flowering cycle, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, or limiting factors. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No new threats and no significant new information regarding the species' biological status have been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated or updated for the 5-year review for 2022. • Surveys and inventories—Continue to survey current and historical range of Hibiscadelphus distans to determine the current status of the species. • Ungulate monitoring and control—Continue to construct and maintain exclosures to protect all occurrences from habitat disturbance and browsing by feral ungulates. • Nonnative invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species and those that compete with H. distans. • Predator and herbivore monitoring and control—Determine level of threat from invertebrate seed predation and the need for additional recovery actions. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and propagative materials for storage and for maintenance of genetic stock. • Reintroduction and augmentation—Continue to augment wild populations and establish new populations within protected and managed suitable habitat. • Build resiliency and redundancy—Increase numbers of individuals and populations through historic range to reduce impacts of landslides, hurricanes, and low numbers. • Human interaction monitoring and management—Develop and implement effective measures to reduce the impacts of hikers and trail maintenance. • Population biology research—Summarize available biological data to determine flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors of H. distans. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2022).

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SPECIES ACCOUNT: *Hibiscus dasycalyx* (Neches River rose-mallow)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/11/2013; Southwest Region (R2)

Physical Description

The rose-mallow is a nonwoody perennial in the Malvaceae (mallow) family that grows 1.9-7.5 feet (ft.) (0.6-2.3 meters (m)) tall. Leaves are alternate, simple, generally t-shaped, and deeply three-lobed with petioles 1.1-1.8 inches (in) (3-5 centimeters (cm)) long. The species generally produces a single creamy white (rarely pink) flower at the base of the leaf stalk along the uppermost branches or stems. Plants are single to multi-stemmed. Each branch or stem can have numerous leaves, with the total number of flowers per plant numbering in the hundreds. Flowering is rain dependent, spanning a few weeks in June and July. Seeds are set in August (T. Philipps, pers. comm. 2016a). Large, numerous stamens are monadelphous, forming a tube that is united with the base of the petals. Potential pollinators may include, but are not limited to: the American bumble bee (Bombus pensylvanicus), Hibiscus bee (Ptilothrix bombiformis), moths, and the scentless plant bug (Niesthrea louisianica) (Klips 1995, Warnock 1995, Warriner 2011). (USFWS, 2018)

Taxonomy

In the Malvaceae (mallow) family (USFWS, 2013)

Historical Range

The natural range is within Trinity, Houston, Harrison, and Cherokee Counties, Texas (USFWS, 2013a)

Current Range

Known from Trinity, Houston, Harrison, Cherokee, and Nacogdoches Counties in east Texas, in the Neches, Sabine, and Angelina River basins and the Mud and Tantabogue Creek basins (USFWS, 2013a).

Critical Habitat Designated

Yes; 10/11/2013.

Legal Description

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for Hibiscus dasycalyx (Neches River rose-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas (78 FR 56072-56120).

Critical Habitat Designation

The critical habitat designation for Hibiscus dasycalyx includes eleven CHUs in Cherokee, Harrison, Houston, Nacogdoches, and Trinity Counties, Texas. This species critical habitat encompasses approximately 166.5 acres (ac) (67 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule (USFWS, 2013).

Unit 1: SH 94 ROW: Unit 1 consists of 3.4 ac (1.4 ha) on both the 94 ROW and on private land in Trinity County.

Unit 2: Harrison County: Unit 2 is found at a location between 0.2–0.4 mi (0.3–0.6 km) north of Farm to Market Road 2625 in Harrison County.

Unit 3: Lovelady: Unit 3 in Houston County, found northwest of Farm to Market 230, extends 0.3 mi (0.5 km) north and contains 6.3 ac (2.5 ha) of private land.

Unit 4: SH 204 ROW: Unit 4 in Cherokee County contains 8.7 ac (3.5 ha) of occupied habitat along SH 204 ROW and within the Mud Creek basin.

Unit 5: Davy Crockett NF, Compartment 55: Unit 5 is the only unit that contains a natural population of the Neches River rose-mallow on Federal lands within the Davy Crockett NF.

Unit 6: Davy Crockett NF, Compartment 11: Unit 6 includes 7.3 ac (3.0 ha) of occupied habitat on Compartment 11 on Federal land in the Davy Crockett NF within Houston County.

Unit 7: Davy Crockett NF, Compartment 20: Unit 7 includes 3.4 ac (1.4 ha) of Federal land in Compartment 20 of the Davy Crockett NF, Houston County.

Unit 8: Davy Crockett NF, Compartment 16: Unit 8 encompasses 32.8 ac (13.3 ha) of occupied Federal habitat in the Davy Crocket NF, Houston County.

Unit 9: Champion: The Champion site, Trinity County, is located on private land approximately 0.7 mi (1.1 km) south-southeast of the Houston County line, about 0.8 mi (1.2 km) north of the confluence of White Rock Creek and Cedar Creek (TXNDD 2012a, p. 55).

Unit 10: Mill Creek Gardens: Unit 10 is an introduced site at Mill Creek Gardens, Nacogdoches County. Stephen F. Austin State University Mass Arboretum purchased the land and created the gardens in 1995 as part of a conservation agreement.

Unit 11: Camp Olympia: Unit 11 is located on private property in Trinity County. The unit contains 0.2 ac (0.1 ha) of palustrine wetland habitat north of Lake Livingston.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Hibiscus dasycalyx critical habitat consists of two components (78 FR 56072-56120):

(i) Hydric alluvial soils and the potential for flowing water when found in depressional sloughs, oxbows, terraces, side channels, or sand bars; and

(ii) Native woody or associated herbaceous vegetation, largely with an open canopy providing partial to full sun exposure with few to no nonnative species.

Special Management Considerations or Protections

Threats to those features that define the primary constituent elements for the Neches River rose-mallow include: (1) Alteration of naturalized flow regimes through projects that require channelization; (2) water diversions or hydrologic change to streams and rivers; (3) encroachment from native woody riparian species and nonnative species; (4) detrimental roadside management practices including inappropriate frequency and timing of mowing during the species' blooming period; (5) herbivory and, (6) trampling from hog and cattle; and (7) drought. Special management considerations or protection are required within critical habitat areas to address these threats. Special management activities that could ameliorate these threats include, but are not limited to: • Construction of cattle exclusion fencing to remedy herbivory at Lovelady to maintain plant survival and suitable habitat; • Restoration of the cattle stock pond back to a natural flatwoods pond at Lovelady to restore the sites hydrology; • Coordination with TXDOT to establish and continue effective management along ROWs for control of native woody species and nonnatives (including, but not limited to mowing, brush-hogging, or other hand-clearing techniques) and completion of these techniques only during the appropriate life stages of the Neches River rose-mallow to maintain open habitat; • Coordination with the Angelina and Neches River Authority and consultation with the U.S. Army Corps of Engineers on the proposed construction of Lake Columbia Reservoir in Cherokee County to maintain hydrology at the downstream Neches River rose-mallow site; • Consultation between the Service and the U.S. Army Corps of Engineers for any filling or draining of Federal jurisdictional wetlands to ensure maintenance of hydrology; and • Clearing or burning on the Davy Crockett NF for control of Chinese tallow and to maintain an adequate level of openness in habitat. (USFWS, 2013)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (USFWS, 2013a)

Lifespan

Adult: Unknown (USFWS, 2013a)

Breeding Season

Adult: Flowering occurs between June and August, sometimes into late October (USFWS, 2013a)

Key Resources Needed for Breeding

Adult: Insects for pollination (USFWS, 2013a)

Reproduction Narrative

Adult: This perennial species dies back to the ground every year and resprouts from the base; however, the plant still maintains aboveground stems. Longevity of the species is unknown, but it may be long- lived. Cross-pollination occurs within populations, and the species has high reproductive potential (fecundity). Flowering occurs between June and August, sometimes into late October; the blooming period may only last 1 day. The species produced an average of 50 fruits per plant, but seed viability and survivorship are not known. Potential pollinators of the Neches River rose-mallow may include, but are not limited to, the common bumblebee (Bombus pensylvanicus), Hibiscus bee (Ptilothrix bombiformis), moths, and the scentless plant bug

Niesthrea louisianica (USFWS, 2013a).

Habitat Type

Adult: Wetlands (USFWS, 2013a)

Habitat Vegetation or Surface Water Classification

Adult: Seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands (USFWS, 2013a)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common (NatureServe, 2015)

Habitat Narrative

Adult: The Neches River rose-mallow is endemic to relatively open habitat of the Pineywoods (or Timber belt) of east Texas, within Cherokee, Houston, Harrison, and Trinity Counties, and has been introduced into Nacogdoches and Houston Counties. It is known from seasonally or regularly inundated sloughs, oxbows, terraces, sand bars, and bottomlands, with hydric alluvial soils (loamy to clayey). An open canopy is typical, but plants also grow in partial sun. Sites are both perennial and intermittent wetlands with water levels between sites varying due to their proximity to water, amount of rainfall, and floodwaters. Intermittent wetlands are inundated during the winter months but become dry during the summer months (USFWS, 2013a).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Neches River rose-mallow seeds are likely to be dispersed by flowing water. Research has not been done to identify methods of seed dispersal upstream; however, avian species may facilitate this process (USFWS, 2013a).

Population Information and Trends

Number of Populations:

11 (8 natural; 3 introduced) (USFWS, 2018)

Population Size:

Approximately 2200 - 2500 individuals (NatureServe, 2015)

Minimum Viable Population Size:

At least 10 viable populations of the rose-mallow, each containing an average of about 1,400 individuals (USFWS, 2018)

Population Narrative:

When the species was listed in 2013, 11 populations were determined to be occupied by the rose-mallow. Of those 11 populations, 3 sites have not been verified in over 20 years and 3 included introductions on the Davy Crockett National Forest. In addition to these natural populations, the Service is also aware of 8 reintroductions, introductions, or display gardens, some of which were coordinated through the Service. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013a)
Exposure:
Response:
Consequence:
Narrative: A primary threat to the Neches River rose- mallow is the ongoing encroachment of nonnative and native woody species into its generally open, intermittent or perennial wetlands. Altered hydrology (including beaver dams) can have huge impacts on habitat since this species is water-dependent. Right-of-way populations are vulnerable to bridge and road expansion, new road construction, and upgrade projects, which could impact the sites' hydrology, soil stability, wetland and riparian vegetation, and water quality. Conversion of wetlands to silvicultural uses and associated herbicide use to remove unwanted vegeation is a threat. Habitat damage from trampling by feral hogs and cattle is also a threat, as is drought periods possible related toc limate change (USFWS, 2013a).

Stressor: Predation (USFWS, 2013a)
Exposure:
Response:
Consequence:
Narrative: Mammalian herbivory has affected the majority of sites; however, grazing pressures are largely attributed to the lack of other available food resources during periods of drought. Neches River rose-mallow recovers quickly from herbivory incidents and can produce secondary growth, minimizing the overall negative effects of mammalian herbivory. This type of herbivory is not considered to be a threat to the species. Insect herbivory was also observed on several of the sites and was not rangewide, but, with anticipated climate change shifts in temperature and the likelihood that insect populations will increase, the Services conclude that insect predation is a minor stressor that will likely continue into the future, but it is not a threat to the species (USFWS, 2013a).

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
A Recovery Plan has not been developed.

Recovery Actions:

- A Recovery Plan has not been developed. The following present the summary statement of recovery needs presented in the 2018 Recovery Outline. (USFWS, 2018)
- - Survey sites that have not been visited in over 20-30 years and determine if they contain the physical and biological features of habitat. - Engage landowners to conduct conservation and stewardship on their property. - Using current niche mdels to identify other areas of potential habitat for rose-mallow and plan to conducty surveys at those sites. Niche models can also be used in future scenarios where climate change might alter the species current range (i.e. range expansion). - Consider introductions and reintroductions that would further the representation and resiliency of the rose-mallow across its range, but that are also in-

line with the species' propagation and reintroduction plan. - Communicate with partners, academics, nurseries, and plant communities about proper introduction procedures and encourage collaboration with the Service. - Continue to monitor existing populations for threats. - Conduct key biological studies to better understand the species reproductive needs (i.e. longevity, seed dispersal, age structure). This information can inform the recovery targets and needs in a recovery plan. - Develop a species Recovery Plan in FY2020. (USFWS, 2018)

- Not available.

References

USFWS. 2018. Recovery Outline for Neches River rose-mallow (Hibiscus dasycalyx). U.S. Fish and Wildlife Service, Houston, Texas. 26 pp.

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SPECIES ACCOUNT: *Hoffmannseggia tenella* (Slender rush-pea)

Species Taxonomic and Listing Information

Commonly-used Acronym: SRP

Listing Status: Endangered; 12/02/1985; Southwest Region (Region 2)

Physical Description

Hoffmannseggia tenella is a perennial legume (Fabaceae: pea family) with spreading stems 8-15 cm long terminating in 3-5 flowered, eglandular inflorescences and having a long woody taproot. Leaves are bipinnately compound with petioles to 13 cm long; leaflets are oblong, 2-4 mm in length, and 1-2 mm broad in 5 or 6 pairs on each of 3-7 pinnae. Flowers are orange and approximately 5 mm long with 10 stamens. Filaments have retrorse hairs. The legumes are 12-15 mm long, 4-6 mm broad and contain 2-4 seeds. Flowering usually occurs from early March to June, sporadically thereafter depending on rainfall (USFWS, 1985b; Mahler, 1982). (USFWS, 1988)

Taxonomy

Slender rush-pea is in the class Magnoliopsida, order Fabales, and family Fabaceae (Poole 1988). There are currently no other scientific or common names for this species (Poole 1988). Although the final rule (FR) listed SRP as belonging to the pea family, Fabaceae, it was later listed under the family Leguminosae. These two family names are used interchangeably. Family Fabaceae is the more widely accepted classification for legumes like the SRP. In addition, the International Union for Conservation of Nature and Natural Resources (IUCN) clarified the correct spelling of the genus as Hoffmannseggia, not Hoffmanseggia (USFWS 1985). (USFWS, 2008)

Historical Range

Historically known from Nuceces and Kleberg Counties, Texas.

Current Range

In Texas, extending from Robstown, Nueces County, on the most northeastern extent of the range to east-central Kleberg County, then west to a point near Kingsville, and north to the vicinity of the Nueces/Jim Wells County line, encompassing approximately 221,000 acres. (USFWS, 2008)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2008)

Breeding Season

Adult: March to June (USFWS, 2008)

Reproduction Narrative

Adult: The SRP has monoclinous flowers, bearing both male and female reproductive parts in the same flower (Poole 1988). The species appears to be reproductively active during the spring and summer months, however this activity can be prolonged into the fall in a sporadic fashion in response to rainfall events, even if the prevailing climatic conditions are dry (Mahler 1982a, Bush 1990). Fruiting dates are documented from February through July (USFWS 1988) and seed/fruit dispersal dates from March through June (Mahler 1982a). (USFWS, 2008)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers sparsely vegetated areas (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 2008)

Environmental Specificity

Adult: Low (inferred from USFWS, 2008)

Habitat Narrative

Adult: Slender rush-pea occurs in the eco-region known as the Gulf Prairies and Marshes biotic zone (Correll and Johnston 1970). All documented SRP sites occur in patches of short-grass native prairies adjacent to intermittent or permanently flowing creeks, with the exception of the two most southeastern Kleberg County populations described by Jones in 1964 as being in a “pasture opening on clay loam” and on a “clayey roadside” (TNDD 2007). This species if found in sparsely vegetated openings within bluestem-sacahuista grasslands on heavy clay soils of the South Texas Coastal Plain. The SRP occurs in areas of Victoria Clays which are calcareous, crumbly, clay soils that are self-mulching and greatly cultivated for crops. This species is a perennial legume that occurs in patches of native short- and mid-grass prairie adjacent to watercourses, such as permanent and intermittent creeks. This species is a member of the lower seral stages of succession, perhaps even a pioneer species” or an invader species of highly disturbed soils where it persists until crowded out by other species. (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

8 (USFWS, 2018)

Population Size:

>10,000 (NatureServe, 2015)

Population Narrative:

As a result of work funded through a 2008-2010 Preventing Extinction cooperative agreement and other monitoring efforts, 8 populations were found to be extant (Table 5), although four of these (Hwy 77, St. James Cemetery, Bishop City Park, and a private residence in Bishop) are less than 2.5 km (1.6 miles) apart from the others and probably function as a single metapopulation. Three of the eight (Sablatura County Park, Bishop City Park, and a private residence between St. James Cemetery and Bishop City Park) are new discoveries, and the Petronila site has been temporarily recovered through suppression of the nonnative grass Kleberg bluestem with grassspecific herbicide. Although the King Ranch training area (KRTA) sites have not been visited since 1993, the populations (probably subpopulations of another metapopulation) are likely extant since we have no knowledge that habitat has been disturbed to the point that it is not suitable for rush-pea. (USFWS, 2018)

Threats and Stressors

Stressor: Habitat alteration (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Historically, conversion of native prairie to row crops and improved pasture was probably the largest factor contributing to losses of SRP populations and habitat (Poole 1988). The range of SRP has likely been considerably contracted by these types of land conversion activities in Nueces and Kleberg counties. Slender rush-pea populations were probably reduced in size or eliminated altogether as habitat was converted to cropland or deliberately planted to monoculture pastures of non-native grasses. Increased cover by woody species may also have impacted some SRP habitat (USFWS 1988). (USFWS, 2008)

Stressor: Non-native plants (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: More recently, threats to the integrity of the remaining habitat have increased as non-native pasture grasses, including Kleberg bluestem, King Ranch bluestem, Coastal Bermudagrass, and other introduced grasses have continued to spread throughout this region (Mahler 1982a, Poole 1988, Kuvlesky et al. 2002). These grasses are opportunistic species, either producing copious amounts of seed that can be spread both deliberately and/or inadvertently, or spreading rapidly by vegetative means. Seeding of highway and pipeline ROWs and highways to reduce erosion has helped to increase the distribution of some of these non-native grasses into the native prairie remnants that constitute natural habitat for SRP, as seen at the Petronilla Creek and Highway 77 ROW sites (Poole 1988). The condition of short-grass prairie habitat within the

unplowed rangeland in Kleberg County is not known. Prescribed winter burns and cattle grazing are the primary land management known to occur in this area.Non-native, pasture grasses, predominantly Kleberg bluestem, King Ranch bluestem (Bothriochloa ischaemum), and Coastal Bermudagrass (Cynodon dactylon), have encroached and altered the composition of the native vegetation community at the three accessible SRP population sites at Petronilla Creek/Highway 70, Highway 77 ROW, and St. James Cemetery (Mahler 1982a, Poole 1988, D. Price pers. comm. 2006). These non-native grasses tend to produce dense monocultures with few short-grass native species able to persist (Mahler 1982a). Woody species, including honey mesquite (Prosopis glandulosa), huisache, retama, and others have also become more prevalent in the remnant prairie fragments where SRP persists (Mahler 1982a, USFWS 1988, Ruth 2000). Kleberg bluestem, native to India, China, North Africa, and Egypt, is considered highly competitive, with long creeping rhizomes and continual seed production throughout the year under favorable conditions. Drought tolerance has enabled people to use this grass as a stabilizer on roadsides and pipeline ROWs, and seeds are highly mobile by several means of transport (Drawe 2004). The shallow, fibrous roots of many grass species such as Kleberg bluestem allow quicker absorption of moisture and nutrients than is capable by tap-rooted species, such as SRP, which must wait for deeper moisture penetration (D'Antonio and Mahall 1991).In addition to subsurface competition, fast growing non-native grasses can spread quickly and potentially out-compete SRP for both space and sunlight (Pressly 1998). Greenhouse shadecloth studies using SRP plants grown at the Kika de la Garza PMC demonstrated significant differences in petiole heights and lengths between non-shaded (controls) verses shaded treatments and also differences in the growth pattern (Pressly 2002). Non-shaded plants grew in a prostrate manner while the petioles of the shaded plants grew upwards (Pressly 2002). However, this greenhouse study did not show significant mortality of SRP at 30%, 40%, or 50% shading (Pressly 2002). (USFWS, 2008)

Stressor: Disturbances from construction and maintenance (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Localized disturbances causing losses of individual SRP plants have been attributed to highway construction projects as well as ROW maintenance procedures, maintenance of gas pipelines, and excavation of burial plots (Poole 1988). Survey reports indicated some damage to SRP individuals at St. James Cemetery caused by mowing with blades set low to the ground. Other observations at the cemetery reported on damage associated with equipment tracking through the population, and from piling of cleared brush on top of SRP. Consequently, TPWD recommended mowing at a height of no less than 6 inches (approximately 15 cm), which has been incorporated into cemetery groundskeeping procedures (Perez 1992). Also, a management agreement between TxDOT and TPWD included recommendations to continue established mowing practices on the Highway 77 ROW with a full-width mowing 4 times a year and a strip mowed every 6 weeks between May through December. (USFWS, 2008)

Stressor: Grazing (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: This was not known as a threat at the time of listing. Poole (1986) did observe that 4 SRP plants at the Petronilla/Hwy 70 population "looked as though rabbits had been biting them."

However, no other evidence, anecdotal or otherwise, exists regarding the effects of grazing or browsing on this species. Data on abundance and distribution of cottontails (Sylvilagus floridanus) and jackrabbits (Lepus californicus) in Nueces and Kleberg counties is lacking; however, it is possible that rabbit populations may have become more concentrated in the remnant strips of habitat in Nueces County. Plants may be susceptible to insect vectors and/or grazing effects, but no research has been conducted to document such effects. No new information regarding the predation or disease of SRP has been found. (USFWS, 2008)

Stressor: Herbicide Use (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Herbicide Use (USFWS, 2022)

Recovery

Reclassification Criteria:
Downlisting Criteria 1: To downlist rush-pea, 15 populations should have an estimated 1,500 mature individual plants per population. Downlisting may be possible if each of these populations is stable or increasing over the next 35 years. The extant populations (eight total), as well as any that may be restored, augmented, or created, should be maintained with at least five natural populations located in the drainage systems (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins) where the species is known to naturally occur to ensure genetic representation. (USFWS, 2018)

Downlisting Criteria 2: Each rush-pea site should be managed for and support high quality shortgrass prairie habitat. High quality shortgrass prairie habitat has these characteristics: 1) occurs in unplowed, relatively undisturbed soils; 2) has a high diversity and high vegetative cover of native grasses and forbs; 3) has a low vegetative cover of introduced grasses; and, 4) has a low vegetative cover of woody species (i.e. native brush). High quality shortgrass prairie habitat should contain species commonly associated with rush-pea (see Table 7 of 2018 Recovery Plan). Prolific and aggressive nonnative grasses should not constitute more than small patches within each high quality shortgrass prairie site and invasive grasses and woody species should not be spreading throughout the site or inhibiting growth and reproduction of rush-pea. Each rush-pea site should be managed and monitored appropriately to ensure the maintenance and restoration of high quality shortgrass prairie habitat conditions and to minimize and control threats over a period of 35 years. (USFWS, 2018)

Recovery Priority Number: 2

Delisting Criteria:
Delisting Criteria 1: A minimum of 20 populations are necessary for delisting and should have at least 1,500 mature individual plants per population. Delisting may be possible if each of these populations remains stable or increasing over a period of 60 years. All existing populations, including those that have been restored, created, or reintroduced, are protected and a minimum of five natural populations are extant within each drainage system (Petronila, Oso, Chilipitin Creek-San Fernando, Alazan Bay-Baffin Bay Creek basins). (USFWS, 2018)

Delisting Criteria 2: Populations will be protected long-term (protection in perpetuity being optimum) through fee title acquisition, conservation easements, or conservation or management agreements. Species-specific, USFWS-approved annual monitoring and management plans will guide these efforts. Each population site should have high quality shortgrass prairie habitat (see Downlisting Criteria 1 for a description). (USFWS, 2018)

Recovery Actions:

- 1. Habitat protection and management of all known population sites of Slender rush-pea in the United States. - Establish positive working relationships with landowners and land managers of all known sites. Maintain contact with all landowners or land managers each year. Educate landowners about the extreme rarity and significance of both the ecosystem and species on their property. Encourage the long-term stewardship of the shortgrass prairie at these sites through technical assistance to landowners; also potentially through long-term leases, conservation easements, and conservation agreements. - Cooperate with landowners and land managers to develop and implement management plans that address landowner and species goals. With willing landowners, determine short- and long-term land use goals and their effects on Slender rush-pea. With all cooperating landowners, develop and implement management plans that are beneficial to the species as well as acceptable to landowners and land managers. Develop a monitoring program that is reviewed by the USFWS and other interested parties, with voluntary landowner assistance, to evaluate the effects of management practices on the species and ensure consistent and reliable monitoring of plant populations and management. - Enforce applicable laws and regulations. Work with regulatory agencies (DOD– NASK, TXDOT, TPWD, USDANRCS, and through internal USFWS coordination) to ensure that existing regulations are used to provide adequate protection of current habitat. (USFWS, 2018)
- 2. Monitor Slender rush-pea on an annual basis. - Use the approved monitoring plans to annually monitor rush-pea, its habitat, management actions, and threats at extant sites. - Monitor species and biotic communities and assess ecological integrity and conservation status of historic sites. (USFWS, 2018)
- 3. Initiate studies to gather biological information needed for effective management and recovery of rush-pea. - Determine specific habitat requirements (specifically limiting factors). Study soils and underlying geology. Determine the plant community structure for Slender rush-pea. Study community dynamics/ecology. - Study population dynamics. Analyze the demographic structure of all populations. Characterize phenology and assess the most vulnerable stages of life cycle. Determine the primary means of reproduction in the wild. Study pollination biology and determine effective pollination requirements and effective pollinators. Study seed production and dispersal. Study seedling recruitment. Study population genetics to determine the genetic diversity within and among populations. (USFWS, 2018)
- 4. Survey for additional populations of rush-pea. As more information about the habitat and biology of the species becomes available, determining areas capable of supporting the species may be more predictable. Models, maps, and other tools will be developed showing the vegetative and edaphic characteristics of occupied sites. This information will help to determine where coastal shortgrass prairie habitats currently might remain intact and/or where the species could be located. These potential areas are a high priority to survey and engage in stewardship efforts. These surveys should be performed to locate existing and new populations and for use as potential reintroduction sites in Texas. (USFWS, 2018) (USFWS, 2018)

- 5. Cooperatively work with landowners and land managers to restore additional shortgrass prairie sites located in one or more of the drainage areas from which rush-pea is known to co-occur. (USFWS, 2018) (USFWS, 2018)
- 6. Establish seed or propagule banks and ex-situ (botanical garden, refugium, research institute, etc.) populations for the species. These banks and ex-situ populations will be established using approved reintroduction plans for Slender rush-pea (see Recovery Action 7 below). (USFWS, 2018)
- 7. Conduct a reintroduction program on public and private lands where there are willing partners. Evaluate and document the success of different cultivation techniques, site preparation, and other management techniques based on research, and assess any additional information necessary to attempt reintroduction. Reintroduced populations for Slender rush-pea should not be considered successful until they are established, reproductively active, self-perpetuating, and demonstrated to be demographically and genetically viable. (USFWS, 2018)
- 8. Develop an education and outreach program. Develop any necessary educational or outreach materials. Provide educational and outreach materials to landowners and land managers. Provide educational and outreach materials to interested parties including agencies, engineering and consulting firms, developers, utilities, county road associations, and others.
- 9. Conduct Population Viability Analyses (PVA) and update the existing MVPs for the species based on current biological and ecological information. Investigate Slender rush-pea' population genetics to ensure long-term persistence. Develop traditional MVP estimates for Slender rush-pea. Reassess the MVP size when new information is made available. (USFWS, 2018)
- 10. Review and track recovery. Maintain the STXPRT to help review the status of Slender rush-pea and assess the effectiveness of the management plans and other recovery tasks. Revise the Recovery Plan as appropriate. Develop a post-delisting monitoring plan when appropriate. (USFWS, 2018)
- Continued loss and degradation of habitat due to invasion by non-native, fast-spreading grasses is the most pressing threat to the continued existence of SRP populations at sites in Nueces County. There is an immediate need to implement and experiment with management actions involving mowing treatments, selective applications of herbicides, hand removal, and potentially even prescribed burning to control exotics at the cemetery and the Highway 77 ROW sites. Monitoring of SRP response will be needed to document effectiveness of various management techniques. Effective methodologies should be incorporated into management plans for both populations. Annual monitoring should be carried out to determine if populations are stable, increasing, or declining. The Service and/or TPWD should establish a cooperative agreement with the cemetery owner to assist the landowner in implementing the management plan. Based on the results of SRP's response to various management treatments, TxDOT should consider changes to their management of the Highway 77 ROW, including changes to mowing schedules. (USFWS, 2008)
- A systematic approach to surveying for new populations is needed, particularly in Kleberg County where the natural habitat is potentially in better condition. If additional populations are located in rangeland settings, the effects of prescribed burns on SRP should be analyzed. (USFWS, 2008)

- A reintroduction plan should be established for the SRP to allow experimental plantings into natural habitat, particularly at the former population sites on the western side of the Highway 77 ROW and at the Petronilla Creek/Highway 70 ROW. The SRP has proven to be easily germinated from untreated seed and prospects seem good for propagating the species. A thorough genetics analysis of SRP is needed to develop a sound reintroduction plan. (USFWS, 2008)
- Knowledge regarding species' habitat requirements, population biology, and population ecology needs to be gathered and analyzed in order to develop down-listing and delisting recovery criteria. Additional research needs include determination of habitat requirements, demographic trends, population biology, reproductive biology, and pollinators. (USFWS, 2008)
- The recovery plan for SRP needs to be revised to incorporate all new information on biology, ecology, and management recommendations. Objective and measurable recovery criteria that relate directly to the 5 listing factors should be developed. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The 2018 Recovery Plan includes actions that are needed to recover the slender rush-pea. The status of the species is still precarious, and we continue to recommend all the actions be implemented and that conservation partners actively seek funding to implement the actions (USFWS, 2022).

References

USFWS. 1988. Slender Rush-pea (Hoffmannseggia tenella) Recovery Plan. U.S. Fish and Wildlife Service, Albuquerque, New Mexico

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Austin Ecological Services Field Office. 25 pp. July 11, 2008. https://ecos.fws.gov/docs/five_year_review/doc1920.pdf

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS. 2008. Slender Rush-pea (Hoffmannseggia tenella)

USFWS. 2018. Texas Coastal Bend Shortgrass Prairie Multi-Species Recovery Plan: Including Slender Rush-Pea (Hoffmannseggia tenella) and South Texas Ambrosia (Ambrosia cheiranthifolia). U.S. Fish and Wildlife Service, Albuquerque, New Mexico. 130 pp. August 23, 2018.

USFWS. 2022. Slender rush-pea (Hoffmannseggia tenella) 5-Year Review: Summary and Evaluation. Texas Coastal Ecological Services Field Office. Corpus Christi, Texas. 7 pp.

SPECIES ACCOUNT: *Holocarpha macradenia* (Santa Cruz tarplant)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with stiffly spreading stems that are bristly and glandular. Inflorescence dense with heads in the upper axils; flowers yellow; phyllaries gland-tipped (NatureServe, 2015).

Taxonomy

A member of the aster family (Asteraceae). Holocarpha macradenia is one of only four species of the genus Holocarpha, all geographically restricted to California (USFWS, 2014).

Historical Range

Historically, habitat for Holocarpha macradenia occurred on grasslands and prairies found on coastal terraces in elevations below 330 feet (100 m), from Monterey County, north to Contra Costa and Marin Counties (USFWS, 2014).

Current Range

Holocarpha macradenia occurs in coastal grasslands and prairies in Contra Costa, Santa Cruz, and Monterey Counties, California (Service 2000) (USFWS, 2014).

Critical Habitat Designated

Yes; 10/16/2002.

Legal Description

On October 16, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Holocarpha macradenia (Santa Cruz tarplant) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in California (67 FR 63968-64007).

Critical Habitat Designation

The critical habitat designation for Holocarpha macradenia includes eleven CHUs in Contra Costa, Santa Cruz, and Monterey Counties, California. This species critical habitat encompasses approximately 2,902 acres (ac) (1,175 hectares (ha)) (67 FR 63968-64007).

Unit A: Mezue: Unit A consists of grassland habitat on sloping alluvial deposits from old marine terraces within Wildcat Regional Park in Contra Costa County. This entire unit of approximately 50 ha (130 ac) is on lands managed by the EBRPD. Management activities at this site include controlled grazing, removal of invasive artichoke thistle, and annual population monitoring (EBRPD 1992, 2001). Of the 22 sites that were used as sites to introduce Holocarpha macradenia seed in the East Bay region between 1982 and 1986, this population has been the only one that has consistently supported a large population of H. macradenia. In the year 2000, this population supported over 17,000 individuals (CDFG 2000). Although this population is an introduced population, this unit is essential to the survival and conservation of the species because this population represents the genetic variability in the northernmost portion of the plant's range and is important for the expansion of the existing population. In recognition of the conservation

value of this population, the Service is contributing funding toward nonnative species removal at this site (Service 2002).

Unit B: Graham Hill: Unit B consists of grasslands on a relatively flat coastal terrace prairie on the west side of Graham Hill Road, approximately 1 mile north of the City of Santa Cruz in Santa Cruz County. This entire unit of approximately 12 ha (30 ac) is on privately owned lands. The unit includes a 7-ha (17-ac) area that has been set aside through a conservation easement to the County of Santa Cruz for conservation of coastal prairie habitat and Holocarpha macradenia as mitigation for an adjacent development that comprises 52 residences and associated amenities. The population has been fenced and nonnative species have been removed; however, efforts to enhance the population, as called for in a management plan (Environmental Science Associates 1996), have not yet been initiated. In 1994, this population numbered 12,000 individuals; by 1998, 675 individuals were counted; and in 2001, approximately 550 individuals were counted (V. Haley, consultant, Felton, California, pers. comm., 2001). This unit is important because it currently supports a population of H. macradenia and because it represents the western limit of the cluster of populations that are found on the northern end of Monterey Bay. This unit, along with the Fairway Unit, occurs at the highest elevation of the native populations (122 m (400 ft)) and consequently the farthest away from the influence of the coastal climate. Preserving the genetic variability within the species that has allowed it to adapt to these different environmental conditions is essential for the long-term survival and conservation of the species.

Unit C: De Laveaga: Unit C consists of grasslands on a relatively flat coastal terrace prairie within De Laveaga Park just north of the City of Santa Cruz in Santa Cruz County. This entire unit of approximately 2 ha (5 ac) is on State lands managed by the CANG and supported by Federal funds from the National Guard Bureau. The CANG does not anticipate undertaking any new military activities on this parcel beyond its current use as an assembly point for monthly drills and as storage for equipment. In 2001, a maintenance crew from the adjacent city-owned golf course spread wood chips from a felled tree over half the population. The CANG has initiated management actions to restore and enhance habitat for H. macradenia, including removal of the wood chips and chunks of eucalyptus logs. In addition, the CANG has initiated development of an INRMP (CANG 2002); if the final plan meets the criteria outlined earlier in our response to comment number eight, the critical habitat designation may be removed from this unit in the future. This unit is essential because it currently supports a population of H. macradenia and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. Despite its small size, this unit is essential because it is located between the Graham Hill, Arana Gulch, and Rodeo Gulch Units, and is important for maintaining connectivity between these other units.

Unit D: Arana Gulch: Unit D consists of grasslands on a relatively flat coastal terrace prairie within an open space preserve just north of Woods Lagoon in the City of Santa Cruz. This entire unit of approximately 26 ha (65 ac) is on lands owned and managed by the City of Santa Cruz. It is bounded on the west, east, and north sides by existing development and on the south side by the Santa Cruz Harbor. Huge population fluctuations have occurred on this site, ranging from 100,000 individuals in the late 1980s when the site was being grazed by cattle, to no plants in 1995 (K. Lyons, in litt., 2001). The City entered into a Memorandum of Understanding with the CDFG in 1997 to manage Holocarpha macradenia, which includes utilizing a variety of management techniques to enhance the population. As of 1998, individuals numbered approximately 12,820; in 2000, they numbered 234; and in 2002 they numbered approximately 10,000 (K. Lyons, in litt.,

2001; Seals 2002). This unit is essential because it currently supports a population of H. macradenia and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. This unit and the Twin Lakes Unit occur at the lowest elevation of the native populations in the northern Monterey Bay area (12 to 18 m (40 to 60 ft)) and are consequently the closest to the influence of the coastal climate. Moreover, these two units are within one-half mile of each other and therefore could retain connectivity between them. It is also essential for the recovery of the species because current management by the City of Santa Cruz has allowed this site to support the third largest standing native population of tarplant. It therefore contributes significantly to the seed bank reserve for the species and is large enough to support management activities that may be necessary to maintain the population at this site.

Unit E: Twin Lakes: Unit E consists of grasslands on relatively flat coastal terrace prairie just north of Schwan Lagoon within the City of Santa Cruz. This entire unit of approximately 11 ha (26 ac) is on lands owned by the CDPR within Twin Lakes State Park. It is bounded on the west, north, and east sides by existing development, and on the south side by Schwan Lagoon. Since 1997, CDPR has been actively managing Holocarpha macradenia habitat by removing invasive, nonnative species and attempting various methods of enhancing the population (Service 2000). CDPR has also funded research on H. macradenia seed bank dynamics (Bainbridge 1999). This population has ranged in size from 120 individuals in 1986 to 21 individuals in 2002 (Hyland 2002). This unit is essential because it currently supports a population of H. macradenia and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. As with the Arana Gulch Unit, it occurs at the lowest elevation of the native populations in the northern Monterey Bay area (12 to 18 m (40 to 60 ft)) and consequently the closest to the influence of the coastal climate. Moreover, the two units are within onehalf mile of each other and therefore could retain connectivity between them.

Unit F: Rodeo Gulch: Unit F consists of sloping alluvial deposits and adjacent relatively flat coastal terrace prairie that straddles the Arana Gulch and Rodeo Gulch drainages north of the community of Soquel in Santa Cruz County. It is bounded on the north, east, and south sides by existing development; the western side is bounded by lands that have not been developed. This entire unit of approximately 11 ha (26 ac) is on privately owned lands. This unit includes a parcel that has recently been proposed for a housing development known as Santa Cruz Gardens Subdivision Unit 12 (Denise Duffy and Associates 2001). This parcel was previously set aside in a ‘‘temporary open space easement’’ as mitigation for destroying a portion of the H. macradenia population by an earlier phase of the development in 1986 (Service 2000). The current development proposal calls for setting aside approximately 23 ha (56 ac) for conservation and recreation purposes, and includes much of the habitat that supports H. macradenia. Salvage of soil and an H. macradenia seed bank is being proposed for another portion of the project site that will be impacted by development (Lyons 1999). This population numbered approximately 60 individuals in 1993; none have been observed since then (CNDDB 2001). However, a seed bank likely persists at this site. This unit is essential because of the likely presence of an H. macradenia seed bank and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. In addition to the seed bank for this population, this unit supports grassland habitat that provides for future expansion of the population. Also, it is within one-half mile of the Soquel Unit, and therefore could retain connectivity between the units.

Unit G: Soquel: Unit G consists of grasslands on sloping alluvial deposits and adjacent relatively flat coastal terrace prairie that straddles the Rodeo Gulch and Soquel Creek drainages north of the community of Soquel in Santa Cruz County. It is bounded on the north, east, and south sides by existing development; the western side is bounded by lands that have not been developed. Approximately 22 ha (55 ac) of this 40- ha (100-ac) unit is within Anna Jean Cummings Regional Park (also known as O'Neill Ranch), which is managed by the County of Santa Cruz. The remaining portion is privately owned. On the park lands, the population has been fenced, and portions of the habitat for the plant are being mowed and raked in accordance with a management plan (Ecosystems West 1999; Joe Rigney, consultant, pers. comm., 2001). The County of Santa Cruz approved a housing development for the privatelyowned parcel (previously known as Tan, but now called Seacrest) in 1997. The development included an approximately 4-ha (10-ac) parcel to be set aside for conservation and a plan to manage the habitat for Holocarpha macradenia. Although part of the same population, the CNDDB has maintained two separate entries (O'Neill and Tan) to reflect the two land ownerships. The total number of individuals in the combined population has never been larger than 200 individuals, with the private parcel supporting only a portion of those (CNDDB 2001). To date, management activities have not resulted in enhancing the population of the species on either parcel. This unit is essential because it has recently supported a population of H. macradenia and the seed bank is still present, and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. In addition to the seed bank for this population, this unit supports grassland habitat that provides for future expansion of the population. Also, it is within one-half mile of the Rodeo Gulch Unit, and therefore could retain connectivity between the units. Moreover, the acreage in Anna Jean Cummings Park represents one of the best remaining fragments of habitat on which to attempt recovery activities for H. macradenia, as it has been subject to fewer impacts than other sites.

Unit H: Porter Gulch: Unit H consists of grasslands on gently sloping alluvial deposits derived from a coastal terrace that straddles the Bates Creek and Porter Gulch drainages north of the community of Soquel in Santa Cruz County. It is bounded on all sides by undeveloped lands. This entire unit of approximately 14 ha (35 ac) is on privately owned lands. The population of Holocarpha macradenia at this site includes an approximately 12-ha (30-ac) parcel that was proposed for a lot split. A management plan for the species was developed as part of the proposed split (Greening Associates 1995); however, the management plan for H. macradenia has not been fully implemented. This unit also includes adjacent coastal prairie habitat, of which approximately 4 ha (9 ac) was deeded in 2001 to the Land Trust of Santa Cruz County for preservation. In 1993, the population of H. macradenia numbered approximately 1,500 individuals (CNDDB 2001). The population numbered only several hundred individuals in 2001 when the site was observed to support a large cover of rattlesnake grass that likely competed with H. macradenia (C. Rutherford, Service, pers. obs., 2001). This unit is essential because it currently supports a population of H. macradenia, and because it is one of only seven populations in the cluster of populations that are found on the northern end of Monterey Bay. Also, along with the Graham Hill Unit, this one occurs at the highest elevation of the native populations (122 m (400 ft)) and consequently the farthest away from the influence of the coastal climate. Preserving the genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species.

Unit I: Watsonville: Unit I consists of grasslands on alluvial fans and marine terraces west of the City of Watsonville in Santa Cruz County; during the remapping for the final rule we removed most of the lowlying drainages that interdigitate with the grasslands. The northern and eastern boundaries reach toward the Corralitos Creek drainage except where it runs up against existing development. The southeastern and southern boundary is formed by the Pajaro River drainage. The western boundary is formed by the Harkins Slough drainage and then generally follows Buena Vista Drive north until it intersects with the northern perimeter of the Watsonville Airport (Airport). This unit excludes paved areas of the Airport, but includes the unpaved portions surrounding the runways. This approximately 488-ha (1,205-ac) unit is partly owned by the City of Watsonville (the Airport and High School) (approximately 125 ha (309 ac)); a small portion is under easement to CalTrans (approximately 8 ha (19 ac)); a portion is designated as a Reserve by the CDFG (approximately 15 ha (37 ac)); and the remaining portion is privately owned (approximately 340 ha (840 ac)). This unit overlaps in part with an area that is targeted for regional conservation planning by the CDFG. Through its Conceptual Area Protection Plan process, CDFG, along with other Federal, State, and local agencies and organizations, are identifying opportunities to preserve sensitive species and habitats, including the Harkins Slough and Watsonville Slough wetlands and adjacent habitats (J. DeWald, in litt., 2001). This unit is essential because it currently supports multiple populations of H. macradenia including the populations known from the Airport, Harkins Slough, Apple Hill, and Bay Breeze (see Background for additional population information). This unit also supports grassland habitat that is important for the expansion of existing populations and for maintaining connectivity between the populations. It is also one of only three areas that support populations of H. macradenia that are found in the central Monterey Bay area and in the southern end of the range of the species. Preserving any genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species. Just prior to publication of this final rule, we were informed that construction of the Millennium High School had been initiated. Therefore, with this unit description, we are removing the 32 acres that are being converted to building, paved surfaces, and playing fields because these areas will no longer support the primary constituent elements. Note, however, that the 32 acres have not been removed from the map depicting this unit; nor have they been subtracted from the unit total and overall total number of acres being designated as critical habitat for the species.

Unit J: Casserly: Unit J consists of open patches of grassland interspersed with golf course greens, cattle pastures, croplands, and orchards. This entire unit of approximately 450 ha (1,110 ac) consists of privately owned lands. It is the unit for which the least amount of information is available, particularly with respect to existing land uses. The Spring Hills population of Holocarpha macradenia occurs within this unit. The population numbered approximately 4,000 individuals in 1990 (CNDDB 2001); the population was observed in 1995 and 2001, though not counted. The population was fragmented by development of the Spring Hills Golf Course, and now consists of five separate occurrences. This unit is essential because it currently supports multiple occurrences of H. macradenia that are found in the Monterey Bay area, including the five populations known from the Spring Hills Golf Course. This unit also supports grassland habitat that is important for the expansion of existing populations, and for maintaining connectivity between these populations. It is one of only three areas that support populations of H. macradenia that are found in the central Monterey Bay area and in the southern end of the range of the species as well as the most inland distribution of the species. Preserving genetic variability within the species that has allowed it to adapt to these slightly different environmental

conditions is essential for the long-term survival and conservation of the species.

Unit K: Elkhorn: Unit K consists of sloping terrain on the edges of a coastal terrace, just south of the Pajaro River in northern Monterey County. The population of Holocarpha macradenia that is found here is unusual in that it occurs on a canyon bottom; it is also the only population that occurs primarily on the Santa Ynez soil series. This unit of approximately 70 ha (170 ac) is privately owned by the Elkhorn Slough Foundation (Foundation). The CDFG holds a conservation easement on an approximately 16-ha (40-ac) parcel that overlaps in part with this unit; the Foundation is managing the parcel for its biological values. Multiple Federal, State, and local government and private agencies have recently developed a conservation plan for the Elkhorn Slough watershed; this critical habitat unit is within the 18,210-ha (45,000-ac) area on which the conservation plan focuses (Scharffenberger 1999). In 1993, the population at this site comprised approximately 3,200 individuals (CNDDB 2001). Salix spp. (willow) planting that has been undertaken as part of a riparian enhancement project may increase shading on an adjacent population of H. macradenia, leading to a reduction in the size of that population (Holl, in litt., 2002). This unit is essential because it currently supports a population of H. macradenia and because it is one of only three areas that support populations of H. macradenia that are found on the central Monterey Bay area and in the southern end of the range of the species. Also, this is the only population that occurs primarily on the Santa Ynez soil series. Preserving any genetic variability within the species that has allowed it to adapt to these slightly different environmental conditions is essential for the long-term survival and conservation of the species. In addition to the current population, this unit comprises grassland habitat that is important for the expansion of the population.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Holocarpha macradenia critical habitat consists of three components (67 FR 63968-64007):

(i) Soils associated with coastal terrace prairies, including the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series.

(ii) Plant communities that support associated species, including native grasses such as Nassella sp.(needlegrass) and Danthonia californica (California oatgrass); native herbaceous species such as members of the genus Hemizonia (other tarplants), Perideridia gairdneri (Gairdner’s yampah), Plagiobothrys diffusus (San Francisco popcorn flower), and Trifolium buckwestiorum (Santa Cruz clover); and

(iii) Physical processes, particularly soils and hydrologic processes, that maintain the soil structure and hydrology that produce the seasonally saturated soils characteristic of Holocarpha macradenia habitat.

Special Management Considerations or Protections

Much of what is known about the specific physical and biological requirements of Holocarpha macradenia is described in the Background section of this final rule. Additional information about appropriate management techniques is being generated by ongoing management efforts and research on life history. As discussed in the Background section, several agencies such as the CDFG, California Department of Parks and Recreation (CDPR), CalTrans, County of Santa Cruz, City

of Santa Cruz, and EBRPD are undertaking efforts to learn how to better enhance habitat for H. macradenia. Some of these efforts are being carried out with the cooperation of researchers from UC Santa Cruz and Berkeley's Jepson Herbarium. Preliminary management and seed bank studies show that habitat manipulation such as burning, mowing, grazing, and scraping can increase standing numbers of plants and may be necessary to enhance and maintain populations of H. macradenia. Active management is often necessary to preserve habitat that is essential for the long-term conservation of H. macradenia. Special management considerations or protections may be needed to maintain the primary constituent elements for Holocarpha macradenia within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecological processes may be sufficient to ensure that populations of H. macradenia are maintained, and have the ability to reproduce and disperse into surrounding habitat at those sites. In other cases, however, active management may be needed to maintain the primary constituent elements for H. macradenia. We have outlined below the most likely special management or protection that H. macradenia may require. (1) The native soils on which Holocarpha macradenia is found should be maintained to optimize conditions for the species. Physical properties of the soil, such as its chemical composition, salinity, texture, and drainage capabilities would best be maintained by limiting or restricting deep tilling and the use of herbicides, fertilizers, or other soil amendments. (2) The hydrologic regime of the area surrounding Holocarpha macradenia habitat should be maintained to provide for the seasonally moist soils that the species favors. Increasing or decreasing surface and subsurface water flow to these areas through habitat alteration that either artificially adds water (e.g., through irrigation) or reduces water (e.g., through diversions associated with construction projects) could decrease the suitability of these areas to support H. macradenia. (3) The grassland communities should be maintained to ensure that the habitat needs of pollinators and dispersal agents are maintained. The use of pesticides should be limited or restricted so that viable populations of pollinators are present to facilitate reproduction of Holocarpha macradenia. Fragmentation of habitat through construction of roads and certain types of fencing should be sufficiently limited to allow seed dispersal agents to move H. macradenia seed throughout the unit. (4) The grassland communities need to be maintained to facilitate germination and the establishment of seedlings, because this is a critical bottleneck in the life cycle of the species (Bainbridge, in litt., 2002b). In particular, this portion of the species' life cycle requires a reduced litter layer and canopy height of surrounding vegetation. This can be achieved through either mowing or livestock grazing. A discussion of more detailed prescriptions is beyond the scope of this rule, as the optimal regime will vary from site to site, depending on a number of variables. However, research efforts that are currently underway will assist in developing more site-specific recommendations. (5) In the grassland communities where Holocarpha macradenia occurs, invasive, nonnative species such as French broom, eucalyptus, acacia, Harding grass, bromes, artichoke thistle, and bristly ox-tongue and other species need to be actively managed to reduce competition and maintain the open habitat that H. macradenia needs. (6) Certain areas where Holocarpha macradenia occurs may need to be fenced to protect them from accidental or intentional trampling by humans and livestock, and to facilitate management of the habitat through intentional grazing or other means.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2014)

Lifespan

Adult: 1 year (USFWS, 2014)

Breeding Season

Adult: July - October (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Insect pollinators, soil seed bank (USFWS, 2014)

Reproduction Narrative

Adult: This is an annual plant. Flowering from July to October, the inflorescences comprise yellow ray and disc flowers. Native bees, flies, wasps, and winged beetles have been observed pollinating H. macradenia (Barber 2002). Plants produce 1 to 60 inflorescences with two types of flowers that produce two types of achenes (seeds) with different morphologies and requirements for germination. Results of studies indicate that disk seeds produced by Holocarpha macradenia germinate within a year of production while ray seeds form persistent seed banks. Holocarpha macradenia is self-incompatible, meaning that individuals will not produce viable seeds without cross pollinating with other individuals (Baldwin, in litt. 2001) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal prairies and grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Periodic fire (USFWS, 2014)

Geographic or Habitat Restraints or Barriers

Adult: 10 - 220 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits coastal prairies and grasslands, often with clay or sandy-clay soils, at 10 - 220 m elevation. Most frequent associates are non-native grasses and non-native French broom (Genista monpessulana). The environmental specificity is moderate (generalist or community with some key requirements scarce) (NatureServe, 2015). Soils associated with coastal terrace prairies include the Watsonville, Tierra, Elkhorn, Santa Inez, and Pinto series. Physical processes, particularly soils and hydrologic processes that maintain the soil structure and hydrology that produce the seasonally saturated soils characteristic of H. macradenia habitat, are necessary features for the conservation of the species. Historically, coastal prairie species such as Holocarpha macradenia may have evolved under light grazing pressure and an intense fire regime used by California Native American groups (Heady et al. 1988). Grazing likely improves habitat quality for H. macradenia by removing plant biomass cover, reducing aboveground

competition during the growing season, and reducing thatch accumulations that inhibit tarplant germination. Additionally, trampling by grazers can open, roughen, and compact surface layers of soil (USFWS, 2014).

Dispersal/Migration

Dispersal

Adult: Low; possibly high if dispersed by animals (USFWS, 2014)

Dispersal/Migration Narrative

Adult: Most seeds remain on the plant until the first significant rain (0.6-1.2 inches (15–30 millimeters (mm)) in late autumn (Service 2002, Holl and Hayes 2006). Neither type of seed appears to have a structural means for dispersal, and most fall within 17.7 inches (45 cm) of the plant (Holl and Hayes 2006) though it is possible that some ray seeds may be dispersed over long distances by animals (Satterthwaite et al. 2007) (USFWS, 2014).

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

15 native, 4 - 8 experimental (USFWS, 2023)

Population Size:

Uncertain, possibly ~25,000 (NatureServe, 2015)

Adaptability:

High (inferred from NatureServe, 2015)

Population Narrative:

The plant is not terribly vulnerable intrinsically; it is a robust composite that can colonize open areas. Long term trend has been one of substantial decline; 50-70%. The short term trend has been one of steady decline (10 - 30%) due to development. It is difficult to trust some of the population data CNDDB has received. For example, one form stated there were "millions" of plants, which seems doubtful. More solid estimates sent to the CNDDB tend to be from the early 1990's and therefore constitute old information. These add up to about 25,000 plants (NatureServe, 2015). Holocarpha macradenia occurs in 14 native and 4 to 8 experimentally seeded populations (USFWS, 2014). There are currently 19 known occurrences that support Santa Cruz tarplant or are presumed to have a viable seedbank and suitable habitat (Table 1). This is an increase of one occurrence, located on private land, since the 2014 5-year review. Eleven occurrences have regular or periodic monitoring that estimate annual abundance of Santa Cruz tarplant and also have active management and/or reintroduction efforts. The remaining eight occurrences have no monitoring and management efforts, or have ceased monitoring and management since 2014 (USFWS, 2022). At listing, Santa Cruz tarplant was

known from 14 natural and 4 to 8 experimentally introduced populations in coastal grasslands and prairies in Contra Costa, Santa Cruz, and Monterey Counties, California (65 FR 14898). Santa Cruz tarplant continues to occur within Contra Costa, Monterey, and Santa Cruz Counties. Currently, 15 natural populations are located within Santa Cruz and Monterey Counties and four experimental populations are located within Contra Costa County (USFWS, 2023).

Threats and Stressors

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: In Santa Cruz County, coastal prairie habitat was converted to ranching and agricultural lands in the late 1800s and early 1900s; subsequently, this habitat was favored for the expansion of urban centers, especially around the cities of Santa Cruz and Watsonville. California coastal prairies have been affected by humans to the extent that their recovery is extremely slow or even unlikely, and will require human intervention (Stromberg and Griffin 1996; Hamilton et al. 2002, as cited in Buisson et al. 2006). The Apple Hill population is located on a small Caltrans right-of-way. The population was once comprised of three colonies, two of which were extirpated by the construction of a housing development on adjacent private property. The remaining colony occurs on a strip of land between the housing development and Highway 152. The Arana Gulch population and its designated critical habitat will be subject to additional habitat alteration and destruction with the construction of a bike path proposed by the City of Santa Cruz. A portion of the habitat associated with the Watsonville Airport may be subject to additional alteration; a proposed development project would permanently impact approximately 2 acres (0.8 ha) of Holocarpha macradenia critical habitat within the Watsonville critical habitat area (Unit I) (Olberding Environmental 2009). The Winkle population of Holocarpha macradenia, also referred to as the Santa Cruz Gardens population, was partially destroyed by development in 1986 (Arnold and Lyons 2009). Further development has been proposed within a 58.6-acre (23.7-ha) project site that includes the Winkle population (USFWS, 2014).

Stressor: Nonnative plants (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Overgrowth of nonnative invasive species is a principal ongoing threat for Holocarpha macradenia populations. Even with management, most populations are in decline due to H. macradenia's inability to compete with the overgrowth of nonnative vegetation. Invasive species that have been identified as threats to H. macradenia populations include but are not limited to: Genista monspessulana (French broom), Foeniculum vulgare (fennel), Eucalyptus spp. (eucalyptus); Acacia decurrens, A. melanoxylon (acacia); artichoke thistle; Rubus discolor (Himalayan blackberry); Phalaris aquatica (harding grass); Festuca arundinacea (tall fescue); Cardaria draba (hoary cress); Carduus pycnocephala (Italian thistle); Picris echioides (bristly ox-tongue); Trifolium angustifolum (narrow-leafed clover); Convolvulus arvense (field bindweed); and Conium maculatum (poison hemlock) (Service 2000, Watsonville Wetlands Watch 2009) (USFWS, 2014).

Stressor: Herbivory (USFWS, 2014)

Exposure:
Response:
Consequence:
Narrative: A study by Maze (2009) indicated that invertebrate herbivory on Holocarpha macradenia significantly affected the survivability of H. macradenia seedlings. Most of the herbivory observed in the study was caused by the nonnative grey garden slug (Deroceras reticulatum). Although results of this study indicate that herbivory could potentially be a problem for H. macradenia, or possibly exacerbate other threats to H. macradenia populations, herbivory does not appear to be a significant threat at this time (USFWS, 2014).

Stressor: Low reproductive success (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The eight populations of Holocarpha macradenia in Contra Costa County are the result of 22 experimental seedings performed from 1982 to 1986, within Wildcat Canyon Regional Park on East Bay Municipal Utility District land. The 22 experimental seedings have been managed with invasive plant removal and a grazing regime, yet have resulted in only 8 lasting populations, with only one of these populations (Mezue) showing substantial numbers and an increasing trend over time. Additionally, of the 8 remaining populations, data show that only about half of these have had persistent numbers of aboveground plants over the past 10 years (Legard, unpubl. data 2010). Although some seeding attempts have been somewhat successful, it appears that the management, timing, location of plantings, and techniques greatly influence the results of the persistence of Holocarpha macradenia, and long term viability in these cases remains unclear (USFWS, 2014).

Stressor: Environmental stochasticity (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Much of the coastal prairie habitat that supports Holocarpha macradenia has been altered, fragmented, or destroyed, so that most of the remaining habitat is of small acreage and supports only very small populations. Because H. macradenia is not capable of self-fertilization, individuals cannot produce viable seeds without cross pollinating with other individuals. Small populations may have a more difficult time attracting pollinators and therefore may experience lower seed production rates, leading to reduced species viability and possible extirpation over time (Service 2000, Satterthwaite 2007). With only 14 naturally occurring populations in a limited portion of its historic range, environmental stochasticity remains a threat to H. macradenia, and is currently a greater threat than it was at the time of listing (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Impacts to H. macradenia under predicted future climate change are unclear. The potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that species will "move" to higher elevations and northward, depending on

the ability of each species to do so (USFWS, 2014).

Recovery

Reclassification Criteria:
Recovery Priority Number: 11

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Coordinate a meeting with CDFW and the Elkhorn Slough Foundation, including species experts and managers of Holocarpha macradenia populations, to collaborate on current status of the species, successful management and census techniques, and to continue efforts toward management of the species and conservation of habitat (USFWS, 2014).
- Work with the appropriate governing agencies or landowners to continue and/or improve management for Holocarpha macradenia populations, and initiate programs for populations that do not currently undergo a management regime. Possibilities may include but are not limited to: At Fairway Drive, working with the County of Santa Cruz and the Homeowners Association toward more active long-term management and restoration of habitat and populations; working with the Spring Hills Golf Course to investigate possibilities to restore and manage habitat and populations on their property; at O'Neill/Tan, working with the County of Santa Cruz and private landowners toward more active long-term management and restoration of habitat and populations; at Atkinson Lane, working with PG&E toward the possibility of long-term management and restoration of habitat and populations; at Apple Hill, working with Caltrans to better manage and restore habitat and populations; and at Arana Gulch, working with the City of Santa Cruz toward more vigorous long-term management and restoration of habitat and populations (USFWS, 2014).
- Investigate opportunities for conservation of lands that support suitable habitat for the species and for future outplanting (USFWS, 2014).
- Evaluate suitable habitat for future outplanting, and investigate seeding and transplanting techniques that will lead to large, self-sustained populations (USFWS, 2014).
- Based on research already conducted by Satterthwaite et al. (2007), Bainbridge (2003, 2007), and the California Department of Parks and Recreation (Hyland, unpubl. data 2002, 2004, 2007, 2009), undertake additional research to investigate seed bank dynamics, particularly how to maintain optimal balance between aboveground populations and the seed bank (USFWS, 2014).
- Conduct research to investigate mowing, raking, grazing, and other techniques that are beneficial to Holocarpha macradenia and develop best management strategies, particularly for management of thatch and nonnative species, utilizing these techniques (USFWS, 2014).
- Investigate the impacts of climate change on Holocarpha macradenia (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Identify techniques for successful reintroduction and management. 2. Secure funding for management at currently unmanaged locations. 3. Include habitat restoration as part of reintroduction efforts. 4. Identify mechanisms to promote and

preserve Santa Cruz tarplant on properties susceptible to development (USFWS, 2022).

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SPECIES ACCOUNT: *Hudsonia montana* (Mountain golden heather)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/19/1980; Southeast Region (R4)

Physical Description

A low, spreading shrub, not over 3-4 dm tall, with evergreen, needle-like leaves. Bright yellow flowers bloom in June and July. (NatureServe, 2015) Stems--Numerous, decumbent-based, often rooting at lower nodes, producing abundant spur shoots, the side branches arching upward, the whole plant forming low open clumps 8-15 cm high, occasionally forming patches 8-10 dm across, most often in clumps 15-20 cm, the old shoot growth with hark a dark reddish-hrown, with numerous irregular narrow cracks revealing paler inner bark, the newer shoots with epidermis more reddish, the newest growth pale reddish-brown or tan, pilose. Leaves--Alternate, ascending and overlapping in tight spirals from base to tip of shoots and spur shoots, linear, mostly 3-8 mm long, sometimes curved, greenish, firm, somewhat thickened, toward the base above somewhat concave, toward the apex thicker, the tips with a conic callus, the surfaces at first pilose, later nearly smooth. Flowers are few to several, solitary from the tips of shoots and spur shoots, on slender, erect or ascending, pilose-tomentose peduncles mostly 5-10 mm long. Flowers are bisexual, regular; calyx turbinate, mm long, the 5 sepals unequal, fused at base to a cup, the 2 longest lobes linear-subulate, the others lance- ovate, acuminate, the outer surface pilose-tomentose; petals 5, distinct, pale yellow, spreading, twice as long as the sepals; stamens distinct, smooth, up to 25, ca. 3 mm long, the anthers broadly ellipsoidal, ca. 0.3 mm long. Ovary superior, 3-carpellate, pilose. Fruits are capsule ovoid, ca. 3 mm long, pilose to base, splitting into 3 firm valves, 1 with the persistent elongate style; seeds few, usually 2-3, asymmetrically oblong-ellipsoidal or ovoid, ca. 1 mm long, the surface covered low, papillose, gray-white bumps. (USFWS, 1983)

Taxonomy

Mountain golden heather was described by Nuttall (1818) in 1816 as Hudsonia montana. In 1972, Skag and Nickerson proposed that it be treated as a subspecies of Hudsonia ericoides (Hudsonia ericoides ssp. montana). This treatment was followed by the Smithsonian Institution in their 1975 report to the Congress and by subsequent Federal Register publications. Various authors however, have continued to recognize the taxon as a distinct species and morphological, cytological, and population studies confirm the distinctness of Hudsonia montana from Hudsonia ericoides (Morse, 1979). (USFWS, 1983)

Historical Range

See current range/distribution.

Current Range

Very narrow endemic, known from only two adjacent North Carolina counties; east rim of Linville Gorge, within 8 km. of Table Rock Mountain, and 2 pops. about 20 miles distant from Linville Gorge. (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/19/1980.

Legal Description

On October 20, 1980, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 19, 1980) for Hudsonia montana (Mountain golden heather) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in North Carolina (USFWS, 1980).

Critical Habitat Designation

The critical habitat designation for Hudsonia montana includes one CHU in Burke County, North Carolina. This species critical habitat encompasses approximately 1,085 acres (ac) (438 hectares (ha)). A description is provided below; a map depicting the critical habitat area is available in the Final Rule (USFWS, 1980).

North Carolina: Burke County; the area bounded by the following: on the west by the 2200' contour: on the east by the Linville Gorge Wilderness Boundary north from the intersection of the 2200' contour and the Shortoff Mountain Trail to where it intersects the 3400' contour at "The chimneys"-then following the 3400' contour north until it reintersects the Wilderness Boundary-then following the Wilderness Boundary again northward until it intersects the 3200' contour extending west from its intersection with the Wilderness Boundary until it begins to turn south-at this point the Boundary extends due east until it intersects the 2200' contour.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Hudsonia montana critical habitat are not defined (45 FR 69360-69393).

Special Management Considerations or Protections

Any activity which would result in increased trampling or disturbance. of the fragile areas where Hudsonia montana occurs would adversely modify the Critical Habitat. The long-term solution for best protecting Hudsonia montuno may be to greatly reduce the human traffic in the immediate areas where this plant occurs. In this respect, Critical Habitat designation may affect Federal activities as this may require prohibiting the development of new trails in areas where the plant occurs, relocating old trails, or other steps by the Forest Service. (USFWS, 1980)

Life History

Food/Nutrient Resources

Breeding Season

Adult: The plant flowers in late May, on warmer, sunnier sites. Each bud produces on flower, which lasts for approximately eight hours—from early morning to late afternoon. All flower parts are persistent except the petals, which wither and shed as the evening approaches, unless the closing sepals trap them. The peak bloom is reached the first full week of June, with only scattered flowers appearing through June. Rarely will a flower be seen in July (USFWS, 1983).

Reproduction Narrative

Adult: According to Pharr (in prep.), the vegetative phenophase of mountain golden heather begins in May when the small, dull-green leaves appear in tufts. One season's vegetative growth ranges from 1 cm on a small plant to 11 cm on a healthy mature plant. Flowering stems produce

little vegetative growth. In October the leaves begin to yellow then brown. Dead brown leaves persist, appressed and scale like, on the other branches, The plant flowers in late May, on warmer, sunnier sites. Each bud produces on flower, which lasts for approximately eight hours—from early morning to late afternoon. All flower parts are persistent except the petals, which wither and shed as the evening approaches, unless the closing sepals trap them. The peak bloom is reached the first full week of June, with only scattered flowers appearing through June. Rarely will a flower be seen in July. Similar in structure to other Hudsonia species, the flowers are self-compatible and may self-pollinate in the late afternoon as the flower closes, forcing the anthers to loose their pollen against the pistil. The plants have a well-formed pollen suggesting sexual rather than asexual reproduction. Pharr further stated that the fruiting phenophase occurs from late June through July, Morse, according to Pharr, has germinated a few seeds collected in July 1979. Pharr also noted that by early August few capsules remain intact and unopened. Seedlings have been found at some sites. (Morse, 1979; Pharr, in prep) (USFWS, 1983).

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Shallow soils that form over quartzite or mica gneiss rock ledges. Usually in the sparsely vegetated ecotone between bare rock and heath bald (NatureServe, 2015). Species is a specialist that inhabits a very narrow range (NatureServe, 2015). This habitat specificity infers that the species requires high ecological integrity of the community and site fidelity and has low tolerance range.

Dispersal/Migration

Population Information and Trends

Population Trends:

Stable (USFWS, 2012)

Number of Populations:

1 - 20 (NatureServe, 2015)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Species suffers from recreational use of habitat; brittle stems break under foot, and plants have been scorched by campfires. Difficult to determine because of its growth habit (spreading); adjacent clumps may have originated by clonal spread from a single individual. Reproduction by seed known in the wild. Known from a few nearby populations in one small area, plus two other populations in an adjacent county (NatureServe, 2015). The low number of populations and specific habitat requirements infers low resiliency, representation and redundancy of the species. USFWS (2012) notes that the 5 known populations are relatively stable.

Threats and Stressors

Stressor: Fire suppression (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Sire suppression is a primary threat to this species, because it facilitates competition from other woody vegetation and suppresses seedling recruitment (e.g., Frost et al., 1995) (USFWS, 2012).

Stressor: Recreational activities (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individual plants
Narrative: Trampling from recreational users is listed as a threat to this species. Paradoxically, recreational impacts (from campers) serve to slow further vegetation succession and occasionally expose mineral soils in these fore suppressed areas, thereby resulting in impacts to established plants while simultaneously facilitating seedling recruitment (Frost, pers. Comm., 2007) (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012).
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The North Carolina Plant Conservation and Protection Act (NC State Code Article 19B, 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, this statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. There are no federal or state statutes that afforded significant protections to H. montana. Therefore, inadequacy of existing regulatory mechanisms continues to threaten this species (USFWS, 2012).

Recovery

Delisting Criteria:
1. The five known populations are maintained as current levels or above and are self-sustaining (USFWS, 2012).

2. Species biology and site dynamics are sufficiently understood to assure effective long-term management strategy (USFWS, 2012).

3. Species biology and site dynamics are sufficiently understood to assure effective long-term management strategy (USFWS, 2012).

4. The species and its habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 2012).

Recovery Actions:

- The known populations have been relatively stable over time, though only trough active land management (USFWS, 2012).
- Although we have learned a large amount of information about the species' biology and site dynamics so far, there are still many unknowns (e.g. water requirements and shade management) (USFWS, 2012).
- More time and management work is required prior to deciding if the policies are effective (USFWS, 2012).
- Hudsonia montana and its habitat are not protected from human-related activities and natural threats. The USFS is unable to perform controlled burns within the habitat that is home to the largest populations of the species due to the proximity of housing developments. The destruction of habitat due to recreation has not been completely eliminated even when trails and camping sites are closed to the public. The possible effects of climate change on this species are currently unknown, so it is not clear if protection can be provided to H. montana if climate change were to become a threat in the future (USFWS, 2012).
- Monitor effects from the 2012 prescribed burn on Woods Mountain (USFWS, 2012).
- Begin a physical removal of duff layer on Woods Mountain and restore H. montana for future introduction into restored area (USFWS, 2012).
- Prepare and finalize individual fire-use and prescribed burns plans for each of the individual populations of the species (USFWS, 2012).
- Resume prescribed burns in Linville Gorge, with emphasis upon those populations with the longest lapse in burning (USFWS, 2012).
- Repeat census of all known populations (USFWS, 2012).
- Perform research to examine H. montana water requirements and shade tolerance (USFWS, 2012).
- Establish a system of interagency cross-checks to ensure that necessary actions are completed each year until restoration efforts are complete and required management is reduced to routine management (USFWS, 2012).
- Obtain low altitude, high resolution aerial (or satellite) imagery sufficient for delineation of currently occupied and restorable habitat. Use this imagery set to set measurable goals for future habitat restoration efforts (USFWS, 2012).
- Digitize photos from long-term photo monitoring project, or a subset of these, with the intent of examining changes in spatial extent (and seedling recruitment) under varying management regimes (e.g. burning) and threat abatement strategies (e.g. closures) (USFWS, 2012).
- Revise recovery criteria and/or the species recovery plan (USFWS, 2012).
- Work with the USFS to continue censusing populations every five years. Work with the USFS and support efforts to complete an EA tor control of exotic, invasive species across all Wilderness areas, including the LGW. Work with and support the USFS, Wild South, and other CFLRP partners, to continue exotic, invasive species inventory and management

projects at the LOW. Work with and support the USFS, Wild South, and other CFLRP partners to quantify visitor use and identify visitor use patterns to prioritize management that would help minimize recreational impacts at the LGW. Coordinate with the USFS and an appropriate botanical garden to collect and bank seeds. Highest priority sites should be those with only one EO, adjacent to a trail, and no prior seed collection (Table Rock and Chimney Gap). Work with the USFS and support efforts to complete an EA for prescribed burning in occupied mountain golden heather habitat or all fire-adapted habitats within the LGW. (USFWS, 2019)

- Attempt to reintroduce the species to the southern end of Table Rock using seeds collected from elsewhere within the Table Rock population, or other sites within Linville forge. (USFWS, 2012)

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SPECIES ACCOUNT: *Hymenoxys herbacea* (Lakeside daisy)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/23/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

The Lakeside daisy is a perennial herb with flowering stalks, 5-25 cm tall, arising from basal tufts of leaves. When the plants are not in bloom, the small tufts of leaves are easily overlooked, but in bloom (late April-June, or July in Canada) the plants are extremely showy, with populations simultaneously producing masses of large (3-4 cm in diameter) yellow flower heads. (NatureServe, 2015)

Taxonomy

The species was listed as Hymenoxys acaulis var. glabra (USFWS, 1988) and is treated that way in most floras. Based upon the work of Cusick (1991), who noted chromosomal, reproductive, and physical differences between the Lakeside daisy and the original nominate species, the Fish and Wildlife Service recognized the Lakeside daisy as a separate species, Hymenoxys herbacea. More recent treatment is Tetraneuris herbacea (USFWS, 2016). The taxonomic name for Lakeside daisy was Hymenoxys herbacea (Asteraceae). However, more recent treatment is to use Edward Greene's name of Tetraneuris herbacea. This is the name used by the Ohio Department of Natural Resources Division of Natural Areas and Preserves (DNAP), USDA, Center for Plant Conservation, Smithsonian National Museum of Natural History, and it is widely accepted by many other scientific organizations. However, this name has not been widely adopted by the Service. (USFWS, 2021)

Historical Range

At the time of listing, the Lakeside daisy was known from only one fragmented population in the U.S., in Ottawa County, Ohio and from two regions in Ontario, Canada. It was presumed extirpated in Will and Tazewell, County Illinois (USFWS, 2016).

Current Range

Currently, the Lakeside daisy is known from sites in Ohio, Illinois, Michigan, and Ontario. It is extant on the Marblehead Peninsula of Ottawa Co., Ohio and in Ontario, Canada on Manitoulin Island and the Bruce Peninsula. The largest populations are in Ontario. Additionally, three introduced populations that are likely not functioning as an ecological community, have been transplanted into appropriate habitat in Erie County, Ohio and in DuPage and Cook County, Illinois. Sites presumed extirpated in Will and Tazewell County, Illinois are now identified as restored populations. The population in Michigan occurs in Brevort Township, Mackinac County (USFWS, 2016). Since the Lakeside daisy was listed as threatened in 1988 (53 FR 23742), the number of populations in the United States has increased from the single large, fragmented population at Marblehead Peninsula in Ottawa County, Ohio. In Michigan two populations were found and three populations were introduced. Additionally, three populations have been restored (two in Will County, Illinois, one in Tazewell County, Illinois). In Illinois three populations have been introduced (two in Cook County and one in DuPage County), two populations were introduced in Michigan (Brevort Lake Road reserve and quarry), and four populations have been introduced in Ohio (three on Kelleys Island and one in Margaretta Township, Erie County). Most populations in Illinois and Michigan appear to be stable, however

some, such as the DuPage and Tazewell County, Illinois populations have been declining. (USFWS, 2021)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrosser (self-incompatible), but also reproduces clonally. (NatureServe, 2015)

Lifespan

Adult: Unknown, possibly decades (USFWS, 1990)

Dependency on Other Individuals or Species

Adult: According to the Recovery Plan, the following types of insects have been observed to pollinate Lakeside daisy: bumble bees (Apidae), small carpenter bees (Xylocopidae), and halictid bees (Halictidae). Recent observations in Ohio, have documented multiple insects visiting and potentially pollinating Lakeside daisy flowers. These include the pearl crescent (Phycoides tharos) (Parshall, Ohio Lepidopterists, personal communication, 2015), a small butterfly, and multiple syrphid flies (Syrphidae) including the transverse-banded flower fly (Eristalis transversa), tufted globetail (Sphaerophoria contingua), and margined calligrapher (Toxomerus marginatus) (USFWS 2021).

Breeding Season

Adult: Flowers late April to early June (USFWS, 1990)

Reproduction Narrative

Adult: The Lakeside daisy is a perennial that flowers from late April to early June. Although locally variable, an average of 75% of the adult plant population in any given area is in flower during this time. Under optimal greenhouse conditions, plants grown from seed can achieve reproductive size within seven months; in natural populations it may take two to three years (DeMauro 1990). Buds are visible by early spring at the rosette center. Flowers are visited by bumble bees (Dr. R. Betz, pers. obs.), small carpenter and halictid bees (R. Panzer, Northeastern Illinois University, pers. obs.), and the pearl crescent butterfly (USFWS, 2016). It is possible that pollination is also achieved by wind. Outcrossing is necessary for seed production because Lakeside daisy exhibits sporophytic incompatibility within a clone (DeMauro l988a). In natural populations, seed production averages 49 seeds per inflorescence (DeMauro 1988a). The number of inflorescences/plant is positively correlated with plant size and although highly variable, the two are positively correlated (DeMauro l988a). Achenes develop quickly and are wind-dispersed three to four weeks following fertilization. In natural populations, spring and fall seed germination have been observed (DeMauro pers. obs.). Under optimal artificial storage conditions, seeds can remain viable for at least three years (DeMauro unpub. data); in natural populations, it is not known how long seeds remain viable or if there is a seed bank. Although the longevity of clonal colonies is not known, plants can grow up to one meter in diameter; under field conditions it may take on the order of decades to achieve this size. (USFWS, 1990).

According to the Recovery Plan, the following types of insects have been observed to pollinate Lakeside daisy: bumble bees (Apidae), small carpenter bees (Xylocopidae), and halictid bees (Halictidae). Recent observations in Ohio, have documented multiple insects visiting and potentially pollinating Lakeside daisy flowers. These include the pearl crescent (Phycoides tharos) (Parshall, Ohio Lepidopterists, personal communication, 2015), a small butterfly, and multiple syrphid flies (Syrphidae) including the transverse-banded flower fly (Eristalis transversa), tufted globetail (Sphaerophoria contingua), and margined calligrapher (Toxomerus marginatus) (USFWS 2021). In addition, other insects appear to feed on the disk flowers. A larva of the wavy-lined emerald (Synchlora aerata) (Wagner, University of Connecticut, personal communication, 2021) was observed on a flower disk in 2021. Multiple shining flower beetles were also observed on the disk flowers (USFWS 2021) and may be responsible for the holes observed in multiple disk flower heads (USFWS, 2021).

Habitat Type

Adult: Alvar habitat (flat limestone or dolostone bedrock with thin to no soil, few to no tress, and subject to seasonal drought) and modified alvar habitat where original habitat has been modified or removed by quarrying activities and is in the form of gravel (USFWS, 2016).

Habitat Vegetation or Surface Water Classification

Adult: Limestone or dolomite outcrops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Thin soils over limestone or dolomite outcrops or soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1990)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1990)

Habitat Narrative

Adult: The Lakeside daisy requires full sun and occurs on limestone or dolomite outcrops, on thin soils over dolomite or limestone, and on dry limestone prairie soils. It may also occur in openings of forests. It is almost exclusively found on such soils or on bare rocks. Typically, the plains are sandy or gravelly with rocks up to one inch in size or larger. An active quarry with the open, gravelly, limestone habitat has one of the best populations of the daisy. (USFWS, 1990)

Dispersal/Migration

Motility/Mobility

Adult: Limited (inferred from USFWS, 1990)

Dispersal

Adult: Low (inferred from USFWS, 1990)

Dispersal/Migration Narrative

Adult: Achenes develop quickly and are wind-dispersed three to four weeks following fertilization, typically in early to mid-June. It is not known how far seeds disperse, however the greatest numbers of seedlings appear within one-half meter of adult plants (DeMauro pers. obs.). (USFWS, 1990)

Population Information and Trends

Population Trends:

Unknown. Inferred from information (USFWS, 2021)

Species Trends:

Unknown. Inferred from information (USFWS, 2021)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

200 - 1,000,000 individuals (USFWS, 2016)

Minimum Viable Population Size:

Minimum of 5,000 individuals is necessary to maintain the balance between mutation and genetic drift; fewer than 50 individuals will result in loss of self-incompatibility alleles (USFWS, 2016)

Adaptability:

Low (NatureServe, 2015)

Population Narrative:

The species is locally abundant in good stands. There are extensive, probably millions of clumps, but the number of clonal colonies is unknown and probably far fewer. Overall, the population size is difficult to determine. Naturally occurring populations are known from two sites on Marblehead Peninsula in Ottawa County, Ohio (Lafarge Quarry and Lakeside Daisy State Nature Preserve) and Manitoulin Island and Bruce Peninsula in Ontario, Canada where 24 extant or more localities are known (Ontario CDC, 3/94). The size of the population within the Lafarge Quarry is estimated to be 10.05 million (5.78 juvenile plants and 4.27 adult plants) individuals as of 2015 but 3 million of the adult plants occur in an area planned for imminent mining in the next 3-5 years. The size of the population on the Lakeside Daisy State Nature Preserve is estimated to be 1.4-1.7 million. An introduced population occurs on Kelleys Island in Erie County, Ohio in 1989 that contained over 18,800 adult plants in 2014 and is increasing. Populations in Illinois were presumed extirpated from Will and Tazewell Counties but they have been identified as restored populations although continue to decline with the population in Will County containing less than 200 plants. Introduced populations also exist in DuPage and Cook Counties, Illinois with varying numbers from 64 to over 400 individuals surveyed in recent years. A population was discovered at a single Michigan site in Brevort Township, Mackinac County and is located on lands managed by Hiawath National Forest and the Michigan Nature Association with less than 200 plants. An additional reserve population was established by the Michigan Nature Association and planted in 2010 . These populations occur on a variety of

private and federally-owned lands with different levels of protection (USFWS, 2016). Since the Lakeside daisy was listed as threatened in 1988 (53 FR 23742), the number of populations in the United States has increased from the single large, fragmented population at Marblehead Peninsula in Ottawa County, Ohio. In Michigan two populations were found and three populations were introduced. Additionally, three populations have been restored (two in Will County, Illinois, one in Tazewell County, Illinois). In Illinois three populations have been introduced (two in Cook County and one in DuPage County), two populations were introduced in Michigan (Brevort Lake Road reserve and quarry), and four populations have been introduced in Ohio (three on Kelleys Island and one in Margaretta Township, Erie County). Most populations in Illinois and Michigan appear to be stable, however some, such as the DuPage and Tazewell County, Illinois populations have been declining. It is likely that some of the populations categorized as stable may also show declining trends if long-term data were available (USFWS, 2021).

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2010; 2016)
Exposure:
Response:
Consequence:
Narrative: The limestone or dolomite outcrops on which the daisy occurs are subject to commercial quarrying. Cottage and industrial development may eliminate habitat, while trampling and soil compaction can result from grazing or recreational activities and may impair habitat (NatureServe, 2015). Quarry operations have increased in recent years and have impacted a significant amount of occupied habitat and no additional habitat has been protected nor can alvar habitat be created. A survey conducted in 2015 shows that occupied habitat within the quarry has declined from 400-450 acres to approximately 92.552 acres mostly due to quarry activity. ATV use can destroy plants or habitat, or lead to the introduction of invasive species. Road and powerline right-of-way maintenance including herbicide spraying and snow plowing, may also adversely impact habitat. (USFWS, 2010; 2016) The greatest threat remains the ongoing quarry activities which occur at the largest population in the U.S. (Table 6). Quarry activities since 1989 have reduced the amount of potential habitat for this species. In addition, activities have expanded to the west and south where some of the highest densities of Lakeside daisy previously occurred. LafargeHolcim continues its quarry operations which reduces the amount of modified alvar habitat available. It is anticipated that once quarry operations are complete, the quarry will then naturally fill with water and become a large lake. The only remaining upland habitat would be limited to the periphery. Thus, without permanent protection of alvar and modified alvar habitat, the amount of suitable habitat for this species will continue to decline. (USFWS, 2021)

Stressor: Succession (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The species requires an open, sunny habitat. Successional growth around forest openings and at the edges male eliminate the open requirement. In some cases, past maintenance of rights-of-way has kept habitat open and needs to continue without herbicide spraying to benefit the species. (USFWS, 2010) Management requirements to maintain suitable habitat for the Lakeside daisy varies at different sites. The populations in Illinois experience

greater vegetative competition, so greater levels of management are needed to maintain open habitat. The Michigan populations are also experiencing some shading by trees, which may require some management to maintain the light levels needed by Lakeside daisy. In Ohio, some removal of cedar, and other woody species, is required to maintain sunny, open alvar habitat. This management is required infrequently. In general, Lakeside daisy is well adapted to occupying alvar habitat that other plants cannot tolerate and therefore competition is limited. (USFWS, 2021)

Stressor: Inadequacy of existing regulations (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Although laws and regulations exist to protect the Lakeside daisy on most public sites, enforcement is lacking and destruction is still occurring. On private land, the Lakeside daisy is not afforded protection, and some populations are being seriously impacted by quarrying activities. (USFWS, 2010) The inadequacy of state and Federal laws for plant and plant habitat protection remain the same as discussed in the 2016 5-year Review for Lakeside daisy. One recent change is that despite coordination between the Erie County Metroparks and the Service, including an MOU, impacts to this species are still occurring. During 2021 monitoring, Lakeside daisy plants were found pulled from the ground in an area where it appeared that illegal camping had also occurred. In addition, recent actions due to right-of-way work resulted in significant disturbance at the Brevort Township site in Michigan. (USFWS, 2021)

Stressor: Self-incompatibility (USFWS, 2010
Exposure:
Response:
Consequence:
Narrative: The self-incompatibility of the Lakeside daisy requires outcrossing between individuals with different self-incompatibility genes. Populations within larger regions, such as those on Marblehead Peninsula and Manitoulin Island, are likely in contact with many individuals that each has a different self-incompatibility gene. However, small populations tend to lose self-incompatibility genes, increasing the probability of nearby plants sharing the same gene, and therefore reducing the potential to effectively outcross. It is theorized that this may have been a leading factor in the natural disappearance of one of the last Lakeside daisy populations in Illinois (DeMauro 1982). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Climate change may be a serious threat for a rare, endemic plant species like the Lakeside daisy. The habitat for the Lakeside daisy currently spans a narrow range of habitat types, including dry, limestone prairies and alvar communities, which are globally rare. According to regional precipitation and temperature models, increased temperatures and increased rainfall may alter the habitat for the Lakeside daisy in such a way that the plant cannot adapt or invasive plants may encroach (Union of Concerned Scientists 2009). It is not known how the Lakeside daisy will be impacted by temperature or precipitation increases, but lowered lake levels caused by increased temperature will further alter the climate (Easterling and Karl 2000). (USFWS, 2010)

Populations of Lakeside daisy cannot expand to unsuitable habitat, and some, particularly those associated with the Great Lakes, including the three sites at Kelleys Island, cannot migrate northwards due to the presence of the Great Lakes and/or development. Some subpopulations in Canada may be at risk from increased wave-wash and ice build up associated with increased storm intensity (COSEWIC, In Press, 2021). (USFWS, 2021)

Stressor: Herbivory (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Disease and predation were not listed as threats to the Lakeside daisy at the time of listing (53 FR 23742), though herbivory was included as an ecological threat to both natural and restored populations in the Recovery Plan (USFWS 1990). Predation, namely deer and rabbit herbivory, of this plant continues to pose a threat to Lakeside daisy, particularly small populations.

Recovery

Delisting Criteria:
1) 475 acres of essential habitat containing the population center at the Marblehead Quarry, Ottawa County, Ohio are acquired and managed. (USFWS, 1990)

2) 465 acres of additional essential habitat at the Marblehead Quarry is protected through easements, restrictive covenants or leases. (USFWS, 1990)

3) The variety is restored to a minimum of one large, stable population in each of two geographically distinct, protected sites of suitable size within the variety's historic range in Illinois. (USFWS, 1990)

4) Restored populations are maintained for fifteen consecutive years, with monitoring to continue for an additional ten years. (USFWS, 1990)

Recovery Actions:
- Provide adequate habitat protection for the only large, naturally-occurring population in the United States, i.e. Marblehead Peninsula, through the purchase or establishment of conservation easements of suitable modified alvar habitat from Lafarge. (USFWS, 2016)
- Coordinate monitoring among all three states where this species currently occurs so that information is consistent and meaningful. (USFWS, 2016)
- Provide necessary management at all protected sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ATV access, and reducing competition. (USFWS, 2016)
- Continue to augment introduced Lakeside daisy populations on suitable sites within the species' historical range. (USFWS, 2016)
- Revise recovery criteria to include new data prior to next 5-year review. (USFWS, 2016)
- Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. (USFWS, 2016)

- Cooperatively work with Lafarge Quarry to collect seed and transplant individuals from the areas of the quarry that are at greatest threat of being quarried and have the highest genetic and habitat diversity. (USFWS, 2016)
- Cooperatively work with the ODNR Division of Mineral Resources Management to amend the Lafarge Quarry mining permit so that undisturbed areas can be recolonized by Lakeside daisy, instead of being planted with other species and creating significant competition. (USFWS, 2016)
- Increase gene pools and population numbers in restored population sites by seeding and transplanting individuals from various locations within natural populations. (USFWS, 2016)
- Improve awareness to the public about the harm of collecting federally listed plant species and the importance of protecting and maintaining unique ecosystems, such as alvars, for recovery of plant species. (USFWS, 2016)
- Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat of Lakeside daisy introduction. (USFWS, 2016)
- Further research into the origin of the Michigan populations to guide future recovery actions. (USFWS, 2016)
- Revise recovery criteria to include new data prior to next 5-year review. (USFWS, 2010)
- Provide adequate habitat protection for the only large, naturally-occurring population in the United States, i.e. Marblehead Peninsula, through the purchase or establishment of conservation easements of abandoned quarry property. (USFWS, 2010)
- Cooperatively work with Lafarge Quarry to protect areas of the quarry that are least likely to be quarried and have the highest genetic and habitat diversity. (USFWS, 2010)
- Determine the presence or absence of seed banks and the duration of seed viability. (USFWS, 2010)
- Establish Lakeside daisy populations on suitable sites within the species historical range. (USFWS, 2010)
- Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat of Lakeside daisy introduction. (USFWS, 2010)
- Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. (USFWS, 2010)
- Increase gene pools and population numbers in restored population sites by seeding and transplanting individuals from various locations within natural populations. (USFWS, 2010)
- Provide necessary management at all protected sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ATV access and prescribed burning (in Illinois only). (USFWS, 2010)
- Conduct genetic research using highly polymorphic genetic loci to determine the genetic distance of natural populations and determine the viability of small, introduced populations. (USFWS, 2010)
- Inform the public about the harm of collecting federally listed plant species and the importance of unique ecosystems. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Future actions required to proceed with the recovery of this species focus on revision of current recovery criteria, population habitat management and protection, as well as research into the genetics of Lakeside daisy. These actions are listed below

with highest priority actions listed first: • Provide adequate habitat protection for the only large, naturally occurring population in the United States, Marblehead Peninsula, through the purchase or establishment of conservation easements of suitable modified alvar habitat from LafargeHolcim. • Cooperatively work with LafargeHolcim to collect seed and transplant individuals from the areas of the quarry that have the greatest threat of being quarried and have the highest genetic and habitat diversity. • Conduct research into the genetics and diversity of the different populations to determine if seed from Ohio could increase the viability of the Michigan and Illinois populations. • Increase genetic diversity by continuing to augment introduced Lakeside daisy populations on suitable sites within the species' historical range with seeds and plants as feasible. • Provide necessary management at all sites, including removing non-native invasive species and woody encroachment, deterring herbivory, limiting ORV access, and reducing competition. • Coordinate monitoring among all three states and Ontario where this species currently occurs so that information is consistent and meaningful for comparisons. • Continue to monitor populations of Lakeside daisy, both natural and introduced, for reproductive output, recruitment, individual plant growth, and survival. • Improve awareness to the public about the harm of collecting federally listed plant species and the importance of protecting and maintaining unique ecosystems, such as alvars, for recovery of plant species. • Botanical and geological surveys should be performed throughout Ohio, Indiana, Illinois, Michigan, and Wisconsin to assess the potential for suitable habitat to establish Lakeside daisy populations. • Consider revising recovery criteria to include new data prior to the next 5-year review. (USFWS, 2021).

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SPECIES ACCOUNT: *Hymenoxys texana* (Texas prairie dawn-flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/13/1986; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

An annual plant 3.5—18 cm (1.4—7.1 in.) high with several divergent branches arising from a rosette of basal leaves. Basal leaves 1—16 mm (.04—59 in.) wide, up to 4 cm (1.6 in.) long, widest toward the tip, margins with short teeth or lobes from mid—blade to tip. Stem leaves few, linear. Flower heads usually few, small. Bracts of flower heads in two series 5—6 mm (.16—.20 in.) long. Ray flowers minute and concealed by the bracts. Disk flowers yellow, 3—4 mm (.12—.16 in.) long. Fruits about 2 mm (.08 in.) long with 5 apical scales 1—2 mm (.04—.08 in.) long (USFWS, 1989).

Taxonomy

Coulter and Rose (1891) described these plants as a new species and placed them in the genus Actinella. Greene (1898) separated the Actinella taxa with free phyllaries into the genus Tetraneuris and placed those with united outer phyllaries into the genus Picradenla. Thus, Hymenoxys texana became Picradenia texana (Coulter & Rose) Greene. Cockrell (1904) recognized Tetraneuris as a distinct genus but could not separate the North American Picradenia species from the genus Hymenoxys of South America. He, therefore, united Picradenia with Hymenoxys and transferred Hymenoxys texana into its present genus. The only specimens available to these early workers were the Thurow collections of 1889 and 1890. Hymenoxys texana was not collected again until 1981 when James Kessler discovered a few small populations north of Cypress in Harris County (Mahler 1982 and 1983). The relationship of Hymenoxys texana to four annual temperate South American species of Hymenoxys has yet to be thoroughly investigated. Three of these South American taxa lack ray flowers and perhaps one or more of them is the near relative of Hymenoxys texana, which has minute rays. A taxonomic treatment of the South American taxa is available (Parker 1962), and Sanderson (1973) reported the basic chromosome number of n = 15 for all four South American species. The North American Hymenoxys most similar to Hymenoxys texana is the annual species, Hymenoxys odorata, but the prominent long ray flowers and the deeply pinnately divided leaves of Hymenoxvs odorata easily distinguish it from Hymenoxys texana. (USFWS, 1989)

Historical Range

Up until about 1992, H. texana was known only from the northwest portion of Houston with only one population located in Fort Bend County (Barker Reservoir), with subsequent populations located in Addicks Reservoir in Harris County (USFWS, 2015).

Current Range

This species is now confirmed in five counties in Texas: Fort Bend, Gregg, Harris, Trinity, and Waller. (USFWS, 2015). A comparison of the current spatial distribution of the Texas prairie dawn flower with historical or previous reviews of this species shows the species has expanded its range westward into Waller County and beyond, and into northern regions of east Texas (USFWS, 2022).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2015)

Breeding Season

Adult: March to April (USFWS, 2015)

Other Reproductive Information

Adult: Although a potential pollinator of the Texas prairie dawn-flower was identified as composite thrips Microcephalothrips abdominalis from specimens collected north of Cypress (Young 1987), new potential pollinators were identified and photographed during the 2022 flowering season. Harvester ants in the genus Pogonomyrmex, which builds characteristic mounds more than 50 cm in diameter in large cleared flat areas with small pebbles, were observed and recorded within many of the saline barrens supporting populations at the Warren Ranch and the Jack Roads Prairies managed by the Coastal Prairie Conservancy. The harvester ants observed on the Warren Prairies during the 2022 flowering season was identified as Pogonomyrmex barbatus (Dr. Ulrich Mueller at University of Texas, Personal mail communication dated July 21, 2022). Additional pollinators were also identified as miner bees in the genus Andrena on the Warren Prairie, and the green miner bee in the genus Lasioglosusm on the Gregg County private lands (Dr. Dan Bennett at Stephen F. Austin University, personal mail communication dated July 28 and 29, 2022, respectively). Future research conducted under the section 6 grant (WSFR Grant F22AP03103-00, Biological Opinion, Reference Ecosphere 2022-0024702) will also identify potential pollinators over the next two years (USFWS, 2022)

Reproduction Narrative

Adult: H. texana is an annual plant that flowers from early March through mid to late April and produces yellow, cone-shaped seed heads. (USFWS, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, barrens, pimple mounds (USFWS, 2015; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found in poorly drained, sparsely vegetated areas (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 2015)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 2015)

Habitat Narrative

Adult: H. texana is found in small, conspicuous, sparsely vegetated areas of fine, sandy, and compact soils. These bare spots are often located on the lower sloping portions of pimple mounds (USFWS 1990). Pimple mounds are low, roughly circular or elliptical domes or shield-like mounds, often with flat tops, composed of unstratified sandy loam soils coarser than, and distinct from, the surrounding less coarse, often clayey soil. Pimple mounds range from 1 to 30 m in diameter, and attain heights from about 10 cm to over 2 m (Johnson and Horwath Burnham 2012). H. texana thrives in disturbed, open areas with barren slicks made up of a select few soils, and where specific hydrological requirements can be met. Common soil series associated with H. texana consist of primarily Gessner Complex (Ge) and Katy Find Sandy Loam (Ka or Kf). Soils are slightly saline, sticky when wet and powdery when dry. Sometimes associated with other Texas Gulf Coastal Plain endemics such as Texas windmill-grass (Chloris texensis) and Houston machaeranthera (Machaeranthera aurea). A recent description of H. texana describes the species as found in localized patches ranging from 2 to 3 m in size or as large as 100 square meters usually associated with Gessner and Katy fine sandy loam soils which sometimes are located at the base of pimple mounds (Smeins 2014). (USFWS, 2015; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

~40 - 50 populations; exact number unclear (USFWS, 2015)

Population Size:

~50,000 in one location surveyed in 2012; population unknown at other sites (USFWS, 2015)

Population Narrative:

While there are 63 known occurrences of H. texana in the TxNDD (TPWD 2014) this can not be interpreted to mean that 63 distinct populations exist. Although nearly 50 populations are known for this species, almost all are threatened by development from the expanding city of Houston. Some sites have been destroyed within a year of their discovery. In 2012, a Gregg county landowner first identified H. texana on 187 ac (75.7 ha) where surveys found the largest H. texana population with estimates greater than 50,000 individuals. (USFWS, 2015)

Threats and Stressors

Stressor: Habitat loss and alteration (USFWS, 2015)
Exposure:
Response:
Consequence:

Narrative: Habitat conversion, fragmentation, and degradation continue to be a threat. Expanding urbanization, paved roadways, feral hogs, alteration of watershed drainages, development of natural resources, and agricultural development contribute to the continued loss of suitable habitat. Heavy grazing and in some cases illegal grazing practices can be detrimental to H. texana and may even prevent the species from recruiting. Although efforts to restore, create, and effectively manage habitat for the H. texana are currently underway, suitable habitat continues to be degraded or lost within this species range. Considerable increases in overstory vegetation are visible in aerial photography over a majority of the current species' range. This increase in canopy cover results in significant declines in some H. texana populations (e.g. Addicks and Barker Reservoirs) where thousands of individual plants once thrived at numerous sites. Due to limited habitat management at Addicks and Barker Reservoir, there is a significant decline in the number of suitable sites with H. texana present at this location and as a result, individual plant numbers have declined as well. Management practices such as mowing (with certain restrictions) do not seem to harm H. texana, and in some instances, promote its existence. However, deep soil disturbances such as plowing and feral hog wallowing can be detrimental to its existence. Many of the current sites are not adequately fenced and are subjected to feral hog and cattle grazing. Managed grazing and installing fence panels aimed at excluding feral hogs will greatly benefit H. texana (USFWS, 2015).

Stressor: Drought (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The distribution of H. texana appears to be naturally restricted as a result of the specific habitat and soil requirements. However, persistent drought conditions can cause the plant to remain dormant and produce smaller, less robust plants with fewer seed heads. The drought of 2011 was especially hard on H. texana as evidenced by the reduced number of mature plants. Cool and wet winter weather seems to be conducive to early spring growth and maturation. (USFWS, 2015)

Stressor: Competition (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Competition from woody vegetation, such as Chinese tallow Triadica sebifera (an invasive exotic), yaupon Ilex vomitoria (native), and other native trees and grasses (at the ground and canopy layers), remains a large threat to the species. In areas where there is no on-the-ground management, the potential for loss is great as the woody vegetation continues to encroach creating a canopy cover that essentially allows other species to outcompete H. texana. The USFWS continues to work with other state and local partners to develop management guidelines to enhancing H. texana habitat. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Our analyses under the Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel

on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2012). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2012). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation). Winter and spring field observations indicate in years where drought conditions are prevalent, H. texana plants tend to respond with fewer, less robust individuals, and fewer seed heads. Conversely, in years where rainfall exceeds normal levels and plants may be inundated for extended periods of time, H. texana respond with fewer and less robust plants with yellowish leaves. Therefore, while it appears reasonable to assume that H. texana may be affected by the intense climate swings forecasted, and climate change should be considered a threat, the Service lacks sufficient certainty to know how climate change specifically will affect this plant. (USFWS, 2015)

Recovery

Reclassification Criteria:
Hymenoxys texana can be downlisted to threatened when: (USFWS, 1989).

(1) at least 50 separate populations, each occupying at least 1 hectare (2.47 acres) of suitable habitat, are discovered or established (USFWS, 1989)

(2) when at least 50 populations are protected from land use practices or land use changes that could destroy the populations (USFWS, 1989)

Recovery Priority Number: 2C.

Delisting Criteria:
Hymenoxys texana can be removed from the threatened and endangered species list when management practices are developed and implemented which ensure the numbers of plants at protected populations remain stable. (USFWS, 1989)

Recovery Actions:

- Protect Hymenoxys texana and its habitat from existing and future threats. Contact private landowners and Federal agency personnel. Work with the landowners and agency personnel to implement management practices that will protect the species. Establish protected sites on both private and public lands. Develop and implement a long range management plan. Enforce applicable Federal and State laws and regulations. Monitor populations. Alter management plans, if necessary, to reflect improvement or deterioration of populations (USFWS, 1989).
- Gather information on the natural history of Hymenoxys texana for use in management. Determine habitat requirements, including edaphic factors, dependence on natural phenomena and cultural practices, local microclimate, and air and water quality. Determine associated species, vegetation types, and community structure. Record associated

vegetation, frequency, density, and dominance. Determine frequently associated species. Determine If the bare soil at Hymenoxys texana sites represents an edaphic climax. Study population biology, including demography, phenology, reproductive biology (types of reproduction, pollination biology, seed dispersal and biology, seeding biology). Study community ecology, beneficial and neutral effects of other species, and negative effects of other species (USFWS, 1989).

- Update management plans as new data accumulates (USFWS, 1989).
- Search for new sites and populations (USFWS, 1989).
- Establish a botanical garden population and, if needed, attempt to establish populations In suitable natural habitat. Develop and refine propagation techniques. Establish a self—sustaining botanical garden population. Search for suitable reintroduction sites (USFWS, 1989).
- Develop public awareness, an appreciation, and support for the preservation and study of Hymenoxys texana (USFWS, 1989).
- The USFWS recommends the following actions be taken for the conservation of H. texana: - Reevaluate the 1990 Recovery Plan to reflect new species information including associated species lists, species range, survey methodologies, and soil findings in partnership with local land managers, botanists, and federal and state resource agency staff. - Develop protocol to delineate and define “populations” for downlisting or delisting this species. - Develop a central database to house all pertinent site population information. - Continue to monitor and survey known populations while searching for additional populations. - Update associated species list as necessary. - Implement section 6-funded projects, USFWS Partners for Fish and Wildlife program projects, and cooperative agreements with state and federal agencies. - Continue to search for additional populations. - Acquire new landowner conservation agreements with interested parties when appropriate. - Continue to support conservation and recovery awareness efforts through public and landowner outreach. - Redefine the range of H. texana through strategic GIS mapping efforts. H. texana is now more broadly distributed than originally thought, soil characteristics may be different at various locations, and associated species may vary at the different locations across the range. - Standardize surveying and monitoring protocols to provide consistent population data. If a new site is found, include soils analysis, associated species, genetic analysis, hydrological conditions, location, identify any threats, and note any pollinators present. - Yearly survey and monitoring data should be deposited with the TxNDD to facilitate accurate and up-to-date species specific information. (USFWS, 2015)
- Research Needs for the continued existence of H. texana - Assess and quantify predator threats (terrestrial mammals and/or insects). - Soil nalysis at each identified site. - Analyze and quantify the role of pollinators at H. texana sites. - Complete a thorough habitat range assessment using GIS analysis due to the increased range spanning five counties. - Conduct further research regarding alternative propagation techniques. - Complete additional studies to optimize frozen storage techniques for H. texana. - Identify propagation and relocation strategies for successful plug and seed transplant to suitable sites within the species range. - Identify the mechanism and/or agents of dispersal, dispersal patterns, and the effects of disturbance on dispersal. - Include genetic analysis for all sites to determine any genetic variability within sites. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that the following actions be taken for the conservation of the Texas prairie dawn flower (Hymenoxys texana): • Evaluate the recent SSURGO soil information on this species in conjunction with aerial imagery that identifies saline barren habitat on Gulf coastal prairies and Post Oak Savannah prairies that have not been previously surveyed, including the National Wildlife Refuges, where the Act does provide some legal protection for federally listed plants on federally owned lands. • Evaluate the genetics of at least 10 populations to determine if the species as a whole still possess levels of genetic diversity and heterozygosity that would be found among nonthreatened Hymenoxys species. • Continue to work with partners to annually monitor populations on their lands and use consistent standardized methods that were used during the 2022 field season that are comparable across all saline barren habitats. • Work with partners to acquire new habitat conservation plans for private landowners. • Investigate climate change effects on the reproductive and seed dispersal mechanisms of the species and its suitable habitat. • Evaluate and quantify predator effects (terrestrial mammals, invertebrates, and/or insects) on the species. • Evaluate and quantify the role of pollinators for this species • Work with partners to implement invasive species management plans and mowing strategies to restore suitable habitat for this species. • Work with partners to identify propagation and relocation strategies for successful plug and seed transplants to restore suitable habitat where invasive species management practices have been successfully implemented. Research conducted under the section 6 grant (WSFR Grant F22AP03103-00, BO Reference Ecosphere 2022-0024702) awarded to TPWD on July26, 2022, may provide new information on the reproductive biology, seed dispersal mechanism, genetics and pollinators for the Texas prairie dawn that will be available for the next 5-year review. We recommend once this information is reviewed, if possible given workloads, a Species Status Assessment could be conducted to guide the development of a revised recovery plan (USFWS, 2022).

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SPECIES ACCOUNT: *Hypericum cumulicola* (Highlands scrub hypericum)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Hypericum cumulicola is a small, short-lived perennial herb reaching 20 to 70 cm in height. It is branched from the base and has a woody, fibrous root system. The stems are shorter and more numerous in winter and spring before reproductive stalks are differentiated. Usually there are three stems, but there can be as many as 17 stems on a healthy plant (Quintana-Ascencio and Morales-Hernández in press). During the reproductive season, all stems of mature individuals bear flowers and fruits. The leaves of H. cumulicola are opposite, simple, entire, and needle-like. Flowers are small, bisexual, and arranged in cymes. The calyx consists of five distinct sepals, while the corolla consists of five bright yellow petals shaped like the blades of a propeller. There are approximately 27 anthers. The gynoecium has three, sometimes four locules, and the ovary is superior with approximately 22 ovules aligned around the walls of the ovary (parietally). The style has three, sometimes four, white lobes. Fruits are small capsules, red when immature and dark purple at the time of dehiscence. Mature seeds are small and dark brown. This species, as other Hypericum, may contain hypericin, a promising compound with protective effect in the control of viral diseases in animals (Duke 1989) (USFWS, 1999)

Taxonomy

Hypericum is a predominantly temperate genus, and a member of the family Hypericaceae. This family is closely related to the Clusiaceae (Guttiferae), and some authorities include both groups together (Cronquist 1988). In central Florida, H. cumulicola is morphologically distinct from other species in its genus (Ward and Godfrey 1978). In 1924, Small first named the plant Sanidophyllum cumulicola. Later, Adams (1962) reassigned the species to the genus Hypericum, renaming it Hypericum cumulicola. Hypericum cumulicola's closest relative in Florida is H. gentianoides, which is very similar morphologically, but branches repeatedly above the base versus only at the base for H. cumulicola (Archbold Biological Station, personal communication 1998). (USFWS, 1999)

Historical Range

See current range.

Current Range

Lake Wales Ridge in Polk and Highlands counties in Florida, from just north of Sunray, Polk County (FWS 1996) to the south end of the Lake Wales Ridge near Archbold Biological Station in Highlands County. (USFWS, 1999)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Because Highlands scrub hypericum has many-flowered stems, a single large plant can have as many as 1,600 reproductive structures (fruits, flowers, or buds) by the end of the reproductive season (Quintana-Ascencio and Morales Hernández 1997). Flowers are exposed one at a time or in small numbers (up to eight per branch) each day. The new flowers open early in the morning and the petals curl up by noon depending on the weather. This species is self-compatible, but the flowers must be visited by pollinators to set seed (ABS 2003). The mature purple capsules remain attached to the stem after releasing seeds. Seeds do not show any obvious primary dispersal mechanism and probably are dispersed passively by gravity. "Native solitary bees (Dialictus spp. and Augochloropsis spp.) appear to be the primary pollinators. Other visitors include Geron sp., Copestilium nigrum, and Bombus sp. Pollinator visitation occurs at similar rates regardless of flower or plant density" (ABS 2003, citing Boyle and Menges 2001; M. Evans, personal communication in Quintana-Ascencio et al. 1998). Most flowering and fruiting occurs between June and September, coinciding with the rainy season and daily thunderstorms typical of the region. Stems dry at the end of the reproductive season and new ones sprout from the base in late winter and early spring. Germination occurs from November through June, but most seedlings germinate between December and February. Plants reach maturity in as little as a year. Highlands scrub hypericum inhabits Florida scrub vegetation on upland areas with excessively drained white sand soil (Judd 1980a). It is almost exclusively found in rosemary balds – patches of bare sand surrounding Florida rosemary within scrub vegetation. It shares these bare patches with a number of other small scrub endemic herbs, grasses, and even a few small shrubs (Christman and Judd 1990). Rosemary balds have a fire frequency from 10 to 100 years (Myers 1990) while the surrounding scrubs have higher fire return intervals. Occasionally, Highlands scrub hypericum occurs in openings in well-drained scrubby flatwoods or with turkey oak on yellow sand soil (P. Quintana-Ascencio, ABS, personal communication, 1995). Where found, it is locally common and can occur in large groups of several thousand individuals (Judd 1980a).

Habitat Type

Adult: Scrub

Environmental Specificity

Adult: Very Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Highlands scrub hypericum is one of a suite of herbs (and a few grasses) that inhabit sunny, sandy gaps between the shrubs that dominate scrub vegetation. Many of these gap-inhabiting species are endemic to the LWR. The gap size requirements of Highlands scrub hypericum appear to be intermediate between those of two other co-occurring rosemary scrub plants: snakeroot, which is restricted to large openings (Menges and Kimmich 1996); and wireweed, which is found in large and small gaps between shrubs (Hawkes and Menges 1995). Highlands scrub populations have a high degree of genetic differentiation among populations (Menges et al. 2001).

Dispersal/Migration

Population Information and Trends

Number of Populations:

34 (USFWS, 2021)

Population Narrative:

Most populations of Highlands scrub hypericum are relatively small. The median size for 34 populations was 539 individuals, and most populations were smaller than 1,000 plants (Menges et al. 1998). A population viability model (Quintana-Ascencio et al. 2003) concluded that "fire kills above-ground individuals, but seeds in the soil survive fire and form long-lived seed banks. Fire suppression and alteration of fire regimes constitute a threat for this species because of its dependence on fire to release local populations from competitive exclusion" (ABS 2003). "After fire in Florida rosemary scrub, Hypericum cumulicola [Highlands scrub hypericum] had higher fecundity, survival, establishment, and population growth rates than in unburned populations" (Quintana-Ascencio et al. 2003). This may be due to a number of mechanisms, including killing back of shrubs, removal of lichens, destruction of allelopathic agents that affect seed germination, and the creation of open gaps that may have higher levels of soil water (Quintana-Ascencio et al. 2003). The seed germination rate for this species is extremely low except at recently-burned sites (Quintana-Ascencio et al. 2003). The most critical life-history stage influencing Highlands scrub hypericum's population growth rate and fitness is seed survival in the soil seed bank. The next-most-important life-history stage is seedling recruitment (Quintana-Ascencio et al. 2003). Massive recruitment of plants in favorable patches and in favorable years allows Highlands scrub hypericum populations to "increase rapidly and/or replenish the soil seed bank. Similar population explosions are documented in other short-lived perennials (Picó et al. 2002) and annual plants with a seed bank (Kalisz and McPeek 1992), which are able to cope with high or unpredictable environmental variation" (Quintana-Ascencio et al. 2003). The survival of Highlands scrub hypericum populations in fire-dependent habitats thus depends on the seed bank, while seedling recruitment is highly variable and depends on environmental cues (Picó et al. 2003). A population viability assessment model (Quintana-Ascencio et al. 2003) strongly also affirms that fire is essential for Highlands scrub hypericum to persist over the long term. Even the largest populations may be imperiled by fire intervals greater than 50 years. Smaller populations are more vulnerable to lack of fire. These authors consider fire suppression and alteration of fire regimes to constitute threats to this species "because of its dependence on fire to release local populations from competitive exclusion" (Quintana-Ascencio et al. 2003; Quintana-Ascencio and Morales Hernández 1997; Quintana-Ascencio and Menges 2000). In planning fire regimes for scrub, it is important to take into consideration the needs of multiple plant and animal species. Management that alternates short and long fire intervals may allow species to coexist, while invariant fire return intervals may harm some species (Quintana-Ascencio et al. 2003). Researchers at ABS have developed spatially explicit disturbance-demographic models of Highlands scrub hypericum. "This spatially explicit, individual-based model improves the precision of prior matrix projections that did not include Florida rosemary or spatial structure. It allows prediction of ranges of Florida rosemary densities that will allow scrub hypericum populations to persist under various fire regimes." The model's predictions agreed with "observed differences in scrub hypericum disappearance among gaps with contrasting rosemary densities but similar times-since-fire," so this modeling approach is likely to prove useful in predicting the effects of fires and other disturbances, including mechanical treatments of overgrown scrub, such as roller-chopping (Quintana-Ascencio et al. 2004). Early inventories of LWR endemic plants found this species at few sites – only 69 of 254 scrub sites

surveyed by Christman (1988) (ABS 2003). This severely restricted range, combined with continuing habitat loss, led to its listing. Highlands scrub hypericum is locally abundant, with populations larger than a thousand plants and presumably large seed banks in the soil at ABS, the properties of the LWRWEA (including Lake Placid, Holmes Avenue, Lake Apthorpe, and Carter Creek), Lake June-in-Winter Scrub State Park, TNC's Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWR State Forest. On these lands, Highlands scrub hypericum has benefited from fire-oriented land management practices and insights provided by the intensive demographic research program at ABS. Highlands scrub hypericum is protected on 22 sites, often with large population sizes and active fire management. However, remaining unprotected populations are in imminent danger of decline and extirpation. Unprotected habitat continues to be developed for agriculture, housing, and other uses. This is likely reducing the number and size of populations of this species. The most recent estimate of the loss of xeric upland habitat on the LWR is 87 percent (Turner et al. 2006). On managed areas that include the protected occurrences, better land management is needed to ensure that protected populations remain extant. Appropriate management includes avoiding fire suppression, avoiding fires before forecasted droughts, creation of gaps, and avoiding damage by vehicles or pedestrian trampling to plants and to the cryptobiotic soil crust, which may facilitate seedling emergence. Inappropriate fire regimes remain a significant threat. Most scrub sites supporting Highlands scrub hypericum are not burned frequently enough to support viable populations and mechanical pre-treatments or surrogates may not provide the same benefits as fire. Exotic species invasion and herbivory are potential threats but have not been directly implicated as causing population declines. Few, small, isolated populations in a limited geographic range present additional risk for Highlands scrub hypericum. These factors, in conjunction with the species' limited dispersal potential, hinder population resiliency and ultimately recovery. Anticipated climate change factors such as alterations to temperature and precipitation patterns, tropical storm intensity, and sea-level risk will only exacerbate these threats. Due to these ongoing threats mentioned above, this species continues to meet the definition of endangered under the ESA. (USFWS, 2021). Highlands scrub hypericum is locally abundant at ABS, the properties of the LWRWEA (including Lake Placid, Holmes Avenue, Lake Apthorpe, Gould Road, and Carter Creek), Lake June in Winter Scrub State Park, The Nature Conservancy's (TNCs) Saddle Blanket Lakes Preserve, and the Arbuckle tract of LWRSF. Many other populations of Highlands scrub hypericum are relatively small. Population size estimates for 34 populations showed a median of 539 individuals, most populations were smaller than 1,000 plants, the largest population was estimated to be greater than 300,000 plants, and the 25th -75th percentiles for population size were 130-4,000 plants (data summarized in Table 1 of Menges et al. 2001). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further

loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of H. cumulicola are adequately protected from further habitat loss, degradation, fragmentation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of sandpine scrub to support H. cumulicola (USFWS, 1999)

4. When monitoring programs demonstrate that populations of H. cumulicola on these sites support sufficient population sizes (USFWS, 1999)

5. When those populations are stable and distributed throughout the historic range (USFWS, 1999)

6. When H. cumulicola are sexually or vegetatively reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:
1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:
- Determine current distribution of H. cumulicola. This species has been relatively well-surveyed and a distribution has been ascertained. Additional surveys will confirm the species' distribution and locate new sites. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of H. cumulicola. Continue the study of basic biology and ecology of this species. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of H. cumulicola. (USFWS, 1999)
- Provide public information about H. cumulicola. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where H. cumulicola is

found. (USFWS, 1999)

- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Continue habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Develop land management plans that address the following threats to Highlands scrub hypericum: avoiding fire suppression, avoiding fires occurring before forecast droughts, creation of gaps, avoiding disturbances from off-road vehicles, and avoid trampling of Highlands scrub hypericum and the cryptobiotic soil crust that may facilitate its seedling emergence. • Collect data on the response of Highlands scrub hypericum to management activities such as roller chopping, mowing, gyro-tracking, logging, and chain-saw felling and, to the extent that responses are dissimilar to post-fire responses, adjust fire-based population viability models. • Develop a metapopulation model using information on population dynamics within populations, the number and distribution of populations, and dispersal among populations (for plants, mainly seed dispersal) to determine the number of self-sustaining populations needed to ensure persistence. • Study seed dispersal among populations of Highlands scrub hypericum for use in a metapopulation model. • Conduct quantitative level 2 surveys (counting individuals in defined areas) at additional sites outside of ABS and the LWRSF. Surveys should track changes in population sizes over time and in response to management treatments. • Land purchase or conservation easement of key parcels (e.g., Hendrie Ranch, Lizzie Lakes) to protect important populations. • Surveys for Highlands scrub hypericum at privately-owned, unprotected sites. • Targeted collection of Highlands scrub hypericum from unprotected sites for ex situ conservation. Highlands scrub hypericum currently has limited protection in Bok Tower Garden’s ex situ collection, with 32,012 seeds collected from 1988-1990 in cryogenic storage, and two plants from one population in their living collection (P. Gonsiska, Bok Tower Gardens, pers. comm. 2020). (USFWS, 2021)

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SPECIES ACCOUNT: *Ilex cookii* (Cook's holly)

Species Taxonomic and Listing Information

Listing Status: Endangered; 6/19/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen shrub or small tree reaching 8 feet (2.5 meters) in height. The leaves are alternate, simple, thin but leathery, glabrous, and entire. They are from 3/4 to 1 3/4 inches (2 to 4 centimeters) long and 3/8 to 7/8 inches (1 to 2.2 centimeters) wide and reach an abrupt point at the apex. The upper surface is dark shiny green and the lower a pale green with microscopic black dots. Ilex cookii is dioecious, male and female flowers are borne on different plants. Female flowers are minute (1/16 inch or 2 millimeters long) and white. Fruits are a drupe approximately 3/16 inch (5 millimeters) in diameter. Male flowers have not been observed (USFWS, 1990).

Taxonomy

Belongs to the family Aquifoliaceae (USFWS, 1990).

Historical Range

Endemic to the dwarf forests of the central mountains of Puerto Rico (USFWS, 1990).

Current Range

It is currently known from only seven herbarium collections, all from Cerro Punta and Monte Jayuya (USFWS, 2013).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1990)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 1990)

Reproduction Narrative

Adult: Ilex cookii is dioecious, producing minute male and female flowers on separate plants. Pollination is probably effected by insects or wind, although the pollination biology of this species has not been studied (USFWS, 1990).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Lower montane wet forest (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Occurs > 2,700 ft. elevation (USFWS, 2013)

Habitat Narrative

Adult: The species appear to be restricted to the dwarf (elfin) forest vegetation in the central mountains (elevations greater than 2700 feet or 830 meters) of Puerto Rico. It occurs wholly within the lower montane wet forest life zone (USFWS, 2013). The clay soils are deep, well-drained, very strongly acid, and overlay a thick layer of highly weathered rock. A deep humus layer is present on the forest floor. Tree roots often form a tight superficial mat (Gierbolini 1973) (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (USFWS, 2013)

Species Trends:

Unknown (USFWS, 2013)

Number of Populations:

5 (USFWS, 2013)

Population Size:

35 (USFWS, 2013)

Population Narrative:

The species status is unknown; the species has not been sighted since 1970 and is only known from 7 very poor herbarium collections. Although specific surveys for the plant have not been conducted, Cook's holly is believed to still occur on two mountain peaks in central Puerto Rico: Cerro Punta and Monte Jayuya in the municipalities of Ponce and Jayuya at the highest elevation points (greater than 2,700 feet [830 meters]) (USFWS, 2019a). Only a few individuals have been documented, 1 adult and 4 seedlings at Cerro Punta and 30 seedlings at Monte Jayuya; there are no recent survey or population estimates currently available for this species (USFWS, 2019b).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Although the known populations are located within the Toro Negro Commonwealth Forest, these areas are subjected to development or expansion of telecommunication infrastructure. Permits to build new communication facilities or expand currently existing ones within or near Commonwealth forest are prevalent (PRDNER 2004). Destruction or modification of this kind of habitat may be irreversible. Therefore, the microhabitat conditions necessary for the recovery of the species may be lost if habitat is modified for the construction of further communication facilities. Mr. José R. Román (2012, pers. comm.), former forest manager of the Toro Negro Commonwealth Forest, states that the telecommunication companies and the Puerto Rico Energy and Power Authority (PREPA) conduct maintenance activities such as trimming and clearing the vegetation without coordination with the forest manager, affecting the forest vegetation and Cook's holly habitat. Un-coordinated vegetation clearing activities and the lack of knowledge of this species may result in accidental damage or extirpation of individuals (O. Monsegur 2012, pers. comm.). Human induced fire is a current threat for the species at Cerro Punta and Monte Jayuya. Areas potentially used by the species in Cerro Punta and Monte Jayuya have been affected by human induced fires (Monsegur-Rivera, 2012 pers. obs.) (USFWS, 2013). Hurricane Maria caused habitat destruction across the Island in 2017 and surveys for other listed species in the same area known to this species showed natural and anthropogenic impacts to habitat (USFWS, 2019).

Stressor: Invasive species (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Invasive native plants such as the fern Gleichenella pectinata may invade and alter diverse native dwarf forest communities, often resulting in plant monocultures that support few wildlife species (Monsegur-Rivera 2012, pers. obs.) Gleichenella pectinata colonize disturbed areas faster than other native plants, thereby excluding the native plants. Gleichenella pectinata may grow as an invasive by forming dense mats and it seems to be fire tolerant and form mats of dry material that serve as fuel for human induced fires. The fern is currently found occupying areas disturbed by fire, landslides and road construction. If the fern continues to spread and colonizes Cook's holly habitat, it could alter the fire regime, microclimate, and nutrient cycling of the habitat that the species depend. Furthermore, the native vine-like fern Hypolepis repens was observed on the area colonizing forest gaps probably created by previous hurricanes. It was also noted that this species was growing over other federally listed species (Cyathea dryopteroides) (Monsegur-Rivera 2012, pers. obs.) (USFWS, 2013).

Stressor: Collection (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The species is recognized by its rarity and restricted range making it more attractive to collectors and scientists. Although Commonwealth Law No. 241 regulates collection of listed plant species (see Factor D evaluation below), permits to collect listed plant species for scientific or educational purposes could be issued by the PRDNER. Currently, few botanists are searching for the species, and the species has not been found. Because little is known about Cook's holly (i.e. abundance, distribution, habitat requirement and phenology), any collection of seedlings, saplings, flowers, fruits, or parts of the individual without appropriated evaluation of its effect on the species could adversely affect the status of the population (USFWS, 2013).

Stressor: Limited distribution and small population size (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: One of the most important factors affecting the continued existence of the Cook's holly is its limited distribution. In the Caribbean, native plant species, particularly endemics with limited distribution, may be vulnerable to natural or anthropogenic events such as hurricanes, landslides and genetic variation. The Cook's holly is more susceptible to natural disturbances such as hurricanes or landslides, because it is confined to geographically small areas (USFWS 1991). Moreover, the low number of individuals per population may represent another limiting factor as small populations may be composed entirely of male or female individuals, thus limiting the potential of breeding. Given the extremely limited geographic distribution and elevation range of Cook's holly, it is highly likely that its genetic variability is extremely low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Monsegur-Rivera 2012, pers. comm.)

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing "climate change" as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007; Glick et al. 2011). The effects of climate change may increase the intensity of hurricanes and landslides. In addition, climate change may alter (modify) the surrounding vegetation around the individuals of Cook's holly. Changes that may occur are changes in soil disturbance and the microclimate of the area caused by the increase in hurricanes and landslides, where lower elevation vegetation may dominate the limited area where Cook's holly could occur. Cook's holly is reported to exist in the highest peak mountains in Puerto Rico and if lower vegetation becomes dominant this species would not be able to survive (USFWS, 2013).

Recovery

Reclassification Criteria:
At least two new populations capable of self-perpetuation have been established within protected units of the Commonwealth Forest (Monte Guilarte or Toro Negro) or on Federal land within the Caribbean National Forest (USFWS, 2013).

Delisting Criteria:
Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (USFWS, 2019b).

The existing six (6) populations of elfin tree fern within protected areas (Commonwealth Forests) show a stable or increasing trend, evidenced by natural recruitment and multiple age

classes (USFWS, 2019b).

Establish two (2) additional populations within protected areas that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (USFWS, 2019b).

Recovery Actions:

- Pursue surveys for Cook's holly within historical collection areas and include non-traditional sites that harbor suitable habitat for the species (USFWS, 2019a).
- Protect current habitat (USFWS, 1990).
- Conduct research on the life history of these species, evaluate methods of propagation and to look for reintroduction sites (USFWS, 1990).
- Propagate and produce seedlings for enhancement of existing populations and the establishment of new populations (USFWS, 1990).
- Monitor all known populations, and develop a long-term management and monitoring protocol of natural and established populations to reduce site-specific threats for Cook's holly and its habitat (USFWS, 2019b).
- Field surveys on Cook's holly should be conducted, within the historical sites for this plant and in non-traditional sites with suitable habitat to determine the existence of this species (USFWS, 2013).
- Field studies on Ilex species in Puerto Rico and the Antilles should be conducted (USFWS, 2013).
- Specimens should be compared with the type material and other herbarium specimens, including the ones not seen by González-Gutiérrez (2007), to confirm the identity and if Cook's holly constitutes a valid species. This should include molecular (DNA) studies to clarify the relationships within the genus (USFWS, 2013).
- Studies should be conducted of the species' phenology and reproductive biology (USFWS, 2013).
- Studies should be conducted to determine the patterns of genetic variation, in order to develop a plan to preserve the species 'germplasm (USFWS, 2013).
- Propagation and reintroduction should be conducted in order to strengthen the existing population. We must take into consideration if the species continues to be viable, existing threats to the species, and if we find ways to propagate without seeds (USFWS, 2013).
- The population should be monitored on a regular basis, and additional survey visits should be made after hurricanes, landslides, or other major disturbances (USFWS, 2013).
- As new information becomes available and when individuals are documented, the recovery plan should be revisited and possibly revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).

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SPECIES ACCOUNT: *Ilex sintenisii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 4/22/1992

Physical Description

A shrub or small tree reaching 4.5 m in height and 7.6 cm in diameter. The alternate leaves are glabrous, obovate to elliptic, and coriaceous, measuring I to 2.5 cm long and 0.6 to 1.9 cm wide (Little et al. 1974). The leaf apex is notched, with edges turned under, and with the midrib slightly sunken. The bark is gray and smooth, usually covered with mosses and liverworts. This is a dioecious species, with white axillary flowers, growing solitary or in small groups, with pedicels of 0.6 to 1.0 cm long. Female and male flowers bear a 4-5 lobed calyx and corolla, with elliptic white petals slightly united at the base. Female flowers contain 4-5 alternate, nonfunctional stamens, and a four-celled ovary; the male flowers bear larger stamens and a small nonfunctional pistil. The fruit is a drupe, which is green when immature (Little et al. 1974) (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

Specimens originally collected in the upper elevations of the Luquillo Mountains, Puerto Rico. (USFWS, 1993). Ilex sintenisii is known only from the dwarf forest type on higher elevations (over 600 meters (1,968 ft) in elevation) at EYNF. It is distributed between two peaks: Pico El Yunque and Pico del Este and along their access roads, where a total of 465 individuals have been reported at three sites (USFWS 2015). However, the species' prime habitat lies in inaccessible areas that have not been surveyed. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. During May of 1991, individuals of Ilex sintenisii were producing flowers and fruits (Garcia and Laboy 1991). According to Little et al. (1974), this species flowers throughout the year (USFWS, 1993).

Habitat Type

Adult: Dwarf forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Dwarf forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander at al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of Callicarpa ampla and Styrax portoricensis, and some localities of Ternstroemia luquillensi and Ternstroemia subsessilis occur within the palo colorado vegetation type. Some localities of Ternstroemia luquillensis and Ternstroemia subsessilis, and all the localities of Ilex sintenisii occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (Inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

23 subpopulations (USFWS, 2015)

Population Size:

~465 total individuals (USFWS, 2015)

Population Narrative:

Ilex sintenisii: When the recovery plan was approved, the number of individuals of this species was known to be between 150 to 200 individuals distributed within El Yunque National Forest: Pico El Yunque and Pico del Este. During the surveys in 2011, a total of 23 subpopulations where identified containing approximately 465 individuals, the majority within the area of Pico El Yunque and Pico del Este (Table 3). Most of the localities are associated with remnants of dwarf forest vegetation along Pico del Este and its access road, and Pico El Yunque and its access road. The dwarf forest is found above 600 m in elevation. This forest type is frequently enveloped by clouds, and its trees, are short, small, dense, and floristically impoverished compared to forests in lower elevations (Weaver 1995). It is probable that the populations reported in the Recovery Plan overlap with the populations surveyed as part of the 2011 surveys (Anastacio Gómez, USFS, 2012, pers. comm.). Furthermore, it is probable that the number of populations and individuals were underestimated as the prime habitat for the species lies within an inaccessible area that is difficult to survey (Omar Monsegur, USFWS, 2011, pers. obs.). Despite the lack of long-term monitoring, the current surveys indicate that I. sintenisii is more common and widespread within its habitat at El Yunque (USFWS, 2015).

Threats and Stressors

Stressor: Forest management (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of I. sintenisii, S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individuals

Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to I. sintenisii, S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was

determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, I. sintenisii seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for I. sintenisii is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of I. sintenisii, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of I. sintenisii as well as S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of viability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of I. sintenisii, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:
An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis , and Ternstroemia subsessilis within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:
1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).

2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:
- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved “Revised Land and Resource Management Plan” (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these

species depend upon is essentially protected (USFWS, 2015).

- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).
- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating Styrax portoricensis. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting Styrax portoricensis (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated Callicarpa ampla by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (Ilex sintenisii, Ternstroemia luquillensis and Ternstroemia subsessilis) (USFWS, 2015).
- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2019 - 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 2019 - 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).
- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of I. sintenisii. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus Ilex in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for

these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).

- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations are additional to the recommendations provided in the 2015 5- year status review for these species. A11 1. Search for the species outside the trails where the historic populations are located, and within suitable habitat in private lands adjacent to EYNF. 2. Conduct genetic studies to determine the viability of these species into the future. 3. Conduct a seed viability study particularly for Callicarpa ampla and Styrax portoricensis to determine if that is a factor that could be affecting their recruitment. 4. Develop a propagation and reintroduction protocol for all five species in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza, and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species. 5. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside the boundary of EYNF to safeguard these lands since they share similar vegetation and habitat characteristics. (USFWS, 2021)

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subsessilis / (no common name) 5-Year Review: Summary and Evaluation U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office Boquerón, Puerto Rico.

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SPECIES ACCOUNT: *Iliamna corei* (Peter's Mountain mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/12/1986; Northeast Region (R5) (USFWS, 2015)

Physical Description

Iliamna corei is an erect, ascending, perennial herb growing from a woody rhizome producing densely pubescent pale-green branches up to 1 m in height. The maple-like leaves are simple, with 5-7 palmate lobes, margins serrate to dentate, bases truncate to cordate, and stellate-pubescent on both surfaces. The size of the leaves decreases gradually towards the tips of the branches. The pink flowers are solitary or clustered in the axils of the upper leaves. There are 5 radially symmetrical, separate petals 2.5-3 cm long and 5 sepals fused 1/4 to 1/2 their length into a bell-shaped, hairy calyx. Stamens are numerous, their bases fused into a tube surrounding the pistil. The flower appears generally similar to the cultivated hibiscus, or rose-of-Sharon. Fruits are lobed capsules with mature carpels 8-10 mm long, densely hairy, containing 2-3 seeds in each carpel. (USFWS, 1990)

Taxonomy

Considered a distinct species known only from a single site in the Virginia mountains. Bodo Slotta & Porter (2006) studied the genetic variation in North American Iliamna and analyses determined that I. corei is distinct. Additional research in the late 1980s also support that this taxon should be separated from I. remota on the basis of genetic analyses. Kartesz considers these differences minor, and includes these Virginia plants, along with Iliamna remota, in his circumscription of the nominate variety of Iliamna rivularis. Included in Iliamna rivularis var. rivularis by Kartesz, 1994 checklist and 1999 floristic synthesis; by others considered distinct from I. rivularis, but included in Iliamna remota. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Only site known is Giles County in Ridge and Valley Province of Virginia. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) and sexual (outcrossing) (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Pollinated by bees (USFWS, 1990)

Breeding Season

Adult: Late June to early August (USFWS, 1990)

Key Resources Needed for Breeding

Adult: Seed scarification is required for germination (Bodo Slotta & Porter 2006) (NatureServe, 2015)

Reproduction Narrative

Adult: Iliamna is rhizomatous. Seed scarification is required for germination (Bodo Slotta & Porter 2006). I. corei flowers from late June to early August. It is believed to be pollinated primarily by sweat bees of the genus Halictus, which are abundant in the area. (USFWS, 1990; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest - Mixed, Forest/Woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny, open areas (USFWS, 1990)

Geographic or Habitat Restraints or Barriers

Adult: Mature Iliamna corei plants appear to prefer open sites without much competing vegetation (USFWS, 1990)

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 1990; NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The dominant trees growing in association with I. corei include Quercus rubra, Q. prinus, Carya spp., Robinia pseudo-acacia, Pinus virginiana, Betula lenta, and Celtis occidentalis. The shrub layer is primarily composed of Berberis canadensis, Crategus spp., and Rhus typhina. The more common herbs, forbs, and vines include Verbesina occidentalis, Tradescantia ohiensis, Polymnia canadensis, Aquilegia canadensis, Chenopodium standleyanum, Rosa carolina, Dioscorea villosa, Clematis viorna, and Parthenocissus guinquefolius. The only plants that appear to be directly competing with the Iliamna are Polymnia and Berberis. (USFWS, 1990)

Habitat Narrative

Adult: Iliamna corei occurs in the shallow soil of the Clinch sandstone outcrops on the northwest-facing slope of Peters Mountain (elevation 1000 m), near the ridge line of a mixed deciduous-evergreen forest. Regarding the species' edaphic requirements, soil tests from the sites of two different Iliamna clones show pH ranging from 5.3 to 5.6. Quantities of macro-and micronutrients from the two sites (in parts per million) include: phosphorus (32 and 53), potassium (157 and 58), calcium (120), and magnesium (101 and 65). Soils underlying the Iliamna population are very dark and appear to be highly organic in composition. The dominant trees growing in association with I. corei include Quercus rubra, Q. prinus, Carya spp., Robinia pseudo-acacia, Pinus virginiana, Betula lenta, and Celtis occidentalis. The shrub layer is primarily composed of Berberis canadensis, Crategus spp., and Rhus typhina. The more common herbs,

forbs, and vines include Verbesina occidentalis, Tradescantia ohiensis, Polymnia canadensis, Aquilegia canadensis, Chenopodium standleyanum, Rosa carolina, Dioscorea villosa, Clematis viorna, and Parthenocissus guinquefolius. The only plants that appear to be directly competing with the Iliamna are Polymnia and Berberis. (USFWS, 1990)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Species Trends:

Declining (USFWS, 2008)

Number of Populations:

1 (NatureServe, 2015)

Population Size:

1 - 250 individuals (NatureServe, 2015)

Additional Population-level Information:

Monitoring reports from The Nature Conservancy indicated that since the 2008 status review, the Peter's Mountain Mallow numbers have fluctuated, but the overall population trend appears to be stable (USFWS 2019).

Population Narrative:

Peters Mountain mallow (Iliamna corei), a member of the family Malvaceae, is known from only a single site on Peters Mountain, near The Narrows of the New River, in Giles County, Virginia. The occurrence is very tolerant to on-site activities. (NatureServe, 2015)

Threats and Stressors

Stressor: Encroachment of vegetation (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: The encroachment of competing vegetation, resulting in a reduction of direct sunlight reaching the plants, appears to be contributing to the decline in the size and reproductive vigor of the population. Historical references indicate that Iliamna corei was previously exposed to a great deal more direct sunlight than is the case today (U.S. Fish and Wildlife Service, 1986). In recent years forest canopy on Peters Mountain has grown considerably, probably in association with fire suppression management. Construction of a hiking trail and a powerline near the mallow site in the early 1970s appears to have promoted the invasion of weedy competitors, primarily Polymnia canadensis. (USFWS, 1990)

Stressor: Lack of recruitment (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: A major concern in regard to recovery of Iliamna corei has been lack of recruitment. Although a viable seedbank exists in the soil, no seedlings are being produced because the seeds are not germinating. Recent experimental evidence indicates that germination is readily stimulated by heat (Baskin and Baskin, 1990) and light fire (C. Baskin and J. Baskin, pers. comm.). (USFWS, 1990)

Stressor: Low sexual fecundity (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: In addition to the lack of seed germination at the natural population site, the remaining I. corei clones have been exhibiting extremely low sexual fecundity. From 1986-1988, only 14 mature capsules were produced, despite profuse flowering. Many buds aborted before flowering, and the majority of buds that did produce flowers disarticulated from the plant after anthesis. The record drought years of 1987 and 1988 may have contributed to reproductive failure; however, the plants were watered regularly during the drought periods of those years. Seed production data from most of the years previous to 1986 are unavailable, but Strausbaugh and Core indicated that, in 1932, the plants were producing an “abundant supply of seeds.” Herbarium specimens collected by Massey in 1934 and 1939 (at VPI&SU) also have mature capsules containing many seeds (J. Randall, pers. comm.). The mystery of seed production in the natural population has been largely solved and the problem ameliorated by recent work at VPI&SU, as described below. (USFWS, 1990)

Stressor: Small population size (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Because so few plants comprise the natural population, removal of individual stems, whether by humans or other animals, constitutes a threat to the species’ survival. In October 1987, a feral goat browsed all of the Iliamna stems to within 30 cm of the ground. In 1987 and 1988, a total of 16 stems were cut, apparently for collection. (USFWS, 1990)

Stressor: Herbivory (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Herbivory by deer and other animals is a continuing threat, mitigated by placement of small wire cages around individual and small groups of PMM. Replacement and enlargement of these enclosures to accommodate plant growth requires continuing annual effort throughout the field season (Edward and SanJule 2007). (USFWS, 2008)

Stressor: Fire suppression (USFWS, 2008)
Exposure:

Response:
Consequence:
Narrative: Suppression of natural fires necessitates an on-going commitment to prescribed burning. (USFWS, 2008)

Recovery

Reclassification Criteria:
1. The natural population has reached carrying capacity and has been self-maintaining or expanding into new areas for at least 5 years. (USFWS, 1990)

2. Life history, ecology, and population biology are understood sufficiently to manage effectively. (USFWS, 1990)

3. There exists an established and continuing management program. (USFWS, 1990)

4. The tract of land on which it occurs is permanently protected. (USFWS, 1990)

5. Plants representing a variety of genotypes are propagated at a minimum of two plant breeding facilities. (USFWS, 1990)

Delisting Criteria:
1. The natural population has reached carrying capacity and has been self-maintaining or expanding into new areas for at least 5 years. (USFWS, 1990)

2. Life history, ecology, and population biology are understood sufficiently to manage effectively. (USFWS, 1990)

3. There exists an established and continuing management program. (USFWS, 1990)

4. The tract of land on which it occurs is permanently protected. (USFWS, 1990)

5. Plants representing a variety of genotypes are propagated at a minimum of two plant breeding facilities. (USFWS, 1990)

6. Studies indicate that it is appropriate to establish new populations. (USFWS, 1990)

7. Five additional populations have been located or established. (USFWS, 1990)

8. These new populations are protected and stable or expanding for at least 5 years. (USFWS, 1990)

Recovery Actions:
- Monitor known population and manage as necessary. (USFWS, 1990)
- Study life history, ecological, and population parameters. (USFWS, 1990)
- Maintain representative individuals at two plant breeding facilities. (USFWS, 1990)
- Outplant individuals within historic range. (USFWS, 1990)
- Acquire full title to the population site. (USFWS, 1990)

- Research to better understand site requirements and germination and care for seedlings so new populations can be established (USFWS 2019).
- Research the seasonality and intensity of fire needed to stimulate germination of seeds in the seed bank. This would help to better manage existing population and plan burns in new areas (USFWS 2019).
- Conduct and assess effects of landscape burn in 2009. Burn implementation is already scheduled and funded. (USFWS, 2008)
- Continue ex situ seed increase efforts and assure long-term seed storage. (USFWS, 2008)
- Update reclassification criteria 1 and 5 to clarify target population size and composition (whole plants and seed production) in the wild and requirements for ex situ conservation. Updated criteria, consistent with the scope and intent of the corresponding criteria in the 1990 recovery plan, should reflect current information about PMM biology. (USFWS, 2008)
- Based on results of initial landscape scale burn, evaluate future burning requirements and associated funding needs. (USFWS, 2008)
- Develop long-term agreements for continuing management of PMM population(s) at the Narrows Preserve. (USFWS, 2008)
- Reconsider need for and desirability of establishing additional PMM populations outside the species' known historic range. Evaluate feasibility of alternative strategies to provide for long-tern security and delisting of PMM. If necessary, revise delisting criteria and recovery plan accordingly. (USFWS, 2008)

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SPECIES ACCOUNT: *Ipomopsis polyantha* (Pagosa skyrocket)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Ipomopsis polyantha is an herbaceous biennial 12 to 24 inches tall, branched from near the base above the basal rosette of leaves. Deeply divided leaves with linear segments are scattered up the stem. Flower clusters are along the stem in the axils of the leaves as well as at the top of the stem. The white flowers are 0.4 in long, with short corolla tubes 0.18 to 0.26 in (0.45 to 0.65 cm) long, and flaring corolla lobes flecked with purple dots, often very dense (Anderson 1988). The stamens extend noticeably beyond the flower tube, and the pollen is blue (Grant 1956), changing to yellow as it matures (Collins 1995). (USFWS, 2011)

Taxonomy

Ipomopsis polyantha was originally described by Rydberg (1904) as Gilia polyantha. Grant (1956) moved the species into the genus Ipomopsis. Two varieties, G. polyantha var. brachysiphon and G. polyantha var. whitingii, were recognized by Kearney and Peebles (1943). Currently available information indicates that I. polyantha is a distinct species (Porter and Johnson 2000; Porter et al. 2003 in Anderson 2004). (USFWS, 2011)

Historical Range

The historical range of Ipomopsis polyantha is unknown, but likely included a much broader area than the currently occupied habitat. (USFWS, 2011)

Current Range

We know of two populations of Pagosa skyrocket. Together, these populations occupy an area of approximately 462 ac (187 ha). The larger Pagosa Springs/Mill Creek population includes two occurrences with high densities of plants. For the purposes of this SSA, we define an occurrence as a distinct location with more than one individual that is separated from another occurrence by more than 1 mile (1.6 km) or by markedly distinct features on the landscape, such as ridges, rivers, or roads. We consider these two occurrences part of the Pagosa Springs/Mill Creek population because of their close, interconnected proximity to one another. The Dyke population is smaller than the Pagosa Springs/Mill Creek population and separated from it by 13 mi (21 km) (Figure 5). Approximately 3.5 ac (1.4 ha) of total occupied habitat occurs on federally managed Bureau of Land Management (BLM) land. The remainder of occupied habitat is located on private land, land owned by the Town of Pagosa Springs, highway ROWs, and an 88 ac (36 ha) parcel owned and managed by CPW. The CPW parcel contains more than 90 percent of all known Pagosa skyrocket plants and is managed with the primary goal of conserving Pagosa skyrocket. (USFWS, 2020)

Critical Habitat Designated

Yes; 8/13/2012.

Legal Description

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Ipomopsis polyantha (Pagosa skyrocket) under the Endangered Species Act of 1973, as amended

(Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

Critical Habitat Designation

The critical habitat designation for Ipomopsis polyantha includes four CHUs in Archuleta County, Colorado. This species critical habitat encompasses approximately 9,641 acres (ac) (3,902 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Dyke Unit, consists of 1,475 ac (597 ha) of Federal and private lands. The Unit is located at the junction of U.S. Hwy 160 and Cat Creek Road (County Road 700) near the historic town of Dyke in Archuleta County, Colorado. Ninety-seven percent of this Unit is on private lands; of these private lands, 1 percent is within highway ROWs. Three percent is on Federal land managed by the BLM, through the Pagosa Springs Field Office of the San Juan Public Lands Center. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including a collection of all three communities (barren shales, open montane grassland (primarily Arizona fescue) understory at the edges of open Ponderosa pine, or clearings within the Ponderosa pine and Rocky Mountain juniper and Utah juniper and oak communities), pockets of shale with little to no competition from other species, suitable elevational ranges from 6,720 to 7,285 ft (2,048 to 2,220 m), Mancos shale soils, suitable climate, pollinators and habitat for these pollinators, and areas where the correct disturbance regime is present. Lands within this Unit are largely agricultural although some housing is present within the Unit. A large hunting ranch also falls within this Unit. While these lands currently have the physical and biological features essential to the conservation of Ipomopsis polyantha, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Ipomopsis polyantha in this Unit include highway maintenance and disturbance (several hundred plants have been documented along Highway 160 (CNHP 2012b, p. 5)), grazing, agricultural use, Bromus inermis encroachment, potential development, and a new road that was constructed through the I. polyantha population.

Unit 2, the O'Neal Hill Botanical Unit consists of 564 ac (228 ha) of USFS land managed by the San Juan National Forest. The Unit is north of Pagosa Springs, roughly 13 mi (21 km) north along Piedra Road. Roughly 49 percent of this Unit (279 ac (113 ha)) falls within the O'Neal Hill Special Botanical Area that was designated to protect another Mancos shale endemic, Lesquerella pruinosa (Pagosa bladderpod). Because L. pruinosa is sometimes found growing with Ipomopsis polyantha, we believe the site has high potential for introduction of I. polyantha. This Unit is not currently occupied. We reduced this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18161) so that the thick pasture grass and riparian areas in the bottomlands that do not contain many of the PCEs for I. polyantha would no longer be included (Holtrop 2011, p. 1). This Unit currently has all the physical and biological features essential to the conservation of the species, including a collection of all three plant communities, pockets of shale with little to no competition from other species, suitable elevational ranges from 7,640 to 8,360 ft (2,330 to 2,550 m), Mancos shale soils, suitable climate, habitat for pollinators (although we do not know if Ipomopsis polyantha pollinators are found here), and areas where the correct disturbance regime is present. Because of the presence of these features, we believe this may make a good introduction area for I. polyantha in the future and is needed to ensure conservation of the species. Threats to Ipomopsis polyantha in this Unit include road maintenance and disturbance, low levels of recreation, including hunting, deer and elk use, and

a utility corridor and related maintenance (Brinton 2011, p. 1). Ipomopsis polyantha is known from only two populations, both with few or no protections (little resilience). For adequate resiliency and protection we believe it is necessary for survival and recovery that additional populations with further protections be established. Because this area receives low levels of use and because it is already partially protected through the special botanical area, the area would make an ideal site for future introductions of I. polyantha. Therefore, we have identified this Unit as critical habitat for I. polyantha.

Unit 3, the Pagosa Springs Unit, is the largest of the four Ipomopsis polyantha CHUs and consists of 6,456 ac (2,613 ha) of municipal, State, and private lands. The Unit is located at the junction of Highways 160 and 84, south along Highway 84, west along County Road 19, and east along Mill Creek Road. Ownership of the land in Unit 3 is divided as follows: 86.1 percent is under private ownership, 9.2 percent is owned by the Town of Pagosa Springs, 1.7 percent is owned and operated by the Colorado State Land Board (SLB), 0.7 percent falls within the Colorado Department of Transportation (CDOT) ROWs, 0.4 percent is found on CDOW lands, 0.2 percent is located on Archuleta County ROWs, and 1.4 percent is located on a parcel newly acquired by Archuleta County. This Unit is currently occupied and contains the majority of I. polyantha individuals. This Unit currently has all the physical and biological features essential to the conservation of the species, including a collection of all three plant communities, pockets of shale with little to no competition from other species, suitable elevational ranges from 6,960 to 7,724 ft (2,120 to 2,350 m), Mancos shale soils, suitable climate, pollinators and habitat for these pollinators, and areas where the correct disturbance regime is present. Lands within this Unit fall into a wide array of land management scenarios, including agricultural use, junkyards, urban areas, small residential lots, and large 30- to 40-ac (12- to 16-ha) residential parcels. While these lands currently have the physical and biological features essential to the conservation of Ipomopsis polyantha, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Since 86 percent of this Unit is under private ownership and there is no land under Federal ownership, the primary threat to the species in this Unit is agricultural or urban development. Other threats include highway ROW disturbances, Bromus inermis and other nonnative invasive species, excessive livestock grazing, and mowing.

Unit 4, Eight Mile Mesa, consists of 1,146 ac (464 ha) of USFS lands that are managed by the Pagosa Springs Field Office of the San Juan National Forest. This Unit is located roughly 6.5 mi (10.5 km) south of the intersections of Highways 160 and 84 in Pagosa Springs, Colorado, and on the western side of Highway 84. This Unit is not currently occupied. We reduced this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18161) so that isolated patches, separated from the rest of the Unit by roads, would no longer be included (Holtrop 2011, p. 1). This Unit currently has all the physical and biological features essential to the conservation of the species including a collection of all three plant communities, pockets of shale with little to no competition from other species, suitable elevational ranges from 7,320 to 7,858 ft (2,230 to 2,395 m), Mancos shale soils, suitable climate, habitat for pollinators, and areas where the correct disturbance regime is present. Because there are so few Mancos shale sites on Federal lands, and because this site has an array of habitat types, it provides the best potential area for introduction of Ipomopsis polyantha in the future. Threats to Ipomopsis polyantha in this Unit include a road running through the site, recreational use, horseback riding, dispersed camping and hunting, and firewood gathering. The road is a threat because it generates fugitive dust and pollutants, provides a source for nonnative invasive plants, causes

habitat fragmentation, increases edge effects and drying, and may limit pollinator movement, among other reasons. The Unit has some dense Ponderosa pine stands, and several small wildfires, which are actively suppressed, occur every year. Benefiting the designation, there is a vacant grazing allotment at this Unit, and noxious weeds are being actively controlled (Brinton 2011, p. 1). Ipomopsis polyantha is known from only two populations, both with few or no protections (little resilience). For adequate resiliency and protection we believe it is necessary for survival and recovery that additional populations with further protections be established. Therefore, we have identified this Unit and one other unoccupied area as critical habitat for I. polyantha.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Ipomopsis polyantha critical habitat consists of five components (77 FR 48356-48415):

(i) Mancos shale soils.

(ii) Elevation and climate. Elevations from 6,400 to 8,100 ft (1,950 to 2,475 m) and current climatic conditions similar to those that historically occurred around Pagosa Springs, Colorado. Climatic conditions include suitable precipitation; cold, dry springs; and winter snow.

(iii) Plant community. (A) Suitable native plant communities (as described in paragraph (2)(iii)(B) of this entry) with small (less than 100 ft\2\ (10 m\2\)) or larger (several hectares or acres) barren areas with less than 20 percent plant cover in the actual barren areas. (B) Appropriate native plant communities, preferably with plant communities reflective of historical community composition, or altered habitats which still contain components of native plant communities. These plant communities include: (1) Barren shales; (2) Open montane grassland (primarily Arizona fescue) understory at the edges of open Ponderosa pine; or (3) Clearings within the ponderosa pine/Rocky Mountain juniper and Utah juniper/oak communities.

(iv) Habitat for pollinators. (A) Pollinator ground and twig nesting areas. Nesting and foraging habitats suitable for a wide array of pollinators and their life- history and nesting requirements. A mosaic of native plant communities and habitat types generally would provide for this diversity. (B) Connectivity between areas allowing pollinators to move from one site to the next within each plant population. (C) Availability of other floral resources, such as other flowering plant species that provide nectar and pollen for pollinators. Grass species do not provide resources for pollinators. (D) A 3,280-ft (1,000-m) area beyond occupied habitat to conserve the pollinators essential for plant reproduction.

(v) Appropriate disturbance regime. (A) Appropriate disturbance levels--Light to moderate, or intermittent or discontinuous disturbances. (B) Naturally maintained disturbances through soil erosion or human-maintained disturbances that can include light grazing, occasional ground clearing, and other disturbances that are not severe or continual.

Special Management Considerations or Protections

The features essential to the conservation of this species (plant community and competitive ability, elevation, soils, climate, reproduction, and disturbance regime) may require special

management considerations or protection to reduce threats. Ipomopsis polyantha's highly restricted soil requirements and geographic range make it particularly susceptible to extinction at any time from commercial, municipal, and residential development; associated road and utility improvements and maintenance; heavy livestock use; inadequacy of existing regulatory mechanisms; fragmented habitat; and prolonged drought (76 FR 45054). Over 86 percent of the species' occupied habitat is on private land with no limits on development (Service 2011c, p. 2). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Introducing new Ipomopsis polyantha populations; establishing permanent conservation easements or acquiring land to protect the species on private lands; developing zoning regulations that could serve to protect the species; establishing conservation agreements on private and Federal lands to identify and reduce threats to the species and its features; eliminating the use of smooth brome and other competitive species in areas occupied by the species; promoting and encouraging habitat restoration; developing other regulatory mechanisms to further protect the species; placing roads and utility lines away from the species; minimizing heavy use of habitat by livestock; and minimizing habitat fragmentation. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, maintaining or restoring plant communities and natural levels of competition, protecting the plant's reproduction by protecting its pollinators, and managing for appropriate levels of disturbance.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Presumably sexual and outcrossing (inferred from USFWS, 2011)

Lifespan

Adult: Biennial (two years) (USFWS, 2011)

Dependency on Other Individuals or Species

Adult: Bees as pollinators (USFWS, 2011)

Breeding Season

Adult: Spring and summer (inferred from USFWS, 2011)

Reproduction Narrative

Adult: Ipomopsis polyantha sets far less fruit when self-pollinated and the male and female reproductive parts are separated both spatially and temporally (Collins, 1995). Therefore, we conclude that pollinators are necessary for the long-term successful reproduction and conservation of the plant. Over 30 different insects have been collected visiting I. polyantha flowers (Collins, 1995). The primary pollinators are all bee species; these include the nonnative honeybee Apis mellifera (honeybees) and native bees that nest in the ground or twigs (Collins, 1995). (USFWS, 2012)Mature seeds germinate to form rosettes that produce flowering stalks during the next growing season, or they may persist as rosettes for a year or more until conditions are right for flowering. Plants produce abundant fruits and seeds, but have no known mechanism for long-distance dispersal (Collins 1995, pp. 111-112). After seeds are mature, the

plants dry up and die. We do not know how long the seeds remain viable. (USFWS, 2011)

Habitat Type

Adult: Rocky, clay (shale) soils (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pinus ponderosa forests with montane grassland understory (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seeds germinate much faster in Mancos Shale soil (USFWS, 2011)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 2011)

Habitat Narrative

Adult: In Colorado, Ipomopsis polyantha occurs on rocky clay soils of the Mancos Shale in the southern San Juan Mountains, typically on road shoulders where the soil has been disturbed. Highest densities are under Pinus ponderosa forests with montane grassland understory (Anderson 2004, Anderson 1988). Elevation is 2073-2195 m. (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Plants have no known mechanism for long-distance dispersal (Collins, 1995). Pollinator-mediated pollen dispersal is typically limited to the foraging distances of pollinators, and no bee species is expected to travel more than 1 mi to forage (Tepedino, 2009). (USFWS, 2011)

Population Information and Trends

Number of Populations:

2 (USFWS, 2020)

Population Size:

~800,000 (USFWS, 2020)

Adaptability:

Very limited (USFWS, 2011)

Population Narrative:

The two known populations of Pagosa skyrocket are located 13 mi (21 km) apart, and dispersal of individuals in each population is not uniform. Rather, there are high density patches throughout the Pagosa Springs/Mill Creek population and lower density patches in the Dyke

population. Natural land and soil variation, land use (i.e. grazing or development), and roads separate these patches from each other. Patches vary in distance from one another; however, in both populations, patches are close enough that outcrossing is likely occurring. In 2011, Ecosphere completed a qualitative estimate of plants on the CPW property. Ecosphere mapped 16 occupied polygons, captured monitoring photos, assessed environmental conditions, vegetative community, and Pagosa skyrocket density, and estimated a total of 3,597,620 Pagosa skyrocket plants with approximately 56 percent flowering adults and 44 percent rosettes over a 27.23 ac (11.03 ha) area (Ecosphere 2012). In 2017, CNAP used a rapid assessment protocol to revisit the 16 polygons and record qualitative estimates of plant density, resulting in an estimated 732,777 plants on the property (Wertsbaugh et al. 2017). (USFWS, 2020). The 2nd population appears to have approx. 100,000 plants

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Ipomopsis polyantha is threatened with destruction of plants and habitat due to commercial, residential, municipal, and agricultural property development, and associated new utility installations and access roads. We have documented recent losses of habitat and individuals within the Pagosa Springs and Dyke occurrences of the species. The species is highly vulnerable to ground disturbance during development because seedlings and rosettes are destroyed and transplanting is not known to be successful. (USFWS, 2011)

Stressor: Highway rights-of-way (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Development of several planned bike trails along highway rights-of-way would eliminate portions of current occurrences located along the highways where the trails would be located. The distribution of Ipomopsis polyantha within highway ROWs makes this species susceptible to threats associated with highway activities and maintenance. Exotic grasses planted by CDOT along roadsides dominate the ROW between pavement and ditch, limiting most I. polyantha plants to the ROW bank between ditch and fence. This limitation to the species' habitat along roadsides is significant because so little habitat exists elsewhere for the species. (USFWS, 2011)

Stressor: Livestock herbivory and disturbance (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: This species is threatened by destruction of flowering plants, rosettes, and seeds due to concentrated livestock disturbance and some herbivory. Observations of the ``fence line effect''--healthy plants outside the fence and impacted plants inside the fence--at several locations on private land used for cattle and horse grazing indicate that Ipomopsis polyantha does not tolerate intensive livestock grazing (Anderson, 2004). Such observations from seven locations (pastures) in 2009 found few or no plants in the three heavily grazed pastures and

numerous plants in the adjacent pastures with light or no grazing (Glenne and Mayo, 2010). We do not know whether the destruction of the plants was a result of herbivory or trampling. I. polyantha is not found in heavily grazed pastures, but occurrences have been observed in lightly grazed horse pastures and abandoned pastures (CNAP, 2007). Plants could possibly recolonize a pasture if livestock numbers were reduced sufficiently and the seed bank was still viable, or if there was a seed source nearby, but few plants persist in areas of continual grazing (Collins, 1995). (USFWS, 2011)

Stressor: Inadequate regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: No State regulations protect rare plant species in Colorado. There are no known town or county regulations that provide for protection or conservation of I. polyantha or its habitat. Road maintenance crews voluntarily refrain from mowing or broadcast spraying ROWs within the range of Ipomopsis polyantha; however, there is no law, regulation, or policy requiring them to do so. Potential new annexations into the Town of Pagosa Springs will change zoning from residential and agricultural parcels to commercial and small lot residential, with anticipated adverse impacts to I. polyantha. Decisions regarding annexations are currently being made to encourage growth that will boost the local economy, but provisions for avoidance or minimization of disturbance to habitat for the plants are not included in these decisions or plans. (USFWS, 2011)

Stressor: Specific physiological requirements for germination and growth (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Ipomopsis polyantha is limited to the 6.5 square miles of Pagosa-Winifred soils derived from Mancos Shale. The species has specific physiological requirements for germination and growth that may prevent its spread to other locations (Anderson, 2004). In greenhouse trials, seeds will germinate and grow on other soils, but they grow much faster on Mancos Shale soils (Collins, 1995). Faster growth may give I. polyantha a competitive advantage on relatively barren Mancos shale that it lacks on other soils, where its smaller seedlings have more competition from other plants for nutrients and water. (USFWS, 2011)

Stressor: Drought (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: I. polyantha is very sensitive to the timing and amount of moisture due to its biennial life history. The species could experience a reduction in its reproductive output as a result of drought or general drying that may result from climate change. The limited geographic range of the Mancos Shale substrate that underlies the entire Ipomopsis polyantha habitat likely limits the ability of the species to adapt by shifting occurrences in response to climatic conditions. (USFWS, 2011)

Stressor: Lack of proven methods for propagation and reintroduction (USFWS, 2011)
Exposure:

Response:
Consequence:
Narrative: In two different situations where plants were removed from utility work, the removed and transplanted individuals (in suitable habitat) survived initially and even produced a very few flowering plants. However, no surviving rosettes were found by the third year. Unless effective transplanting methods are developed, populations cannot be successfully moved out of the way of any development and thus is highly vulnerable to development. (USFWS, 2011)

Recovery

Reclassification Criteria:
1. Downlisting Criterion 1 – Three populations of Pagosa skyrocket maintain a stable or increasing growth rate (lambda equal to or greater than 1), as described below: a. Both currently known populations of Pagosa skyrocket (Pagosa Springs/Mill Creek and Dyke) maintain a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive 15-year period, with or without augmentation (based on annual monitoring). Plant abundance may fluctuate at individual sites, but overall, each population should have a stable or increasing growth rate over the 15-year time period. The 15-year period may start retroactively if existing data can be utilized to inform a consecutive 15-year period. b. One additional population maintains a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive 10-year period within the 15-year monitoring period of the Pagosa Springs/Mill Creek and Dyke populations. This population may be an existing, newly discovered population or it may be introduced. Plant abundance may fluctuate at individual sites, but overall, this population should have a stable or increasing growth rate over the 10-year time period. (USFWS, 2022)

2. Downlisting Criterion 2 – Each of the three populations meets or exceeds a minimum number of individual plants over the same 10- and 15-year time periods, as described below: a. The Pagosa Springs/Mill Creek and Dyke populations each meet or exceed 4,824 individual plants on average over the same 15-year time period described in criterion 1 (identified in the SSA as the population size needed to maintain a high level of resiliency). This may be accomplished by augmentation at existing sites. b. The third population meets or exceeds 1,500 individual plants on average over the same 10-year time period described in criterion 1 (identified in the SSA as the population size needed to maintain a moderate level of resiliency). This may include augmentation of an existing, newly discovered population or introduction of a third population (USFWS, 2022)

3. Downlisting Criterion 3 – All three populations (Pagosa Springs/Mill Creek, Dyke, and a third population yet to be identified) have regulatory mechanisms or similar protective measures in place that reduce or ameliorate threats associated with habitat loss and degradation such that habitat in each of the populations is of the quantity and quality to support stable, resilient populations as described in criteria 1 and 2 for the foreseeable future. Examples of regulatory mechanisms or protective measures could include, but are not limited to, designated special management areas, conservation plans, conservation easements, and conservation agreements. a. Within the Pagosa Springs/Mill Creek population, Colorado Parks and Wildlife owns and manages an 88 ac (36 ha) parcel with a primary goal of conserving Pagosa skyrocket. At a minimum, similar protective regulatory mechanisms or conservation plans should be implemented for the Reservoir Hill occurrence, which occurs in a forested area and likely

improves representation for the species. b. Within the Dyke population, similar protective regulatory mechanisms or conservation plans should be implemented for each of the two sub-units. c. Similar protective regulatory mechanisms or conservation plans should be implemented for a third population (USFWS, 2022).

4. Downlisting Criterion 4 – Both known populations (Pagosa Springs/Mill Creek and Dyke) are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004, entire) to preserve the genetic diversity (representation) of Pagosa skyrocket and provide added protection from potential stochastic events. The ex-situ seed collection should be updated to represent genetic diversity across the range of the species if new populations or subpopulations are discovered. (USFWS, 2022)

Recovery Priority Number: 8C

Delisting Criteria:
1. Delisting Criterion 1 – Three populations of Pagosa skyrocket maintain a stable or increasing growth rate (lambda equal to or greater than 1) without augmentation, as described below: a. Both currently known populations of Pagosa skyrocket (Pagosa Springs/Mill Creek and Dyke) maintain a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive 15-year period based on annual monitoring. Plant abundance may fluctuate at individual sites, but overall, each population should have a stable or increasing growth rate over the 15-year time period. The 15-year period may start retroactively if existing data can be utilized to inform a consecutive 15-year period. b. One additional population maintains a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive 10-year period within the 15-year monitoring period of the Pagosa Springs/Mill Creek and Dyke populations. This population may be an existing, newly discovered population or it may be introduced. Plant abundance may fluctuate at individual sites, but overall, this population should have a stable or increasing growth rate over the 10-year time period. (USFWS, 2022)

2. Delisting Criterion 2 – Each of the three populations meets or exceeds a minimum number of individual plants over the same 10- and 15-year time periods without augmentation. a. The Pagosa Springs/Mill Creek and Dyke populations each meet or exceed 4,824 individual plants on average over the same 15-year time period described in criterion 1 (identified in the SSA as the population size needed to maintain a high level of resiliency). b. The third populations meets or exceeds 1,500 individual plants on average over the same 10-year time period described in criterion 1 (identified in the SSA as the population size needed to maintain a moderate level of resiliency). This may be an existing, newly discovered population or an introduced population (USFWS, 2022).

3. Delisting Criterion 3 – All three populations (Pagosa Springs/Mill Creek, Dyke, and a third population yet to be identified) have regulatory mechanisms or similar protective measures in place that reduce or ameliorate threats associated with habitat loss and degradation such that habitat in each of the populations is of the quantity and quality to support stable, resilient populations as described in criteria 1 and 2 for the foreseeable future. Examples of regulatory mechanisms or protective measures could include, but are not limited to, designated special management areas, conservation plans, conservation easements, and conservation agreements. a. Within the Pagosa Springs/Mill Creek population, Colorado Parks and Wildlife owns and manages an 88 ac (36 ha) parcel with a primary goal of conserving Pagosa skyrocket. At a

minimum, similar protective regulatory mechanisms or conservation plans should be implemented for the Reservoir Hill occurrence, which occurs in a forested area and likely improves representation for the species. b. Within the Dyke population, similar protective regulatory mechanisms or conservation plans should be implemented for each of the two sub-units. c. Similar protective regulatory mechanisms or conservation plans should be implemented for a third population. (USFWS, 2022)

4. Delisting Criterion 4 – Both known populations (Pagosa Springs/Mill Creek and Dyke) are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004, entire) to preserve the genetic diversity (representation) of Pagosa skyrocket and provide added protection from potential stochastic events. The ex-situ seed collection should be updated to represent genetic diversity across the range of the species if new subpopulations are discovered. (USFWS, 2022)

Recovery Actions:

- Priority 1 Actions 1. Maintain or expand all known Pagosa skyrocket populations, and maintain a new population, either newly discovered or introduced (Criteria 1, 2, and 3). 1.1 Conduct research and develop biologically-relevant avoidance buffers and surface disturbance caps to protect plants, populations, habitat function, and seedbanks. 1.2 Develop or improve conservation measures, regulatory mechanisms, and protective measures to reduce habitat loss and fragmentation. 1.3 Restore habitats or establish new habitats. 2. Monitor all Pagosa skyrocket populations (Criteria 1 and 2). 2.1 Determine population abundance and population trends. 2.2 Monitor quantity and quality of available habitat. 2.3 Evaluate stressors. (USFWS, 2022)
- Priority 2 Actions 3. Develop ex-situ (off-site) collections of seeds and tissues to preserve Pagosa skyrocket's genetic diversity (representation) and provide the capability to augment existing populations or introduce new populations in the wild, if necessary (Criterion 4). 3.1 Select and contract with organizations to collect and preserve seeds and tissues. 3.2 Investigate seed viability, germination requirements, and tissue propagation. 4. Survey for additional populations of Pagosa skyrocket (Criteria 1 and 2). 4.1 Identify suitable habitat and perform surveys to inform land management, project planning, and recovery efforts. (USFWS, 2022)
- Priority 3 Actions 5. Maintain consistency and momentum of conservation efforts for Pagosa skyrocket across the occupied range by communicating and collaborating across jurisdictions and agencies with partners and stakeholders (Criteria 1, 2, 3, and 4). 5.1 Conduct meetings at least twice per year. 5.2 Complete and share annual status report with partners. 6. If a third population is not discovered or established, or if there is a population decline or loss, develop and implement a range-wide strategy for population augmentation and/or introductions, if necessary (Criteria 1 and 2). (USFWS, 2022)

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SPECIES ACCOUNT: *Ipomopsis sancti-spiritus* (Holy Ghost ipomopsis)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/23/1994; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A herbaceous biennial or short-lived perennial that can remain as a low rosette of leaves for several years before it flowers and dies. The mature plant has one or a few erect stems 3 - 8 decimeters (dm) (12 - 32 inches (in)) tall. The basal and stem leaves are pinnately divided with sharp points terminating each division. The flowers are pink, tubular, and terminate in five spreading lobes. The stamens and the short style of the ovary are deep inside the flower tube (USFWS, 2002).

Taxonomy

In the phlox family (Polemoniaceae) and a member of the Ipomopsis aggregata complex of species and subspecies (USFWS, 2002).

Historical Range

See Current Range.

Current Range

Endemic to a single canyon in the Sangre de Cristo Mountains, New Mexico (USFWS, 2002)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: diurnal hummingbirds and nocturnal hawkmoths (USFWS, 2002).

Key Resources Needed for Breeding

Adult: Insects and hummingbirds for pollination (USFWS, 2002)

Reproduction Narrative

Adult: Maschinski (1996) found that Ipomopsis sancti-spiritus needs pollinators for either self- or outcross-fertilization and that fertilization is required to produce fruits. Paige and Whitham (1985) observed some Arizona populations of Ipomopsis aggregata where plants with lighter colored flowers (pink to white) become more frequent in the latter part of the flowering season when pollinator frequency shifts from diurnal hummingbirds to nocturnal hawkmoths. (USFWS 2002).

Habitat Type

Adult: Terrestrial (USFWS, 2002)

Habitat Vegetation or Surface Water Classification

Adult: Roadsides and small woodland clearings beneath Ponderosa pine on steep, south- or southwest-facing slopes (NatureServe, 2015).

Geographic or Habitat Restraints or Barriers

Adult: Elevation from 2,350 - 2,500 m (USFWS, 2002)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2002)

Habitat Narrative

Adult: Holy Ghost ipomopsis grows in Holy Ghost Canyon on relatively dry, steep, west to southwest-facing slopes on about the lower one third of the canyon side (excluding the creek riparian margin). The geologic substrate is partly weathered Terrero Limestone. Appears to grow best in bare mineral soils with its highest densities on disturbed sites such as road cuts. The occupied habitat in Holy Ghost Canyon ranges in elevation from 2,350 - 2,500 m (USFWS, 2002). Grows in roadsides and small woodland clearings beneath Ponderosa pine on steep, south- or southwest-facing slopes (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Not available.

Number of Populations:

1 (USFWS, 2020)

Population Size:

50 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Monitoring data has captured large fluctuations in the Holy Ghost ipomopsis population, ranging from a high of 2,047 in 1996 to a low of 240 in 2001. Plot monitoring between 2003 and 2008 has shown that the average number of individuals per year is 703, divided into an average of 183 flowering plants and 520 rosettes per year, with flowering individuals comprising 26% of the total number of individuals (Sivinski and Tonne 2007, 2008)(USFWS, 2008).

Threats and Stressors

Stressor: Limited distribution (USFWS, 2002)
Exposure:
Response:
Consequence:

Narrative: Holy Ghost ipomopsis is found in a single population of approximately 2,500 plants in one canyon on the Pecos Santa Fe National Forest. The population is vulnerable to stochastic events such as wildfire and disease. A related threat is the apparently limited reproductive success of Holy Ghost ipomopsis, leading to a possible deficit of compatible alleles for pollination or inbreeding depression. In controlled pollination studies, only 13% of the flowers of a sample of 10 plants successfully set fruit (Maschinski and Sivinski, unpublished data 2002). In comparison, the more common species Ipomopsis arizonica has an average of 76% of flowers successfully set fruit (USFWS, 2002).

Stressor: Heavy recreational use (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: There are approximately 36 summer cabins and a USFS campground within Holy Ghost Canyon. A nearby trout stream is used by anglers resulting in intense recreational use during the months the plant is flowering. Impacts to Holy Ghost ipomopsis from recreation are mostly from residents and campers who walk the forest road and occasionally pick native wildflowers. Holy Ghost ipomopsis is pleasingly showy and sometimes taken. When the flowering stem is broken off, some plants will produce new stems from the lateral buds. This response has been studied in other species of Ipomopsis. For I. aggregate, Paige (1992a) found fruit and seed production equal between plants with stems removed late in the flowering season and undamaged plants. For I. arizonica, Maschinski (1989) found fruit and seed production lower for plants with late season stem removal than for undamaged plants. No studies of this compensating growth response have been done for Holy Ghost ipomopsis; however, Maschinski (Arboretum at Flagstaff, pers. comm. 2002) has noted that plants with broken stems in August produced no fruit for the season (USFWS, 2002).

Stressor: Inadequate protection by regulatory mechanisms (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Prior to listing, no Federal law protected the Holy ghost ipomopsis and no USFS management plan had been developed for the species. Now listed as Federally endangered, the Act prohibits the malicious damage, destruction, or removal and reduction to possession of plants occurring on Federal lands. However, because of the heavy recreational use within the plant's range and its attractive flower, it continues to be vulnerable to unauthorized picking. A comprehensive USFS management plan is needed to assure the population's continuing viability (USFWS, 2002).

Stressor: Management activities (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Dependence on human disturbance to create habitat puts Holy Ghost ipomopsis directly in the path of future ground-disturbing activities, including road widening, use of heavy equipment, competition from non-native plants, and control of spruce budworm (USFWS, 2002).

Stressor: Exclusion of fire and timber harvest (USFWS, 2002)

Exposure:
Response:
Consequence:
Narrative: Extended fire suppression produces dense thickets and suppresses the herbaceous understory (Moir and Dieterich 1988). This trend is obvious in Holy Ghost Canyon where fire has been excluded for at least 80 years. The forest openings required by Holy Ghost ipomopsis are rare and the species has become confined almost entirely to road cuts and other habitat created through human disturbance. As these disturbance sites are recolonized by trees and shrubs, Holy Ghost ipomopsis numbers decline. Because frequent prescribed fire is incompatible with the present use of the area, this species is now dependent on recurrent soil disturbance associated with Forest Road 122 and the residential home sites in Holy Ghost Canyon. These activities may be insufficient to create or maintain enough habitat to perpetuate a viable population of Holy Ghost Ipomopsis. Timber harvest or significant forest thinning could potentially simulate the effects of natural fire and create Ipomopsis habitat. The principal land uses in the canyon are now summer homes and recreation. Timber harvest, which conflicts with these uses, has been eliminated from the canyon for several decades (USFWS, 2002).

Recovery

Reclassification Criteria:
1. Maintenance of the current population in Holy Ghost Canyon at an average of 2,000 plants per year (USFWS, 2002).

2. Establishment of four additional populations in the upper Pecos Basin, and (3) implementation of a management plan to assure the continued survival of the species (USFWS, 2002).

3. Implementation of a management plan to assure the continued survival of the species (USFWS, 2002).

Recovery Priority Number: 2C

Delisting Criteria:
The Holy Ghost Ipomopsis will be considered for delisting when: 1. The Holy Ghost Canyon population is shown to be stable or improving over a 20-year period with at least 10,000 individuals (flowering adults) according to the following measures: accommodate for periods of fluctuation in population size or years when monitoring may not be possible. c) Species presence and abundance is maintained with at least 1,000 individuals within each of these additional populations. The populations shall be considered stable when a linear regression analysis (or other method which has been peer-reviewed by species experts and approved by the Service) of the population numbers estimated from the results of annual demographic trend monitoring reveals no significant decline in numbers. d) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain resiliency across these four populations. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria would be reassessed or adjusted to establish an

accurate population numbers to achieve a resilient population, if necessary. Justification: The criteria ensure redundancy through the establishment of at least four additional resilient populations of Holy Ghost Ipomopsis. 3. Genetic diversity will be maintained within the core Holy Ghost Canyon population of at least 10,000 individuals (flowering adults) and the additional populations within the upper Pecos Basin of at least 1,000 individuals (flowering adults) each, according to the following measures: a) Any efforts undertaken to augment the Holy Ghost Canyon population will utilize standardized methods approved by the Service and peer-reviewed to maintain sufficient genetic diversity within the population to ensure population resiliency. b) Any efforts undertaken to establish and/or augment the additional populations of Holy Ghost Ipomopsis outside of Holy Ghost Canyon will utilize standardized methods approved by the Service and peer-reviewed to maintain sufficient genetic diversity within and among those populations to ensure population resiliency. Justification: These criteria ensure genetic and ecological representation of Holy Ghost Ipomopsis across large portions of its range. 4. The existing species-specific management recommendations (developed in coordination with the Service and implemented by the appropriate land management entity) should be proven effective and successful in protecting the species over the 20-year period required to reach delisting criteria described above. In addition, all land managing agencies will have developed a Post-Delisting Monitoring Plan (which has been approved by the Service's Southwest Regional Director) to cover a minimum of 5 years post-delisting of the species and be prepared to implement this plan prior to delisting to ensure the ongoing conservation of the listed species and the continuing effectiveness of management actions. a) In addition to this criterion, monitoring and research have been completed to conclude with a high degree of certainty that population sizes, quality, configuration, and management are adequate to provide a high probability of species survival (greater than 90 percent over 100 years). Justification: These criteria will help ensure the continued amelioration of threats to the Holy Ghost Ipomopsis via management actions. All classification decisions consider the following five factors: (1) is there a present or threatened destruction, modification, or curtailment of the species' habitat or range; (2) is the species subject to overutilization for commercial, recreational scientific or educational purposes; (3) is disease or predation a factor; (4) are there inadequate existing regulatory mechanisms in place outside the Act (taking into account the efforts by states and other organizations to protect the species or habitat); and (5) are other natural or manmade factors affecting its continued existence. When delisting or downlisting a species, we first propose the action in the Federal Register and seek public comment and peer review. Our final decision is announced in the Federal Register. (USFWS, 2019) a) The Holy Ghost Canyon population has been designated as the core recovery population. The Holy Ghost Canyon population includes the natural population along Holy Ghost Canyon Road and any augmentation efforts within Holy Ghost Canyon which have resulted in successful reproductive exchange. This core population should be monitored yearly using annual demographic trend monitoring at representative sites to provide a population estimate based on methodology peerreviewed by species experts and approved by the Service. The 20-year monitoring period will accommodate for periods of fluctuation in population size or years when monitoring may not be possible; this monitoring period may include any data that satisfies accepted monitoring techniques and analyses. b) Approximately every 5 years, range wide and peripheral counts will be conducted using standardized methods peer-reviewed by species experts and approved by the Service. c) Species presence and abundance is maintained with at least 10,000 individuals (flowering adults) within the core Holy Ghost Canyon population. The population shall be considered stable when a linear regression analysis (or other method which has been peer-reviewed by species experts and approved by the Service) of the population numbers estimated from the results of annual

demographic monitoring reveals no significant decline in numbers. d) A population viability analysis (PVA) (or other appropriate method which has been peer-reviewed by species experts and approved by the Service) will be conducted to determine the demographic parameters necessary to maintain a resilient population. A resilient population is one that is able to maintain approximately a 95% likelihood of persistence over a 100-year period (or other appropriate period of time which has been peer-reviewed by species experts and approved by the Service). Based on the PVA, the recovery criteria may be reassessed or adjusted to establish an accurate population number to achieve a resilient population, if necessary. Justification: These criteria allow for the threat of demographic and environmental stochasticity to be mitigated through the establishment of a resilient core population which is protected from random population fluctuations. 2. At least four additional populations in the upper Pecos Basin are shown to be stable or improving over a 20-year period with at least 1,000 individuals (flowering adults) each according to the following measures: a) Maintain or increase suitable habitat within currently established population areas and/or identify additional suitable habitat in other areas. b) Monitor these additional populations yearly for 20 years at representative sites to provide a population estimate based on methodology peer-reviewed by species experts and approved by the Service. The 20-year monitoring period will

Recovery Actions:

- Protect the Holy Ghost ipomopsis population and habitat from existing threats (USFWS, 2002).
- Complete studies to determine the habitat and biological requirements of Holy Ghost ipomopsis (USFWS, 2002).
- Maintain plants in cultivation at a botanical garden and establish a seed bank (USFWS, 2002).
- Survey potentially suitable habitats (USFWS, 2002).
- Develop and implement a plan to establish more populations (USFWS, 2002).
- Encourage public awareness and support for the preservation of Holy Ghost ipomopsis (USFWS, 2002).
- Use the results of monitoring and research studies to determine if populations can sustain themselves and to establish criteria for removing the species from the list of threatened and endangered species (USFWS, 2002).
- Develop a post-recovery monitoring plan (USFWS, 2002).
- Commence interagency discussions about management issues regarding the following management needs: archeological surveys, authorized by the USFS, in occupied and potential Holy Ghost ipomopsis habitat that could provide the opportunity for disturbance experiments at a small scale and for WUI project implementation at a large scale; design and implementation of disturbance and forest thinning experiments; augmentation of the Holy Ghost Canyon population with seed and greenhouse-grown material; development of experimental plots to study control of invasive grasses; fire management and road maintenance concerns; spruce budworm control using BT; and, development of a USFS species-specific management plan for the Holy Ghost ipomopsis and/or a USFS area-specific management plan for Holy Ghost Canyon (USFWS, 2008).
- Revisit the 1991 population estimate of 1,250 to 2,500 individuals to see if those numbers and the ratio used to estimate the number of flowering adults and rosettes accurately reflect current numbers of Holy Ghost ipomopsis individuals (USFWS, 2008).

- Conduct a census of the Holy Ghost Canyon population and map all portions of the population including peripheral colonies. Map all monitoring transects and estimate the portion of the total population represented by monitoring data (USFWS, 2008).
- Continue propagation of Holy Ghost ipomopsis for replanting within Holy Ghost Canyon provided that there are projects and clearances in place for their use (USFWS, 2008).
- Establish a botanical garden population and a seed bank for restoration efforts (USFWS, 2008).
- Establish a Botanical Reserve Area in Holy Ghost Canyon to protect the only naturally occurring population of Holy Ghost ipomopsis (USFWS, 2008).
-

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommendations below are summarized from the 2019 Recovery Summary Report; more detailed information can be found on pages 28-29 of the report (Roth 2019). • Closely monitor and manage anthropogenic activities in Holy Ghost Canyon. Disruptions to its reproductive cycle threaten the species' persistence. The collection of flowering plants, especially in high, human traffic areas, should be discouraged. • If possible, land managers should avoid Holy Ghost ipomopsis habitat when considering resource extraction activities within Santa Fe National Forest. Decision-makers can consider alternatives to minimize and avoid impacts on the species. • Conduct a population viability analysis at naturally occurring and transplantation sites to evaluate and measure success of these populations and better understand reproductive process of the Holy Ghost ipomopsis. • Management agencies should create a comprehensive fire management plan which incorporates the habitat needs of the Holy Ghost ipomopsis. Integrating the Holy Ghost ipomospis into post-fire restoration plans to both establish and reestablish populations of the species would increase species resiliency. (USFWS, 2020)

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SPECIES ACCOUNT: *Isodendrion laurifolium* (Aupaka)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 10-20 dm tall. The flowers are purple and are borne singly along the stems (NatureServe, 2015).

Taxonomy

A member of the violet family (Violaceae). Other published names considered synonymous with Isodendrion laurifolium are I. forbesii, I. lydgatei, I. subsessilifolium, and I. waianaeense (Wagner et al. 1990) (USFWS, 1999).

Historical Range

It was historically known from scattered locations on Kauai and the Koolau and Waianae Mountains on Oahu (USFWS, 2009).

Current Range

Island Distribution: Found on Kauai and Oahu (USFWS, 2021c)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Isodendrion laurifolium (Aupaka) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Isodendrion laurifolium (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 9,271 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Isodendrion laurifolium includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Isodendrion laurifolium on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat desisgnation for Isodendrion laurifolium includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 9,271 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and

277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

The critical habitat designation for Isodendrion laurifolium includes two units totaling 1,979 acres in Kauai County, Hawaii. The units are Kauai 11—Isodendrion laurifolium— a, b.

Kauai 11—Isodendrion laurifolium—a: This unit is critical habitat for Isodendrion laurifolium and is 401 ha (991 ac) on State land (Kuia NAR). This unit contains portions of Mahanaloa Valley and Milolii Ridge. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Isodendrion laurifolium and is currently occupied with

between 86 and 96 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest dominated by Metrosideros polymorpha, Acacia koa or Diospyros spp. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event. Kauai 11—Isodendrion laurifolium—b: This unit is critical habitat for Isodendrion laurifolium and is 400 ha (988 ac) on State land (Alakai Wilderness Preserve) containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Isodendrion laurifolium and is currently occupied with between six and eight plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic forest dominated by Metrosideros polymorpha, Acacia koa or Diospyros spp. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Isodendrion laurifolium critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Isodendrion laurifolium occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex and was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Diverse mesic forest dominated by Metrosideros polymorpha, Acacia koa or Diospyros spp. and containing one or more of the following associated native plant species: Alphitonia ponderosa, Antidesma spp., Claoxylon sandwicense, Dodonaea viscosa, Dubautia spp.,

Elaeocarpus bifidus, Euphorbia haeleeleana, Hedyotis terminalis, Kokia kauaiensis, Melicope anisata, Melicope barbigera, Melicope ovata, Melicope peduncularis, Myrsine lanaiensis, Nestegis sandwicensis, Pisonia spp., Pittosporum glabrum, Pleomele aurea, Pouteria sandwicensis, Psydrax odorata, Streblus pendulinus, or Xylosma hawaiiense; and

(ii) Elevations between 397 and 1,164 m (1,303 and 3,817 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Isodendrion laurifolium to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2013)

Breeding Season

Adult: February - December (USFWS, 2009)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than ten years) (USFWS, 2013). Specimen vouchers at Bernice P. Bishop Museum (C. Imada, Bernice P. Bishop Museum, pers. comm. 2008), the herbarium database at the National Tropical Botanical Garden (2008), and data from Hawaii Biodiversity and Mapping Program (2007) reveal the following phenological patterns: on Kauai, flowering specimens were noted from February through April, July through September, and November to December; fruiting specimens were noted in February, March, May, July through September, and November to December. On Oahu, flowering was noted from February to March, May to June, August, and October; fruiting was noted in February and May (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Ohia, koa-ohia or ohia-lama mesic or wet forest (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: 1,620 - 2,700 ft. elevation (USFWS, 1999)

Habitat Narrative

Adult: Inhabits moist forests, or rarely wet forests. On gulch slopes (NatureServe, 2015). Environmental requirements and limiting factors are unknown. Isodendrion laurifolium is usually found at elevations between 490 and 820 meters (1,620 and 2,700 feet) in diverse mesic forest, or rarely wet forest, dominated by ohia or koa-ohia, or ohia-lama with hame, maua, Hedyotis terminalis(manono), Pisonia sp. (papala kepau), and Pouteria sp. (alan) (USFWS 1996a; S. Perlman, personal communication 1999) (USFWS, 1999).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Decrease in population number; increase in population size (USFWS, 2013)

Number of Populations:

16 (USFWS, 2013). 9 (USFWS, 2021c)

Population Size:

219 (USFWS, 2013). 212 (USFWS, 2021c)

Additional Population-level Information:

Isodendrion laurifolium has been found on Kauai at Makaha (ca 70 individuals), Paaiki (one individual), Poopooiki (one individual), Kawaiula (nine individuals), Kalalau (one individual), Kuia drainage (nine individuals), Nualolo (one individual), and on Waialae Trail (ca 50 individuals) (NTBG 2013a, 2014a-f, 2015a-e, 2016a-d). In 2015, Wood et al. reported 9 "subpopulations" (considered "populations" by USFWS) on Kauai totaling 130 individuals (Wood et al. 2015). This is a decline from the last five year review. On Oahu, I. laurifolium is reported from the Waianae Mountains at Makaha (58 individuals), Waianae Kai (12 individuals), and Pahole (12 individuals) (PEPP 2017). Currently, there are nine populations on Kauai, and three on Oahu. These populations total about 212 individuals, with the majority of individuals on Kauai. (USFWS 2017)

Population Narrative:

The numbers on Kauai remain around 150 individuals in 13 or fewer populations; three populations of Isodendrion laurifolium are located on Oahu. Populations of Isodendrion laurifolium appear to have fluctuated since the last five-year review, with fewer populations but an increase from 164 to 219 individuals (USFWS, 2013).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The species is threatened by habitat degradation from feral goats (Capra hircus), feral pigs (Sus scrofa), black-tailed or mule deer (Odocoileus hemionus); competition with introduced invasive plant species such as: Psidium cattleianum (strawberry guava), Rubus rosifolius (thimbleberry), Lantana camara (lantana), Grevillea robusta (silky oak), Kalanchoe pinnata (air plant) and Erigeron karvinskianus (daisy fleabane); and potentially from military activities (Factor E) (USFWS 1996, 1999, 2003a, b, 2007; K. Wood, pers. comm. 2008) (USFWS, 2009).

Stressor: Climate change (USFWS 2017)
Exposure:
Response:
Consequence:
Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. This assessment concluded that Isodendrion laurifolium is extremely vulnerable to the impacts of climate change with a vulnerability score of 0.843 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future. Seed storage and propagation efforts are ongoing, with individuals outplanted in managed areas. (USFWS 2017)

Recovery

Reclassification Criteria:

1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against feral and wild ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- Captive propagation for genetic storage and reintroduction—Seed collection and plant propagation for Oahu populations is ongoing and almost complete with over 2,000 seeds in storage from 51 founders. PEPP also has 19 plants from nine different collections growing at the Pahole Rare Plant Facility (Lyon Arboretum 2017). There are three seed collections that have been made over the last few years from plants on Kauai (NTBG 2017). (USFWS 2017)
- Reintroduction and translocation—There is an outplanting on Oahu of approximately 40 individuals (PEPP 2017). On Kauai, there are about 25 individuals in three separate exclosures (HBMP 2010; PEPP 2012, 2013, 2014). (USFWS 2017)
- Fire monitoring and control—On Oahu, the Waianae Mountains Watershed Partnership is controlling nonnative plant species and growing a native plant fuel break in Waianae Kai to reduce the risk of wildfires. (USFWS 2017)
- Predator and herbivore monitoring and control—On Oahu, the Oahu Army Natural Resources Program (OANRP) is controlling ungulates and rats within fenced exclosures at Makaha (U.S. Army 2016). (USFWS 2017)

- Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species (USFWS 2017).
- Invasive plant monitoring and control (USFWS 2017) o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations.
- Population biology research—Study Isodendrion laurifolium populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS 2017).
- Genetic research—Assess genetic variability within extant populations (USFWS 2017).
- Captive propagation for genetic storage and reintroduction: Collect cuttings or seed from tagged individuals, recording maternal source. Continue to collect seeds from all existing populations (USFWS, 2013).
- Reintroduction / translocation: Determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. Continue to reintroduce the species back into its known historical range (USFWS, 2013).
- Ungulate exclosures: Construct ungulate-proof fenced exclosures around each population and monitor the fences for any signs of breaching. Protect all populations against disturbances from feral ungulates (USFWS, 2013).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2013).
- Predator / herbivore control - Implement effective control methods for rodents (USFWS, 2013).
- Surveys / inventories - Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Threats research: Develop and implement effective measures to reduce the impact of landslides and flooding and military activities. Assess the modeled effects of climate change on this species, and use results to determine future landscape needed for the recovery of the species (USFWS, 2013).
- Fire protection - Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2013).
- Genetics research - Assess genetic variability within extant populations (USFWS, 2013).
- Population biology research - Study Isodendrion laurifolium populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).

Conservation Measures and Best Management Practices:

- New Management Actions: • Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) and the Army's Natural Resources Program (ANRP) monitor and survey populations in the Waiʻanae mountains of Oʻahu, and PEPP monitors populations on Kauaʻi (PEPP 2017, 2018, 2019). • Nonnative plant control—PEPP and the ANRP collaborate with other agencies for nonnative plant control at Pahole and Mākaha (Oʻahu) (PEPP 2018). • Collection and propagation for genetic storage and reintroduction— o In 2020, the Lyon Arboretum Micropropagation Laboratory reported storage

of 35 explants representing one founder from Mākaha, Oʻahu (Lyon Arboretum 2020). In 2016, the Lyon Arboretum Seed Conservation Laboratory reported storage of 186 seeds representing 31 founders from two populations at Mākaha on Oʻahu; in 2018, there were five seeds in storage representing one founder from Kaʻawa Gulch (Oʻahu) and 76 seeds in storage from four plants in a living collection at Koko Crater Botanical Garden that represents the Mākaha population (Oʻahu) (Lyon Arboretum 2020). o The Pahole Rare Plant Facility (PRPF; Oʻahu) reported between 49 and 73 plants in storage representing five founders from Mākaha, two founders from Waiʻanae Kai, and one founder from an unspecified location (Oʻahu) (Native Ecosystems Protection and Management [NEPM] 2020; PRPF 2019). • Reintroduction and translocation—On Kauaʻi, one individual was reintroduced in 2018 within an exclosure at Miloliʻi-Upper Mahanaloa (PEPP 2019). On Oʻahu, there is one reintroduced population (in 2014) at Mākaha-Kūmaipō of 43 individuals and two reintroduced populations at Pahole gulch (12 individuals in 2015 and 47 individuals in 2019), and one outplanted population of five individuals at Waiʻeli (Oʻahu) (PRPF 2019; PEPP 2019). (USFWS, 2021b)

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021. • Surveys and inventories—Survey current and historical range for a complete assessment of the species' status. • Ungulate monitoring and control—Continue to construct exclosures to protect all occurrences from the impacts of feral ungulates, including browsing. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species at all wild and reintroduced populations. • Fire monitoring and control—Implement fire management plan for military training areas and develop and implement fire management plans for all wild and reintroduced populations at other locations. • Predator and herbivore monitoring and control—Implement effective measures to control rodents at all populations. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into managed suitable habitat. • Reintroduction and translocation— o Continue reintroductions and augmentations into suitable habitat within historical range in areas that are managed for known threats. o Monitor reintroductions for successful recruitment. o Increase numbers of populations and individuals to reduce impacts from landslides and erosion. • Population biology research— o Assess genetic variability within extant populations. o Determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to impacts of climate change. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2021b)

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SPECIES ACCOUNT: *Ivesia kingii var. eremica* (Ash Meadows ivesia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/20/1985; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb that forms a tuft of narrowly divided, grayish leaves. Flowering stems are about 9 cm long and bear white flowers from August to October. Some botanists question whether this taxon is distinctive enough to be maintained as a discrete variety of the species I. kingii. (The species as a whole is extremely variable and somewhat rare.) (NatureServe, 2015).

Taxonomy

A member of the Rosaceae family (USFWS, 1990). Kartesz (1994 checklist and 1999 floristic synthesis) does not recognize varieties in this species; however, USFWS recognizes var. eremica as distinct from the typical var. kingii. As Kartesz notes (in letter to Larry Morse, 25Nov99), he reviewed all of the available Nevada collections and concluded that "this [var. eremica] is nothing more than an extremely variable expression of Ivesia kingii"; he also notes that various individuals, including Barbara Ertter, had listed characters considered useful in separating the two taxa, she (Ertter) has more recently indicated (in a personal communication with Kartesz) that researchers in the Netherlands "also maintain it as nothing more than a taxonomic synonym of Ivesia kingii." However, Ertter (in a personal communication to Jim Morefield) as of 06 Apr 99 still considered this a valid taxon at the varietal level (NatureServe, 2015).

Historical Range

Endemic of Ash Meadows, south Nye County, Nevada. Type found in Coville and Funston, Nye County, Nevada in 1891 (NatureServe, 2015).

Current Range

Small, local populations are scattered throughout Ash Meadows in Nevada (USFWS, 1990).

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Ivesia kingii var. eremica (Ash Meadows ivesia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Ivesia kingii var. eremica includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Ivesia kingii var. eremica critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include saline seep areas of light colored clay uplands.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from sews, 1990)

Lifespan

Adult: 2+ years (inferred from USFWS, 1990)

Breeding Season

Adult: Summer - fall (USFWS, 1990)

Reproduction Narrative

Adult: Plants are perennial. It produces flowers during the late summer and autumn (Mozingo and Williams 1980) (USFWS, 1990).

Habitat Type

Adult: Wetland, terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Saltbrush scrub near springs (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 657 - 690 m elevation (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Solitary clumps (USFWS, 1990)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits moist alkaline areas in openings of saltbrush scrub near springs. It is dependent on springs. Dust from erosion may smother plants. Found at elevations of 657 - 690 m. It is narrowly confined to a single spring-fed desert wetland area with extremely saline soils (NatureServe, 2015). It occupies highly alkaline, barren soils that remain moistened by water spreading outward from surface flow discharged by springs. Plants occur as solitary clumps (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

8-9 (USFWS, 2020)

Population Size:

510,744 (USFWS, 2020)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

In 1987, Ash Meadows ivesia was known from seven populations within the Ash Meadows area (Knight and Clemmer 1987, pp. 73–74). In 1998, Knight and Clemmer's populations were re-surveyed and re-confirmed, and an additional population of Ash Meadows ivesia at Jackrabbit Spring was discovered (Service, unpubl. survey, 1998). In 2001, Ash Meadows ivesia was estimated to occur across 9 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 8 maximum scale occurrences (0.6 mi (1 km) separation distance) on approximately 9.1 ac (3.7 ha) (Morefield 2001, p. 1). Refuge-wide surveys at the Ash Meadows National Wildlife Refuge (Refuge) of listed and rare plants, including Ash Meadows ivesia, were initiated in 2008 and completed in 2010 (BIO-WEST 2011, entire). As a result of these surveys, 9,000 ac (3,642 ha) were surveyed and the approximate Refuge area covered by Ash Meadows ivesia is 116.1 ac (47 ha) (BIO-WEST 2011, pp. 121– 123). On these 116.1 ac (47 ha), 19 minimum scale occurrences (0.1 mi (0.16 km) separation distance) or 2 maximum scale occurrences (0.6 mi (1 km) separation distance) were reported (BIO-WEST 2011, pp. 121–123). Distribution of Ash Meadows ivesia is depicted in Figure 1. At the time of listing, a population estimate of Ash Meadows ivesia was unknown (Service 1985, p. 20777). In 2001, the Ash Meadows ivesia population on the Refuge was estimated to be approximately 3,862 individuals (Morefield 2001, p. 1). Results from the 2008–2010 Refugewide rare plant survey produced an estimate that 510,744 individuals are present on the Refuge (Table 1; BIO-WEST 2011, pp. 121–123). This estimate remains the best available for the Refuge population. Estimates of Ash Meadows ivesia individuals on the BLM ACEC and private lands within the Refuge boundary do not exist. (USFWS, 2020)

Threats and Stressors

Stressor: Past habitat destruction and modification (USFWS, 1985)
Exposure:
Response:

Consequence:
Narrative: The presence of water in Ash Meadows has long attracted human activity and provided a refuge for man's survival in an arid desert. The magnitude of man's impact on the local environment has increased over time and resulted in the decline of local endemic species Large-scale disturbance began in the early 1960's when approximately 2,000 acres of upper Carson Slough was mined for peat. This removed approximately six feet of substrate and eliminated on of the largest marshes in southern Nevada. Endemic plant populations were reduced or eliminated when lands were cleared for crops and pasture, roads were constructed, and when impoundments were constructed then filled (Sanchez 1981). Impoundments now inundate several hundred acres of habitats believed to support the Ash Meadows ivesia. Many roads were built through areas now designated as critical habitat for plant species. Approximately 65 miles of gravel and unimproved roads now exist within the essential habitat, directly affecting Ash Meadows ivesia. All of the endemic species were additionally affected by secondary impacts of these roads, which largely resulted from increased vehicular access to sensitive areas. Because of all past activities, small populations of species endemic to Ash Meadows presently occupy a small portion of their historic habitat (USFWS, 1990).

Stressor: Introduced species (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Introduced species, including salt cedar (Tamarix), mosquitofish, sailfin mollies (Poecelia lativinna), wild horses, bullfrogs, and crayfish further reduced endemic plant and animal populations by displacement through competition for food and space, and/or predation (Miller 1948, Beatley 1977 a, b; Reveal 1978 a, b, c; Soltz and Naiman 1978, Schoenherr 1981, Knight and Clemmer 1987). Roads facilitated introduction of non-native species (particularly aquatic species), and the detrimental influence of trampling caused by water-oriented recreation. Introduced species are now widespread throughout the area, and trampling has reduced populations of endemic mollusks and plant populations adjacent to springs. Large herds of wild horses altered spring morphology and impacted endemic plant and snail populations (Hershler and Sada 1987, Landye 1973, Mozingo and Williams 1980) (USFWS, 1990).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. The species is present in all locales it historically occupied within Ash Meadows (USFWS, 1990).

2. The species has reached self-sustaining populations (as measured by frequency values for plants on critical habitat) (USFWS, 1990).

3. The essential habitat is free of threats from all non-native animals, exotic plants, and detrimental human disturbances (USFWS, 1990).

4. Springs have returned to historic discharge rates and water flow is reestablished into historic channels (USFWS, 1990).

5. Native plant and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 1990).

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990).
- Conduct research on the biology of the species (USFWS, 1990).
- Conduct management activities within essential habitat (USFWS, 1990).
- Reestablish populations/monitor new and existing populations (USFWS, 1990).
- Determine/verify recovery objectives (USFWS, 1990).
- Approval of the Ash Meadows Habitat Management Plan by the Bureau initiated a number of more recent conservation programs on public domain lands (USBLM 1980). Barbed wire fencing was installed to prevent wild horses' entrance to approximately 425 acres surrounding Big and Jackrabbit Spring s, and emergent vegetation has been periodically removed from School Springs. Wild horses were captured during August 1985 to eliminate trampling of springs, stream banks, and rare plants (USFWS, 1990).
- The States of Nevada and California and the Service have been actively involved in recognizing the declining status of species endemic to Ash Meadows. These agencies variously list a number of local species as either threatened or endangered. Numerous botanists affiliated with various universities and native plant societies throughout the nation have surveyed the area's vegetation and documented rare plant distribution. Although much work has been conducted, much of it has been directed toward preventing further loss of populations and habitat and not toward habitat or population enhancement. The purchase of much of the area by The Nature Conservancy and subsequent purchase of these lands by the Service to establish the Ash Meadows Refuge has been the single largest step toward providing security for these species (USFWS, 1990).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); and III. Support Ash Meadows ivesia research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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SPECIES ACCOUNT: *Ivesia webberi* (Webber Ivesia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 07/03/2014; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial, tap-rooted low spreading herb to 2.5 dm across, hairy throughout; overall color greenish-gray foliage with dark red stems and bright-yellow clusters of flowers, the whole plant becoming reddish-tinged late in the season. Leaves 3-7 cm long, mostly basal, with 4-8 pairs of leaflets crowded toward tips; leaflets 3-10 mm long, each further divided into 2-5 narrow segments. Flower clusters at stem tips, about 15-50 mm across, with 5-15 flowers each; each flower about 10 mm across on a stalk 1-8 mm long, petals 5, bright yellow, 2-3 mm long, much smaller than the green sepals; stamens 5 (NatureServe, 2015).

Taxonomy

A member of the Rose family (Rosaceae) (USFWS, 2014).

Historical Range

Known from Upper Long Valley on the California-Nevada border, and elsewhere in Nevada from both north and southwest of Reno, Washoe County, and from the western slope of the Pine Nut Mountains, Douglas County (NatureServe, 2015)

Current Range

Ivesia webberi is currently known to occupy a total of approximately 165 acres (66.8 hectares) within five counties in California and Nevada along the transition zone between the eastern edge of the northern Sierra Nevada and the northwestern edge of the Great Basin (Service 2014, p. 8) (USFWS, 2014).

Critical Habitat Designated

Yes; 6/3/2014.

Legal Description

On June 3, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Eriogonum codium (Umtanum Desert buckwheat) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 16 critical habitat units (CHUs), in California and Nevada (79 FR 32126-32155).

Critical Habitat Designation

The critical habitat designation for Eriogonum codium includes 16 CHUs in Plumas, Lassen, and Sierra Counties in northeastern California, and in Washoe and Douglas Counties in northwestern Nevada. This species critical habitat encompasses approximately 2,170 acres (ac) (879 hectares (ha)) (79 FR 32126-32155).

Unit 1: Sierra Valley: Unit 1 consists of 274 ac (111 ha) of Federal, State, and private lands. This unit is located near the junction of State Highway 49 and County Highway A24 in Plumas County, California. Nineteen percent of this unit is on Federal lands managed by the BLM, 16 percent is on California State land, and 65 percent is on private lands. This unit is currently occupied and is

the most western occupied unit within the range of Ivesia webberi. The Sierra Valley Unit is important to the recovery of I. webberi because it supports 44.8 ac (18.1 ha), or nearly one-third (27.2 percent), of all habitat (165 ac (66.8 ha)) that is occupied by I. webberi across the species' range. Threats to I. webberi in this unit include nonnative, invasive species; wildfire; OHV use; roads; livestock grazing; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 2: Constantia: Unit 2 consists of 155 ac (63 ha) of Federal land. This unit is located east of U.S. Highway 395, southeast of the historic town of Constantia, in Lassen County, California. One hundred percent of this unit is on Federal lands managed by the BLM. This unit is currently occupied and is the most northern occupied unit within the range of Ivesia webberi. The Constantia Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Not a lot is known about the current condition of I. webberi and its habitat at this site; however, wildfire and any other forms of vegetation or ground-disturbing activities are threats to I. webberi in this unit. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 3: East of Hallelujah Junction: Wildlife Area (HJWA)–Evans Canyon Unit 3 consists of 122 ac (49 ha) of Federal and State lands. This unit is located east of U.S. Highway 395 on the border of HJWA in Lassen County, California. Eighty-two percent of this unit is on California State land managed as the HJWA, and 18 percent is on Federal land managed by the BLM. This unit is currently occupied and is approximately 1.6 mi (2.6 km) away from Unit 4, which may allow for social pollinator dispersal between these two units. Additionally, this is the only place where Ivesia webberi is found as a co-dominant in an Artemisia tridentata Nutt. (big sagebrush) community instead of an Artemisia arbuscula (low sagebrush) community. The perennial bunchgrass and forb components of the Artemisia tridentata community found within this unit are the same as those occurring in locations where A. arbuscula is co-dominant with I. webberi. The East of HJWA–Evans Canyon Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Wildfire and any other forms of vegetation or grounddisturbing activities are threats to I. webberi in this unit. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required

to maintain these features in this unit. These threats should be addressed as detailed above in the ‘‘Special Management Considerations or Protection’’ section.

Unit 4: Hallelujah Junction Wildlife Area (HJWA): Unit 4 consists of 69 ac (28 ha) of State lands. This unit is located west of U.S. Highway 395 within HJWA in Sierra County, California. One hundred percent of this unit is on California State land managed as the HJWA. It is currently occupied and is approximately 1.6 mi (2.6 km) away from Unit 3, which may allow for social pollinator dispersal between these two units. The HJWA Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species’ distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Wildfire and any other forms of vegetation or grounddisturbing activities are threats to I. webberi in this unit. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ‘‘Special Management Considerations or Protection’’ section.

Unit 5: Subunit 5a–Dog Valley Meadow and Subunit 5b–Upper Dog Valley Subunit 5a–Dog Valley Meadow Subunit 5a consists of 386 ac (156 ha) of Federal lands. This subunit is located east of Long Valley Road in Dog Valley in Sierra County, California. One hundred percent of this subunit is on Federal lands managed by the Forest Service. It is currently occupied and is 0.5 mi (0.8 km) away from Subunit 5b, which may allow for social pollinator dispersal between these two subunits. The Dog Valley Meadow Subunit is important to the recovery of Ivesia webberi because it supports 71.58 ac (28.97 ha), or nearly half (43.5 percent), of all habitat (165 ac (66.8 ha)) that is occupied by I. webberi across the species’ range and 100,000 plants, or approximately 2 to 10 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species’ range (Service 2014, pp. 15–16). Threats to I. webberi in this subunit include nonnative, invasive plant species; wildfire; OHV and other recreational use; and any other forms of vegetation or grounddisturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 16). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the ‘‘Special Management Considerations or Protection’’ section. Subunit 5b—Upper Dog Valley Subunit 5b consists of 29 ac (12 ha) of Federal and private lands. This subunit is located west of Long Valley Road and south of the Dog Valley campground in Dog Valley in Sierra County, California. Forty-one percent of this subunit is on Federal lands managed by the Forest Service, and 59 percent is on private lands. It is currently occupied and is 0.5 mi (0.8 km) away from Subunit 5a, which may allow for social pollinator dispersal between these two subunits. The Upper Dog Valley Subunit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within

the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this subunit include nonnative, invasive plant species; wildfire; OHV use; and any other forms of vegetation or ground-disturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment is currently vacant (Service 2014, p. 16). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 6: White Lake Overlook: Unit 6 consists of 109 ac (44 ha) of Federal and private lands. This unit is located north of Long Valley Road in Sierra County, California. Ninety percent of this unit is on Federal lands managed by the Forest Service and 10 percent is on private lands. This unit is currently occupied and is 1 mi (1.6 km) or less away from Units 7 and 9, which may allow for social pollinator dispersal between these units. The White Lake Overlook Unit is important to the recovery of Ivesia webberi because it supports 13.56 ac (5.49 ha), or 8.2 percent, of all habitat (165 ac (66.8 ha)) that is occupied by I. webberi across the species' range. Threats to I. webberi in this unit include wildfire and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 7: Subunit 7a—Mules Ear Flat and Subunit 7b—Three Pine Flat and Jeffrey Pine Saddle: Subunit 7a—Mules Ear Flat Subunit 7a consists of 65 ac (27 ha) of Federal and private lands. This subunit is located west of the CaliforniaNevada border and southeast of Long Valley Road in Sierra County, California. Forty-eight percent of this subunit is on Federal land managed by the Forest Service, and 52 percent is on private lands. This subunit is currently occupied and is 1 mi (1.6 km) or less away from Units 6 and 9, which may allow for social pollinator dispersal between these units. The Mules Ear Flat Subunit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this subunit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 17). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section. Subunit 7b—Three Pine Flat and Jeffrey Pine Saddle Subunit 7b consists of 68 ac (27 ha) of Federal and private lands. This subunit is located east of the CaliforniaNevada border in Washoe County, Nevada. Four percent of this subunit is on Federal lands managed by the Forest Service, and 96 percent is on private lands. It is currently occupied and is 1 mi (1.6 km) or less away from Units 6, 8, and 9, which may allow for social pollinator dispersal between these units. The Three Pine Flat and Jeffery Pine Saddle

Subunit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this subunit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this subunit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 17). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this subunit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 8: Ivesia Flat: Unit 8 consists of 62 ac (25 ha) of Federal land. This unit is located south of U.S. Highway 395 in Washoe County, NV. One hundred percent of this unit is on Federal land managed by the Forest Service. It is currently occupied and is 1 mi (1.6 km) away from Subunit 7b, which may allow for social pollinator dispersal between these two units. The Ivesia Flat Unit is important to the recovery of Ivesia webberi because it supports 100,000 plants (Service 2014, p. 17), or approximately between 2 and 10 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species' range. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, pp. 17–18). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 9: Stateline Road 1: Unit 9 consists of 193 ac (78 ha) of Federal and private lands. This unit is located along the California-Nevada border in Sierra County, California, and Washoe County, Nevada. Ninety-six percent of this unit is on Federal land managed by the Forest Service, and 4 percent is on private lands. It is currently occupied and is 1 mi (1.6 km) or less away from Units 6, 7, and 10, which may allow for social pollinator dispersal between these units. The Stateline Road 1 Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; development; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 18). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or

Protection'' section.

Unit 10: Stateline Road 2: Unit 10 consists of 66 ac (27 ha) of Federal land. This unit is located along the California–Nevada border in Sierra County, California, and Washoe County, Nevada. One hundred percent of this unit is on Federal land managed by the Forest Service. It is currently occupied and is less than 1 mi (1.6 km) away from Unit 9, which may allow for social pollinator dispersal between these units. The Stateline Road 2 Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; development; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 18). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 11: Hungry Valley: Unit 11 consists of 56 ac (23 ha) of Federal land. This unit is located west of Eagle Canyon Drive in Washoe County, Nevada. One hundred percent of this unit is on Federal land managed by the BLM. It is currently occupied and is the eastern most occupied unit within the range of Ivesia webberi. The Hungry Valley Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both sitespecific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; OHV use and other recreational use; roads; livestock grazing; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 12: Black Springs: Unit 12 consists of 163 ac (66 ha) of Federal and private lands. This unit is located northwest of North Virginia Street and south of U.S. Highway 395 in Washoe County, Nevada. Eighty-two percent of this unit is on Federal land managed by the Forest Service, and 18 percent is on private lands. It is currently occupied and is approximately 1 mi (1.6 km) away from Unit 13, which may allow for social pollinator dispersal between these units. The Black Springs Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby

buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. Additionally, this unit historically was grazed, but the grazing allotment currently is vacant (Service 2014, p. 19). While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ‘‘Special Management Considerations or Protection’’ section.

Unit 13: Raleigh Heights: Unit 13 consists of 253 ac (103 ha) of Federal and private lands. This unit is located northwest of North Virginia Street and south of U.S. Highway 395 in Washoe County, Nevada. Ninety-one percent of this unit is on Federal land managed by the Forest Service, and 9 percent is on private lands. It is currently occupied and is approximately 1 mi (1.6 km) away from Unit 12, which may allow for social pollinator dispersal between these units. The Raleigh Heights Unit is important to the recovery of Ivesia webberi because it supports between 100,000 to 4,000,000 plants (Service 2014, p. 19), or approximately 10 to 79.5 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species’ range. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; OHV use; roads; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ‘‘Special Management Considerations or Protection’’ section.

Unit 14: Dutch Louie Flat: Unit 14 consists of 54 ac (22 ha) of Federal and private lands. This unit is located southwest of South McCarran Boulevard in Washoe County, Nevada. Twenty-four percent of this unit is on Federal lands managed by the Forest Service, and 76 percent is on private lands. It is currently occupied and is approximately 0.5 mi (0.8 km) away from Unit 15, which may allow for social pollinator dispersal between these units. The Dutch Louie Flat Unit is important to the recovery of Ivesia webberi because it supports between 600,000 to 693,795 plants (Service 2014, pp. 19–20), or approximately 14 to 61 percent (i.e., dependent on which population estimate range is used for the calculation) of individuals known to exist across the species’ range. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; OHV and other recreational use; roads; development; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ‘‘Special Management Considerations or Protection’’ section.

Unit 15: The Pines Powerline: Unit 15 consists of 32 ac (13 ha) of private lands. This unit is located southwest of South McCarran Boulevard in Washoe County, Nevada. One hundred percent of this unit is on private lands. It is currently occupied and is approximately 0.5 mi (0.8 km) away from Unit 14, which may allow for social pollinator dispersal between these two units. The Pines Powerline Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating

throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; OHV and other recreational use; roads; development; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Unit 16: Dante Mine Road: Unit 16 consists of 14 ac (6 ha) of Federal and private lands. This unit is located east of U.S. Highway 395 in Douglas County, Nevada. Seventy-three percent of this unit is on Federal land managed by the BLM, and 27 percent is on private lands. It is currently occupied and is the southernmost unit within the range of Ivesia webberi. The Dante Mine Road Unit is important to the recovery of I. webberi primarily because it represents one of relatively few locations within the Great Basin where the species is known to exist. Given the increasing prevalence of both site-specific and landscape-scale threats operating throughout this region and specifically within areas occupied by I. webberi (Service 2014, entire), this location and most others where the species occurs confer redundancy within the species' distribution, thereby buffering the species against the risk of extirpation likely to result from these threats or other less-predicable stochastic events. Threats to I. webberi in this unit include nonnative, invasive plant species; wildfire; roads; development; and any other forms of vegetation or ground-disturbing activities. While these lands currently have the physical and biological features essential to the conservation of I. webberi, because of a lack of cohesive management and protections, special management will be required to maintain these features in this unit. These threats should be addressed as detailed above in the ''Special Management Considerations or Protection'' section.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Eriogonum codium critical habitat consists of four components (79 FR 32126-32155):

(i) Plant community. (A) Open to sparsely vegetated areas composed of generally short-statured associated plant species. (B) Presence of appropriate associated species that can include (but are not limited to): Antennaria dimorpha, Artemisia arbuscula, Balsamorhiza hookeri, Elymus elymoides, Erigeron bloomeri, Lewisia rediviva, Poa secunda, and Viola beckwithii. (C) An intact assemblage of appropriate associated species to attract the floral visitors that may be acting as pollinators of Ivesia webberi.

(ii) Topography. Flats, benches, or terraces that are generally above or adjacent to large valleys. Occupied sites vary from slightly concave to slightly convex or gently sloped (0–15°) and occur on all aspects.

(iii) Elevation. Elevations between 4,475 and 6,237 feet (1,364 and 1,901 meters).

(iv) Suitable soils and hydrology. (A) Vernally moist soils with an argillic horizon that shrink and swell upon drying and wetting; these soil conditions are characteristic of known Ivesia webberi populations and are likely important in the maintenance of the seedbank and population recruitment. (B) Suitable soils that can include (but are not limited to): Reno—a fine, smectitic, mesic Abruptic Xeric Argidurid; Xman—a clayey, smectitic, mesic, shallow Xeric Haplargids; Aldi—a clayey, smectitic, frigid Lithic Ultic Argixerolls; and Barshaad—a fine, smectitic, mesic Aridic Palexeroll.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat contain features that will require some level of management to address the current and future threats. In all units, special management will be required to ensure that the habitat is able to provide for the growth and reproduction of the species. A detailed discussion of threats to Ivesia webberi and its habitat can be found in the Ivesia webberi Species Report (Service 2014, pp. 22–32). The features essential to the conservation of I. webberi (plant community and competitive ability, and suitable topography, elevation, soils, and hydrology required for the persistence of adults as well as successful reproduction of such individuals and the formation of a seedbank) may require special management considerations or protection to reduce threats. The current range of I. webberi is subject to human-caused modifications from the introduction and spread of nonnative invasive species including Bromus tectorum, Poa bulbosa, and Taeniatherum caputmedusae; modified wildfire regime; increased access and fragmentation of habitat by new roads and OHVs; agricultural, residential, and commercial development; and soil and seedbank disturbance by livestock (Service 2014, pp. 22–32). Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Treatment of nonnative, invasive plant species; minimization of OHV access and placement of new roads away from the species and its habitat; regulations or agreements to minimize the effects of development in areas where the species resides; minimization of livestock use or other disturbances that disturb the soil or seeds; and minimization of habitat fragmentation. Where the species occurs on private lands, protection and management could be enhanced by various forms of land acquisition from willing sellers, ranging from the purchase of conservation easements to fee title acquisition. These activities would protect the primary constituent elements for the species by preventing the loss of habitats and individuals, protecting the habitat and soils from undesirable patterns or levels of disturbance, and facilitating the management for desirable conditions, including disturbance regimes.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown; probably sexual: cross-pollination (NatureServe, 2015)

Lifespan

Adult: 2+ years (USFWS, 2014)

Key Resources Needed for Breeding

Adult: Presumably insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: No studies of reproduction or dispersal are known for Ivesia webberi. Insect-mediated out-crossing is the most likely reproductive mode. No asexual or vegetative reproduction is apparent in this species (NatureServe, 2015). This is a perennial plant (USFWS, 2014). Pollinators specific to Ivesia webberi have not been identified. However, most Ivesia species reproduce from seed with insect-mediated pollination occurring between flowers of the same or different plants (Witham 2000, p. 20) (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Flat, bench, terrace (USFWS, 2013); shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Dense vegetation (NatureServe, 2015); 4,475 - 6,237 ft. elevation (USFWS, 2013)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits shallow shrink-swell clay soils with a gravelly surface layer over volcanic, generally andesitic bedrock, usually codominating with Artemisia arbuscula and Elymus elymoides in association with Antennaria dimorpha, Balsamorhiza hookeri, Erigeron bloomeri, Lewisia rediviva, Viola beckwithii, etc. Ivesia webberi has been found only in relatively open plant associations where competition for light and moisture with other species is low. It is absent from adjacent, otherwise appropriate habitat where deeper soils and taller, denser vegetation has developed. It can tolerate some moderate disturbance as it has been observed in some mildly disturbed sites; however long-term survival depends upon the continued availability of undisturbed mid-elevation benches or saddles with shallow, very rocky pavement-like soils derived from andesite or similar volcanic material. The environmental specificity is narrow; the vast majority of apparently suitable habitat has proven to be unoccupied by the species, suggesting that more cryptic habitat factors may also be involved (NatureServe, 2015). Known populations of Ivesia webberi occur between 4,475 and 6,237 feet (ft.) (1,364 and 1,901 meters (m)) in elevation (Steele and Roe 1996, unpubl. survey; Witham 2000, p.16; Howle and Henault 2009, unpubl. survey). It occurs in flats, benches, or terraces that are generally above or adjacent to large valleys, on slightly concave, convex, and gently sloped (0–15°) landscapes, in soils with an argillic horizon (USFWS, 2013).

Dispersal/Migration

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seed dispersal for this species is probably low to none. The seeds are relatively large and probably become lodged in crevices in the rocky pavement-like soils very soon after being shed by the parent plant (NatureServe, 2015).

Population Information and Trends

Population Trends:

Decline of 30-50% (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

14 (NatureServe, 2015)

Population Size:

~ 4,855,200 (NatureServe, 2015); unknown (USFWS, 2014)

Population Narrative:

This species has experienced a long-term decline of 30-50%. The number of occurrences with good viability has declined recently (10 - 30%) due to encroachment of residential development and invasive plant species. The population estimated to be at least 4,855,200 individuals. These plants occur densely on very limited acreage. May 2005 records from California indicate 112,500 plants there. Currently known from 6 extant populations in Washoe and Douglas Counties, Nevada, and 8 extant populations in Lassen, Plumas and Sierra Counties, California. This brings the total extant sites to about 14 (NatureServe, 2015). Reliable estimation of population sizes or trends in I. webberi is complicated because past population estimates have usually been obtained by different observers employing a variety of methodologies and varying levels of survey effort (Service 2014, p. 12) (USFWS, 2014).

Threats and Stressors

Stressor: Nonnative plants and altered fire regime (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The primary threat to I. webberi is the combined and synergistic effect from the encroachment of nonnative, invasive plant species into the I. webberi plant community and the modified fire regime resulting from this encroachment (Service 2014, pp. 23– 26). Nonnative, invasive plant species, such as Bromus tectorum (cheatgrass), Poa bulbosa (bulbous bluegrass), and Taeniatherum caput-medusae (medusahead), have become established and are part of the associated plant community at 12 of the 16 extant populations of I. webberi. Nonnative, invasive plant species negatively affect I. webberi through competition, displacement, and degradation of the quality and composition of the Artemisia arbuscula—perennial bunchgrass—forb community

in which I. webberi occurs. In addition to these effects, these nonnative, invasive plant species, once established, contribute fuels that increase the frequency and likelihood of wildfire in I. webberi habitat (USFWS, 2014).

Stressor: Roads and off-highway vehicles (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: OHV impacts to I. webberi populations have increased during the past 20 years as population growth and associated development have increased (Bergstrom 2009, p. 22), especially in the Reno urban area where 6 of the 16 populations occur. Eleven of 16 extant I. webberi populations are adjacent to or intersected by dirt roads and have been impacted to some degree by road development and OHV use (Service 2014, pp. 26–27). Roads cause habitat loss and degradation, and when vehicles drive off existing roads and trails, they can crush plants, compact soils, and provide a means for nonnative, invasive plant species to invade otherwise remote, intact habitats (USFWS, 2014).

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Development, which results in direct mortality and in habitat loss, degradation, and fragmentation, has resulted in the extirpation of one Ivesia webberi population and the loss of a portion of another population (Service 2014, p. 27). Residential or commercial development is ongoing or planned at each of the four Nevada populations located on private lands. In addition, construction of a 120-kV overhead transmission line may impact two I. webberi populations located on Forest Service lands (Service 2014, pp. 27–28) (USFWS, 2014).

Stressor: Grazing (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Livestock grazing has the potential to result in negative effects to I. webberi due to trampling and substrate disturbance, but this situation is dependent on factors such as stocking rate and season of use. Two I. webberi populations occur in areas that are currently grazed by cattle, and another seven populations occur within vacant grazing allotments that could be reopened to grazing to alleviate grazing pressures on nearby allotments (Service 2014, p. 30) (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Climate change is likely to affect Ivesia webberi, although it is difficult to project specific effects. In the Great Basin, temperatures have risen 0.9 to 2.7 degrees Fahrenheit (°F) (0.5 to 1.5 degrees Celsius (°C)) in the last 100 years and are projected to warm another 3.8 to 10.3 °F (2.1 to 5.7 °C) over the rest of the century (Service 2014, p. 31). Under current climate change projections, it is anticipated that future climatic conditions will favor the further spread of

nonnative, invasive plants and increase the frequency, spatial extent, and severity of wildfires (Service 2014, p. 31). Alteration of temperature and precipitation patterns as a result of climate change also may result in decreased survivorship of I. webberi by causing physiological stress, altering phenology, and reducing reproduction or seedling establishment (USFWS, 2014).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: UNK

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Not available

References

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SPECIES ACCOUNT: *Jacquemontia reclinata* (Beach jacquemontia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015)

Physical Description

Beach jacquemontia is a perennial vine which has a main stem with numerous laterals spreading out from a stout rootstock (Robertson, 1971). These reclining, partly twining or ascending, slender stems are woody at the base and may twine over other plants (Robertson, 1971; Austin, 1979). The older leaves and stems of this species can be glabrous, but the pubescence makes younger leaves and stems appear whitish (Austin, 1979). The leaves are entire, alternate, estipulate, spirally arranged, and almost always petiolate, reaching one to three cm in length and 0.5 to 2.5 cm in breadth (Small, 1905; Robertson, 1971; Austin, 1979). The flowers of this species are white to light pink and the sepals are persistent. The inflorescences can be axillary cymose or solitary with branches 8-40 millimeters (mm) long, usually not exceeding the leaves (Robertson, 1971; Austin, 1979). The fruit is a light brown capsule about four to five mm long (Small, 1905; Robertson, 1971). Additional physical descriptions of beach jacquemontia can be found in Small (1905) and Robertson (1971).

Taxonomy

Though J. havanensis is closely related, beach jacquemontia's main distinction is its ciliolate (marginal fringe of hairs) sepals and rather succulent leaves (Robertson, 1971). This ciliolate on the outer sepals and fleshy leaves also distinguishes this species from J. curtissii, which has hairless sepals and narrow leaves that are not fleshy (Austin, 1979). There are about 100 species of the genus Jacquemontia, most of which are found in tropical and subtropical America (Robertson, 1971). Beach jacquemontia is the only species found along the beaches of southeastern Florida (Austin, 1979). Beach jacquemontia was first described from specimens collected in 1903 at northern Miami Beach (Small, 1905). The original treatment of this taxon as a distinct species was upheld by Robertson (1971) during a review of the genus Jacquemontia. Three other species are found in Florida: J. curtissii inhabits pinelands on the mainland, while J. jamaicensis and J. pentantha occur in the Florida Keys (Small, 1933). Although Small (1933) considered beach jacquemontia's range to extend into the West Indies, Austin (1979) considered it endemic to the east coast of Florida.

Historical Range

Found historically in Martin Co. FL (NatureServe, 2015)

Current Range

Palm Beach, Broward, and Dade Cos., FL; reintroduction projects initiated. (NatureServe, 2015). Beach jacquemontia is a member of the morning glory family (Convolvulaceae) that is restricted to the southeastern coast of Florida. Much of the primary habitat of this species, beach coastal strand and maritime hammock, has been destroyed or altered for residential and commercial construction. Fewer than 1,000 individual plants exist. They are found in small, widely separated populations in Miami-Dade, Broward, and Palm Beach counties, where habitat loss and modification place this species at a high risk of extinction. Habitat conservation and management and reintroduction efforts are needed to make sure of the survival of this species. The information presented here is from the Multi-species Recovery Plan for South Florida

(Service, 1999), which represents a revision of the existing recovery plan for the beach jacquemontia (Service, 1995).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: flowers from November to May

Reproduction Narrative

Adult: Beach jacquemontia flowers from November to May, but may vegetatively propagate at any time. The incidence or importance of vegetative propagation is not known at this time. At some sites, beach jacquemontia sets fruit and disperses seed prolifically (Robertson, 1971); however, few seedlings or young plants are ever found near adult plants. Microhabitat conditions and locations relative to adult plants probably play a major role in providing suitable germination sites (Austin, personal communication, 1997; Kernan, personal communication, 1997). For example, at Crandon Park, naturally sown seeds had extremely low germination rates (unmeasurable) compared to seeds taken from this site and germinated under greenhouse conditions (70%). Findings from these investigations indicated that germination rates were highest in more organic soils in the shade, but that the seed viability was short-lived once sowed.

Habitat Type

Adult: Coastal dunes/shrubby hammocks

Environmental Specificity

Adult: Very Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Pine rocklands and the crest and lee side of coastal dunes. (Based on Ward 1979, Wunderlin 1982.) (NatureServe, 2015). At Crandon Park, Dade County, beach jacquemontia exists on dune faces at the edge of shrubby hammocks. At Hugh Taylor Birch State Recreation Area [SRA], Broward County, beach jacquemontia is located in coastal scrub with little canopy cover and exposed sandy substrate. There, it receives protection from direct ocean winds and sea spray (Lippincott, 1990). Seedling and young beach jacquemontia grow best when shaded. Under natural conditions, young plants are typically found growing in the shade of adjacent shrubs and trees. When mature, beach jacquemontia spread laterals from the rootstock into adjacent exposed sites (Kernan, personal communication, 1997).

Dispersal/Migration

Population Information and Trends

Number of Populations:

20 populations (8 natural and 12 introduced) (USFWS, 2021)

Population Size:

~700

Population Narrative:

The barrier islands within the range of beach jacquemontia are entirely urbanized except for a few small parks and private estates. Johnson et al. (1993) inventoried all tracts of native coastal vegetation in southeast Florida that were four or more hectares in size. They found only 24 tracts of that description in the known range of beach jacquemontia, five of them entirely or mostly in private ownership. These tracts comprised about 87 hectare [ha] of beach strand vegetation in public ownership, 10.5 ha in private ownership, and 26.7 ha of maritime hammock in public ownership. In 1991, less than 1,000 individual plants of beach jacquemontia were known to occur on 12 sites (Austin 1991). Eleven of these sites were in public parks or recreation areas operated by State, county, or local governments in Palm Beach (eight sites), Broward (one site), and Dade (two sites) counties. The only known privately owned site, in Broward County, had just one plant (Johnson et al., 1993; Austin, 1991). A 1995 survey for beach jacquemontia located 450 to 600 plants at ten sites in Dade and Palm Beach counties (Kernan, personal communication, 1995). More than half of these plants were located at two sites: Red Reef Park in Palm Beach County and Crandon Park in Dade County. The remaining plants were scattered in populations of fewer than 50 individuals in Broward, Dade, and Palm Beach counties. As of 1996, beach jacquemontia was known from only nine sites in Dade and Palm Beach counties (Garview, personal communication, 1997; Davis, personal communication, 1997). Eight of these sites contained natural populations, while one site was established from restoration efforts. Several previously known sites have been lost over the past several years, including re-established populations at Coral Cove Park and Gemini Gardens (private), and Juno Beach Park, Nasa (private). There may be an additional historic site in Palm Beach County added if future surveys confirm the presence of beach jacquemontia. Since 1996, surveys have revealed that more beach jacquemontia colonies in Palm Beach County have been lost. Colonies are now known to exist at Carlin Park, Logggerhead Park, Red Reef Park, Red Reef Golf Course, South Beach Park, and South Inlet Park. Gemini Gardens, Atlantic Dunes Park and Spanish River Park were not included in those surveys (Davis, personal communication,1998). Information from specific localities of beach jacquemontia suggests that the species is relatively secure at some sites but susceptible at others. For example, it was collected at South Coral Cove Park, Jupiter Island, Palm Beach County, in 1962, but was not found there in 1990 (Johnson et al., 1993). The disappearance from this site is due to beach erosion and shading from Australian pines (Johnson et al., 1993). Several specimens identified as beach jacquemontia from the Jupiter Lighthouse on the mainland opposite the southern tip of Jupiter Island have been subsequently identified as J. curtissi (Davis, personal communication, 1998). Land clearing for residential development has eliminated beach jacquemontia from other sites in this area (Austin, 1979). Although apparently suitable habitat exists at Blowing Rocks Preserve and Hobe Sound NWR on Jupiter Island, beach jacquemontia has not been found there (Johnson et al., 1993). Surveys conducted in 2003-2004 estimate the total population to be 700 individuals on nine sites (Maschinski et al., 2004). This number is down slightly from the 2003 estimate of 760 individuals on nine of ten existing sites surveyed. The populations at Carlin Park and Loggerhead Park in Palm Beach County experienced a greater than 50% population reduction observed in the fall of 2003, probably due in part to canopy closure caused by encroachment of hardwoods. Two plants were discovered at Lake Worth Inlet in Palm Beach County in 2001, but only one

remained in January 2004. Outplanted populations remained steady. At Red Reef Park in Palm Beach County, 15 of 18 outplanted individuals were surviving in January 2004, the same number observed during the 2003 visit. At Bill Baggs State Park in Miami-Dade County, seven of 93 plants remained of the outplanted population in February 2004, with one plant lost since the survey conducted in the previous year.

Threats and Stressors

Stressor: Loss and degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Loss of habitat to urbanization and beach erosion led to the listing of beach jacquemontia as endangered on November 24, 1993 (Service, 1993). The vast majority of beach coastal strand and maritime hammock vegetation, the primary habitat of this species, has been destroyed by residential and commercial construction. Habitat within public lands has also been destroyed or degraded due to construction of parking lots, pedestrian routes, picnic areas, and other modifications for recreational uses. Additional habitat has been lost to beach erosion at some sites (Johnson et al. 1993, Davis, personal communication, 1997).

Stressor: Fragile demographics
Exposure:
Response:
Consequence:
Narrative: The limited geographic distribution, fragmentation of remaining habitat, small sizes of beach jacquemontia populations, and possibility of stochastic natural events make it doubtful that many of the existing populations will persist for 100 years.

Recovery

Recovery Actions:

- To ensure the survival of this plant, the remaining populations of beach jacquemontia on public lands will require active management and a program of propagation, germplasm conservation, and augmentation. Basic demographic, pollination, seed dispersal, seed germination and seed establishment information is needed to recover this endangered species. Successful management will require new surveys for sites that contain beach jacquemontia, complete knowledge of where it existed historically, and surveys for sites within its historic range that would be suitable for re-establishment. In addition, threats to existing and proposed sites posed by commercial and residential development and invasion of exotic species need to be addressed. Because additional protection of beachfront property through fee title acquisition or easement is unlikely due to real estate costs, beach jacquemontia will be best protected and recovered through re-establishment efforts. Greenhouse propagated plants were successfully re-established to three sites in Crandon Park in 1989; however, two plants used in the Coral Cove Beach Dune Restoration Project in 1994 did not survive (Davis, personal communication, 1994). Although this attempt was unsuccessful, we believe the recovery of this species can be partially accomplished through re-establishment as part of dune restoration projects. Dade County is planning to re-establish about 60 beach jacquemontia plants at Bill Baggs Cape Florida SRA, Key Biscayne,

Dade County (Carter, personal communication, 1997). It is important to remember that beach jacquemontia should only be re-established in areas within its historic range. Restoration efforts should also consider using other plants that occur naturally with beach jacquemontia, so that more of a representative vegetative complex is re-created. Some of the existing beach jacquemontia sites and many other potentially suitable recipient sites for beach jacquemontia translocation will require removal and control of exotic vegetation as part of the restoration process. It seems that this species does best in sparsely vegetated habitats, and that one of the factors responsible for its decline is the lack of sparsely vegetated areas that are typical of overwashed dunes (Davis, personal communication, 1998). At Crandon Park, herbicides are being used on a few plots where beach jacquemontia is suppressed by St. Augustine grass, and the plants do not seem to be adversely affected. Fire may also play an important role in habitat maintenance for beach jacquemontia as demonstrated by the short-term response to a recent burn on Bear Cut Preserve on Key Biscayne, Dade County (Kernan, personal communication, 1996). The long-term effects of burning will need to be analyzed over the next several years. Mowing or bush-hogging could also be used where fire cannot be safely used, or in areas where the plants currently exist as a result of mowing.

Conservation Measures and Best Management Practices:

- IV.RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1999). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Conduct hardwood reduction and invasive species removal to maintain or restore suitable habitat at all populations. • During invasive species (e.g. beach naupaka, Brazilian pepper) removal on dunes, efforts should be made to remove biomass off-site and shift toward open habitat rather than focus on dense replanting. • Increase the smaller populations (less than 30 plants; Tables 1 and 2) through augmentation using the appropriate genetic guidelines and source materials as described in Thornton et al. 2008 and Maschinski et al. 2013 (see section II.C.1.c.) to help ensure preservation of genetic diversity. • Prioritize restoring and maintaining the habitat quality of extant natural and introduced populations over establishing new introduced populations. • Prior to introducing new experimental populations or augmenting extant populations, ensure that a habitat management plan is in effect and being implemented. • Seed collections for long-term storage should be made continuously following CPC guidelines to not harvest more than 10 percent of the annual seed crop of a given population. Seeds should be separated by maternal line to maximize ability to utilize genetic diversity into future research and introduction efforts. Monitoring/Research Activities • Develop survey metrics that are more easily collected and can serve as indicators of population condition, such as patch size, total area occupied, estimated plants counts, shoot counts (quadrat system), or stem density. • Continue to assess, document, and study the impacts sea level rise (shoreline shift, king tide, storm surge, and saltwater intrusion) on this coastal dune species and its habitat. • Promote and increase partnerships to evaluate the current protection status and management needs at each park and to develop cooperative assistance and information sharing plans between parks. • Re-survey populations that do not have recent site visits or are considered extirpated (see Tables 1 and 2). Consider possible habitat management or restoration actions at these sites. • Public access should continue to be managed to prevent trespassing on the dunes and enforce "no trespassing" regulations. Public education should be implemented to educate visitors about this rare species and help control public access to the dunes. • Continue work on genetics (single sequence repeat markers) to further determine degree of genetic differentiation within the J. havanensis clade, to which J. reclinata belongs, and the species' taxonomic status in that clade

(Namoff et al. 2008). • Conduct a population viability analysis when enough demographic data are available. Data need to be collected on survival of seedlings in the wild (current data are based on seedlings in a nursery setting). • The role of fire should continue to be explored and understood. On sites where prescribed fire may be used, develop appropriate methods to use fire in small areas in the coastal dune system. (USFWS, 2021)

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SPECIES ACCOUNT: *Juglans (=Nogal) jamaicensis* (West Indian Walnut (=Nogal))

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 1/13/1997

Physical Description

A large distinctive tree with fissured bark which may reach up to 25 meters (82 feet) in height. Twigs, buds, and leaf axes have minute rusty hairs. The leaves are alternate (growing at alternating intervals on either side of the stem) and compound (having two or more leaflets born on single stalk) and consist of from 16 to 20 mostly paired, nearly stalk-less-leaflets (small leaf or segment of a compound leaf). Leaflets are from 5.5 to 9.0 centimeters (2.2 to 3.5 inches) long and 2.2 to 4.0 centimeters (0.9 to 1.6 inches) wide, thin and nearly hairless, except on the veins beneath. Leaflets are lanceolate (narrow and tapering at each end), finely toothed, long-pointed and rounded, and unequal at the base. Nogal is monoecious; male and female flowers are borne in different clusters or catkins on the same tree. Staminate or male flowers are numerous and in drooping catkins, 8.8 to 11.0 centimeters (3.5 to 4.3 inches) long, that are borne on the twigs of the previous year. Pistillate or female flowers are several along an axis, 4.4 to 8.8 centimeters (1.7 to 3.5 inches) long, borne at the ends of the shoots of the season. Individual male flowers are composed of a 6-lobed calyx (outer protective covering of a flower) and many stamens (pollen producing reproductive organ of a flower). Female flowers are about 0.5 centimeters (0.2 inches) long, composed of a 4-toothed scale opening at one side and 4 sepals (one of the segments forming the calyx). The fruit, a drupe, is a walnut which is composed of a blackish husk, a brown rough-ridged hard shell from 1.6 to 2.75 centimeters (0.6 to 1.1 inches) wide and one large, oily, edible seed (Little et al. 1974, Proctor 1992) (USFWS, 1999).

Taxonomy

The name Juglans jamaicensis C. DC. has been used for plants from Cuba, Hispaniola, and Puerto Rico. Adams (1972) stated that the single report of the species from Jamaica was probably an error. Schaarschmidt (2002) recognized two varieties: var. insularis (Griseb.) H.Schaarschmidt from western Cuba, and var. jamaicensis from central and eastern Cuba, Hispaniola, and Puerto Rico. Schaarschmidt (2002) stated that the Puerto Rican population may be a third subspecies of J. jamaicensis. However, there is no formal change in the nomenclature of the species (USFWS, 2019).

Historical Range

See current range/distribution.

Current Range

Known from Cuba, Hispaniola, and Puerto Rico, but little information is currently available on its status in the first two countries (Liogier and Martorell 1982). The Center for Plant Conservation (1992) described it as “not common” and Proctor (1992) stated it was becoming increasingly rare on these two islands (USFWS, 1999).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Lack of natural recruitment represents one of the major threats to the Nogal. The known population is predominantly composed of old individuals as sapling stages are missing (Omar A. Monsegur, Service, pers. obs., 2011). Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals of Nogal die. In the case of future (not yet planned) efforts to enhance the natural populations by planting seedlings and saplings, it remains unknown if the planted individuals will develop as mature plants capable of reproduction. Flowering or fruit production of individuals planted in the wild has not been reported to date. Therefore, we consider the lack of natural recruitment a high and imminent threat to the species (USFWS, 2013).

Habitat Type

Adult: Forest (USFWS, 1999)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1999)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1999)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1999)

Site Fidelity

Adult: High (inferred from USFWS, 1999)

Habitat Narrative

Adult: Nogal or the West Indian walnut is found on lands adjacent to the Monte Guilarte Commonwealth Forest in the central mountains of Puerto Rico. The mountains are upper Cretaceous, volcanic in origin. Soils are derived from these fine-grained igneous (volcanic) rocks and are high in permeable clay and low in silt and sand. Red or purplish in color, the well-drained soils have a very acidic subsoil (layer of soil beneath the surface soil). The most widely distributed soil is the Los Guineos series (Department of Natural Resources 1976). The area of the known population falls within the subtropical lower montane wet forest life zone (Ewel and Whitmore 1973). Four vegetation associations have been described in the Monte Guilarte Commonwealth Forests. Upper slopes are covered by sierra palm (Prestoea montana) forest interspersed with forest dominated by caimitillo (Micropholis garcinifolia) and granadillo (Buchenavia capitata). High peaks and exposed ridges are characterized by a dwarf or elfin forest which is dominated by evergreen, gnarled, small leaved species. Lower slopes and valleys were originally planted in coffee under shade trees (e.g., Inga sp., Citrus sp.) (USFWS, 1999). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred by the specific habitat requirements of this species and the low number of known populations (USFWS, 2013). Francis and Alemañy (1994) described the habitat of J. jamaicensis

throughout its range. The most important recent development for the species is the acquisition of the land where the Adjuntas population occurs and the incorporation of that land into the Guilarte Commonwealth Forest (Rubén Padrón, pers. comm., 2011). In Puerto Rico, Nogal occurs within the subtropical wet forest and lower montane wet forest life zones (Ewel and Whitmore 1973). Rainfall in both of these life zones, which differ in elevation, ranges from approximately 2,000 to 4,000 mm (ca. 80-160 in.) per year. These Holdridge life zones occupy areas that were extensively deforested for agriculture, especially during the nineteenth century. Areas in which agricultural activities have been abandoned and regeneration of natural vegetation has occurred may provide possible sites for the establishment of new populations of Nogal (USFWS, 2019).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Many fruits were seen on the ground, but most appeared too old and no longer viable. The absence of pericarp and the presence of fruits under rocks suggest animal dispersal, perhaps by rodents. In fact, predation of Nogal fruits by rats (Rattus rattus) and weevils has been reported (Ovidio González, DNER, pers. comm. 2011) (USFWS, 2013).

Population Information and Trends

Number of Populations:

One (USFWS, 2013)

Population Size:

~31 individuals (USFWS, 2013)

Population Narrative:

Acevedo (1984) stated that the population of Nogal in Adjuntas, Puerto Rico, consisted of about twenty individuals, ranging from 8 to 20 meters (m) in height. Proctor (1992) stated that “at last count, only 14 trees of this species were known to survive in the wild”. The population visited by Service and UPRM staff on March 10, 2011 consisted of 19 adult trees, two juveniles and eight seedlings. The trees ranged from 7 to 20 m in height (mean = 12.0 m, s.d. = 4.28), and 6.0 to 85.2 centimeters (cm) in dbh (mean = 31.5 cm, s.d. = 19.80). One had two trunks and another was branched near the base. About two of the trees were partly or largely dead, and two others were found dead. No trees were observed with flowers or fruits. Many fruits were seen on the ground, but most appeared too old and no longer viable. The absence of pericarp and the presence of fruits under rocks suggest animal dispersal, perhaps by rodents. In fact, predation of Nogal fruits by rats (Rattus rattus) and weevils has been reported (Ovidio González, DNER, pers. comm. 2011) (USFWS, 2013). Low resiliency, representation and redundancy are inferred based on this species single known population and low number of individuals (USFWS, 2013). The Plan specifies that the Service will consider delisting Juglans jamaicensis when: 1. protection of the known populations has been achieved (through means which may include acquisition and landowner agreements), and 2. new populations (the numbers of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as the Monte Guilarte or Toro Negro Commonwealth Forests. The Plan specifies that these are minimum requirements and could be expanded upon if the regenerative or propagative potential of natural and ex situ populations proves to be insufficient. Alternatively, if new populations of the species are discovered, it may be preferable to place

greater emphasis on protection, rather than propagation, in order to achieve a minimum number of plants necessary for recovery. Criterion 1 has partially been met. The known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Commonwealth Forest. However, there is the potential that the known population forms part of a larger population that extends to private properties and has not been surveyed. If landowner agreement can be obtained, those private properties should be surveyed for the presence 5 of the species to determine if the area should be targeted for potential acquisition and/or protection. Criterion 2 has not been met. Attempts to establish new populations have been conducted at "Bosque del Pueblo" in Adjuntas and other adjacent areas, including the Guilarte Commonwealth Forest. However, there is no data about the status of these individuals or the establishment of any self-sustainable population of this species in Puerto Rico (USFWS, 2019). Acevedo (1984) stated that the population of Nogal in Adjuntas, Puerto Rico, consisted of about twenty individuals, ranging from 8 to 20 meters (m) in height. Proctor (1992) stated that "at last count, only 14 trees of this species were known to survive in the wild". The population visited by Service and UPRM staff on March 10, 2011 consisted of 19 adult trees, two juveniles and eight seedlings. The trees ranged from 7 to 20 m in height (mean = 12.0 m, s.d. = 4.28), and 6.0 to 85.2 centimeters (cm) in dbh (mean = 31.5 cm, s.d.= 19.80). One had two trunks and another was branched near the base. About two of the trees were partly or largely dead, and two others were found dead. No trees were observed with flowers or fruits. Many fruits were seen on the ground, but most appeared too old and no longer viable. The absence of pericarp and the presence of fruits under rocks suggest animal dispersal, perhaps by rodents. In fact, predation of Nogal fruits by rats (Rattus rattus) and weevils has been reported (Ovidio González, DNER, pers. comm. 2011). In 2009, over 50 individuals of the species were planted in the Guilarte Forest as a reintroduction (DNER 2011) (see additional discussion under C.1.f). However, it is too soon to determine whether or not this will become a viable, self-sustaining population (USFWS, 2019). Studies of genetic variation have not been conducted, but based on the very small number of individuals, limited genetic variability is expected. Reintroduction of plants from the Dominican Republic, where the species is more abundant, would likely alter the pattern of genetic variation in Puerto Rico (cf. Francis and Alemañy 1994) (USFWS, 2019).
Spatial distribution: Juglans jamaicensis occurs in all of the Greater Antilles except Jamaica, even though its name suggests otherwise (a misunderstanding by the botanist describing it originally; Proctor 1992). This species was considered increasingly rare in Cuba, Hispaniola, and Puerto Rico. In fact, it was virtually extinct in the wild in Puerto Rico at the time of Proctor's 1992 report. Nogal was first collected in Puerto Rico around 1865 by Agustín Stahl from an area between Peñuelas and Adjuntas at an elevation of approximately 2,297 ft (700 m). The species was subsequently collected by the German botanist Paul Sintenis in 1886 from Saltillo near Adjuntas and again in 1887 from Santa Rosa near Utuado. Bartolomé Barcela made an additional collection in 1915 from an area near Adjuntas. Nogal became so scarce that it was considered possibly extinct until the early 1970s. The species was not reported again until 1974, when it was rediscovered at an elevation of 3,120 ft (950 m) west of Cerro La Silla de Calderón, an area located near the southwest corner of the municipality of Adjuntas. A survey of these trees was conducted in 1992 by the U.S. Forest Service. A total of 14 individuals were documented, the largest of which was more than 66 ft (20 m) in height. Plant specimens deposited in herbaria can be mapped using the information provided in their labels. UPRM staff used the point-circle method (Chapman and Wieczorek 2006) that assigns coordinates for the location of the collection as well as an estimate of their uncertainty (in meters), based on the locality descriptions obtained from the specimen labels of such localities, to allow the creation of an accurate species distribution map. Specimens with location uncertainties less than 300 m (Figure

1) have been collected from montane forests at elevations between 2,950 and 3,281 ft. (900 and 1000 m). Such accurate locations, within the Adjuntas municipality, include Ultisols of the Maricao clay, Los Guineos clay and Los Guineos-Maricao soil associations,and Inceptisols of the Mucara silty clay soil association, all on slopes of 20-60% inclination. The other eight specimen localities, with inaccurate locality descriptions (inaccuracies from 2,000 to 15,620 m), were collected within the municipalities of Utuado and Adjuntas (Appendix 1). Juglans jamaicensis may have been more widespread in Puerto Rico historically, but much of the forested areas in the central mountain region were cut for the planting of sun coffee, although most of the recently documented trees today survive in former sun coffee plantations. The species, possibly never a common one, may also have been cut for the use of its valuable wood (USFWS, 2019). Addendum 1. In December 2017, Dr. Eugenio Santiago, affiliate professor of the University of Puerto Rico, Río Piedras Campus, visited Cerro La Silla de Calderon in the municipality of Adjuntas to assess the only known natural population of nogal in Puerto Rico (Santiago 2018, pers. comm.). During his assessment, from the 20 individuals of nogal previously estimated from this location (USFWS 2013), Dr. Santiago only found 3 adult individuals that were in good conditions and that suffered minimal damage from Hurricane María (Table 1)(Santiago 2018, pers. comm.). Dr. Santiago estimated a 40% to 50% reduction on canopy cover after the hurricane on that area. However, he reported seeing around 20 seedlings in great conditions and developing leafs (Santiago 2018, pers. comm.). Thus, he believes that canopy openness caused by Hurricane María promoted breeding and germination at the site, resulting in those seedlings, (Santiago 2018, pers. comm.). In addition, he reported a possible fourth adult individual in the proximity of the original locality, but he was not certain about the identification of that individual as a nogal (Table 1) (Santiago 2019, pers. comm.). No herbivory nor diseases were observed on adults or seedlings (Santiago 2019, pers. comm.). As for the reintroduction efforts, the current status of the 50 nogal individuals planted at the Guilarte Commonwealth Forest in 2009 is unknown (Cintron, PRDNER, 2019, pers. comm.) (Table 1). In December 2013, an additional 10 individuals were planted also at the Guilarte Commonwealth Forest near the trail known as “Vereda Interpretativa”, but by December 2014 all trees had died (Cintron, PRDNER, 2019, pers. comm.) (Table 1). Causes of death of these individuals include heavy drought, excess of canopy cover caused by growth of Palma de Sierra (Prestoea montana), and fallen organic debris on planted nogal individuals (Cintron, PRDNER, 2019, pers. comm.) (USFWS, 2019).

Threats and Stressors

Stressor: Land clearing (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Most known individuals are located on public lands within the Guilarte Commonwealth Forest. The property that harbors the known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Forest. Thus, the individuals located within these lands are protected. However, there is the potential that this known population forms part of a larger population that extends to other adjacent private properties that have not been surveyed. Therefore, habitat modification as a result of land clearing of mature secondary forest currently present within the known range of the species for agricultural purposes, urban development and construction of infrastructure may pose a threat to this species because these forest lands may harbor undetected individuals or populations of Nogal

that are not protected. Based on the above information, we consider habitat destruction or modification as a low and non-imminent threat to the species (USFWS, 2013).

Stressor: Disease (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: UPRM staff observations of partly or completely dead trees suggest that disease may be a current threat to the species. However, because of limited information available, we consider this threat low and non-imminent (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of viability/reproduction
Narrative: Seed predation by rats and weevils has been reported under nursery conditions (Ovidio González, PRDNER, pers. comm. 2011). Thus, predation of seeds in the wild may occur. Due to the very small number of live trees currently known to exist, disease and predation should be considered as a possible threat to this species in Puerto Rico. However, because of limited information available, we consider this threat low and non-imminent (USFWS, 2013).

Stressor: Hurricanes and Landslides (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Hurricanes frequently affect the islands of the Caribbean. As a species endemic to the Greater Antilles, Nogal should be well adapted to tropical storms, but the damage observed on trees in the Adjuntas population might suggest otherwise. In addition, the very heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Given the steep slopes on which most known Nogal trees grow, a massive landslide would not only take out the trees and their young offspring, but their seed bank and substrate as well. Nogal may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008.). Due to the extremely low number of adult individuals and the problems regarding the natural recruitment of the species, severe hurricanes and associated landslides pose a threat to the species. However, the frequency of severe hurricanes is low so the Service considers severe tropical storms as a low and non-imminent threat to the species (USFWS, 2013).

Stressor: Genetic Variation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of genetic variability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size of Nogal in Puerto Rico, it is highly likely that its genetic variability is extremely low (Duane Kolterman, UPRM, pers. comm., 2011). In order to safeguard the remaining genetic diversity, the origin and

survival of reintroduced individuals needs to be monitored as well as their development into mature individuals. Consequently, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the lack of genetic variation a high and imminent threat to the species (USFWS, 2013).

Stressor: Lack of natural recruitment (USFWS, 2013)
Exposure:
Response:
Consequence: No young trees/aging population
Narrative: Lack of natural recruitment represents one of the major threats to the Nogal. The known population is predominantly composed of old individuals as sapling stages are missing (Omar A. Monsegur, Service, pers. obs., 2011). Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals of Nogal die. In the case of future (not yet planned) efforts to enhance the natural populations by planting seedlings and saplings, it remains unknown if the planted individuals will develop as mature plants capable of reproduction. Flowering or fruit production of individuals planted in the wild has not been reported to date. Therefore, we consider the lack of natural recruitment a high and imminent threat to the species (USFWS, 2013).

Stressor: Unknown pollination biology for this species including presumption of wind-pollination (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: The pollination biology of the species remains unknown, but it is presumed that Nogal, like other members of its genus and family, is wind-pollinated. At least in order to allow outcrossing, this strategy requires adequate abundance of individuals and population density, adequate exposure to wind, and windy conditions during the flowering season. According to Duane Kolterman (UPRM, pers. comm., 2011) this is an uncommon strategy in tropical forests, and may represent a limitation for the species (USFWS, 2019).

Stressor: Apparent lack of a natural fruit and seed dispersal agent (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Of even greater concern is the apparent lack of a natural fruit and seed dispersal agent. The fruits are apparently dispersed primarily by gravity and secondarily by animals (probably introduced rats). However, the Nogal's distribution suggests that some native animal(s) must have assisted in its dispersal in the remote past. The fruits (large and heavy, mesocarp hard rather than fleshy, endocarp hard and bony) do not seem well adapted for dispersal by bats, and there have not been any native terrestrial mammals in Puerto Rico for hundreds of years or longer. Temperate species of Juglans are mammaldispersed. For example, in the northeastern United States, J. nigra (the Black walnut) is dispersed by native squirrels (Duane Kolterman, UPRM, pers. comm., 2011). The absence of a disperser may well represent a serious limitation for the species. It would be interesting to inquire as to the dispersal agents that may have been observed on other Greater Antillean islands (Hispaniola and Cuba) (USFWS, 2019).

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Most known individuals are located on public lands within the Guilarte Commonwealth Forest. The property that harbors the known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Forest. Thus, the individuals located within these lands are protected. However, there is the potential that this known population forms part of a larger population that extends to other adjacent private properties that have not been surveyed. Therefore, habitat modification as a result of land clearing of mature secondary forest currently present within the known range of the species for agricultural purposes, urban development and construction of infrastructure may pose a threat to this species because these forest lands may harbor undetected individuals or populations of Nogal that are not protected. Based on the above information, we consider habitat destruction or modification as a low and nonimminent threat to the species (USFWS, 2019).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: In 1974, Little et al. believed that J. jamaicensis might be extinct in Puerto Rico. They stated that "the walnut trees, which probably were uncommon or rare, might have been cut for the prized wood." Overcollection of the edible nuts could also reduce the species' reproductive ability. However, at present, the very small number of trees and the fact that the known population lies within a protected area does not lend itself to commercial harvesting. There is no evidence that the species has been affected by overutilization for scientific or educational purposes. Based on the above, we believe that overutilization is no longer a threat to the species (USFWS, 2019).

Stressor: Disease or predation (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: UPRM staff observations of partly or completely dead trees suggest that disease may be a current threat to the species. In addition, seed predation by rats and weevils has been reported under nursery conditions (Ovidio González, PRDNER, pers. comm. 2011). Thus, predation of seeds in the wild may occur. Due to the very small number of live trees currently known to exist, disease and predation should be considered as a possible threat to this species in Puerto Rico. However, because of limited information available, we consider this threat low and non-imminent (USFWS, 2019).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019).
Exposure:
Response:
Consequence:

Narrative: The Commonwealth of Puerto Rico approved Law No. 241 in 1999, known as "Nueva Ley de Vida Silvestre de Puerto Rico" (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species, declare as the property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, hunting activities, and exotic species, among others. Law No. 241 includes plants as part of the wildlife species. In 2004, the Puerto Rico Department of Natural and Environmental Resources (PRDNER) approved the "Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico" (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). Nogal has been included in the list of protected species and designated as endangered under Regulation 6766. Under Article 2.06, this regulation prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. Based on the presence of Commonwealth laws and regulations protecting Nogal, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to this species. However, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of 10 individuals of endangered plants has occurred due to lack of knowledge of the species by private land owners. This is highlighted because Nogal is difficult to identify unless it is in fruit or the person (private land owner, law enforcement officers or biologists) has expertise on the species (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Hurricanes and Landslides (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Hurricanes and Landslides. Hurricanes frequently affect the islands of the Caribbean. As a species endemic to the Greater Antilles, Nogal should be well adapted to tropical storms, but the damage observed on trees in the Adjuntas population might suggest otherwise. In addition, the very heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Given the steep slopes on which most known Nogal trees grow, a massive landslide would not only take out the trees and their young offspring, but their seed bank and substrate as well. Nogal may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008.). Due to the extremely low number of adult individuals and the problems regarding the natural recruitment of the species, severe hurricanes and associated landslides pose a threat to the species. However, the frequency of severe hurricanes is low so the Service considers severe tropical storms as a low and non-imminent threat to the species (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Nonnative Species (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Nonnative Species. Introduced rats (Rattus spp.) are apparently serving as secondary dispersers for Nogal, but they are also reported to be seed predators. It is unlikely that rats are as efficient as the (hypothetical) original dispersers were, but they are well known to be efficient seed predators (Duane Kolterman, UPRM, pers. comm., 2011). The Service considers nonnative

species a low and non-imminent threat to Nogal as no evidence exists to link rat seed predation to the low recruitment of the species (see Factor C) (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Genetic Variation (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Genetic Variation. Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size of Nogal in Puerto Rico, it is highly likely that its genetic variability is extremely low (Duane Kolterman, UPRM, pers. comm., 2011). In order to safeguard the remaining genetic diversity, the origin and survival of reintroduced individuals needs to be monitored as well as their development into mature individuals. Consequently, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the lack of genetic variation a high and imminent threat to the species (USFWS, 2019).

Stressor: Other natural or manmade factors affecting its continued existence: Lack of Natural Recruitment (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Lack of Natural Recruitment. Lack of natural recruitment represents one of the major threats to the Nogal. The known population is predominantly composed of old individuals as sapling stages are missing (Omar A. Monsegur, Service, pers. obs., 2011). Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals of Nogal die. In the case of future (not yet planned) efforts to enhance the natural populations by planting seedlings and saplings, it remains unknown if the planted individuals will develop as mature plants capable of reproduction. Flowering or fruit production of individuals planted in the wild has not been reported to date. Therefore, we consider the lack of natural recruitment a high and imminent threat to the species (USFWS, 2019).

Stressor: The species continues to be threatened by same factors identified in the 2013 5-year status review for the species (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Addendum 1. Threat Factor Analysis: The information gathered during this review indicates that from the only known population of nogal, located in the Guilarte Commonwealth Forest, only three (possibly four) adult nogal individuals are left. However, no cause for the disappearance of the rest of the individuals of this population has been identified. In fact, minimal damage to the population from Hurricane María was documented. Nevertheless, impacts of wind forces from the hurricane resulted on an estimated reduction of 40% to 50% of canopy cover on the suitable habitat for the species. From our review, the species continues to

be threatened by same factors identified in the 2013 5-year status review for the species. However, a comprehensive assessment of this population should be conducted to determine if there are additional trees, and if observed seedlings were successfully recruited into the population (USFWS, 2019).

Stressor: Due to undetected presence on private lands, habitat modification (i.e. vegetation clearance for road reconstruction and agriculture or residential projects) continues to be a threat to the species (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Addendum 1. Threat Factor Analysis: Since undetected individuals or population of nogal may be present in private lands adjacent to the Silla de Calderón area, habitat modification (i.e. vegetation clearance for road reconstruction and agriculture or residential projects) continues to be a threat to the species. However, these effects may be ameliorated by regulatory mechanisms currently in place in Puerto Rico to protect listed species and their habitats (e.g., Commonwealth Law No. 241-1999 and Regulation 6766) (See Five Factor Analysis Section above) (USFWS, 2019).

Recovery

Delisting Criteria:
1. Protection of the known populations has been achieved (through means which may include acquisition and landowner agreements) (USFWS, 2013).

2. New populations (the numbers of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as the Monte Guilarte or Toro Negro Commonwealth Forests (USFWS, 2013).

Recovery Actions:
- Criterion 1 has partially been met. The known population at the base of La Silla de Calderón has been acquired and incorporated into the Guilarte Commonwealth Forest. However, there is the potential that the known population forms part of a larger population that extends to private properties and has not been surveyed. If landowner agreement can be obtained, those private properties should be surveyed for the presence of the species to determine if the area should be targeted for potential acquisition and/or protection (USFWS, 2013).
- Criterion 2 has not been met. Attempts to establish new populations have been conducted at “Bosque del Pueblo” in Adjuntas and other adjacent areas, including the Guilarte Commonwealth Forest. However, there is no data about the status of these individuals or the establishment of any self-sustainable population of this species in Puerto Rico (USFWS, 2013).
- The known population should be monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species and maintain genetic diversity. Seed material from Puerto Rico should be sent to botanical gardens (Kew, Fairchaild, etc.) to ensure that the species is propagated and its genetic identity is safeguarded (USFWS, 2019).

- Propagation and reintroduction efforts must continue. It is essential that the seed sources be as diverse as possible, and that record-keeping be both meticulous and as redundant as necessary to ensure that no data are lost (USFWS, 2019).
- All existing known trees should be monitored on a yearly basis; additional visits should be made after hurricanes, landslides, or other major disturbances to determine their effects on the population (USFWS, 2019).
- Monitoring should also consider the presence of possible pests affecting the establishment of seedling and saplings (USFWS, 2019).
- Studies should be conducted to determine the patterns of genetic variation of the species in order to develop a plan to preserve the species germplasm. This should include a comparison with trees from Hispaniola and Cuba (var. jamaicensis) (USFWS, 2019).
- Enhancement of the genetic diversity of J. jamaicensis with germplasm from outside Puerto Rico should be considered (USFWS, 2019).
- The Adjuntas Substation of the UPR-Mayagüez Agricultural Experiment Station (EEA) should be considered for the propagation of the species as well as for the establishment of an experimental population. The EEA-Adjuntas offers plenty of land, appropriate ecological conditions, adequate security, and resident personnel trained in plant propagation and maintenance (USFWS, 2019).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2019).
- 1. The known population should be monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species and maintain genetic diversity. Seed material from Puerto Rico should be sent to botanical gardens (Kew, Fairchild, etc.) to ensure that the species is propagated and its genetic identity is safeguarded (USFWS, 2013).
- 2. Propagation and reintroduction efforts must continue. It is essential that the seed sources be as diverse as possible, and that record-keeping be both meticulous and as redundant as necessary to ensure that no data are lost (USFWS, 2013).
- 3. All existing known trees should be monitored on a yearly basis; additional visits should be made after hurricanes, landslides, or other major disturbances to determine their effects on the population (USFWS, 2013).
- 4. Monitoring should also consider the presence of possible pests affecting the establishment of seedling and saplings (USFWS, 2013).
- 5. Studies should be conducted to determine the patterns of genetic variation of the species in order to develop a plan to preserve the species germplasm. This should include a comparison with trees from Hispaniola and Cuba (var. jamaicensis) (USFWS, 2013).
- 6. Enhancement of the genetic diversity of J. jamaicensis with germplasm from outside Puerto Rico should be considered (USFWS, 21013).
- 7. The Adjuntas Substation of the UPR-Mayagüez Agricultural Experiment Station (EEA) should be considered for the propagation of the species as well as for the establishment of an experimental population. The EEA-Adjuntas offers plenty of land, appropriate ecological conditions, adequate security, and resident personnel trained in plant propagation and maintenance (USFWS, 2013).
- 8. The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2013).

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SPECIES ACCOUNT: *Justicia cooleyi* (Cooley's water-willow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 7/27/1989

Physical Description

An erect, perennial, rhizomatous herb growing to 5 dm tall. Stems are quadrangular, covered with hairs. Leaves are opposite, up to 7 cm long. Flowers are axillary or terminal. Corolla is about 10 mm long, deep reddish-purple, with a tube 5 mm long and with 2 prominent lips. (Based on Ward 1979.) (NatureServe, 2015)

Taxonomy

Distinct species. (NatureServe, 2015)

Historical Range

See Current

Current Range

Hernando, Lake, and Sumter counties, Fla. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Kral (1983), relying on sparse data, suggested a flowering season of August-December, or November-March. Specimen label data indicate flowering beginning by mid-August, flowering in mid-September, and flowering in February (Wunderlin et al. 1980) (USFWS, 1994). USFWS (2010) notes that the flowering period is from October-December.

Habitat Type

Adult: Hardwood hammocks/hardwood & Pine Forests (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Fine sandy loams or silty clay loams of shady, moist, deciduous hammocks underlain by limestone, along small gullies or meandering streams, low rises in swamp woodlands, and hammocks (Ward 1979). MESIC HARDWOOD HAMMOCKS AND HARDWOOD-PINE FORESTS AND ALONG ADJACENT ROADSIDES, USUALLY IN DENSE TO LIGHT SHADE. SOILS RANGE FROM MOIST TO SEASONALLY WET AND ARE TYPICALLY UNDERLAIN BY LIMESTONE (NatureServe, 2015). High ecological integrity of the community, site fidelity and low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Population Information and Trends

Population Trends:
Decreasing (NatureServe, 2015)

Number of Populations:
6 - 20 (NatureServe, 2015)

Population Size:
1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:
The short-term population trend is a 10-30% decline. TWO POPULATIONS ON CHINSEGUT HILL HAVE CA. 200 PLANTS EACH. CA. 1500 PLANTS KNOWN FROM USDA PLANT MATERIALS CENTER. SEVERAL HUNDRED PLANTS KNOWN FROM ROADSIDES. 15 EORS CONFIRMED WITHIN THE LAST DECADE (1990-2000), 14 SITES IN HERNANDO AND 1 SITE IN SUMTER COUNTIES (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals. J. cooleyi has also been at two sites found along Highway 50 in Sumter County and Highway 98 in Hernando County, and on private lands bordering both roadways in both counties. The Florida Department of Transportation (FDOT) has maintained both of these sites by mowing and herbicide treatments to control invasive species in areas occupied by J. cooleyi. (USFWS, 2019)

Threats and Stressors

Stressor: Invasive plants (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition and shading by invasive plants is listed as a threat to this species (USFWS, 2010).

Stressor: Agricultural development (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural development is listed as a threat to this species (USFWS, 2010).

Stressor: Residential development (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Residential development is listed as a threat to this species (USFWS, 2010).

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence: Population decline
Narrative: Deer herds have been documented browsing heavily on J. cooleyi at the Headquarters Tract in the Withlacoochee State Forest (FDOF 2001). This predation has resulted in reducing the size and density of this plant at this site. More information is needed to determine if the threat of vertebrate predation on this species has increased beyond what has naturally occurred and is causing a decline in the populations (USFWS, 2010).

Stressor: Disease (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals/Decreased health of populations
Narrative: A fungal or bacterial disease has been found and is affecting the plants at the USDA Plant Materials Center (USFWS 1994, Landry 1995). There have been no attempts to identify the pathogen to determine the best treatment for this species (USFWS, 2010).

Stressor: Inadequacy of existing regulations (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Justicia cooleyi is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations. Existing Federal and State regulations prohibit the removal or destruction of listed plant species on public lands. However, such regulations afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a 'Federal nexus' is involved for other lands, meaning any action that is authorized (e.g. permitted), funded or carried out by a Federal agency. In addition, State regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants on private land. J. cooleyi is located on State conservation lands and USDA lands in Hernando County. J. cooleyi is also found along roadways and private lands at several sites in Hernando and Sumter Counties. In the absence of protections provided under the Act, we believe existing State regulatory mechanisms described above are inadequate to protect this species (USFWS, 2010).

Stressor: Mining (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Loss of habitat due to limestone mining is expected to be a continuing threat to this species (USFWS, 2010).

Stressor: Right-of-way maintenance
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Right-of-way maintenance (mowing and herbicide use) is listed as a threat to this species if it takes place at the wrong time of year (USFWS, 2010)

Recovery

Delisting Criteria:
To develop objective, measurable criteria, we need to better understand the distributions of this plant. Delisting of this species should become feasible as habitat is protected and new populations are (re)established. Plausible criteria for recovery for Cooley's water-willow recovery would require at least 15 viable and self-sustaining populations, totaling at least 4 10,000 individuals. Population viability at recovery levels must be demonstrated for 10 consecutive years (USFWS, 2010).

Recovery Actions:

- 1. Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology (USFWS, 2010).
- 2. Support further research on: a. Effects of mowing and predator control on this species. b. Life history needs. c. Microhabitat requirements of this species. d. Identification and treatment of the pathogen causing the fungal or bacterial disease. e. Genetics of this species. f. Transplant experiments, long-term seed viability trials, and optimizing germination protocols (USFWS, 2010).
- 3. Continue working with public land managers to increase management efforts to benefit J. cooleyi on their lands (USFWS, 2010).
- 4. Conduct surveys at known sites of occurrence and expand surveys to other suitable areas in Hernando and Sumter Counties to provide distribution information needed to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites (USFWS, 2010).
- 5. Determine effective methods to control invasive species in areas where J. cooleyi occurs. Follow up with monitoring of herbicide treatment effects on this species (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The previous 5-year review included a list of recommendations to improve recovery of the species. Accomplishments towards these recommended actions are summarized below. A. Revise the current recovery plan to include updated objective and measurable recovery criteria for reclassifying this species to threatened status and delisting that are related to reducing the threats identified in the recovery plan, as well as updated information on the species distribution and biology. B. Support further research on: 1. Effects of mowing and predator control on this species– The SR-50 population has expanded since

the previous 5-year review. The FDOT uses standard mowing procedures that maintain the grass between five and twelve inches and treats exotic invasive plant species with herbicide if they consist of more than 25% of the vegetation (Maggio 2019). 2. Life history needs– No progress. 3. Microhabitat requirements of this species– No progress. 4. Identification and treatment of the pathogen causing the fungal or bacterial disease– No progress. 5. Genetics of this species– Limited genetics information has been collected, showing that the Citrus population is distinct. A more in-depth study using microsatellites is necessary (Peterson, BTG pers. comm. 2018). 6. Transplant experiments, long-term seed viability trials, and optimizing germination protocols– One germination trial was conducted in 2010 using freshly collected seed from one plant. Seed has not been collected since 2010 and seed from as far back as 1988 remains in long-term storage at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. 7. Continue working with public land managers to increase management efforts to benefit J. cooleyi on their lands– WSF's invasive plant species management has maintained suitable habitat for the species at seven sites. Maintenance is necessary to control invasive exotic plant species. In addition, efforts to control feral hog populations and reduce overbrowsing by deer needs to be continued. 8. Continue surveys at known sites of occurrence and expand surveys to other suitable areas in Hernando and Sumter Counties to provide distribution information needed to determine where plants currently exist and to prioritize recovery actions such as reintroductions at suitable sites– Four new populations have been discovered since the previous 5-year review due to WSF's efforts to map invasive exotic plant species. However, no systematic counts have been conducted. 9. Determine effective methods to control invasive species in areas where J. cooleyi occurs. Follow up with monitoring of herbicide treatment effects on this species– WSF has effectively controlled invasive exotic plant species where seven populations of J. cooleyi and will continue efforts at a low level to keep the invasive exotics in control. (USFWS, 2019)

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SPECIES ACCOUNT: *Kadua (=Hedyotis) coriacea* (Kio`ele)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

Kadua coriacea is in the Rubiaceae, or coffee family. It is a small, many-branched, erect shrub, with leathery leaves that are more or less oval-shaped. The leaves are hairless above, hairless or downy below, and 3 to 8 centimeters (1.2 to 3.2 inches) long with sheath-like petioles. Stipules are reduced and attached to the petiole base. Flowers are clustered, trumpet-shaped, cream colored, and fleshy. Fruits are cup or top-shaped, containing dark-brown, irregularly angled seeds. Kadua coriacea is distinguished from other species in the genus by its small flowers with triangular leaf-like appendages (calyx lobes) that do not enlarge when the fruit develops. The fruits are longer than wide and flower buds are square in cross-section (U.S. Army 2003a).

Taxonomy

In 2012, USFWS revised the taxonomic status for this species when it revised critical habitat on Oahu, with no change in range or distribution (USFWS 2012a). This species is now listed as Kadua coriacea (formerly Hedyotis coriacea) and addressed as such for the remainder of this review. (USFWS, 2015)

Historical Range

Historically, Kadua coriacea was found on Oahu, Maui, and Hawaii Island (Wagner et al. 1999). (USFWS, 2015)

Current Range

It is presently known from the islands of Maui and Hawaii. At least one plant is currently known on the island of Maui (West Maui Natural Area Reserve). On the island of Hawaii, plants are known from the Kipuka Kalawamauna Endangered Plants Habitat, along Charlie Circle, and near Kipuka Alala (U.S. Army 2003a).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On May 14, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated critical habitat for Kadua coriacea (Kio`ele (=Hedyotis)) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On September 18, 2012, the U.S. Fish and Wildlife Service (Service), designated revised critical habitat for Kadua (=Hedyotis) coriacea on the island of Oahu, Hawaii.

Critical Habitat Designation

The critical habitat designation for Kadua coriacea includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Gouania hillebrandii, Kadua coriacea, Remya mauiensis, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and Tetramolopium capillare, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by Ctenitis squamigera, Cyanea obtusa, Hesperomannia arbuscula, Hibiscus brackenridgei, Lysimachia lydgatei, Neraudia sericea, Schiedea salicaria, Sesbania tomentosa, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants Hibiscus brackenridgei and Schiedea salicaria, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Ctenitis squamigera, Cyanea obtusa, Gouania hillebrandii, Hesperomannia arbuscula, Kadua coriacea, Lysimachia lydgatei, Neraudia sericea, Remya mauiensis, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Spermolepis hawaiiensis, Tetramolopium capillare, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for Kadua (=Hedyotis) coriacea includes 7 units totaling 7,823 acres on Oahu. The units are Oahu—Lowland Mesic—Unit 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Although this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland

Mesic—Unit 2 consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 3 consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. Although this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 4 consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. This unit includes the lowland mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 5 consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. This unit includes the mesic forest and shrubland, the moisture regime, and canopy, subcanopy and understory native plant species identified as physical or biological features in the lowland mesic ecosystem. Although this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 6 consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Although this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery. Oahu—Lowland Mesic—Unit 7 consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge. Although

this unit is not known to be occupied by Kadua (=Hedyotis) coriacea, the Service has determined this area to be essential for the conservation and recovery of this species because it provides the PCEs necessary for the reestablishment of wild populations within the historical range of the species. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Kadua coriacea critical habitat consists of one component. Lowland dry (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Within these units, the physical and biological features of critical habitat are:

(i) Elevation: Less than 3,300 ft (1,000 m).

(ii) Annual precipitation: 50 to 75 in (130 to 190 cm).

(iii) Substrate: Shallow soils, little to no herbaceous layer.

(iv) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum.

(v) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax.

(vi) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp.

lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to

further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

All critical habitat, except in the coastal ecosystem on Oahu, requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs and goats). Feral ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required during nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat posed by fire to Oahu—Lowland Mesic—Unit 2, 3, 7. Oahu—Lowland Mesic—Unit 1, 2, 3, 4, 5, 6, 7 may require special management to reduce the threat of landslides, rockfalls, and flooding.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Life history information is unknown, including flowering cycles, pollination vectors, seed dispersal agents, longevity, and environmental requirements. Immature and mature fruits have been observed in August, flowers in September, vegetative growth in December, and immature fruits and flowers in January 1999 (U.S. Army 2003a).

Habitat Type

Adult: Mesic shrublands or forests

Habitat Narrative

Adult: Kadua coriacea is found on steep, rocky, slopes in dry Dodonaea Shrublands and forests on the island of Maui. On the island of Hawaii, the species occurs on pahoehoe lava flows in Sparse Metrosideros Treelands and Open Metrosideros Treelands with sparse to dense shrub understories. It is found at elevations from 1,500 to 1,700 meters (4,921 to 5,577 feet) at PTA. Associated species include Metrosideros polymorpha, Leptecophylla tameiameiae, Alyxia

oliviformis, Bidens menziesii, Gouania hillebrandii, Sida fallax, Melanthera lavarum, Myoporum sandwicense, and Schiedea menziesii.

Dispersal/Migration

Population Information and Trends

Number of Populations:
6 (USFWS, 2020)

Population Size:
147 (USFWS, 2020)

Population Narrative:
Currently, there are six populations of Kadua coriacea totaling 147 individuals on the island of Hawai'i. A landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that K. coriacea is highly vulnerable to the effects of climate change. All known wild and reintroduced individuals are provided protection from feral ungulates by fencing. Some nonnative plant control is ongoing within exclosures. Seed collection, propagation, and reintroduction are ongoing; however, there is very little natural recruitment. (USFWS, 2020)

Threats and Stressors

Stressor: Climate change destruction or degradation of habitat (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that K. coriacea is moderately vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future. (USFWS, 2015)

Stressor: Stochastic events – Drought mortality or reduced viability (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on K. coriacea (U.S. Army 2014). (USFWS, 2015)

Recovery

Recovery Actions:

- Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Captive propagation for genetic storage and reintroduction Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Expand locations of genetic resources for storage. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Ungulate monitoring and control – Maintain existing fences and continue removing ungulates from remaining fenced units to protect them from the impacts of feral ungulates. (USFWS, 2015)
- Population viability monitoring and analysis – Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- The following important conservation actions are needed: 1) additional populations of Kadua coriacea should be established across the species' range to increase the number of individuals; 2) existing populations of K. coriacea should be protected by constructing ungulate exclosures; 3) control non-native plants species; and 4) monitor plants and habitat. Research should be conducted on pollinators, reproductive biology, and other possible limiting factors that affect this species including specific research to determine if this species is susceptible to direct or indirect damage by ants (Service 1997). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of K. coriacea is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: There are no new threats or other significant new information regarding the species' biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Surveys and inventories—Continue to survey geographical and historical range of Kadua coriacea for a current assessment of the species' status. • Ungulate monitoring and control—Continue to construct, maintain, and monitor exclosures and remove any remaining ungulates from within to protect individuals from their negative impacts. • Ecosystem-altering invasive plant monitoring and control—Continue to control nonnative invasive plant species and those that degrade and destroy habitat and that compete with K. coriacea within exclosures. • Fire protection—Continue to improve and implement the fire management plan developed for PTA. • Drought protection—Continue to monitor and control feral ungulates and nonnative plants to protect and increase vigor of K. coriacea during times of drought. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery. • Predation and herbivory by invertebrates—Determine effects of invertebrates and develop and implement effective control methods within the vicinity of all known K. coriacea populations if necessary. • Captive propagation for genetic storage and reintroduction— o Continue collection and

propagation efforts for maintenance of genetic stock and for reintroduction into protected suitable habitat within historical range. o Expand locations of storage of genetic resources. o Assess the need for placing additional genetic resources into long-term storage due to this species' low natural recruitment and vulnerability to climate change. • Reintroduction and translocation—Continue to establish new populations in historical (Maui, Oʻahu) and other suitable habitat, and augment wild populations on the island of Hawaiʻi. • Population biology research—Carry out studies to determine possible causes for lack of natural recruitment. • Alliance and partnership development—Continue to work with the U.S. Army Garrison at PTA and other partners and land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—The U.S. Army Garrison monitors Kadua coriacea quarterly at Pōhakuloa Training Area (PTA) (U.S. Army Garrison 2010, 213 pp.). PTA reported conducting surveys over eight census periods from 2016 to 2019 to assess the status of K. coriacea and recorded its presence at 119 locations (U.S. Army Garrison 2020, pp. 6, 11, 17–18). • Captive propagation for genetic storage and reintroduction— o In 2019, PTA reported collection of almost 20,000 seeds for genetic storage representing at least 51 founders from Nāʻōhuleʻelua-Charlie Circle, Nāʻōhuleʻelua-Northwest New Bobcat Trail, Kīpuka ʻAlalā North, and Kīpuka Kālawamauna East, and 280 seeds collected from plants in the Rare Plant Propagation Facility (RPPF) (PTA 2019; U.S. Army Garrison 2020, p. 35, 61). o In 2019, 349 individuals of K. coriacea were propagated in the RPPF (U.S. Army Garrison 2020, p. 42). o PTA conducted 18 germination trials of 810 seeds from K. coriacea, and reported that seeds germinated readily, with 71 percent germination (U.S. Army Garrison 2020, p. 40). Longevity of seeds is estimated to be nine years (U.S. Army Garrison 2013, p. 16). • Reintroduction— o PTA reported reintroduction on PTA of 107 individuals representing three founders of K. coriacea at four locations, of which 64 survive (61 percent). Of those reintroduced at Puʻuwaʻawaʻa between 2004 and 2015, 13 mature and three immature individuals survive (U.S Army Garrison 2020, pp. 43, 48, 122–125, 132–138). (USFWS, 2020)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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USFWS. 2020. 5-YEAR REVIEW Short Form Summary Species Reviewed: Kadua coriacea (kio‘ele) Current Classification: Endangered. 9 pp.

SPECIES ACCOUNT: *Kadua (=Hedyotis) degeneri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Hedyotis degeneri var. degeneri (aka Kadua degeneri) is a short-lived perennial shrub in the Rubiaceae (coffee) family. The long stems sprawl on the ground or are supported by surrounding vegetation. The stems bear short leafy shoots in the leaf axils, and older stems have peeling, corky layers of bark. The oppositely arranged leaves are 1 to 3 cm (0.4 to 1.2 in) long. Inflorescences at the branch tips contain 1 to 10 greenish flowers. Some flowers are perfect (with both male and female reproductive parts) and others possess only female reproductive parts. The round seed capsules split open across the top when mature (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016). A prostrate, branched shrub. Flowers in terminal clusters of up to 10 flowers. (NatureServe, 2015)

Historical Range

Hedyotis degeneri var. degeneri is endemic to the northern Waianae Mountains of Oahu. Records indicate this taxon historically was known from Mt. Kaala in the northern Waianae Mountains, and was found primarily on the windward side of the range. Hedyotis degeneri var. degeneri in the Kahanahaiki area of Makua are the only ones recorded on the leeward side of the Waianae Mountains (USFWS, 2016).

Current Range

Endemic to Waianae Mountains, Oahu.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Kadua (=Hedyotis) degeneri under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Kadua (=Hedyotis) degeneri (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Kadua (=Hedyotis) degeneri includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Kadua (=Hedyotis) degeneri includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Kadua (=Hedyotis) degeneri critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Kadua (=Hedyotis) degeneri occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None.

(E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (E) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Kadua (=Hedyotis) degeneri to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Lifespan

Adult: ~10 years (USFWS, 2015)

Reproduction Narrative

Adult: Flowering and fruiting has been recorded at various times of the year. The flowers are likely to be insect-pollinated, but dispersal agents for the fruits are unknown. The longevity of H. degeneri var. degeneri individuals is unknown, but it is probably similar to that of other small shrubs that live less than 10 years (Makua Implementation Team 2003). Other demographic information for H. degeneri var. degeneri in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seasonality of reproduction, pollination and seed dispersal, vegetative reproduction, and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Shrubland/forest (NatureServe, 2015; USFWS, 2016)

Habitat Narrative

Adult: Moist shrublands and forests. On shrubby cliffs or exposed shrubby ridges, or in the forest understory on gulch slopes. (NatureServe, 2015). Hedyotis degeneri var. degeneri typically grows on upper gulch slopes and on ridge tops between elevations of 570 and 720 m (1,870 to 2,360 ft). It usually occurs in the understory of mesic forests dominated by Diospyros sandwicensis and/or Metrosideros species. Hedyotis degeneri var. degeneri also occurs where scrubby forests of the upper gulch slopes grade into shrubland on ridge crests (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

5 (USFWS, 2019)

Population Size:

136 mature, 141 immature, and 150 seedlings (USFWS, 2019)

Population Narrative:

Fragility unknown. Currently fewer than 100 plants known. 2 current (between 1982 and 1997) and 2 historical occurrences. (NatureServe, 2015). It is estimated only one occurrence of six individuals of H. degeneri var. degeneri was known when the species was listed in 1991 (56 FR 55770). All except one of the known H. degeneri var. degeneri population units were discovered in the last eight years, so population trends are not yet evident (Makua Implementation Team 2003). More individuals were discovered in 2003, when there were five occurrences totaling 131-146 individuals. Since 2003 additional individuals have been discovered. Currently, there are 322 known individuals in two population units located on Federal, State, and private lands (Table SB 19) (U.S. Army Garrison 2005b). Two of these population units exceed minimum numerical criteria for stabilization population units (defined as 100 mature, reproducing individuals per population unit) (USFWS, 2016). Currently there are 136 mature, 141 immature, and 150 seedlings of Kadua degeneri subsp. degeneri in three population units and five scattered locations in the Waiʻanae mountains of Oʻahu. The large majority of individuals are found in one population (ANRP 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Non-native ungulates (USFWS, 2016; NatureServe, 2015)
Exposure:
Response:
Consequence: Loss of individuals/loss of habitat
Narrative: Major threats include destruction by feral pigs (NatureServe, 2015; USFWS, 2016)) and other non-native ungulates (USFWS, 2016).

Stressor: Non-native plants (USFWS, 2016; NatureServe, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Major threats include alien plant species (Christmasberry, molasses grass, and strawberry guava) (NatureServe, 2015; USFWS, 2016).

Stressor: Small number of individuals (NatureServe, 2015)
Exposure:
Response:
Consequence: Extinction
Narrative: A major threat to this species is the small number of extant individuals. (NatureServe, 2015)

Stressor: Climate change loss or degradation of habitat (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Kadua degeneri is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.815 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2019)

Recovery

Reclassification Criteria:
For downlisting, a total offive to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each ofthese populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population forlong-lived perennials and a minimum of300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:
A total of 8 to 10 populations ofeach taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).

Conservation Measures and Best Management Practices:
- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations

for future actions are reiterated for the 5-year review for 2019. • Surveys, inventories, and monitoring—Continue surveys and monitoring for occurrences in known historical sites and in suitable habitat. • Ungulate monitoring and control—Continue fencing and ungulate control at all known populations. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species, and those that compete with Kadua degeneri. • Fire monitoring and control—Implement fire management plans and coordinate fire response efforts. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Rodent predation and herbivory—Implement rat control methods if necessary. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. o If Kadua degeneri subsp. coprosmifolia is found, genetic material should be collected to determine if the taxon represents a distinct subspecies of K. degeneri or is more closely related to K. cordata. • Reintroduction and translocation—Continue to augment or establish new populations within historical habitat to increase numbers of individuals and populations. • Alliance and partnership development—Work with the U.S. Army and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)

- New Management Actions: • Ungulate monitoring and control—The Army Natural Resources Program-O‘ahu (ANRP) has removed ungulates from two population units, Kahanahaiki to Pahole, and Alaiheihe and Manuwai (ANRP 2018). • Invasive plant monitoring and control—The ANRP controls nonnative plants in two population units, Kahanahāiki to Pahole, and Alaiheihe-Manuwai (ANRP 2018). • Captive propagation for genetic storage and reintroduction— o In 2018, the ANRP reported that 143 plants have seeds stored in the seed bank, and 122 of those plants have adequate representation (50 or more seeds in storage) (ANRP 2018). o Lyon Arboretum Micropropagation Laboratory reports 36 explants in storage representing one individual from Manuwai (Lyon Arboretum 2018). • Reintroduction—The ANRP reports reintroduction of 58 mature and 63 immature Kadua degeneri at Alaiheihe and Manuwai (ANRP 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Labordia triflora* (Kamakahala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/03/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub with long lax stems. The tubular greenish flowers are borne singly or in clusters of three (NatureServe, 2015).

Taxonomy

A member of the logan family. In the 1990 "Manual of the Flowering Plants of Hawaii" (Manual) (Wagner et al. 1990), this species was considered to be synonymous with L. tinifolia var. lanaiensis. Timothy Motley recently revised this endemic Hawaiian genus, and resurrected L. triflora as a valid species (Motley 1995) (USFWS, 2002).

Historical Range

Until 1990, Labordia triflora was known only from the type collection at Mapulehu on the island of Molokai, and was believed to be extinct (USFWS, 2002).

Current Range

Occurs only on the island of Molokai (USFWS 2008; USFWS, 2014).

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Labordia triflora (Kamakahala) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Labordia triflora includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not

known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Labordia triflora critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those

required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var.

lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2014)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mixed mesic ohia forest (USFWS, 2002)

Geographic or Habitat Restraints or Barriers

Adult: 625 - 3,755 ft. elevation (USFWS, 2002)

Habitat Narrative

Adult: Inhabits moist forests in gulch bottoms and on gulch slopes (NatureServe, 2015). This species occurs on gulch slopes in mixed mesic Metrosideros polymorpha (ohia) forest between 190 and 1,145 meters (625 to 3,755 feet) elevation (USFWS, 2002).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Decreasing (USFWS, 2014)

Number of Populations:

2 (USFWS, 2023)

Population Size:

4 wild (USFWS, 2023)

Population Narrative:

Overall, L. triflora has decreased from 11 individuals reported in the previous 5-year review to approximately 4 wild individuals (3 mature and 1 immature) (PEPP 2012). Unfortunately, the 2012 PEPP annual reports only provides status information for two of the four wild populations as identified in the proposed rule and the 2013 PEPP annual reports only provides status information for one of the four wild populations (USFWS, 2014). New Status Information: • The latest review of the species by IUCN in 2015 reported one occurrence of three individuals on Molokaʻi (Chau et al. 2015). • In 2017, the Plant Extinction Prevention Program (PEPP) reported for Labordia triflora that five founders have been collected from (two individuals from Wāwāʻia and three individuals from Kua Gulch), and progeny have been outplanted together in Kawela (PEPP 2017a). The wild individuals at Wāwāʻia have died. • In 2016, critical habitat was designated in the lowland mesic ecosystem on Molokaʻi for Labordia triflora (8,770 ac; 3,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018). • Currently, there are two wild individuals of Labordia triflora at Wāwāʻia and two wild individuals at Kapulei (Kapualei) on Molokaʻi (Molokaʻi Plant Extinction Prevention Program [MoPEPP] 2019–2020). Translocations of more than 300 individuals at six sites are monitored; however, no natural recruitment is reported (MoPEPP 2019–2020). • Currently, four founders (wild plants) are represented in ex situ storage and propagation (USFWS, 2023).

Threats and Stressors

Stressor: Stochastic events (USFWS, 2014 and 2002)
Exposure:
Response:
Consequence:
Narrative: Landslides and flooding is reported as a threat to this species and has resulted in loss of individuals of L. triflora in Kua Valley on Molokai (PEPP 2010) (USFWS, 2014). Catastrophic extinction could occur through environmental events and reduced reproductive vigor due to the small number of individuals remaining in the only known population (USFWS, 2002).

Stressor: Predation (USFWS, 2014 and 2002)
Exposure:
Response:
Consequence:
Narrative: Herbivory by slugs (unidentified species) has been reported as a severe threat to remote populations of L. triflora (PEPP 2010, 2011, 2012, 2013) (USFWS, 2014). Rats eat seeds of this species (USFWS, 2002).

Stressor: Collection (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Potential threats include unrestricted collecting or excessive visits by individuals interested in seeing rare plants (U.S. Fish and Wildlife Service 1999b, 2002c; Motley 1995) (USFWS, 2002).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:

Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Labordia triflora is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.998 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this assessment classified L. triflora as a “wink-out” species. “Wink-out” species are those species with no future climate envelope on the islands the species has occurred. No projected suitable climate areas exist for the species to persist in the future. Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat on islands outside of its known range (USFWS, 2018).

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2002).

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 2002).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 2002).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 2002).

Recovery Actions:
- Protect habitat and control threats (USFWS, 2002).
- Expand existing wild populations (USFWS, 2002).
- Conduct essential research (USFWS, 2002).
- Develop and maintain monitoring plans (USFWS, 2002).
- Reestablish wild populations within historic range (USFWS, 2002).
- Validate and revise recovery criteria (USFWS, 2002).
- Construct exclosures to protect populations against feral ungulates (USFWS, 2002).

- Maintain adequate genetic stock (USFWS, 2002).
- Control competing alien plant species (USFWS, 2002).
- Reduce threats from rodent predation (USFWS, 2002).
- Enhance wild populations and establish new populations (USFWS, 2002).
- New Management Actions: • Surveys and monitoring—The PEPP surveys for and monitors populations of Labordia triflora on Molokaʻi (PEPP 2012, 2013, 2014, 2015, 2016, 2017b). • Ungulate monitoring and control—In 2016, the Hawaiʻi Department of Land and Natural Resources, Division of Forestry and Wildlife and The Nature Conservancy (TNC; for the East Molokaʻi Watershed Partnership) submitted a draft Environmental Assessment for the proposed Pākuʻi Watershed Project. The proposed project's goal is the construction of a 5.5-mile fence, which, in conjunction with the existing Kapualei Extension fence, will enclose the Pākuʻi Unit and protect 2,080 ac of vital watershed on southeast Molokai (TNC 2016). If completed, the fence would provide protection from ungulates to the occurrences of L. triflora and other rare plant species at Kua Gulch. • Captive propagation for genetic storage and reintroduction— o Currently, five founders are represented in collections (PEPP 2017). o The Lyon Arboretum Micropropagation Laboratory reports two containers of propagules in storage and three propagules in the greenhouse. The Lyon Arboretum Seed Conservation Laboratory reports a little over 1,000 seeds total in storage collected from one individual from Kua gulch and another individual in Wāwāʻia on Molokaʻi (Lyon Arboretum 2017). o The Olinda Rare Plant Facility (ORPF) reports 19 potted plants in storage representing one individual from Wāwāʻia, two potted plants representing two individuals from Kua Gulch, and 16 cuttings taken from four individuals in Kua Gulch (ORPF 2014, 2015). ORPF has sent out 370 plants for outplanting over the last year (ORPF 2018). o PEPP monitors wild individuals and reintroduces plants on Molokaʻi (PEPP 2012, 2013, 2014, 2015, 2016). Currently, 133 individuals were reintroduced individuals at Snail Meadow, 109 individuals reintroduced individuals at Kua Gulch, and 22 individuals reintroduced with Dunbar's enclosure (PEPP 2012, 2013, 2014, 2015, 2016, 2017b) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue to survey known localities and suitable habitat areas on Molokaʻi determine the current status of all populations of Labordia triflora. Search historical habitat on Molokaʻi for occurrences of this species. • Ungulate monitoring and control—Construct and maintain exclusion fences, or strategic fencing as appropriate, to protect L. triflora from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation—Augment current populations and continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Rodent predation or herbivory—Implement effective methods to control rats at known populations. • Invertebrate predation or herbivory—Determine and implement effective methods to control slugs at known populations. • Population viability monitoring and analysis—Study populations to determine viable population size and structure,

geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to increase natural regeneration in the wild. • Stochastic events—Build resiliency and redundancy—Increase numbers of populations and individuals scattered through suitable habitat to reduce impacts from landslides. • Climate change adaptation strategy—Research the suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. Develop a strategy for prevention of the extinction of this species if no suitable habitat is available in the future. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).

- Ungulate monitoring and control – Fence remaining populations of L. triflora to protect against feral ungulates (USFWS, 2014).
- Captive propagation for genetic storage and reintroduction Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Reintroduction / translocation – Reintroduce individuals into suitable habitat within the current and historical range in areas where threats are managed (USFWS, 2014).
- Predator / herbivore monitoring and control – Control slugs and rodents within the vicinity of all known L. triflora populations (USFWS, 2014).
- Surveys / inventories – Survey the geographical and historical range of L. triflora to assess the status of known populations and possible additional populations (USFWS, 2014).
- Invasive plants monitoring and control – Control invasive introduced plants within the vicinity of L. triflora populations (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future (USFWS, 2014).
- Population viability monitoring and analysis – Study populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats to increase natural regeneration in the wild (USFWS, 2014).
- Alliance and partnership development –Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2023. • Surveys and monitoring—Continue to survey known localities and suitable habitat areas on Moloka'i to determine the current status of all individuals of Labordia triflora. • Ungulate monitoring and control—Continue to maintain exclosures to protect individuals from the negative impacts of habitat destruction and degradation, and herbivory, by feral ungulates. • Invasive nonnative plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species within and around all wild and translocated populations of L. triflora. • Climate change adaptation strategy—Research the suitability of habitat for translocation of this species in the future

due to the impacts of climate change and develop a strategy for prevention of the extinction of this species if suitable habitat may not be available in the future. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents at all wild and translocated populations. o Develop and implement effective control methods for invertebrates at all populations. • Captive propagation for genetic storage and reintroduction— o Continue collection and propagation efforts for maintenance of genetic stock and for translocation. o Evaluate genetic resources currently in storage to determine the need to place additional materials into long-term storage due to this species' vulnerability to climate change. • Translocation and augmentation—Continue to augment the wild populations and translocate individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats, to increase natural regeneration. • Build resiliency, redundancy, and representation—Increase numbers of populations and individuals throughout historic range to reduce impacts of landslides, predation, and natural regeneration. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2023).

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SPECIES ACCOUNT: *Lasthenia burkei* (Burke's goldfields)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/02/1992; Pacific Southwest (R8)

Physical Description

An annual herb that ranges in height from approximately 13 cm (5 in) (Patterson in litt. 2000) to as much as 61 cm (24 in) (Greene 1886), but is typically less than 30 cm (11.8 in) tall (Ornduff 1993). It has hairy stems, which may be simple or branched. The narrow, opposite leaves are no more than 8 cm (3.1 in) long and may be lobed or not. From April to June, the end of each branch bears one daisy-like flower head approximately 1.5 cm (0.6 in) across. The fruits are achenes (dry, one-seeded fruits) less than 1.5 mm (0.06 in) in length. The fruits of L. burkei can be distinguished from those of other goldfields by the presence of one long awn (bristle and numerous short scales) (Ornduff 1993). Individual L. burkei plants may exhibit some geographic variation in morphology (McCarten 1985 as cited in CH2M Hill 1995, Patterson et al. 1994). A diagnostic feature of Lasthenia burkei is the usual presence of a single long awn on the achene intermixed with 8 to 10 short scales (Ornduff 1993, Patterson et al. 1994). However, several occurrences have mixtures of typical achenes with a single awn and atypical achenes with a varied number of awns. Species experts consider these mixed occurrences to represent Burke's goldfields (Ornduff 1969b, Patterson et al. 1994, CNDDB 2013). (USFWS, 2016)

Taxonomy

The scientific name originally given to Burke's goldfields was Baeria burkei (Greene 1886). Both the specific epithet and the common name commemorate J. H. Burke, who collected the type specimen "near Ukiah, Mendocino County" (Greene 1886). Greene later placed the genus Baeria within Lasthenia, creating the new name Lasthenia burkei for Burke's goldfields (Greene 1894). However, for many years other botanists (e.g., Hall 1914, Jepson 1925, Abrams and Ferris 1960) did not believe that Burke's goldfields was distinct from Fremont's goldfields (Lasthenia fremontii), a more widespread species to which it is very similar, nor did they agree with Greene's (1894) decision to lump Baeria with Lasthenia. Not until 1966, when Ornduff (1966) published a comprehensive study of the genus Lasthenia, was Burke's goldfields recognized as a distinct species and the name Lasthenia burkei accepted widely. Continuing research indicated that Burke's goldfields, Fremont's goldfields, and Contra Costa goldfields (Lasthenia conjugens) form a closely related species group (Ornduff 1969b, Crawford and Ornduff 1989). However, Burke's goldfields was found to be genetically distinct from Fremont's and Contra Costa goldfields (Crawford and Ornduff 1989). Lasthenia burkei and its relatives are members of the aster family (Asteraceae). (USFWS, 2016)

Historical Range

Endemic to the central California Coastal Range region and has been reported historically to be located within Mendocino, Lake, and Sonoma counties. (USFWS, 2016)

Current Range

In California, within Mendocino, Lake, Napa, and Sonoma Counties. (USFWS, 2019)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: insect-pollinated (USFWS, 2016)

Lifespan

Adult: 1 year (USFWS, 2008)

Dependency on Other Individuals or Species

Adult: Pollinators (USFWS, 2016)

Breeding Season

Adult: April - June (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Soil seed bank, insect pollinators. heavy fall rains (USFWS, 2016)

Other Reproductive Information

Adult: Like many other rare vernal pool plants, Lasthenia burkei is an annual. Lasthenia burkei typically germinates in autumn following heavy rains, although late initiation of rains may delay seedling emergence (Ornduff 1969b). Laboratory germination tests (Rancho Santa Ana Botanical Garden, unpublished data) indicate that germination occurs rapidly in a single flush, with relatively high germination rates (49 to 100 percent). Both the ray and disk flowers of all goldfields species produce achenes, increasing the potential for seed production per head. However, the reproductive output of individual plants is highly variable, depending on plant density and vigor, and probably on pollinator behavior as well. Each flower head can produce as many as 35 achenes, and the number of flower heads per plant can range from 1 to more than 20 (Patterson et al. 1994). Annual survival rates and other demographic parameters have not been investigated. Lasthenia burkei has also likely adapted to “risky environments” by producing a persistent seed bank. Some occurrences have reappeared after no plants were evident for 2 years, suggesting that viable seeds remained in the soil during that period (Patterson 1990). (USFWS, 2016)

Reproduction Narrative

Adult: The flowers of Lasthenia burkei are predominantly pollinated by outcrossing but they are capable of self-pollination (Sloop et al. 2012c). They are thought to be insectpollinated rather than wind-pollinated. Insects known to visit the flowers of the genus Lasthenia include butterflies (Lepidoptera), beetles (Coleoptera), flies (Diptera), true bugs (Hemiptera), bees (Hymenoptera), and wasps (Hymenoptera) (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of Lasthenia spp. are solitary bees (family Andrenidae); these include two species in the subgenus Diandrena (Andrena submoesta and A. puthua) and five or six species in the subgenus Hesperandrena (Andrena baeriae, A. duboisi, A. lativentris, and two or three undescribed species) (Thorp and Leong 1998). Gilmore, Sloop and Rank (2012) conducted a pollinator study of L. burkei, and found that although the solitary bee (Andrena submoesta) specializes on L. burkei and is apparently dependent on it as a food

source, the plant may not rely on A. submoesta for pollination (Gilmore et al. 2012). The Bombyliid fly (also called a bee fly), Conophorus cristatus, was found to be the dominant visitor of L. burkei and may be its primary pollinator. Syrphid flies (members of several genera in the family Syrphidae (hover flies)) were also found to be an important part of the pollinator community for this plant (Gilmore et al. 2012). (USFWS, 2016)

Habitat Type

Adult: Wetland (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Mesic meadow, vernal pool (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Wide range, up to 1900 feet in elevation (USFWS, 2016)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: The primary habitats of Lasthenia burkei are shallow vernal pools and wet swales within valley grassland and oak woodland habitats (CNDDB 2013). On the Plain, L. burkei grows in the bottoms of pools ranging from less than 25 cm (10 in) in depth to 50 cm (20 in) (Patterson 1990, Patterson et al. 1994, Patterson in litt. 2000). Lasthenia burkei grows in naturally-occurring pools that range in surface area from approximately 2 square m (21.5 square ft) to 0.3 ha (0.75 ac (Patterson in litt. 2000)). Most of the vernal pools where L. burkei grows are loosely classified as northern vernal pools (Keeler-Wolf et al. 1998), but the Manning Flat occurrence in Lake County is in a northern volcanic ashflow vernal pool (Sawyer and Keeler-Wolf 1995). Lasthenia burkei also has been observed occasionally in artificially-created depressions such as drainage ditches and in disturbed sites such as orchards and disked fields (Patterson 1990, Patterson et al. 1994). (USFWS, 2016)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are not known. Pappus awns (needle-like appendages attached to the achene) may assist in windborne seed dispersal. Other seed dispersal mechanisms may include water or wildlife. (USFWS, 2016)

Population Information and Trends

Population Trends:

Decline of >90% (NatureServe, 2015)

Species Trends:

> 70% decline (NatureServe, 2015)

Number of Populations:

20 or less (NatureServe, 2015)

Population Size:

Variable depending on year; 24,860 - 8.1 million in most recently surveyed populations (USFWS, 2016)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

This species inhabits highly vulnerable vernal pool plant endemic to small area, mostly in Sonoma County, California. It has experienced a long term decline of > 90%. It is declining rapidly (> 70% short term) due to runaway urban development in its habitat (Bittman 1998). Numbers fluctuate depending on rainfall; last counts indicated about 100,000 plants at all sites (some may now be extirpated). Known from twenty-eight occurrences. A maximum of twenty occurrences may be extant, but we believe the number to be far lower (fewer than ten viable occurrences) (California Natural Diversity Database, May/1998 report) (NatureServe, 2015). The largest known extant occurrences are at the Alton North Conservation Bank, with approximately 8.1 million plants in 2013; the Alton Lane Vernal Pool Preserve, with approximately 1.4 million plants in 2013; the Wright Preservation Bank, where the number of plants has decreased from approximately 5.3 million down to 1 million over the past 5 years; and Woodbridge Preserve, east of Fulton Road near Piner Road, where the number of plants increased from 350 plants in 1998 to 18.5 million plants in 2009, with 24,860 found at this site in 2012 (CNDDB 2014, Stromberg 2013) (see Figure 5). Sloop and Ayres (2009) found that thirteen Lasthenia burkei occurrences were genetically distinct despite showing some gene flow between them (USFWS, 2016).

Threats and Stressors

Stressor: Development and conversion to agriculture (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of

seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

Stressor: Alteration of hydrology (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

Stressor: Off-highway vehicles (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Damage by off-highway vehicles was noted as a threat to this species. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

Stressor: Grazing managment and thatch accumulation (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of

invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (Phalaris aquatica), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

Stressor: Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern

Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including B. bakeri, L. burkei, and L. vinculans. (USFWS< 2016)

Stressor: Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Chance events constitute a serious threat to Blennosperma bakeri. Because the known occurrences of B. bakeri are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998). (USFWS, 2016)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

Stressor: Non-native invasive species (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water, the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

Recovery

Reclassification Criteria:
A/1: Seventy-five percent of extant, native occurrences, not protected as of December 2014, within each core area (Windsor Core Area, Alton Lane Core Area, and Lasthenia burkei Southern Core Area) are permanently protected and managed to maintain the habitat and the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that are isolated and/or genetically unique.(USFWS, 2016)

A/2: The following additional habitat is needed in order to delist or downlist L. burkei. New preserves consist of a minimum of 50 ac in the Windsor Core Area, a minimum 400 ac in the Alton Lane Core Area, and a minimum of 400 ac in the Lasthenia burkei Southern Core Area. These preserves will consist of occupied habitat that is not protected as of December 2014. The

ecological integrity (e.g., water quality, hydrology, and uplands condition) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses must be sufficient to ensure that there are no significant adverse effects to Lasthenia burkei, such as changes in hydrology, or contamination by pesticides or herbicides, currently and into the foreseeable future. (USFWS, 2016)

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences or those providing protection to a large occurrence are less than 10 ac. The preserves are as near to new or existing preserves as possible. (USFWS, 2016)

A/4: New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac preserve). The total new preserve acreage in the core areas includes a minimum of 125 ac of vernal pools and swales distributed among the Alton Lane Core Area, Lasthenia burkei Southern Core Areas, and Windsor Core Area. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: All native occurrences, extant as of December 2014, are replicated at 1:2 (tripled in numbers of occurrences) in permanently protected sites in the three core areas. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016)

E/2: The preserves noted in Factor A are occupied by Lasthenia burkei at a density of 500 plants per square meter when measured on a 25- year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrence size and climate change, among other threats, are developed and are being effectively implemented. (USFWS, 2016)

Delisting Criteria:
A/1: At least 90 percent of native occurrences of Lasthenia burkei, extant as of December 2014, have been protected in perpetuity. (USFWS, 2016)

A/2: New preserves have no greater than 20 percent wetlands at each site (no more than 2 ac of vernal pools and swales in each 10 ac preserve). (USFWS, 2016)

E/1: In addition to replication noted in E/1 of the downlisting criteria for Lasthenia burkei, all occurrences in management areas have been replicated at 1:2 at permanently protected

appropriate locations. (USFWS, 2016)

E/2: All replicate occurrences in management areas have achieved the same density (500 plants per square meter) as the core area occurrences. (USFWS, 2016)

E/3: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ. Identification of some genetically unique occurrences is not yet known but will be determined during research as defined in the Recovery Plan. (USFWS, 2016)

Recovery Actions:

- 1. Protect extant occurrences and potential habitat for Lasthenia burkei. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)
- 2. Develop a central database for survey data from all natural and created occurrences of Lasthenia burkei including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).
- 3. Collect and store seed from all occurrences of Lasthenia burkei. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
- 4. Survey historical locations and other potential habitat (not previously surveyed) where Lasthenia burkei may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for Lasthenia burkei. Table 2 of the Recovery Plan lists research tasks needed for the development of a

population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)

- 6. Conduct necessary biological research on Lasthenia burkei and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of Blennosperma bakeri, Lasthenia burkei, and Limnanthes vinculans. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for Lasthenia burkei. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)
- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)
- 10. Engage and educate the public about Lasthenia burkei recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)

- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)

References

USFWS. 2019. Sonoma sunshine (Blennosperma bakeri), Burke's goldfields (Lasthenia burkei) and Sebastopol meadowfoam (Limnanthes vinculans)

5-Year Review. U.S. Fish and Wildlife Service, Sacramento, California. May 1, 2019. 12 pp.

USFWS. 2016. Recovery Plan for the Santa Rosa Plain: Blennosperma bakeri (Sonoma sunshine)

Lasthenia burkei (Burke's goldfields)

Limnanthes vinculans (Sebastopol meadowfoam)

California Tiger Salamander Sonoma County Distinct Population Segment (Ambystoma californiense). U.S. Fish and Wildlife Service, Pacific Southwest Region, Sacramento, California. vi + 128 pp.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Lasthenia conjugens* (Contra Costa goldfields)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/18/1997; Pacific Southwest (R8) (USFWS, 2017)

Physical Description

An annual herb, 1-4 dm tall, that produces showy yellow flower heads in the spring (NatureServe, 2015). The achenes (fruit) of L. conjugens are less than 1.5 millimeters (0.06 inch) long and always lack a pappus (the hair-like or scale-like structures attached to an achene, which assist in dispersal; Ornduff 1969, Ornduff 1993) (USFWS, 2013).

Taxonomy

The two closest relatives of Lasthenia conjugens are L. burkei (Burke's goldfields) and L. fremontii (Fremont's goldfields) (USFWS, 2005).

Historical Range

Historically occurred in seven vernal pool regions: Central Coast, Lake-Napa, Livermore, Mendocino, Santa Barbara, Santa Rosa, and Solano-Colusa (Keeler-Wolf et al. 1998). In addition, several historical occurrences in Contra Costa County are outside of the defined vernal pool regions (Keeler-Wolf et al. 1998). Ornduff (1966) reported collections from 13 sites in Alameda, Contra Costa, Mendocino, Napa, Santa Barbara, Santa Clara and Solano counties. Although he cited three specimens each from Contra Costa and Santa Barbara Counties, Ornduff (1966; 1979) noted that the species was most common in Solano County. One additional site in Alameda County was documented in 1959 by G. Thomas Robbins, who collected a specimen (# 3963, housed at the Jepson Herbarium) on the "shore of the San Francisco Bay" south of Russell (Service 2005a; USFWS, 2013).

Current Range

L. conjugens has been reported in ten counties within California: Alameda, Contra Costa, Marin, Mendocino, Monterey, Napa, Santa Barbara, Santa Clara, Solano, and Sonoma (CNDDB 2012; USFWS, 2013). Currently, the distribution of the species remains as described in our 2013 status review. The Diversity Database now reports 36 occurrences of Contra Costa goldfields (Appendix A; Diversity Database 2023, entire). The two occurrences (occurrences #45 & 46) added to the Diversity Database since the 2013 status review are found in Solano County in proximity to other known occurrences on Travis Air Force Base and are mapped as "transplanted populations" (Diversity Database 2023, p. 41). These occurrences do not represent new populations of Contra Costa goldfields, but are part of ongoing conservation efforts and mitigation for projects on Travis Air Force Base (Collinge 1999, entire) (discussed in Conservation Efforts). These transplanted occurrences are within the previously known range of the species and do not change our understanding of the distribution of the species (USFWS, 2024).

Critical Habitat Designated

Yes; 8/6/2003.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lasthenia conjugens (Contra Costa goldfields) under the Endangered Species Act of 1973, as

amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in California (70 FR 46924-46999).

Critical Habitat Designation

The critical habitat designation for Lasthenia conjugens includes eight CHUs in Alameda, Contra Costa, Mendocino, Napa, and Solano counties, California. This species critical habitat encompasses approximately 14,730 acres (71 FR 7118-7316).

Unit 1: Mendocino County, California. From USGS 1:24,000 scale quadrangle Point Arena.

Unit 2: Napa County, California. From USGS 1:24,000 scale quadrangles Yountville, Capell Valley.

Unit 3: Napa County, California. From USGS 1:24,000 scale quadrangles Napa, Cuttings Wharf.

Unit 4: Solano County, California. (i) Unit 4A: Solano County, California. From USGS 1:24,000 scale quadrangle Fairfield South. (ii) Unit 4B: Solano County, California. From USGS 1:24,000 scale quadrangles Fairfield South. (iii) Unit 4C: Solano County, California. From USGS 1:24,000 scale quadrangles Elmira, Denverton.

Unit 5: Solano County, California. (i) Unit 5A: Solano County, California. From USGS 1:24,000 scale quadrangle Elmira. (ii) Unit 5B: Solano County, California. From USGS 1:24,000 scale quadrangles Elmira, Denverton.

Unit 6: Contra Costa County, California. From USGS 1:24,000 scale quadrangle Benicia.

Unit 7: Contra Costa County, California. From USGS 1:24,000 scale quadrangles Byron Hot Springs, Clifton Court Forebay.

Unit 8: Alameda County, California. (i) Unit 8A: Alameda County, California. (ii) Unit 8B: Alameda County, California. From USGS 1:24,000 scale quadrangles Milpitas, Niles.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lasthenia conjugens critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described below in paragraph (2)(ii), providing for dispersal and promoting hydroperiods of adequate length in the pools;

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of

permanently flooded emergent wetlands;

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas determined to be essential for conservation may require special management considerations or protections. As we undertake the process of designating critical habitat for a species, we first evaluate lands defined by those physical and biological features essential to the conservation of the species for inclusion in the designation pursuant to section 3(5)(A) of the Act. Secondly, we then evaluate lands defined by those features to assess whether they may require special management considerations or protection. In designating critical habitat, we also have considered how this designation highlights habitat that needs special management considerations or protection. For example, we have many regional HCPs under development, and this designation will be useful in helping applicants determine what vernal pool habitat areas should be highest priority for special management or protection, and where there may be more flexibility in conservation options. This designation will guide them and us in ensuring that all local habitat conservation planning efforts are consistent with conservation objectives for these species. Once a vernal pool habitat has been protected from direct filling, it is still necessary to ensure that the habitat is not rendered unsuitable for vernal pool species because of factors such as altered hydrology, contamination, nonnative species invasions, or other incompatible land uses. Many of the factors that cause the decline and localized extirpation of vernal pool species can be avoided. Actions that should be avoided include the following: (1) Actions that increase competition from invasive species as many of the species addressed in this rule are threatened by invasion of nonnative species (CNDDB 2001). (2) Alteration of natural hydrology such as construction of dams or other structures that artificially increase the length of vernal pool inundation or construction of ditches that artificially drain vernal pools. (3) Human degradation of vernal pools such as off-road vehicle use, dumping, and vandalism that threatens many of the species addressed in this rule.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2013)

Lifespan

Adult: One year (see physical description)

Breeding Season

Adult: March - June (USFWS, 2013)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2005)

Reproduction Narrative

Adult: L. conjugens flowers from March to June (Ornduff 1966, Ornduff 1976) and is self-incompatible (USFWS, 2013). Although L. conjugens has not been the subject of pollinator studies, observations suggest that the same insects visit all outcrossed species of Lasthenia, rather than concentrating on any particular species (Thorp 1976). Insect visitors to flowers of

Lasthenia belong to five orders: Coleoptera, Diptera, Hemiptera (true bugs), Hymenoptera, and Lepidoptera (Thorp and Leong 1998). Most of these insects are generalist pollinators. All of the specialist pollinators of Lasthenia are solitary bees (family Andrenidae); these pollinators include two species in the subgenus Diandrena (Andrena submoesta and A. puthua) and five or six species in the subgenus Hesperandrena (Andrena baeriae, A. duboisi, A. lativentris, and two or three undescribed species) (Thorp and Leong 1998) (USFWS, 2005).

Habitat Type

Adult: Wetland (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow vernal pools (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Typically occurs < 200 ft. elevation, but may occur up to 1465 ft. (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits vernal pools in open grassy areas at elevations up to 470 m (NatureServe, 2015). Lasthenia conjugens typically grows in vernal pools, swales, and low depressions in open valley and foothill grasslands and have been found in three types of vernal pools: Northern Basalt Flow, Northern Claypan, and Northern Volcanic Ashflow (Sawyer and Keeler-Wolf 1995). This species is commonly found at elevations less than 61 meters (m) (200 feet (ft)) but has been documented at 445 m (1465ft) in Napa County and at 137 m (450ft) in Monterey County (CNDDB 2012)(USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms in Lasthenia conjugens are unknown. However, the lack of a pappus or even hairs on the achenes makes wind dispersal unlikely (Ornduff 1976) (USFWS, 2005).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

25 presumed extant occurrences (USFWS, 2024)

Population Narrative:

Of the 23 presumed extant records, four occurrences may now be extirpated: (1) an occurrence in Mendocino County has not been observed since 1937; (2) an occurrence in Alameda County has not been observed since 1959; (3) in 1987, a single plant was observed in Napa County and

has not been documented since; (4) an occurrence in Solano County was noted on a field checklist in1996 and the location is unknown (CNDDB 2012). Ramp Neale et al. (2008) found high levels of genetic diversity and moderate levels of differentiation among populations (USFWS, 2013). Currently, the distribution of the species remains as described in our 2013 status review. The Diversity Database now reports 36 occurrences of Contra Costa goldfields (Appendix A; Diversity Database 2023, entire). The two occurrences (occurrences #45 & 46) added to the Diversity Database since the 2013 status review are found in Solano County in proximity to other known occurrences on Travis Air Force Base and are mapped as "transplanted populations" (Diversity Database 2023, p. 41). These occurrences do not represent new populations of Contra Costa goldfields, but are part of ongoing conservation efforts and mitigation for projects on Travis Air Force Base (Collinge 1999, entire) (discussed in Conservation Efforts). These transplanted occurrences are within the previously known range of the species and do not change our understanding of the distribution of the species. Seven occurrences continue to be considered extirpated and four are considered potentially extirpated (Diversity Database 2023, entire). The majority of the presumed extant occurrences are located in Solano County, where 13 occurrences are presumed extant (Diversity Database 2023, pp. 4–41). Other large concentrations of occurrences are in Monterey County and Alameda County, each with three occurrences (Diversity Database 2023, p. 25). Of the 25 presumed extant records, 4 occurrences may now be extirpated having not been seen for some time or the exact location is unknown (Diversity Database 2023, p. 39): (1) An occurrence (occurrence #16) in Mendocino County has not been observed since 1937; (2) An occurrence (occurrence #37) in Alameda County has not been observed since 1959; (3) A single plant (occurrence #21) was observed in Napa County in 1987 and has not been documented since; and (4) An occurrence (occurrence #43) in Solano County was noted on a field checklist in 1996 and the specific location of the occurrence is unknown. The distribution of Contra Costa goldfields is uncertain due in part to the difficulty of relocating sites and because this species may reappear on a site after several years of it being absent. In December 2022, Vollmar Natural Lands Consulting, as part of the Contra Costa goldfields captive propagation and reintroduction to Contra Costa County project (discussed in Conservation efforts), conducted a status survey of 20 subpopulations associated with 9 known Contra Costa goldfields occurrences (occurrences # 1, 3, 7, 20, 23, 24, 30, & 33). Data from these status surveys have not yet been added to the Diversity Database. Their findings are in line with previous understanding of Contra Costa goldfields habitat requirements. They found that while Contra Costa goldfields occurs in a wide range of habitats, all occupied sites have similar characteristics: grassland habitat grazed by cattle, seasonally wetted soils, and fine-grained soil with high clay or silt content that is likely alkaline. Abundance: The final listing rule provided no abundance data for Contra Costa goldfields. The 2008 status review stated that informal status surveys had occurred at five occurrences and that annual monitoring had been initiated at various localities in Solano County in support of development of the Solano Habitat Conservation Plan (Service 2008, p. 14). The 2013 status review presented the results of informal status surveys conducted at several occurrences and monitoring data for the five Solano County occurrences that were censused annually for 3- or 4-year periods between 2006 and 2011 (Service 2013, p. 6). Overall, Contra Costa goldfields population size can vary greatly season to season based on rainfall and other site-specific factors (e.g., prevalence of invasives, thatch ground cover, grazing practices, etc.). Only a few of the known occurrences have long term monitoring in place from which population dynamics and trends can be identified, which are described below. Initial abundance estimates from the Contra Costa goldfields captive propagation and reintroduction to Contra Costa County project (discussed in Conservation efforts) are presented in Appendix A. Additional years of

monitoring are needed to better understand the population dynamics and trends at these locations (Vollmar 2022, pp. 5– 6). The 2019 annual report for the Noonan Ranch Conservation Bank (Conservation Bank) in Solano County, California, was submitted to the Service by LSA Associates, Inc. in February 2020. The report includes the results of the initial years (2008–2013 and 2019) of long-term monitoring for the Contra Costa goldfields population at the Conservation Bank (Occurrence #24). Monitoring for Contra Costa goldfields on the Conservation Bank will continue every five years. Table 1 below provides a summary of the monitoring results through 2019. According to the report, Contra Costa goldfields continues to occur in the majority of the wetlands on the Conservation Bank with distribution, emergence, and density varying within individual wetlands (LSA 2020, entire). Contra Costa goldfields populations are only found within wetlands with specific hydrologic characteristics (LSA 2020, pp. 2–6). Average percent cover on the Conservation Bank during this time period varied from 9.9 percent in 2012 to 31 percent in 2019 (LSA 2020, pp. 2–5). This variation in average percent cover is largely attributed to the number of small wetlands present on the Conservation Bank in a given year. The number of small wetlands with conditions suitable for Contra Costa goldfields germination and growth on the landscape is highly dependent on the seasonal timing of rainfall (USFWS, 2024).

Threats and Stressors

Stressor: Habitat destruction and modification (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: One of the primary threats to L conjugens is conversion of landuse, for example residential and industrial development, wetland drainage, and agricultural land conversion (including vineyards) (USFWS 2008). Since 65% of this species occurs on private land and is not protected, this is an ongoing problem (USFWS 2008). Just as significant are such associated threats as introduced invasive plants (like Italian ryegrass and waxy mannagrass), recreational uses (such as off-road, equestrian, and mountain bike traffic), road construction and widening, and the resulting habitat fragmentation (USFWS 2008). Other threats to the species include landfill expansion, gravel mining, and both intensive grazing practices and the lack of grazing (USFWS 2008). Moderate grazing (in stocking numbers, frequency, and duration) is important to keeping invasive plants in check and improving soil conditions when burning is not possible (USFWS 2008) (NatureServe, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, the Service believes other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2013).

Stressor: Invasive plants (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: Competition from invasive plant species poses a primary threat to this species. Non-native grasses occur commonly in vernal pool complexes and have become a threat to native vernal pool species through their capacity to change pool hydrology. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture. Lolium multiflorum and Glyceria declinata (waxy mannagrass) increase thatch buildup, which leads to increased oxygen depletion in the pools (Dunne and Leopold 1978) and contributes to the shortening of inundation periods through increased evapotranspiration (Marty 2005). As vernal pool complexes become surrounded by residential development and disturbed habitat, the likelihood of invasion by nonnative plants increases (Zedler and Black 2004) (USFWS, 2013).

Stressor: Inappropriate grazing regimes (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Both lack of grazing and excessive grazing may cause an increase in organic matter in the habitat that can eliminate the natural vernal pool invertebrate community and promote opportunistic and invasive nonnative species, such as Lolium spp., that outcompete the obligate vernal pool species (Rogers 1998; Rogers 2006). The cessation of cattle grazing has been found to exacerbate the negative effects of invasive non-native plants on vernal pool inundation period. Appropriate levels of grazing may help maintain soil conditions and limit the amount of thatch accumulation near vernal pools (Rogers 2006). Increased grass cover in and around ungrazed pools may lead to an increase in evapotranspiration rates, resulting in a decreased hydroperiod (Marty 2005). In areas where long-term grazing has been in effect, moderate grazing (in both stocking numbers and amount of time) may be an important tool in combating non-native plant species, when burning is not an option. Moderate grazing may be a necessary tool to maintain the species diversity of the natural vernal pool ecosystem (Marty 2005) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). Lasthenia conjugens is dependent upon vernal pool wetlands that signify the importance of water availability on the survival and recovery for this species. If California receives more rainfall through intense precipitation events, suitable vernal pool habitat for L. conjugens may increase, which would benefit the species. However, if California enters into a drying trend, the resulting droughts could adversely affect L. conjugens. While drought conditions are a normal part of environmental variability in California, a severe drought would exacerbate adverse effects associated with small, disjunct populations of Lasthenia conjugens, and would place additional strains on vernal pool ecosystems (USFWS, 2013).

Recovery

Reclassification Criteria:

1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. 1A. Suitable vernal pool habitat within each prioritized core area for the species is protected. 1B. Species localities distributed across the species' geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. 1C. Reintroduction and introductions must be carried out and meet success criteria. 1D. Additional localities that are detected (and determined essential to recovery goals) are permanently protected. 1E. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2013).

2. Adaptive Habitat Management and Monitoring: 2A. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E. 2B. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.). 2C. Monitoring indicates that ecosystem function has been maintained in areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of postdrought monitoring. 2D. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2013).

3. Status Surveys: 3A. Status surveys, 5-year reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multiyear period that includes above average, average, and below average local rainfall, a multiyear drought, and a minimum of 5 years of post-drought monitoring. 3B. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2013).

4. Research: 4A. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. 4B. Research on genetic structure has been completed (for species where necessary - for reintroduction and introduction, seed banking) and results incorporated into a habitat protection plan to ensure that within- and among-population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in sections 1A-E. 4C. Research necessary to determine appropriate parameters to measure population viability for each species has been

completed (USFWS, 2013).

5. Participation and Outreach: 5A. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. 5B. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. 5C. Participation plans for each vernal pool region have been completed and implemented. 5D. Vernal pool region working groups have developed and implemented outreach incentive programs that develop partnerships contributing to achieving recovery criteria 1- 4 (USFWS, 2013).

Recovery Priority Number: 5C

Delisting Criteria:
See reclassification criteria.

Recovery Actions:

- Protect vernal pool habitat in the largest blocks possible from loss, fragmentation, degradation, and incompatible uses (USFWS, 2005).
- Manage, restore, and monitor vernal pool habitat to promote the recovery of listed species and the long-term conservation of the species of concern (USFWS, 2005).
- Conduct range-wide status surveys and status reviews for all species addressed in this recovery plan to determine species status and progress toward achieving recovery of listed species and long-term conservation of species of concern (USFWS, 2005).
- Conduct research and use results to refine recovery actions and criteria, and guide overall recovery and long-term conservation efforts (USFWS, 2005).
- Develop and implement participation programs (USFWS, 2005).
- L. conjugens occurrences that are currently protected and managed for the benefit of the species include: (1) the North Suisun Mitigation Bank, in Solano County, (2) Travis AFB, in Solano County, (3) the State Route 4 Preserve, in Contra Costa County, (4) Don Edwards San Francisco Bay NWR, in Alameda County, and (5) the former Fort Ord, in Monterey County. Protection of additional localities of this species is necessary to recover this species. Protecting occurrences in Sonoma, Marin, and Napa Counties should be a priority over the next five years, as this is the northwestern edge of the species' range, and no occurrences in these counties are protected at this time (USFWS, 2013).
- Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans (USFWS, 2013).
- Conduct research at as many of the presumed extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of L. conjugens and other listed vernal pools plants. c. Conduct further research on the genetic structure of the species to determine the feasibility of introducing L. conjugens to biologically appropriate vernal pool regions and soil types from which status surveys

indicate the species has been extirpated (USFWS, 2013).
- Regional vernal pool working groups should be created in regions where L. conjugens is known to occur to aid with monitoring and management efforts (USFWS, 2013).
- Conduct additional research on how L. conjugens is pollinated. If certain insects are found to be important to pollination, and therefore to seed production, their habitat must be protected in each core area to contribute to the recovery of L. conjugens (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Contra Costa goldfields. Some of these recommendations have already been discussed in previous recovery documents (Service 2013, pp. 28–29) and remain valid. 1. The majority of known localities of this species are on private land and not protected. Protection of additional localities is necessary to recover this species. Protecting occurrences in Sonoma, Marin, and Napa counties should be a priority over the next five years, as this is the northwestern edge of the species' range, and no occurrences in these counties are protected at this time. 2. Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. 3. Conduct monitoring and research at as many of the presumed extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species and will aid in the development of methods to ameliorate these threats. b. Conduct research on invasive weedy plant species to determine the most appropriate methods to control these plants and increase population numbers of Contra Costa goldfields and other listed vernal pool plants. c. Conduct further research on the genetic structure of the species to determine the feasibility of introducing Contra Costa goldfields to biologically appropriate vernal pool regions and soil types from which status surveys indicate the species has been extirpated. 4. Regional vernal pool working groups should be created in regions where Contra Costa goldfields is known to occur to aid with monitoring and management efforts. 5. Conduct additional research on how Contra Costa goldfields is pollinated. If certain insects are found to be important to pollination, and therefore to seed production, their habitat should be protected in each core area to contribute to the recovery of Contra Costa goldfields. 6. Expand studies on captive propagation and reintroduction to areas outside of Contra Costa County (USFWS, 2024).

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SPECIES ACCOUNT: *Layia carnosa* (Beach layia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/2/2022; Pacific Southwest (R8) (USFWS, 2022)

Physical Description

The unbranched to highly branched plants range up to 6 inches tall and 16 inches across. Characteristics distinguishing Layia carnosa from similar species include its fleshy leaves, inconspicuous flower heads with short, 0.08 to 0.1 inch long white ray flowers and yellow disk flowers, and bristles around the top of the one-seeded achene, or dry fruit (USFWS 1998). The number of seed-heads on individual plants varies with plant size. Typically unbranched, short plants on dry, exposed sites will produce a single head, while highly branched plants in moist dune hollows may produce more than 100 heads (USFWS, 2012).

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2012). In 1841, Thomas Nuttall described this species as Madarog/ossa carnosa based on specimens he collected in 1835. In 1843, John Torrey and Asa Gray transferred this species to the genus Layia. In 1892, Edward Greene transferred it to the genus Blepharipappus. However, subsequent taxonomic considerations ofthis species agreed with Torrey and Gray (Munz and Keck 1959; Ferris 1960) (USFWS, 1998).

Historical Range

California endemic; Humboldt, Monterey, Marin, and Santa Barbara counties. Believed to be extirpated from San Francisco county (NatureServe, 2015).

Current Range

The current distribution includes occurrences spread across six very isolated dune systems (Freshwater Lagoon, Humboldt Bay, mouth of the Mattole River, Point Reyes, Monterey Peninsula, Vandenberg [a part of the Guadalupe-Nipomo Dunes), over about 500 miles of shoreline in northern and central California. Beginning at Freshwater Lagoon Spit in northern Humboldt County, Layia carnosa occurs intermittently over 70 miles of shoreline as far south as the mouth of the Mattole River. From there, it jumps some 170 miles to Point Reyes NS (Marin County), and then another 120 miles to the Monterey Peninsula (Monterey County). From Monterey, a gap of about 150 miles separates it from the southernmost site at Vandenberg AFB, in Santa Barbara County. Five historical occurrences located in San Francisco, Monterey and Humboldt counties are believed to have been extirpated (U.S. Department of the Interior 1998) (USFWS, 2012).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (based on closely related species) (NatureServe, 2015)

Lifespan

Adult: One year (USFWS, 2012)

Breeding Season

Adult: April - June (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Spring rains (NatureServie, 2015)

Reproduction Narrative

Adult: Based on other Layia species, which are self-incompatible, this species would be an obligate outcrosser. It is dependent on spring rains as an annual (NatureServe, 2015). As a winter annual, Layia carnosa germinates during the rainy season between fall and mid-winter, blooms in spring (April to June), and completes its life cycle before the dry season (USFWS, 2012). The number ofseed-heads on individual plants varies with plant size, ranging from unbranched, short, erect plants on dry, exposed sites with a single head to highlybranched plants in moist hollows in dunes with over 100 heads (USFWS, 1998).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Coastal sand dune (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Excessive shading (inferred from USFWS, 2012); typically occurs between 0 - 100 ft. elevation (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Patchy colonies (USFWS, 2012)

Environmental Specificity

Adult: Very narrow (Natureserve, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2012)

Habitat Narrative

Adult: The environmental specificity is very narrow; it is only known from narrow coastal strand in three main areas in California (NatureServe, 2015). Populations tend to be patchy and subject to large annual fluctuations in size and dynamic changes in local distribution associated with the shifts in dune blowouts, remobilization, and natural dune stabilization that occur in the coastal dune ecosystem. Colonies often occur where sparse vegetation traps wind-dispersed seeds, but causes minimal shading. Layia carnosa is restricted to openings in coastal sand dunes ranging in elevation from 0 to over 100 feet, where it colonizes sparsely vegetated, semi-stabilized dunes and blowouts. The species often occurs in narrow bands of moderately disturbed habitat along

the edges of trails and roads (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are dispersed by wind mostly during late spring and summer months (USFWS 1998; USFWS, 2012).

Population Information and Trends

Population Trends:

Decline of 50-70% (NatureServe, 2015); stable distribution since listing (USFWS, 2012)

Number of Populations:

18 (NatureServe, 2015)

Population Size:

Unknown, > 10 million (USFWS, 2012)

Adaptability:

Low (NatureServe, 2015)

Population Narrative:

Highly vulnerable due to annual habit and sensitivity of coastal habitat. Long term trend is severe decline (50-70%). Numbers of this annual fluctuate depending on spring rain and available open sand. In 2005, the CNDDB knew of 24 total EO's, 6 of which were historical or extirpated (NatureServe, 2015). No significant change in the distribution of Layia carnosa has occurred since the species was listed. Accurate estimation of population size is difficult and costly for diminutive, short-lived annual species such as Layia carnosa, which tends to occur in small patches scattered across large areas of habitat. Overall total habitat occupied by Layia carnosa, based on data collected between 1999 and 2010, is estimated on the order of 456 acres, which may be conservative given the difficulty in detecting the plant and conducting thorough surveys. The Humboldt Bay population clearly is the largest across the range, likely exceeding 10 million individuals. The population at the mouth of the Mattole, estimated in the millions, occupies about 27 acres, and at least for the present, is relatively free of invasive species. The Point Reyes population has not been accurately censused, but appears to number in the 10’s of thousands or higher (USFWS, 2012).

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The threat of off-road vehicles has reduced significantly, with the exception of some of the privately held habitat located in Humboldt County. The remaining occupied habitat most susceptible to human destruction or modification includes the dunes located near the mouth of McNutt Gulch, and the Signal Hill Dunes on the Monterey Peninsula. Although livestock trampling

was indicated as a threat when Layia carnosa was listed, the only population known to be currently exposed to livestock is near the mouth of McNutt Gulch. No information is available on the size of that population, or degree of impacts by livestock. Many populations of Layia carnosa across its range continue to be impacted by uncontrolled pedestrian or equestrian traffic. However, evidence suggests that, for many sites where natural dune processes may be lacking, at least some recreation-related mortality may be a necessary consequence of the need for adequate disturbance to preclude overstabilization of the habitat. Acute levels of foot traffic clearly directly eliminate Layia carnosa from the center of traveled pathways, but at the same time, monitoring data and anecdotal evidence has consistently documented a strong preference by Layia carnosa for moderately disturbed habitat located along roads and trails (whether pedestrian or equestrian) in what otherwise would be unoccupied habitat.

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: It is expected that sea level may rise at least 16 inches along the California coast by 2050, with a 50-inch rise predicted by 2100 (Heberger et al. 2009). Beyond the direct influence of ocean-rise in potentially inundating the lower range of Layia carnosa habitat, even small changes in water level may cause significant changes in wave energy and the potential for shoreline damage from wave forces (California Coastal Commission 2001). Another coastal process that has the potential to affect Layia carnosa habitat, at least at Humboldt Bay, is vertical land deformation. Recent investigation suggests that deformation is occurring both during and between seismic events, and appears to vary in its direction (i.e., subsidence or uplift) and magnitude across the bay region (Walters 2011). Enhanced dune erosion may already be occurring in portions of the Humboldt Bay dune system, evidenced by the recent development of two unusually large, moving dune blowouts that show no sign of stabilizing, as well as a general loss of dune habitat on the North Spit (A. Pickart, pers. comm. 2011b) (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: While those and other statutes (CEQA, California Coastal Act, Federal Coastal Zone Management Act) all provide limited protections for Layia carnosa on private and public property, many of its current threats are either unregulated, or of a kind not affected by land use regulations (invasive species encroachment, pedestrian impacts). Thus regulatory restrictions, even when applicable, are currently inadequate to conserve this species (USFWS, 2012).

Stressor: Invasive plants (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Layia carnosa was listed, in part, due to the past introduction and invasion of its habitat by a variety of invasive, non-native plant species. These species threaten virtually the entire distribution of Layia carnosa, through direct competition for space, stabilization of the dunes, and in some cases, enrichment of the soils which then stimulates invasion by other aggressive species. In Humboldt County the primary threats are invasive annual grasses,

European beachgrass, yellow bush lupine, iceplant, and jubata grass (Cortaderia jubata). Iceplant, annual grasses, and in some cases European beachgrass, are the primary threats farther south in its range. Evidence suggests these taxa will continue to invade Layia carnosa habitat, necessitating routine and long-term management action. While the threat posed by invasive species has been addressed to some extent, at least temporarily, no mechanism has been implemented which ensures continued funding and implementation of an invasive species control program, or the monitoring necessary to effectively implement such a program (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Annual species such as Layia carnosa are vulnerable to random fluctuations (stochasticity) and variation in annual weather patterns or other environmental factors (USFWS 1998). All of the Monterey and Santa Barbara County populations, and the Freshwater Lagoon Spit site in Humboldt County, due to their relatively small size and area of occupied habitat, continue to be vulnerable to stochastic extinction (USFWS, 2012).

Recovery

Reclassification Criteria:
Not available

Recovery Priority Number: 8

Delisting Criteria:
Protection ofhabitat presently occupied by the species, with long-term commitments to conserving the species and the native vegetation (USFWS, 1998).

In protected habitat, successful control ofinvasive non-native plants (and snails) and successful management oflesser problems, including grazing, pedestrians, and off-road vehicles. Management success must be demonstrated through ten years of biological monitoring. The time is needed to observe the effectiveness ofmanagement in dry and wet years (USFWS, 1998).

The threatened Chorizanthe pungens var. pungens may be considered for delisting when permanent protection has been implemented, as currently planned, in the Fort Ord disposal and reuse process and the coastal populations receive protected status (USFWS, 1998).

Recovery Actions:
- Protect existing populations and habitats (USFWS, 1998).
- Minimize the threats to the plants and butterfly (USFWS, 1998).
- Develop management strategies incorporating ecological and land use strategies (USFWS, 1998).
- Manage populations and habitats to achieve delisting (USFWS, 1998).
- Monitor population trends to evaluate recovery success (USFWS, 1998).
- Coordinate recovery actions to protect other listed and sensitive species (USFWS, 1998).

- Develop and implement an outreach program (USFWS, 1998).
- Continued collaboration with Redwood NP, CDPR, BLM, Manila CSD, City of Eureka, Point Reyes NS, Vandenberg AFB, and perhaps private landowners is essential to the successful recovery of this species (USFWS, 2012).
- The type locality population for Layia carnosa at the Point Pinos dunes has not been detected since 1919 (CDFG 2007). The Point Pinos dunes are currently undergoing restoration and endangered species augmentation as part of a plan related to expansion of the golf course and transfer of the property from the US Coast Guard to the City of Pacific Grove. Unfortunately Layia carnosa was not included in the restoration plan. An attempt should be made to reintroduce Layia carnosa to Point Pinos from seed collected at nearby Asilomar SB or Indian Dunes. Whether or not the recovery goal for that population can be met is unknown. However, the attempt to establish a vigorous population there is called for under one of the delisting criteria, and could reestablish a historically significant population. In addition, the planned reintroduction of Layia carnosa to restored habitat near the historical occurrence at the mouth of Little River should be pursued (Forys 2006) (USFWS, 2012).
- Population and Occupied Habitat Inventories: Habitat owned by the USFWS, BLM, City of Eureka, Manila CSD, Point Reyes NS, CDPR and Pebble Beach Company (Indian Village Dunes) have been the focus of one or more dunes restoration projects. Periodic reassessment of these populations and occupied habitat at these sites, employing consistent methodology, is critical to establish trends, provide feedback on the restoration efforts, and determine whether the current recreational management is compatible with conservation of the species. Baseline population and habitat inventories are needed for the City of Eureka Elk River Spit, the privately held dunes near the mouth of McNutt Gulch, and the Signal Hill site owned by Pebble Beach Company on the Monterey Peninsula. Where populations are too large to census, a uniform methodology similar to that utilized by the USFWS and BLM at Humboldt Bay should be adopted (USFWS, 2012).
- Disturbance Monitoring: Habitat disturbance is known to be a necessary element in the ecology of Layia carnosa; however, too much or too little disturbance is detrimental. Therefore, in order to effectively tailor recreational management to the needs of Layia carnosa, quantitative data are needed indicating its response to specific recreational use. Research is needed to measure the rate of establishment and mortality of Layia carnosa in response to varying types and levels of disturbance (USFWS, 2012).
- Priorities for increased protection, by fee acquisition, conservation easement, or other legal protective mechanism, include: • Signal Hill Dunes, on the Monterey Peninsula • City of Eureka dunes habitat located on the North Spit, and Elk River Spits of Humboldt Bay. • Private owned dunes habitat on the North Spit of Humboldt Bay, and north of the mouth of the Mattole River. The monitoring and restoration conservation easement proposed by Pebble Beach Company as part of the Spyglass Hill Golf Course project could serve as a template for future agreements needed to ensure future conservation of critical dunes habitat for this species. Such agreements would in many cases contribute to recovery of multiple listed species, including the Monterey spineflower (Chorizanthe pungens var. pungens, sand gilia (Gilia tenuiflora ssp. arenaria), Tidestrom's lupine (Lupinus tidestromii) and Menzies' wallflower (Erysimum menziesii ssp. menziesii) on the Monterey Peninsula; Tidestrom's lupine at Point Reyes NS; and Menzies wallflower (E. m. Eurekense) in the Humboldt Bay portion of the range (USFWS, 2012).

- Due to the vulnerability of its habitat to stabilization by invasive species, and as a result, the highly transient nature of its habitat, the requirement to ensure future maintenance of Layia carnosa habitat is paramount to the recovery effort. It is imperative that efforts to control invasive species continue across the range, and that restoration methods incorporate the most cost-effective means available. Manual removal, or where existing populations will not be impacted, mechanical removal or burning followed with herbicide post-treatment has shown to be particularly effective. The problem species could change overtime, but inevitably, encroachment by invasive species and resulting over-stabilization of its habitat will continue to threaten Layia carnosa in perpetuity. Therefore, habitat monitoring followed by removal of invasive species, when warranted, must be considered a permanent element in maintaining Layia carnosa, even after the delisting (USFWS, 2012).
- Efforts should be made to determine which of the following three options for ensuring long-term protection best applies to individual sites and ownership: 1) endowment of conservation easements specifically written to include the necessary monitoring and habitat maintenance needed to conserve the species; 2) incorporation of language within the management guidance documents for each of the agencies that own property supporting significant populations of Layia carnosa, which emphasizes invasive species monitoring and control efforts in perpetuity, and at least some level of Layia carnosa population monitoring, even after it is delisted; 3) implementation of conservation agreements which combine the necessary elements of the above two options in ensuring future maintenance of Layia carnosa habitat after it is delisted (USFWS, 2012).
- Permanent Funding: With respect to the privately held habitat, the level of funding necessary to adequately monitor Layia carnosa populations and habitat, and implement maintenance actions prior to onset of population decline needs to be determined. Opportunities should then be pursued to secure permanent funding in the form of an endowment or trust fund, which ensures that the responsive management is conducted in perpetuity (USFWS, 2012).
- The California Shoreline Mapping Project, implemented in 2010, will provide high resolution LIDAR photography enabling development of accurate DEM's (California Ocean Protection Council 2011). Those data should be analyzed in conjunction with occupied habitat maps and periodic population monitoring data for sites across the range, particularly the Humboldt Bay, Mattole River, and Point Reyes populations, to help evaluate future trends in population and habitat as they correlate with elevation (USFWS, 2012).
- Future dunes habitat restoration projects across the range, but most importantly at Humboldt Bay, the mouth of the Mattole River, and at Point Reyes should utilize elevation data available from the DEM for those areas, and begin focusing restoration efforts in areas at sufficient elevation, and if possible, located geographically so as to insulate Layia carnosa as much as possible from the effects of ocean-rise (USFWS, 2012).
- Research should include a comparison of climate and soil factors, and other factors that may affect reproductive success in populations of Layia carnosa, both at the limits of its range, and within the center of its range (for example, Humboldt Bay). As soon as those results are available, the feasibility and practicality of meeting the existing delisting recovery criteria for the species should be evaluated, and recommendations made regarding adequacy of the existing recovery criteria (USFWS, 2012).
- Focused inventories for Layia carnosa should be conducted at all the significant dune systems located along the coast between the Monterey Peninsula and Vandenberg AFB, which constitutes a 150 mile long gap in the known distribution for the species (USFWS,

2012).

- Initial efforts have been made to restore near-shore dunes habitat at Vandenberg AFB, and expand the relatively small population of Layia carnosa. The results of the Layia carnosa life history study, scheduled to be initiated in fall 2011, hopefully should indicate whether range limiting factors, or simply the absence of an appropriate disturbance regime is preventing this population from expanding. Due to the fact it is the southernmost site for the species, and in accordance with the recovery plan, seed from this site should be deposited at an approved seedbank as soon as adequate seed are available (USFWS, 2012).

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SPECIES ACCOUNT: *Leavenworthia crassa* (Fleshy-fruit gladecress)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 8/1/2014

Physical Description

A winter annual from a basal rosette of leaves. Flowers (March-May) are whitish-yellow with yellow to orange claws. the first flowers are borne on erect stalks; those forming later usually are borne in loose clusters on true stems arising from the axils of the rosette leaves. Fruits are fleshy, 6-12 mm long. (NatureServe, 2015)

Taxonomy

Two questionably distinct varieties (crassa and elongata) are often recognized (e.g., Rollins, 1993; Kartesz 1994 and 1999). The USFWS (2004) does not maintain the varieties, citing evidence that the ranges of variation in fruit lengths overlap (McDaniel and Lyons, unpublished status report, 1987). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to a 13-mile radius area in Lawrence and Morgan counties in northwest Alabama. (NatureServe, 2015)

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Leavenworthia crassa under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Alabama (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for Leavenworthia crassa includes seven CHUs in Lawrence and Morgan Counties, Alabama. This species critical habitat encompasses approximately 20.6 acres (ac) (8.4 hectares (ha)) (79 FR 50990-51039).

Unit 1: Bluebird Glades: Unit 1 consists of 0.2 ha (0.5 ac) of privately owned land located in southeast Lawrence County, Alabama. The unit contains two subpopulations and is located along Alabama State Route 157 approximately 3.5 km (2.2 mi) southeast of the intersections of State Routes 36 and 157, approximately 3.7 km (2.3 mi) southwest of Danville, Alabama. These plants are located within a highly disturbed, limestone glade within a former mobile home site. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glades

and possible changes in land use, including road widening or development. Due to human-caused disturbances, exotic species, most notably Chinese privet and Japanese honeysuckle, threaten this site (Schotz 2009, pp. 13–14).

Unit 2: Stover Branch Glades: Unit 2 consists of 3.2 ha (7.8 ac) of privately owned land located in southeast Lawrence County, Alabama. The unit contains two subpopulations; one subpopulation is located on the southwest side of County Road 203 approximately 1.4 km (0.9 mi) southsoutheast of Alabama State Route 157, and one subpopulation is located along the southwest side of State Route 157, approximately 1.6 to 2.1 km (1 to 1.3 mi) southeast of State Route 36, in Speake, Alabama. These subpopulations are located within a pasture and are actively maintained by livestock grazing. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 15–16).

Unit 3: Indian Tomb Hollow Glade: Unit 3 consists of 0.5 ha (1.1 ac) of federally owned land located within the Bankhead National Forest in Lawrence County, Alabama. The unit is located on the west and northwest side of County Road 86 at a point roughly 4.5 km (2.8 mi) south of State Route 36 near Speake, Alabama. Habitat in this unit consists of a relatively small glade characterized by a flat limestone outcrop that is heavily buffered by nearly impenetrable tangles of eastern red cedar and upland swamp privet. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The U.S. Forest Service provides management to control encroachment of invasive species (PCE 3). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glade and damage from vehicles. Moderate encroachment of exotic species, most notably Chinese privet and Japanese honeysuckle, threatens this site along the glade periphery (Schotz 2009, pp. 18–19). This site also shows minimal incidence of trash disposal and damage from recreational vehicles.

Unit 4: Cedar Plains South: Unit 4 consists of 0.04 ha (0.1 ac) of privately owned land located in Morgan County, Alabama. This unit is located on Cedar Plains Road, 1.2 km (0.75 mi) south of County Road 55 and approximately 8 km (5 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. This population represents an excellent landscape context but contains the smallest number of plants of any of the known occurrences. Habitat in this unit consists of a well-lighted limestone glade opening (PCE 2) located within a limestone forest primarily comprised of eastern red cedar and various other hardwoods. Herbaceous vegetation characteristic of glade communities is present within the well-lighted glade (PCE 1), and competition and shading from native and invasive, nonnative plants are currently not a threat to the habitat in this unit (PCE 3). The features essential to the conservation of the species in this unit may require special management considerations or protections to prevent future adverse effects due to competition and shading caused by encroachment of native and invasive, nonnative plants.

Unit 5: Cedar Plains North: Unit 5 consists of 1.7 ha (4.2 ac) of privately owned land located in Morgan County, Alabama. This unit is located on Cedar Plains Road, from 0.6 to 1 km (0.4 to 0.6 mi) north of County Road 55, approximately 8 km (5 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. These populations are located within a pasture and are actively maintained by livestock grazing. Well-lighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. This glade complex, although subjected to ongoing agricultural interests, represents the greatest concentration of plants currently known for the species. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 23–24).

Unit 6: Massey Glade: Unit 6 consists of 2.75 ha (6.8 ac) of privately owned land located in Morgan County, Alabama. This unit is located on County Road 55, 0.3 to 0.6 km (0.2 to 0.4 mi) west of Cedar Plains Road, approximately 8.3 km (5.2 mi) west of the junction of U.S. Highway 31 and County Road 55 in Falkville. This population is located within a highly disturbed complex of limestone pavement barrens scattered in an actively utilized pasture and within the yards and fields of nearby homes. Welllighted, open areas (PCE 2), with shallow soils and exposed limestone bedrock or gravel that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of invasive species into open glades and incompatible livestock grazing. Invasive species encroachment and continuous livestock grazing during the plant's reproductive cycle constitute ongoing threats to this site (Schotz 2009, pp. 25–26).

Unit 7. Hillsboro Glade: Unit 7 consists of 0.04 ha (0.1 ac) of privately owned land in Lawrence County, Alabama. This unit is currently occupied and is located within a powerline right-of-way approximately 400 feet south of the intersection of County Roads 217 and 222, near Hillsboro. Habitat in this unit consists of a relatively small limestone glade outcrop within a powerline right-of-way that is bordered by a forested area. Wellilluminated, open areas (Primary Constituent Element (PCE 2), with shallow soils and exposed limestone bedrock that are dominated by characteristic glade vegetation (PCE 1), are present within the unit. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of the invasion of exotic species into open glades, indiscriminate herbicide use or mowing for electrical transmission line right-of-way maintenance, and possible changes in land use, including agriculture or development.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Leavenworthia crassa critical habitat consists of three components (79 FR 50990-51039):

(i) Shallow-soiled, open areas with exposed limestone bedrock or gravel that are dominated by herbaceous vegetation characteristic of glade communities.

(ii) Open or well-lighted areas of exposed limestone bedrock or gravel that ensure fleshy-fruit gladecress plants remain unshaded for a significant portion of the day.

(iii) Glade habitat that is protected from both native and invasive, nonnative plants to minimize competition and shading of fleshy-fruit gladecress.

Special Management Considerations or Protections

The features essential to the conservation of fleshy-fruit gladecress may require special management considerations or protection to reduce the following threats: (1) Actions that remove the soils and alter the surface geology of the glades; (2) building or paving over the glades; (3) construction or excavation up slope that alters water movement (sheet flow or seepage) down slope to gladecress sites; (4) planting trees adjacent to the edges of an outcrop resulting in shading of the glade and accumulations of leaf litter and tree debris; (5) encroachment by nonnative and native invading trees, shrubs, and vines that shade the glade; (6) the use and timing of application of certain herbicides that can harm gladecress seedlings; and (7) access by cattle to gladecress sites where habitat and plants may be trampled. Management activities that could ameliorate these threats include (but are not limited to): (1) Avoiding limestone glades when planning development, conversion to agriculture, and other disturbances to glade complexes; (2) avoiding above-ground construction and/or excavations in locations that would interfere with natural water movement to gladecress habitat sites; (3) locating suitable habitat and determining the presence or absence of the species and identifying areas with glade complexes and protecting or restoring as many complexes as possible; (4) reaching out to all landowners, including private and State landowners, to raise awareness of the plant and its specialized habitat; (5) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; (6) avoiding pine tree plantings near glades; and (7) managing, including brush removal, to maintain an intact native glade vegetation community. More information on the special management considerations for each critical habitat unit is provided in the individual unit descriptions below.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2013)

Reproduction Narrative

Adult: Fleshy-fruit gladecress is an annual, spring-flowering member of the mustard family (Brassicaceae). As an annual, the seeds germinate in the fall, overwinter as rosettes, and commence a month-long flowering period beginning in mid-March. The first seeds mature in late April, and during most years the plants dry and drop all of their seeds by the end of May. It is unlikely that all seeds produced in spring germinate the next fall, but the length of dormancy in the soil is not known (McDaniel and Lyons 1987, p. 10); thus we do not know whether the species is capable of forming a seed bank. Native bees in the families' Andrenidae and Halictidae (sweat bees), including the species Halictus ligatus (sweat bee), were observed carrying pollen from Leavenworthia crassa (fleshy-fruit gladecress) and L. alabamica (Alabama gladecress) in northern Alabama (Lloyd 1965) (USFWS, 2013).

Habitat Type

Adult: Glades (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2013)

Site Fidelity

Adult: High (inferred from USFWS, 2013)

Habitat Narrative

Adult: This species is a component of glade flora and occurs in association with limestone outcroppings. The terms ‘‘glade’’ and ‘‘cedar glades’’ are used interchangeably to refer to shallow soiled, open areas that are dominated by herbaceous plants and characterized by exposed sheets of limestone or gravel. Eastern red cedar (Juniperus virginiana) trees are frequent in the deeper soils along the edges of the glades (Hilton 1997, p. 1; Baskin et al. 1986, p. 138; Baskin and Baskin 1985, p. 1). Glades can vary in size from as small as a few square meters to larger than 1 square kilometer (km2) (0.37 square miles (mi2)) and are characterized as having an open, sunny aspect (lacking canopy) (Quarterman 1950, p. 1; Rollins 1963, p. 5). Historically, glades in northern Alabama occurred as glade complexes where sparsely vegetated patches of exposed, or nearly exposed, limestone occurred in a matrix of woody vegetation to form a mosaic of habitats grading into one another (Hilton 1997, pp. 1, 5, 64). Herbaceous diversity was irregular over these complexes, affected by changes in soil gradient and moisture, and the presence or absence of a woody vegetation component. Few undisturbed examples of this community type remain (Hilton 1997, pp. 5, 8; McDaniel and Lyons 1987, p. 11; Baskin and Baskin 1985, p. 1; Rollins 1963, p. 5–6) (USFWS, 2013). High ecological integrity of the population and site fidelity along with low tolerance ranges are inferred based on this species specific habitat requirements.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Resiliency:

In the Status Quo scenario, resilience is expected to remain the same for most populations in 20 years. While both Danville populations are likely extirpated in the future given the poor condition of all resilience factors, the drastic change in the resilience of the Cedar Plains South population is due population size becoming a limiting factor in the viability of this population. In the Increased Management scenario, resilience for all populations is expected to increase, as habitat management increases both the habitat and land use condition. Even with the downranking of land use condition for populations under private ownership, the majority of populations are assessed to be resilient (e.g., high or very high resilience) under this scenario. In the Introductions scenario, the initial population size of new populations will be determined by

the introduction strategy (number of plants, timing of plantings, locations). The overall resilience of introduced populations in the Introductions scenario cannot be quantitatively assessed at this time. (USFWS, 2020a)

Representation:

Representation and redundancy is reduced for L. crassa in the Status Quo, increased in the Increased Management and could be greatly increased in the Introductions scenario. Under the Status Quo scenario, two resilient populations remain, with one containing both SI and SC individuals, and one with an unknown mating system. The Increased Management scenario does not lose any populations, and resilient populations include one SI, one SI/SC, two SC, and two with an unknown mating system. The Introductions scenario could focus on gathering seed from populations likely to become extirpated under Status Quo that also utilize mating systems that are not well represented, or that better contribute to genetic diversity and adaptive potential (e.g., SI). The total number of resilient populations should increase from three currently to nine under the Introductions scenario, given increased management is also co-occurring. If populations are added at the same rate (three per decade) following the initial 10-year planning period (and all populations are robust), the Introductions scenario could add 12 resilient populations within 50 years. To achieve eight to ten introduced populations in 50 years, the introduction program would need to maintain its momentum, though two to four introduced populations could be below resilient status (not assessed as having high or very high resilience) and the introduction goal could still be met within a 50-year period. (USFWS, 2020a)

Redundancy:

Representation and redundancy is reduced for L. crassa in the Status Quo, increased in the Increased Management and could be greatly increased in the Introductions scenario. Under the Status Quo scenario, two resilient populations remain, with one containing both SI and SC individuals, and one with an unknown mating system. The Increased Management scenario does not lose any populations, and resilient populations include one SI, one SI/SC, two SC, and two with an unknown mating system. The Introductions scenario could focus on gathering seed from populations likely to become extirpated under Status Quo that also utilize mating systems that are not well represented, or that better contribute to genetic diversity and adaptive potential (e.g., SI). The total number of resilient populations should increase from three currently to nine under the Introductions scenario, given increased management is also co-occurring. If populations are added at the same rate (three per decade) following the initial 10-year planning period (and all populations are robust), the Introductions scenario could add 12 resilient populations within 50 years. To achieve eight to ten introduced populations in 50 years, the introduction program would need to maintain its momentum, though two to four introduced populations could be below resilient status (not assessed as having high or very high resilience) and the introduction goal could still be met within a 50-year period. (USFWS, 2020a)

Number of Populations:

8 (USFWS, 2020)

Population Narrative:

Being a seed-banking winter annual, this species has good survival but poor competitive abilities (USFWS 2004). The very low numbers of fruiting individuals seen most years suggest that the populations may be highly vulnerable to stochastic factors as well. The plants are usually self-incompatible (Rollins 1993), thus requiring cross-pollination for seed production. However,

given proper habitat conditions, this species is able to grow and reproduce quickly. More than 50% of the appropriate glade habitat has been lost in north-central Alabama, with only five glades remaining in good condition (Hilton 1997 cited by Everson 2009). Fifteen historical occurrences have been lost. Also, the range may have contracted significantly, if an unconfirmed historical record from Lauderdale County is accepted. Some of the extant occurrences have been degraded by grazing, road construction, and plowing or cultivation (Everson 2009). Decline of 70-90% Population size value left blank for this seed-banking annual because the large number of individuals suggests a sense of security that is not warranted. Abundant locally, with some sites containing thousands of individuals. Individual populations range from <50 individuals to up to 10,000. In March 2009, a total of approximately 12,000 individuals were counted in the six occurrences (Schotz 2009). Endemic to northwest Alabama, where six occurrences were verified extant in 2009 (Schotz 2009) (NatureServe, 2015). NatureServe (2015) notes that the short term trend is a decline of 30-50% and the Long-term trend is a decline of 70-90%. USFWS (2013) notes there are 5 extant populations. Low resiliency, representation and redundancy are inferred based on the number of populations and the relatively small geographic area this species is known to inhabit. The Service is aware of ten occurrences of fleshy-fruit gladecress in eight populations in the Moulton and Tennessee valleys in Alabama, with four occurrences discovered 2008–2016 and one occurrence newly discovered since listing (Service 2019). One additional occurrence was extirpated prior to the species listing in 2014. Little trend data is available for these populations, but the Service has no evidence any extant population known at the time of listing is extirpated. (USFWS, 2020)

Threats and Stressors

Stressor: Agricultural conversion (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Conversion of this species habitat to agriculture (pasture) is listed as a threat to this species (USFWS, 2013).

Stressor: Incompatible agricultural practices (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural practices such as herbicide use at the wrong time of year are listed as a threat to this species (USFWS, 2013).

Stressor: Rights-of-way maintenance (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Rights-of way maintenance (including herbicide use and mowing prior to seed set) is listed as a threat to this species (USFWS, 2013).

Stressor: Industrial development (USFWS, 2013)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: Industrial development is listed as a threat to this species (USFWS, 2013).

Stressor: Shading and competition (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Shading and competition by non-native exotic plants and natural forest succession are listed as a major threat to this species (USFWS, 2013).

Stressor: Off-road vehicle use (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/loss of individual plants
Narrative: Off-road vehicle use is listed as a threat to this species (USFWS, 2013).

Recovery

Reclassification Criteria:
Recovery Priority Number: 2

CRITERION 1. At least 15 geographically distinct populations – separated by at least 1 kilometer – of at least moderate size (at least 100 individuals) are distributed across the species' range, maintaining a mixture of self-incompatible and self-compatible populations, with each of the 2 known ecoregions (Eastern Highland Rim and Dissected Plateau)1 supporting at least 6 such populations, including 1 population within each of the 7 designated critical habitat units (USFWS, 2023).

CRITERION 2. At least 3 large populations (at least 500 individuals), protected by long-term conservation mechanisms, occur in each of the two known ecoregions, for a total of 6 protected populations, and are managed to promote open-canopied habitat, native plant community integrity, and support resilient populations2 of fleshy-fruit gladecress (USFWS, 2023).

CRITERION 3. Monitoring demonstrates that these populations (described in Criteria 1 and 2) are viable, as evidenced by natural recruitment and having stable to increasing populations for at least 10 years (approximately 10 generations) (USFWS, 2023).

Delisting Criteria:
Fleshy-fruit gladecress may be considered for delisting when the above criteria are met and when: CRITERION 4. At least 15 additional geographically distinct populations of at least moderate size occur within the species' known range for a total of at least 30 extant populations (USFWS, 2023).

CRITERION 5. At least 2 additional large populations are protected and managed as described in Criterion 2 within each of the 2 known ecoregions, for a total of at least 10 protected populations (USFWS, 2023).

CRITERION 6. Monitoring demonstrates that these additional populations (described in Criteria 1, 2, 4, and 5) are viable, as evidenced by natural recruitment and having stable to increasing populations for at least 10 years (approximately 10 generations) (USFWS, 2023).

Recovery Actions:

- Work with partner biologists, state agencies, non-governmental conservation organizations, and private landowners to obtain protection for populations on privately owned lands (USFWS, 2023).
- Work with roadside rights-of-way stakeholders to develop and implement management agreements (USFWS, 2023).
- Develop and implement management plans for all populations (USFWS, 2023).
- Work with partners and stakeholders to develop and implement a monitoring strategy for all populations (USFWS, 2023).
- Increase the representation and genetic diversity of ex situ (off-site) safeguarding collections of fleshy-fruit gladecress (USFWS, 2023).
- Continue to facilitate and support surveys to identify new populations (USFWS, 2023).
- Conduct research that enhances knowledge of fleshy-fruit gladecress to facilitate the development of scientifically sound management plans, population viability models, and species/habitat distribution models (USFWS, 2023).
- Augment protected populations that are unable to grow in response to habitat management due to low population size and/or establish populations in suitable, but unoccupied, managed habitat on conservation lands (USFWS, 2023).
- Continue to coordinate with federal, state, county, and local agencies, private landowners, and other stakeholders to promote fleshy-fruit gladecress recovery and identify innovative ways to increase public awareness of the need to protect this species and its habitats (USFWS 2023).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We will prepare a recovery plan for Leavenworthia crassa that includes objective and measurable criteria which, when met, will ensure the conservation of the species. Recovery criteria will address all meaningful threats to the species, as well as estimate the time and the cost to achieve recovery. The priority need is to address habitat-directed recovery actions. Viability of fleshy-fruit gladecress depends on protecting occurrences and suitable habitat from further degradation and fragmentation; restoring potentially suitable habitat within its historical range; evaluating and reducing threats from incompatible land uses, shading, and nonnative plants; increasing the size of current populations; conserving genetic diversity; and potentially establishing populations where suitable conditions are present on protected lands. The core actions include monitoring and protecting existing populations, long term conservation easements to protect existing populations (though the likelihood of landowner participation is uncertain), restoration of habitat through removal of woody invasive species (i.e., cedar and privet), and education and outreach. Detailed actions for fleshy-fruit gladecress conservation include: • Encourage landowner partnerships and proactive management with best management practices for species protection. Potential habitat protection mechanisms with landowners include fee simple purchase, conservation easement, or establishing a conservation agreement to ensure habitat receives necessary management and is protected from incompatible land uses. • Develop agreements with Departments of Transportation, railroad authorities, and transmission line companies to ensure population protection extends onto rights-of-ways in the species range to

address issues such as invasive nonnative species and proactively curb herbicide use and mowing during sensitive periods of the year. • Continue to support efforts by the U.S. Forest Service to protect and manage the Indian Tomb Hollow Glade population on Bankhead National Forest. • Encourage and support additional surveys for populations. • Establish methods to effectively monitor, and if necessary, develop a captive propagation and reintroduction program for fleshy-fruit gladecress. • Initiate regular monitoring at each site, to include counts from discrete clusters, where possible. Monitoring should include periodic checks of viability and germination rates in order to evaluate whether diminished reproductive fitness poses a long-term threat to populations. • Determine the number of populations required to recover fleshy-fruit gladecress – i.e., to reduce the risk of extinction to the point that the species is no longer threatened or endangered. • Continue to coordinate with federal, state, county agencies, and non-governmental conservation agencies to promote plant recovery and find innovative ways to increase public awareness of the need to protect this species and its habitat. • Initiate public education efforts and direct contact with landowners to inform the public about the species and its habitat, and opportunities to participate in conservation efforts. • Work with partners to study missing data related to the species biology and life history to support understanding of species resiliency, representation, and redundancy, including: o Length of seed dormancy in soil and implications of potential seed banking. o Understanding the impact of increasing levels of self-fertilization in light of pollinator declines. o Conditions and techniques in a propagation and reintroduction plan to inform a captive propagation program. o Determination of the mating systems of populations that are currently unknown and/or confirm the presence of two mating systems in a population (USFWS, 2020)

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SPECIES ACCOUNT: *Leavenworthia exigua laciniata* (Kentucky gladecress)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/05/2014; Southeast Region (Region 4) (USFWS, 2016)

Physical Description

A winter annual. Plants are about 5 to 10 cm (1.97 to 3.94 in) in height with early leaves that are simple with a slender petiole (central stalk of the leaf) and mature leaves that are sharply lobed (appear as disconnected pieces along the main leaf vein), somewhat squarish at the ends and arranged as a rosette (circular cluster of leaves) (Evans and Hannan 1990). The flowers are small (3 to 6 mm (0.12 to 0.24 in)), white to lilac in color with four petals, green rather than lavender sepals (the outer of two floral leaves that make up the flower), and leafless stems. Leaves typically disappear by the time the plant is in fruit (Evans and Hannan 1990). The fruit is flat and pod-shaped. Flowering begins in March, with seed dispersal occurring by mid-May. (USFWS, 2016; NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Kentucky: Bullitt and Jefferson counties. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/6/2014.

Legal Description

On May 6, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Leavenworthia exigua laciniata (Kentucky glade cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in Kentucky (79 FR 25689-25707).

Critical Habitat Designation

The critical habitat designation for Leavenworthia exigua laciniata includes six CHUs (sixteen sub-units) in Bullitt and Jefferson Counties, Kentucky. This species critical habitat encompasses approximately 2,053 acres (ac) (830 hectares (ha)) (79 FR 25689-25707).

Unit 1: McNeely Lake, Jefferson County, Kentucky: Unit 1 consists of 18 acres (ac) (7 hectares (ha)) within McNeely Lake Park in Jefferson County, Kentucky. This critical habitat unit is under county government ownership. This critical habitat unit occurs at the northwestern edge of the species' range, where there is little remaining habitat and few occurrences, and therefore this unit is important to the distribution of the species. Habitat degradation (e.g., erosion, invasive species) is impacting the species' ability to persist within this unit; however, the landowner has received funding and is working with the Service and KSNPC to develop a management plan for the site and to implement habitat improvement practices. These planned activities are expected to improve population numbers and viability at this important site. This unit helps to maintain

the geographical range of the species and provides opportunity for population growth. Within Unit 1, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with encroachment by nonnative plants or forage species, and forest encroachment due to fire suppression.

Unit 2, Subunits A, B, and C: Old Mans Run, Jefferson and Bullitt Counties, Kentucky: Unit 2 consists of three subunits totaling 1,014 ac (410 ha) in Bullitt and Jefferson Counties, Kentucky. It is located just south of the Jefferson/Bullitt County line and extends north of Old Mans Run. This critical habitat unit includes four element occurrences. Subunit 2B represents the best remaining populations and habitat for L. exigua var. laciniata in Jefferson County. Subunits 2A and 2C are important areas at the northern extent of the species' range. These three subunits represent the northeastern extent of the population's range and increase population redundancy within the species' range. The features essential to the conservation of the species in Unit 2 may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment. Subunit 2A is 102 ac (41 ha) in size and is located west of US 150 and northwest of Floyds Fork. It is in private ownership. While all PCEs are present within this subunit, it contains few native plant associates for L. exigua var. laciniata, and the increased competition from lawn grasses may decrease the ability of L. exigua var. laciniata to persist. This subunit is important for maintaining the northern distribution of L. exigua var. laciniata. Subunit 2B is 870 ac (352 ha) in size and is located east of US 150 and extends north and south of Old Mans Run. It is in private ownership. This is the largest of the subunits and contains the two highest ranked (1–B and 1–C) occurrences in Jefferson County. It represents the best remaining habitat in this portion of the range and may contain more than half of the total L. exigua var. laciniata population based on a 2011 survey by KSNPC, which estimated more than 20,000 individuals at 4 sites within this subunit. In this subunit, competition from lawn grasses impacts L. exigua var. laciniata and may decrease the plant's ability to persist. Subunit 2C is 42 ac (17 ha) in size and is located west of US 150 and east of Floyds Fork, extending into both Bullitt and Jefferson Counties. It is in private ownership. This subunit is primarily pasture, and habitat for L. exigua var. laciniata is impacted by competition from lawn grasses. Habitat management within this subunit to improve habitat for L. exigua var. laciniata is important for maintaining the northern distribution of the species.

Unit 3, Subunits A, B and C: Mount Washington, Bullitt County, Kentucky: Unit 3 consists of 42 ac (17 ha) and includes three subunits in Bullitt County, Kentucky, primarily within or adjacent to the city limits of Mount Washington. This critical habitat unit includes three element occurrences and provides an important link between the northern and southern portions of the species' range. Within Unit 3, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 3A is 25 ac (10 ha) in size and is located northeast of Mount Washington. It is in private ownership. Habitat for L. exigua var. laciniata within this subunit is degraded and would improve with management. It represents important habitat on the eastern extent of the species' range. In this subunit, habitat conversion and ORV use impact L. exigua var. laciniata habitat and may decrease the species' ability to persist at this site. Subunit 3B is 7 ac (3 ha) in size and is located east of Hubbard Lane and south of Keeneland Drive. It is in private ownership. The glade habitat has been degraded by adjacent land use and would benefit from improved management. The

subunit represents an important link between other subunits. Subunit 3C is 10 ac (4 ha) in size and is located east of US 150 and south of Highway 44E. It is in private ownership. The subunit represents an important and high quality cedar glade in an area of ongoing, intensive development. Land use surrounding the glade remnant appears stable and the glade contains several native plant species associated with L. exigua var. laciniata.

Unit 4, Subunits A, B, C, D, E, F, G, and H: Cedar Creek, Bullitt County, Kentucky: Unit 4 consists of 547 ac (221 ha) and includes eight subunits, all in Bullitt County, Kentucky. This unit is located south of the Salt River and northeast of Cedar Grove and seems to represent the core of the remaining high-quality habitat for L. exigua var. laciniata. It includes eight element occurrences. In addition to being a stronghold for the species, these subunits are generally within close proximity (less than 0.5 miles (0.8 km)) to each other and represent the best opportunity for genetic exchange between occurrences. Within Unit 4, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 4A is 91 ac (37 ha) in size and is located south of Cedar Creek and west of Pine Creek Trail. This subunit is owned by The Nature Conservancy and encompasses most of the Pine Creek Barrens Preserve. This excellent-quality glade represents the only remaining ‘‘A’’ rank occurrence for L. exigua var. laciniata. Subunit 4B is 69 ac (28 ha) in size and is located along an unnamed tributary to Cedar Creek, and south of KY 1442. This good-quality glade includes the Apple Valley Glade State Nature Preserve, owned by KSNPC (approximately 30 percent of subunit), as well as private land, including some under permanent conservation easement (approximately 41 percent of subunit) to protect L. exigua var. laciniata. Approximately 29 percent of this subunit is under private ownership without any protections for L. exigua var. laciniata. Subunit 4C is 83 ac (34 ha) in size and located north of Cedar Creek and south of Apple Valley State Nature Preserve. It is in private ownership. This subunit contains high-quality glades with a community of native plants present. Subunit 4D is 46 ac (19 ha) in size and is located north of Cedar Creek and south of Victory Church. It is in private ownership. This subunit has been degraded and would benefit from improved management. Native plants associated with L. exigua var. laciniata occur within this subunit, but competition from lawn grasses, as well as forest encroachment due to fire suppression, impacts L. exigua var. laciniata and may decrease its ability to persist. Subunit 4E is 102 ac (41 ha) in size and is located southeast of subunit 4D and across Cedar Creek. It is in private ownership. It contains a large number of L. exigua var. laciniata (several thousand), but the habitat has been degraded by adjacent land use and would benefit from improved management. Competition from lawn grasses, as well as forest encroachment due to fire suppression, affects L. exigua var. laciniata and may decrease the plant’s ability to persist. Subunit 4F is 120 ac (49 ha) in size and is south of the confluence of Cedar Creek and Greens Branch. It is in private ownership. This is a degraded glade that still contains native plants associated with L. exigua var. laciniata. The subunit is disturbed by existing and surrounding land uses, as well as utility line maintenance and ORV use, which may decrease the species’ ability to persist. Subunit 4G is 20 ac (8 ha) in size and is located along either site of KY 480 near White Run Road. It is in private ownership. This site contains a large number of plants; however, improved habitat conditions are needed for longterm viability of the L. exigua var. laciniata occurrence. Impacts to L. exigua var. laciniata, which may decrease its ability to persist at this site, include incompatible agricultural or grazing practices, ORV use, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 4H is 16 ac (6 ha) in size and is located 0.95 miles southeast of the KY 480/KY 1604 intersection. It is in private ownership. Within this

subunit, several patches of good habitat for L. exigua var. laciniata remain as well as a good diversity of native plant associates. However, competition from lawn grasses, as well as forest encroachment due to fire suppression, affects L. exigua var. laciniata and may decrease its ability to persist.

Unit 5, Subunits A and B: Cox Creek, Bullitt County, Kentucky: Unit 5 consists of 58 ac (23 ha) and includes two subunits, both in Bullitt County, Kentucky. It includes two element occurrences, representing the most easterly occurrences south of the Salt River. These subunits are important for maintaining the distribution and genetic diversity of the species. Within Unit 5, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with illegal waste dumps, development on private land, incompatible agricultural or grazing practices, ORV or horseback riding, competition from lawn grasses, and forest encroachment due to fire suppression. Subunit 5A is 8 ac (3 ha) in size and is located east of Cox Creek and west of KY 1442. It is in private ownership. This site is threatened by ORV use and would benefit from improved habitat management. Subunit 5B is 50 ac (20 ha) in size and is located west of Cox Creek near the Bullitt/Spencer County line. It is in private ownership. Incompatible agricultural practices and ORV use impacts L. exigua var. laciniata and may decrease its ability to persist. The native flora is mostly intact, and L. exigua var. laciniata would benefit from improved habitat management.

Unit 6: Rocky Run, Bullitt County, Kentucky: Unit 6 consists of 374 ac (151 ha) in Bullitt County, Kentucky. This critical habitat unit includes habitat that is under private ownership, including one 16-acre registered natural area. It includes one element occurrence. This unit appears to represent the largest intact glade habitat remaining within the range of the species. Within Unit 6, the features essential to the conservation of the species may require special management considerations or protection to address potential adverse effects associated with development on private land, incompatible agricultural or grazing practices, competition from lawn grasses, and forest encroachment due to fire suppression.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Leavenworthia exigua laciniata critical habitat consists of two components (79 FR 25689-25707):

(i) Cedar glades and gladelike areas within the range of L. exigua var. laciniata that include: (A) Areas of rock outcrop, gravel, flagstone of Silurian dolomite or dolomitic limestone, and/or shallow (1 to 5 centimeters (0.393 to 1.97 inches)), calcareous soils; (B) Intact cyclic hydrologic regime involving saturation and/or inundation of the area in winter and early spring, then drying quickly in the summer; (C) Full or nearly full sunlight; and (D) An undisturbed seed bank.

(ii) Vegetated land around glades and gladelike areas that extends up and down slope and ends at natural (e.g., stream, topographic contours) or manmade breaks (e.g., roads).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Threats to those features that define primary constituent elements for L. exigua var.

laciniata include (but are not limited to): (1) Residential and commercial development on private land; (2) construction and maintenance of roads and utility lines; (3) incompatible agricultural or grazing practices; (4) off-road vehicle (ORV) use or horseback riding; (5) encroachment by nonnative plants or forage species; and (6) forest encroachment due to fire suppression. These threats are in addition to random effects of droughts, floods, or other natural phenomena. Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could address these threats include (but are not limited to): (1) Avoiding cedar glades (or suitable gladelike habitats) when planning the location of buildings, lawns, roads (including horse or ORV trails), or utilities; (2) avoiding aboveground construction and/or excavations in locations that would interfere with natural water movement to suitable habitat sites; (3) protecting and restoring as many glade complexes as possible; (4) research supporting the development of management recommendations for grazing and other agricultural practices; (5) technical or financial assistance to landowners that may help in the design and implementation of management actions that protect the plant and its habitat; (6) avoiding lawn grass or tree plantings near glades; and (7) habitat management, such as brush removal, prescribed fire, and/or eradication of lawn grasses to maintain an intact native glade vegetation community.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2016)

Breeding Season

Adult: Begins in March (USFWS, 2016)

Reproduction Narrative

Adult: A winter annual. L. exigua var. laciniata persist through the winter as rosettes, and flowering begins in late February to early March (Baskin and Baskin 1981; Evans and Hannan 1990). Seeds are set and plants die in April and May as the glade habitats dry out (Baskin and Baskin 1985; Solbrig 1971). At maturity, most of these seeds are dormant and will not germinate following dispersal, even if the soils are moist (Baskin and Baskin 1985). During the summer, these seeds undergo physical changes known as after-ripening and move from dormancy to conditional dormancy and finally, become non-dormant for fall germination (Baskin and Baskin 1985). (USFWS, 2016)

Habitat Type

Adult: Terrestrial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Cedar glades (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Shade intolerant and prefers sparse vegetation (USFWS, 2016)

Environmental Specificity

Adult: Very Narrow (USFWS, 2016)

Habitat Narrative

Adult: L. exigua var. laciniata appears to be adapted to environments with shallow soils interspersed with flat-bedded, Silurian dolomite and dolomitic limestones, which is an uncommon geological formation in Kentucky (Rollins 1963; Evans and Hannan 1990). The soil on these horizontally bedded limestone areas is often only a few inches in depth or may be completely lacking in some areas (Rollins 1963). Because of the thin soils and underlying limestones, these habitats, called cedar or limestone glades, are extremely wet from late winter to early spring and quickly become dry in May and June. The natural habitat for L. exigua var. laciniata is these cedar glades (Baskin and Baskin 1981), but the taxon is also known from overgrazed pastures, eroded shallow soil areas with exposed bedrock, and areas where the soil has been scraped off the underlying bedrock (Evans and Hannan 1990). L. exigua var. laciniata does not appear to compete well with other vegetation and is shade intolerant (Evans and Hannan 1990) (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Short-term trends suggest declines of 10-50% (NatureServe, 2015)

Number of Populations:

77 (USFWS, 2020)

Population Size:

1000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

The Kentucky glade cress is endemic to a portion of Jefferson and Bullitt counties, Kentucky and is currently known to occur in 77 extant populations. After the taxon was listed as threatened in 2014, 12 new populations have been found. More than half of the known extant occurrences are considered to have poor resiliency. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: The greatest threat to Leavenworthia exigua var. laciniata is the destruction and degradation of glades through development, roads, utilities, and conversion to lawns. Documented impacts from horseback riding, off-road vehicle use, and changes in grazing practices have resulted in the loss or degradation of several L. exigua var. laciniata occurrences.

These activities are expected to continue in the future but to an unknown extent. Forest encroachment is expected to continue in areas without active management. Climate change has the potential to impact this species, but to what extent cannoted be predicted (USFWS, 2014).

Stressor: Narrow range and small populations (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Leavenworthia exigua var. laciniata has a narrow range, occurring in only small portions of two counties. Within this range, L. exigua var. laciniata is restricted to cedar glades and similar shallow-soiled areas that occur sporadically across the range. More than half of the remaining occurrences had low (fewer than 100 individuals) population counts at the time of the most recent survey. Additionally, the presumed low genetic diversity within individual occurrences of L. exigua var. laciniata could place those occurrences at a high risk of extirpation as their capacity for adaptation to change is reduced (USFWS, 2014).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 9

Delisting Criteria:
Criterion 1. At least 40 Kentucky Glade Cress populations1 , distributed across its range, exhibit a stable or increasing trend over 10 years of monitoring (Factors A and E). Criterion 2. At least 20 of the populations from Criterion 1 occur on natural or restored high-quality glade habitat and have 1,000 or more plants during 5 of the past 10 years of monitoring. Criterion 3. All of the populations in Criterion 1 are permanently protected and managed under an agreement such that threats are abated to the extent to ensure population viability for the foreseeable future. (USFWS, 2022)

Recovery Actions:

- 1. Permanently protect Kentucky Glade Cress populations and immediate surrounding habitat from destruction and degradation by development, with an emphasis on those in designated critical habitat and other areas of high-quality glade habitat. Estimated Cost $17,000,000 . 2. Conduct routine monitoring of Kentucky Glade Cress populations. Estimated Cost: $100,000. 3. Implement management activities to restore degraded glades and maintain high-quality glades that contain Kentucky Glade Cress populations. Estimated Cost: $50,000. 4. Encourage measures to avoid Kentucky Glade Cress patches in proposed developments. 5. Foster public appreciation for Kentucky Glade Cress and glade habitat through public outreach within and in the vicinity of its range. Estimated Cost: $15,000. 6. Research the biology of Kentucky Glade Cress. Estimated Cost: $259,000. 7. Reintroduce or introduce populations in suitable habitat within the taxon's range. Estimated Cost: $10,000 (USFWS, 2022)
- Conservation measures are not available.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recovery actions should be made a priority over the next 5 years: 1. Complete a recovery plan. 2. Continued public outreach to provide education on the species and its habitat and to explore opportunities for conservation on private property. 3. Look for opportunities to protect existing populations through voluntary conservation easements or other voluntary mechanisms. 4. Develop and implement management strategies for the taxon and its habitat. 5. Develop a program to monitor trends in population resiliency. 6. Establish methods and a plan to effectively reintroduce or introduce the taxon into suitable habitat within its range. 7. Enhance the suitability of known sites and potential reintroduction sites. 8. Define population regulation factors. (USFWS, 2020)

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SPECIES ACCOUNT: *Leavenworthia texana* (Texas golden Gladecress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/11/2013; Southwest Region (Region 2)

Physical Description

A weakly rooted, glabrous (smooth, glossy), winter annual (completes its life cycle in 1 year). Texas golden gladecress is small in stature, less than 3.9 inches (in) (10 centimeters (cm)) in height, making it difficult to find except during flowering or when it bears fruit. The leaves are 0.8-3.1 in (2-8 cm) long and 0.4-0.6 in (1-1.5 millimeters (mm)) wide, forming rosettes at the base of the plant. Terminal leaf segments are wider-than-long, and usually distinctly lobed, with angular teeth. Flowers are bright yellow and borne on scapes (leafless flowering stems or stalks arising from the ground) that are 1.2-3.5 in (3-9 cm) long early in the flowering season. Later in the season, the flowers occur on unbranched flower clusters that come off a single central stem from which the individual flowers grow on small stalks, at intervals. The four petals are bright golden-yellow with a slightly darker base, narrowly obovate (tongue-shaped), 0.3-0.4 in (7-10 mm) long and 0.1-0.2 (3.5-5 mm) wide. The fruit is a slender seed capsule, known as a silique, with a length (0.6-1.2 in (15-30 mm)) that is more than twice its width (0.08-0.22 in (2-5.5 mm)) and that contains 5 to 11 flattened, circular or spherically shaped seeds. (USFWS, 2013a)

Taxonomy

In the mustard family (Brassicaceae). Dr. M. C. Leavenworth, an Army physician, first collected the taxon in Choctaw County, Oklahoma, in 1835, and the specimens were later described as a new species, Leavenworthia aurea, by Torrey (Mahler 1981, pp. 76-77). From 1836 to 1837, Leavenworth collected similar specimens near the present-day town of San Augustine, San Augustine County, Texas, and these were also identified as L. aurea. E. J. Palmer (1915 and 1918), and D. S. and H. B. Correll (1961 to 1962) as cited by Mahler (1981, pp. 83) made later collections of the plant in the San Augustine area. George and Nixon (1990, pp. 117-127) studied and mapped populations in this area between 1979 and 1980. W. H. Mahler studied the collected specimens and their habitat, and described the Texas plants as a new species, Leavenworthia texana (Mahler 1987, pp. 239-242), based on differences in morphological characteristics of flowers and leaves, and in chromosome number, between the Oklahoma and Texas plants (Mahler 1987, pp. 239-242). According to Mahler (1987, p. 240), Texas golden gladecress flower petals were a brighter, deeper yellow than those of L. aurea, and the petals were egg-shaped and flat instead of being broad and notched. The L. texana had wider-than-long terminal leaf segments that were usually distinctly lobed while L. aurea' s terminal leaves were essentially unlobed, flat, and more circular. Texas plants had a chromosome number of 2n = 22 (Nixon 1987, pers. comm. in Mahler 1987, pp. 239, 241) while the Oklahoma L. aurea had 2n = 48 (Rollins 1963, pp. 9-11; Beck et al. 2006, p. 156). We are aware that a recently completed monograph of the genus may have taxonomic implications for the Texas and Oklahoma Leavenworthia species in the future, but several questions, including the differences in chromosome number, remain unresolved and no supporting information that would change the current status of Texas golden gladecress has been published to date (Poole 2011a, pers. comm.). (USFWS, 2013a)

Historical Range

Texas golden gladecress is known from eight locations (historic and extant), including one introduced population, all within a narrow zone that parallels SH 21 in San Augustine, Sabine, and Nacogdoches Counties (Texas Natural Diversity Database (TXNDD) 2012b). (USFWS, 2013a)

Current Range

San Augustine and Sabine Counties in eastern Texas, on a particular geologic formation (the Weches Formation). (USFWS, 2013a)

Critical Habitat Designated

Yes; 10/11/2013.

Legal Description

On September 11, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective October 11, 2013) for Leavenworthia texana (Texas golden Gladecress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Sabine and San Augustine Counties, Texas. (USFWS, 2013b)

Critical Habitat Designation

The critical habitat designation for Leavenworthia texana includes four CHUs in Sabine and San Augustine Counties, Texas. This species critical habitat encompasses approximately 1,353 acres (ac) (548 hectares (ha)). Brief descriptions are provided below; maps depicting these areas are included in the Final Rule. (USFWS, 2013b)

Unit 1: Geneva: Unit 1 consists of 388 ac (157 ha) of private and State land located in northwest Sabine County, Texas. The unit is located 1.5 mi (2.3 km) south of Geneva, Texas, and 4.8 mi (7.7 km) north of Milam, Texas, and is bisected by SH 21.

Unit 2: Chapel Hill: Unit 2 consists of 150 ac (61 ha) of privately owned land, with one county road ROW, in northwestern San Augustine County, Texas. This unit is located 1.0 mi (1.6 km) south of SH 21, due west of the San Augustine-Sabine County line, and lies alongside County Road (CR) 151. This unit is linear in shape, running from southeast to northwest. Aside from CR 151, all other land in Unit 2 is privately owned. Current land cover appears to be approximately 70 percent woody cover; much of the forest being rows of pine trees.

Unit 3: Southeast Caney Creek Glades: Unit 3 consists of 39.9 ac (16.2 ha) just southeast of the City of San Augustine, San Augustine County, Texas. Approximately 99 percent of the land within this unit is privately owned, with the other 1 percent being county ROW under the management of TXDOT. This unit is located 0.8 mi (1.2 km) south from SH 21 near San Augustine, Texas, along the north side of FM 3483. This unit is located across Sunrise Road from a glauconite quarry.

Unit 4: Northwest Caney Creek Glades: Unit 4 consists of 775.3 ac (313.7 ha) that extends in a diagonal line from northeast to southwest, to the north and south of SH 21 just east of the City of San Augustine, San Augustine County, Texas. The unit is approximately 0.7 mi (1.1 km) wide.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Leavenworthia texana critical habitat consists of three components (USFWS, 2013b):

(i) Exposed outcrops of the Weches Formation within Weches prairies. Within the outcrop sites, there must be bare, exposed bedrock on top-level surfaces or rocky ledges with small depressions where rainwater or seepage can collect. The openings should support Weches Glade native herbaceous plant communities.

(ii) Thin layers of rocky, alkaline soils, underlain by glauconite clay (greenstone, ironstone, bluestone), that are found only on the Weches Formation. Appropriate soils are in the series classifications Nacogdoches clay loam, Trawick gravelly clay loam, or Bub clay loam, ranging in slope from 1– 15 percent.

(iii) The outcrop ledges should occur within the glade such that Texas golden gladecress plants remain unshaded for a significant portion of the day, and trees should be far enough away from the outcrop(s) that leaves do not accumulate within the gladecress habitat. The habitat should be relatively clear of nonnative and native invasive plants, especially woody species, or with only a minimal level of invasion.

Special Management Considerations or Protections

Texas golden gladecress may require special management considerations or protection to reduce the following threats: quarrying or other excavations, including pipeline installations; building over the top of occupied glades; construction or excavation upslope that alters water movement (sheet flow or seepage) downslope to Texas golden gladecress sites; pine tree plantings near glades; and invasive (native and nonnative) plants. Refer to the five-factor analysis in the listing determination for the Texas golden gladecress for more information on these threats. The features essential to the conservation of Texas golden gladecress may require special management considerations or protection to reduce the following threats: • Actions that remove the soils and alter the surface geology of the glades; • Building or paving over the glades; • Construction or excavation upslope that alters water movement (sheet flow or seepage) downslope to Texas golden gladecress sites; • Planting trees adjacent to the edges of an outcrop resulting in shading of the glade and accumulations of leaf litter and tree debris; • Encroachment by nonnative and native invading trees, shrubs, and vines that shade the glade; • The use and timing of application of certain herbicides that can harm Texas golden gladecress mature plants and seedlings; and • Fence placement such that livestock are likely to be directed through gladecress sites where habitat and plants may be trampled. Management activities that could ameliorate these threats include (but are not limited to): • Avoiding Weches glades when planning the location of quarries, well pads, roads, other facilities or structures, or pipeline routes, through glade complexes; • Avoiding above-ground construction or excavations in locations that would interfere with natural water movement to Texas golden gladecress habitat sites; • Locating suitable habitat and determining the presence or absence of the species and identifying areas with glade complexes and protecting or restoring as many complexes as possible; • Extending outreach to all landowners, including private and State, to raise awareness of the plant and its specialized habitat; • Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; • Avoiding pine tree plantings near glades; and • Brush removal, to maintain an intact native glade vegetation community. (USFWS, 2013b)

Life History

Food/Nutrient Resources

Breeding Season

Adult: March to April (NatureServe, 2015)

Reproduction Narrative

Adult: A winter annual, 2-10 cm tall, that produces bright yellow flowers in March and April. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Wet glades, herbaceous communities (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Vernally wet environment (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Herbaceous communities in vernally wet glades with shallow, calcareous soils on Weches Formation ironstone outcrops. Associated species include the rare white bladderpod (Lesquerella pallida), as well as flat stemmed spike-rush (Eleocharis compressa), and rock stonecrop (Sedum pulchellum). (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Long-term trends indicate a decline of 30-70%, whereas short-term trends suggest a decline of 30-50% (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2024)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Long-term population trends indicate a decline of 30-70%, whereas short-term trends suggest a decline of 30-50%. The small population size and low number of sites make this taxon vulnerable to effects of stochastic phenomena and catastrophic events; it has very low numbers in drought

years (USFWS, 2004). At least two historical sites have been lost due to glauconite mining (USFWS 2012). Numbers of (growing) plants vary somewhat year-to-year. In 2009, the three extant sites had 98, 29, and 260 plants respectively (USFWS 2012). Three natural occurrences with intact habitat as of 2011 (USFWS 2012). An introduced site had plants through 2009 but a 2011 survey found the plants had been removed by a pipeline installation (USFWS 2012). Seed banks may persist at two historical sites (USFWS 2012). (NatureServe, 2015). The Texas golden gladecress is an annual plant and member of the family Brassicaceae. The best available information suggests that 4 extant populations occur in Texas on private and state-owned lands within San Augustine, Sabine, and Nacogdoches counties, Texas. Three of these populations are natural, and 1 introduced (Nacogdoches County). These populations are represented by Texas Parks and Wildlife Department's Element of Occurrence (EO) IDs from the Texas Natural Diversity Database (TXNDD; 2020, pp. 1-18. These populations are distributed across the Weches geologic formation that loosely parallels Texas State Highway 21 within these counties (Figure 1). Sites are relatively bare (treeless) and host a diverse set of associated species that vary throughout the annual cycle of the Texas golden gladecress. The species depends on cool, wet winter months to aid in its growth, promoting a short flowering season in February and March each year. When temperatures warm in summer, Texas golden gladecress withers away, and drought-tolerant species emerge. Glade exposures on the Weches geology are naturally small, giving rise to smaller population sizes, and therefore increasing the species' chances of negative effects from stochastic events. Due to its annual nature, plant numbers fluctuate each year. Little is known about the species' seed biology, reproductive strategies (i.e., need of pollinators), and/or genetic relatedness among and within populations. Known threats to the species include habitat loss, modification, degradation; climate change; and ineffective management strategies (USFWS, 2024).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The most significant threat to habitat of Texas golden gladecress is surface quarrying of glauconite and the exploration and development of oil and natural gas wells and associated roads and pipelines have destroyed 50 percent of the known populations between the mid-1990s and 2011. In addition, excavations may occur when pipelines for water, sewer lines, gas connections to homes, and communication lines are installed may damage populations and habitat. Texas golden gladecress also faces threats throughout its range from competition for light and nutrients from both native and nonnative, invasive, woody plants, including the nonnative Macartney rose. Additionally, herbicides used to control Macartney rose may be a threat to the Texas golden gladecress if applied to or persisting in the soil during the species' period of growth, from late fall through early summer. A recent, ongoing trend in local land use is the conversion of open pasture to pine plantations. However, densely planted pine trees may degrade the species' habitat due to competition for light and nutrients and by contributing masses of leaf litter onto formerly sparsely vegetated glades. Finally, the information regarding climate change is not yet specific enough for us to determine the potential long-term effects to the Texas golden gladecress's habitat. However, long-term drought has negatively affected and will likely continue to negatively affect the reproduction and germination of Texas golden gladecress seeds (USFWS, 2013).

Stressor: Small populations (USFWS, 2013a)
Exposure:
Response:
Consequence:
Narrative: Texas golden gladecress is a historically rare species with some adaptations, such as a mixed mating system, that help to alleviate part of the inherent risks of small population size. The continued existence of Texas golden gladecress is negatively impacted by natural factors including being limited to only a few remaining populations that contain very small numbers of individual plants with a distribution restricted to extremely small areas of outcrop. The species' current, reduced occurrences across a range that has been highly fragmented by past and ongoing human activities increase its vulnerability. With only three remaining populations, loss of an entire population could be catastrophic for this species' long-term viability. Therefore, the small number of remaining populations, all of which are small in size, in conjunction with the threats to habitat, constitutes a threat to the species and greatly exacerbates other the threats identified for this species (USFWS, 2013a).

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 5

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Recovery actions are not available.
- Conservation measures are not available.

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SPECIES ACCOUNT: *Lepidium barnebyanum* (Barneby ridge-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/28/1990; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Barneby ridge-cress is a perennial, herbaceous plant in the mustard family, approximately 2 to 6 inches tall, typically with raised clumps or cushions up to 8 inches wide. The species arises from a deep woody taproot; its stems are smooth and hairless with narrow leaves clustering at the base of the plant. The cream-colored flowers are about 0.25 inches across and alternate along a stem rising above the base of the plant. (USFWS, 2016)

Taxonomy

The plant was first described as Lepidium montanum ssp. Demissum and later renamed by James Reveal as Lepidium barnebyanum. (USFWS, 1990)

Historical Range

The current species distribution is essentially the same as the historical distribution known from past records. (USFWS, 1993)

Current Range

The species' current range has expanded to approximately 9 mi (14 km) and contains 985 ac (399 ha) of occupied habitat. We revised the potential habitat polygon in 2021 using the best available information for the species and its current range (Figure 1; Lindstrom 2021). The new polygon contains 45,714 ac (18,500 ha) of potential habitat (Service 2021). Access to the three populations for monitoring and survey efforts has been intermittent since they are located on non-Federal lands. As a result, we lack range-wide surveys and long-term population trend information. Most population information has been collected during project-level surveys for proposed oil and gas projects. (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2016)

Lifespan

Adult: Long-lived (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Pollinators unknown (USFWS, 2016)

Breeding Season

Adult: Flowers April to May (USFWS, 2016)

Reproduction Narrative

Adult: Reproduction is sexual, with flowering occurring from April to May and fruiting occurs May to June. The specific pollination mechanism and vectors are not known. (USFWS, 2016) It has an apparent low rate of reproduction (Davern pers. comm. 1988; England pers. comm. 2008). This could be due to a very low ratio of ovules developing into seeds, which may result in embryonic failure and a loss of reproductive capacity (Weins et al. 1989). Reasons for this are unknown. (USFWS, 2011)

Habitat Type

Adult: Shale barrens (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Mixed desert shrub and pinyon-juniper community (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Soils (USFWS, 1993)

Environmental Specificity

Adult: Very narrow specialist with key requirements scarce (inferred from USFWS, 1993)

Site Fidelity

Adult: Very high (inferred from USFWS, 1993)

Habitat Narrative

Adult: The habitat is poorly developed soils derived from white, marly shale outcrops of the Uinta Formation in pinyon-juniper communities. It occurs at 1890 and 1985 m elevation. (NatureServe, 2015) The soil characteristics of the habitat are not common within the species range, and effectively form "islands" of suitable habitat within a "sea" of unsuitable soil types derived from other differing geologic substrates. (USFWS, 1993)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No dispersal information has been provided in USFWS or NatureServe documents. However, very specific soil requirements that occur as small "islands" within the pinyon juniper community limit the dispersal of the species. (USFWS, 1993)

Population Information and Trends

Population Trends:

Stable (USFWS, 2011)

Species Trends:

Declining (USFWS, 1993)

Population Growth Rate:

Poor (USFWS, 2011)

Number of Populations:
3 (USFWS, 2021)

Population Size:
approximately 7,731 plants (USFWS, 2021)

Adaptability:
Very low (USFWS, 2011)

Population Narrative:
We now know of three populations1 (Indian Canyon, Starvation Reservoir, and Coyote Canyon) that contain approximately 7,731 plants (Spector 2015; EIS 2021; Service 2021). The most recent population estimate of 6,614 individuals for the Indian Canyon population is larger than we identified at listing (Service 2021). Two new populations were located in 2014 and 2015, the Starvation Reservoir and Coyote Canyon populations, respectively (Figure 1). The Starvation Reservoir population was found during project-level surveys unrelated to this species (EIS 2014). The Starvation Reservoir population is entirely on private land and has 27 individuals (EIS 2014; Service 2021). The Coyote Canyon population was found during plant surveys on State of Utah lands managed by the Utah Department of Wildlife Resources (UDWR) as a wildlife management area (WMA). The Coyote Canyon population contains at least 1,090 individuals, though additional suitable habitat has not been surveyed (Spector 2015; Service 2021). (USFWS, 2021)

Threats and Stressors

Stressor: Off-road vehicles (UFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: In the listing package and Recovery Plan, off-highway vehicles were cited as a significant threats due to its narrow distribution along ridgelines (55 FR 39862; USFWS 1993). Since listed, recreational (trail riding and hunting related) OHV use within the species' occupied habitat has been very light due in large part to Tribal control and active policing to prevent trespass. Therefore, we now consider the threat of recreational OHV to be low throughout the species' range. (USFWS, 2011)

Stressor: Oil and gas energy development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The location of the species' habitat on the top of relatively level ridgelines in an area of very steep topographic relief exposes the species to an increased likelihood of habitat destruction from oil and gas industry related activities (i.e., OHV use, pipeline installation, and road and well-site construction). These threats affect all stands of the species' single population (UDOGM 2009; Chester pers. comm. 2008; O'Hearn pers. comm. 2008; Secakuku pers. comm. 2008). Oil and gas field development is the current action that has the greatest potential to adversely affect the species. The entire area containing the known population has been leased

for development. (USFWS, 2011)

Stressor: Low reproductive success (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The species has a very low ratio of ovules developing into seeds, which may result in embryonic failure and a loss of reproductive capacity (Weins et al. 1989). Reasons for this are unknown. Seedlings of Barneby ridge-cress are rare, and more research is needed to determine the conservation implications of these preliminary observations. (USFWS, 2011)

Stressor: Invasive weeds (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Introduced weeds (Bromus tectorum and Halogeton glomeratus) are invading in disturbed areas near roads and well pads (Chester pers. comm. 2008; England pers. comm. 2008; Secakuku pers. comm. 2008). The presence of Bromus tectorum shortens fire return intervals and allows the weed to out-compete native shrubs and grasses that are adapted to longer fire return intervals (Gorrell et al. 2005; Zouhar 2003). Fires within areas infested with exotic weeds also tend to occur earlier in the season leading to further damage to native vegetation (Zouhar 2003). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Climate change could potentially impact Lepidium barnebyanum or its pollinators, although the specific impacts of altered temperature and precipitation regimes are unknown. L. barnebyanum's phenology could be altered and could result in disruption of pollinator availability and activity, germination, or other life history needs. (USFWS, 2011)

Recovery

Reclassification Criteria:
A total population of 20,000 individuals is documented for 5 years (USFWS, 1993)

Five separate stands of at least 2,000 individuals each are maintained and have been demonstrated to be at minimum viable population level with formal land management designations in place to protect the species and its habitat. (USFWS, 1993)

Delisting Criteria:
1. A Conservation Agreement (CA) has been developed and implemented for Barneby ridge-cress that addresses all five listing factors on the lands it would cover. (USFWS, 2019).

2. An ex-situ seed bank collection is maintained at a Center for Plant Conservation affiliated institution and contains a minimum of 500 seeds. The ex-situ seed bank contains genetic material collected from each known subpopulation across the range of the species and is

collected over a period of at least five-years. (USFWS, 2019).

3. Maintain a viable and self-sustaining metapopulation consisting of at least five subpopulations. This will be determined through a population viability analysis indicating the sub-populations are at or above minimum viable population levels, or through monitoring data indicating a stable or increasing trend in the metapopulation and at least five sub-populations (lambda equal to or greater than one) over a period of at least ten years. (USFWS, 2019).

Recovery Actions:

- Control activities that affect the habitat of L. barnebyanum through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 1993)
- Inventory suitable habitat for L. barnebyanum and determine with a reasonable degree of accuracy the population and distribution of the species. (USFWS, 1993)
- Establish and conduct minimum viable population studies on at least three different populations of L. barnebyanum, (USFWS, 1993)
- Document the presence of or, if necessary, establish formal land management designations that would provide for long term, undisturbed habitat for L. barnebyanum. (USFWS, 1993)
- Develop public awareness, appreciation, and support for the conservation of L. barnebyanum. (USFWS, 1993)
- Revise the Recovery Plan to include the delisting criteria, reevaluate threats, and provide updated conservation recommendations. (USFWS, 2011)
- The BIA, with support of the Tribe and the USFWS, should conduct population surveys within the species' known range and potential habitat in the general region (Uinta Basin of northeast Utah) to better understand the species' range, abundance and potential threats. (USFWS, 2011)
- The BIA, with support of the Tribe and the USFWS, should conduct population monitoring to determine natural population dynamics and trends. (USFWS, 2011)
- The BIA, with support of the Tribe and the USFWS, should conduct monitoring to avoid impacts to the species' habitat from oil and gas development and other possible threats. (USFWS, 2011)
- The BIA, with cooperation of the Tribe and the Service, should conduct research of the species' life history including reproduction. (USFWS, 2011)
- We will ensure that the Section 7(a)(2) process addresses threats posed by invasive plants, dust, habitat fragmentation from road development and other indirect impacts from oil and gas development. (USFWS, 2011)
- We will work with the Tribe and BIA to evaluate the potential to establish a conservation area or a management plan to protect the species in perpetuity. (USFWS, 2011)
- We will investigate the species' response to climate factors by collecting the appropriate data during monitoring and by compiling relevant information from surrogate species. (USFWS, 2011)
- Denver Botanic Gardens currently has several thousand seeds of Lepidium barnebyanum in long term storage, although the collection is not considered complete. We will work with Denver Botanic Gardens to determine how much additional seed collection is needed, and we will work with the Tribe and BIA to obtain additional seeds. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Recommended future actions: Based on recent discussions with Federal agencies and conservation partners, we recommend the following future actions to support the recovery of the species (in order of priority): (1) work with private, State, and Tribal land owners to develop and implement conservation agreements that provide long-term protections for this species where it occurs; (2) survey suitable habitat areas to locate additional populations; (3) develop and implement standardized range-wide, long-term monitoring procedures for the species; (4) implement and maintain ex-situ (off-site) seed collection and preservation at a Center for Plant Conservation affiliated institution; (5) establish a set of need-based research priorities into the species' biology and life history aimed at minimizing threats and supporting recovery; (6) communicate with partners and stakeholders regarding the species' recovery needs and progress; and (7) evaluate the effect of climate change and drought on the species.

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SPECIES ACCOUNT: *Lepidium papilliferum* (Slickspot peppergrass)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/16/2016; Pacific Region (R1)

Physical Description

An intricately branched, tap-rooted plant, averaging 2 to 8 in. tall, but occasionally reaching up to 16 in. tall. Leaves and stems are covered with fine, soft hairs, and the leaves are divided into linear segments. Flowers are numerous, 0.11 to 0.15 in. in diameter, white, and four-petalled. Fruits (silicles, which are seed capsules that are less than twice as long as they are wide) are 0.10 to 0.15 in. wide, round in outline, flattened, and twoseeded (Moseley 1994, pp. 3, 4; Holmgren et al. 2005, p. 260). (USFWS, 2020)

Taxonomy

Slickspot peppergrass is a member of the Mustard Family (Brassicaceae). . Louis Henderson originally described slickspot peppergrass as L. montanum var. papilliferum in 1900. It was renamed L. papilliferum by Aven Nelson and J. Francis Macbride in 1913 based on its distinctive growth habit, short lifespan, and unusual pubescence (Nelson and Macbride 1913, p. 474). Hitchcock regarded slickspot peppergrass as L. montanum var. papilliferum influencing several publications including Flora of Idaho and Flora of the Pacific Northwest (Davis 1952, p. 347; Hitchcock et al. 1964, p. 516; Hitchcock and Cronquist 1973, p. 170; Steele 1981, p. 55; Moseley 1994, p. 2). In a 1993 review of taxa in the mustard family (Brassicaceae), Reed Rollins maintained the species based on differences in the physical features between the slickspot peppergrass and L. montanum (mountain pepperweed): • Slickspot peppergrass has trichomes (hair-like structures) occurring on the filaments of stamens (part of flower that produces pollen), but mountain pepperweed does not; • All the leaves on slickspot peppergrass are pinnately divided whereas mountain pepperweed has some leaves that are not divided; • The shape of the silicle [silique] (seed capsule) of slickspot peppergrass is different from that of mountain pepperweed; and • The silicle of slickspot peppergrass has no wings, or even vestiges of wings, at its apex (end of the capsule), unlike that of mountain pepperweed (Rollins 1993, p. 578; Moseley 1994, p. 2). Common names for this plant include slickspot peppergrass (Holmgren et al. 2005, p. 259), slick spot peppergrass (Moseley 1994, p. 1), and Idaho pepperweed (ITIS 2018, p. 1). The common name refers to its typical habitat—in or near slick spot microsites, and the peppery taste of the seeds. 'Grass' is a misnomer, and most members of the genus Lepidium are referred to as peppercress, pepperweed, or pepperwort (IDFG in litt. 2018, p. 2). Throughout this SSA, we refer to the species as slickspot peppergrass. (USFWS, 2020)

Historical Range

Historical extent is unknown. (USFWS, 2020)

Current Range

Slickspot peppergrass occurs only in southwestern Idaho in Ada, Canyon, Gem, Elmore, Payette, and Owyhee counties. This species is from three geographic areas based on landform: the Foothills geographic area, the Snake River Plain geographic area, and the Jarbidge geographic area. (USFWS, 2020)

Critical Habitat Designated

Yes; 6/5/2023.

Legal Description

We, the U.S. Fish and Wildlife Service (Service or USFWS), finalize the designation of critical habitat for slickspot peppergrass (Lepidium papilliferum) under the Endangered Species Act of 1973 as amended (Act). In total, approximately 31,569 hectares (78,009 acres) in Ada, Elmore, Gem, Payette, and Owyhee Counties in Idaho fall within the boundaries of the final critical habitat designation. The effect of this final rule is to designate critical habitat for the slickspot peppergrass, which is a threatened species under the Act.

Critical Habitat Designation

pilliferum (Slickspot Peppergrass) (1) Critical habitat units are depicted for Ada, Elmore, Gem, Owyhee, and Payette, Counties, Idaho

Primary Constituent Elements/Physical or Biological Features

Within these areas, the specific physical or biological features (PBFs) essential to the conservation of slickspot peppergrass consist of four components:

(i) Ecologically functional microsites or ‘‘slick spots’’ that are characterized by: (A) A high sodium and clay content, and a three-layer soil profile, which allows for successful seed germination, seedling growth, and maintenance of the seed bank. The surface horizon consists of a thin, silty vesicular, pored (small cavity) layer that forms a physical crust (the silt layer). The subsoil horizon is a restrictive clay layer, with an abruptic (referring to an abrupt change in texture) boundary with the surface layer, that is natric or natric-like in properties (a type of argillic (clay-based) horizon with distinct structural and chemical features); this is the restrictive layer. The second argillic subsoil layer (that is less distinct than the upper argillic horizon) retains moisture through part of the year (the moist clay layer). (B) Sparse vegetation, with invasive, nonnative plant species cover absent or limited to low to moderate levels.

(ii) Relatively intact, native Wyoming big sagebrush (Artemisia tridentata ssp. wyomingensis) vegetation assemblages, represented by native bunchgrasses, shrubs, and forbs, within 500 m (1,640 ft) of slickspot peppergrass element occurrences to protect slick spots and slickspot peppergrass from disturbance from wildfire, slow the invasion of slick spots by nonnative plant species and native harvester ants, and provide the habitats needed by slickspot peppergrass’ pollinators.

(iii) A diversity of native plants whose blooming times overlap to provide pollinator species with flowers for foraging throughout the seasons and to provide nesting and egg-laying sites; appropriate nesting materials; and sheltered, undisturbed places for hibernation and overwintering of pollinator species. In order for genetic exchange of slickspot peppergrass to occur, pollinators must be able to move freely between slick spots. Alternative pollen and nectar sources (other plant species within the surrounding sagebrush vegetation) are needed to support pollinators during times when slickspot peppergrass is not flowering, when distances between slick spots are long, and in years when slickspot peppergrass is not a prolific flowerer.

(iv) Sufficient pollinators for successful fruit and seed production, particularly pollinator species of the sphecid and vespid wasp families, species of the bombyliid and tachnid fly families, and halictid bee species, most of which are solitary insects that nest outside of slick spots in the

surrounding sagebrush-steppe vegetation, both in the ground and within the vegetation.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. A detailed discussion of the threats affecting the PBFs essential to the conservation of slickspot peppergrass, and that may require special management consideration or protection, can be found in the final listing rule published in the Federal Register on October 8, 2009 (74 FR 52014), the 2016 final rule reinstating threatened status for the species under the Act (81 FR 55058, August 17, 2016), in the recently completed SSA report (USFWS 2020, pp. 59–83, 85–103), and in the latest 5- year review (USFWS 2021). The primary threats to the PBFs for slickspot peppergrass include the following direct and indirect effects: the current wildfire regime (i.e., increasing frequency, size, and duration), invasive, nonnative plant species (e.g., cheatgrass), and habitat loss and fragmentation due to agricultural and urban development. One of the indirect threats experienced by slickspot peppergrass is the negative impact on insect pollinators caused by conversion and fragmentation of native habitats due to invasive, nonnative plant species and various forms of development. Another indirect threat is the potential increase in seed predation by Owyhee harvester ants resulting from the conversion of sagebrush-steppe to grasslands. Livestock pose a threat to slickspot peppergrass, primarily through mechanical damage to individual plants and slick spot habitats; however, current livestock management conditions and associated conservation measures address this potential threat such that it does not pose a significant risk to the viability of the species as a whole. In the 2009 listing rule (74 FR 52014, October 8, 2009), climate change in and of itself was not considered to represent a significant range-wide threat to slickspot peppergrass; however, it was acknowledged that climate change potentially plays an important supporting role in intensifying the primary threats to the species. Information identified in the SSA (USFWS 2020, pp. 79–82) indicated that climate change has already amplified the effects of wildfire and invasive, nonnative plants on slickspot peppergrass, and through its influence on invasive, nonnative annual grass spread, climate change may have been a factor in the continuing downward trend in slickspot peppergrass population numbers observed over the past decade. Other, less significant factors that have the potential to impact the species include the effects from rangeland revegetation projects, wildfire management practices, recreation, and military use. All areas of critical habitat may require some level of management to address current and future threats to slickspot peppergrass and to maintain or restore the PBFs. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the nearby plant community components. Rapid response to wildfires from local and government fire agencies can potentially limit the size of wildfires and the spread of wildfire into slickspot peppergrass habitat. For fires that do occur in critical habitat, post-fire restoration plans can identify ways to limit invasive, nonnative vegetation and restore habitat using native plants. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of invasive, nonnative unseeded plant species and seeded nonnative plants (also referred to as ‘‘highly competitive nonnative seeded plants’’ (USFWS 2020, p. 68)) may include the following: (1) protecting remnant blocks of native vegetation, (2) educating the public about invasive, nonnative species, (3) supporting research and funding for nonnative plant species control and native species restoration, (4) preventing or restricting the establishment of nonnative plant

species, (5) washing vehicles prior to travel into areas containing slickspot peppergrass, and (6) reducing the likelihood of wildfires. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of livestock use may include conservation measures and actions to minimize the effects of livestock use on these lands. Existing conservation plans and land use plans contain numerous measures to avoid, mitigate, and monitor the effects of livestock use on slickspot peppergrass. For example, livestockgrazing conservation measures are implemented through the conservation agreement between the Bureau of Land Management (BLM) and the Service (BLM 2014, pp. 8–12) and the Mountain Home Air Force Base Integrated Natural Resources Management Plan (INRMP; U.S. Air Force 2017, p. 192). Existing conservation measures include prescribing a minimum distance for the placement of salt and water troughs, identifying livestock use restrictions to reduce trampling of slick spots during wet periods, constructing fences, or potentially modifying current livestock use. We recognize the potential for negative impacts to slickspot peppergrass populations and slick spots that may result from seasonal, localized trampling events. However, under current management conditions, we do not consider livestock use to pose a significant threat to slickspot peppergrass. We encourage the continued implementation of conservation measures and associated monitoring to ensure potential impacts of livestock trampling to slickspot peppergrass are avoided or minimized. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of residential and agricultural development may include the following: (1) creating managed plant reserves and open spaces, (2) limiting disturbances to and within suitable habitats, (3) increasing compliance inspections with livestock grazing permit holders, (4) requiring project fencing with adjacent construction activities, (5) disallowing new roads, and (6) evaluating the need for, and conducting, restoration efforts or revegetation of native plants in open spaces, plant preserves, or disturbed areas. Special management to protect the features essential to the conservation of slickspot peppergrass from the effects of Owyhee harvester ant seed predation are addressed under the special management considerations for the current wildfire regime and invasive nonnative plants. Finally, the protection of pollinators and their habitat is essential to the conservation of slickspot peppergrass. General pollinator management practices include: (1) maintaining a diversity of native plants with overlapping bloom times to provide flowers for foraging throughout the pollinators' active season, (2) nesting and egg-laying sites (e.g., bare ground, hollow stems, bunchgrasses, and larval host plants), (3) sheltered, undisturbed places for overwintering, (4) a landscape free of pesticides and high levels of pathogens, and (5) connected habitat patches (The Xerces Society 2018, pp. 15–17). The designation of critical habitat does not imply that lands outside of critical habitat do not play an important role in the conservation of slickspot peppergrass. Activities with a Federal nexus that may affect those areas outside of critical habitat, such as development, agricultural, or road construction activities, are still subject to review under section 7 of the Act if they may affect slickspot peppergrass.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Seed Production: Depending on an individual plant's vigor, the effectiveness of its pollination, and whether it is functioning as an annual or a biennial, each slickspot peppergrass plant produces varying numbers of seeds (Quinney 1998, pp. 15, 17). Biennial plants normally produce many more seeds than annual plants (Meyer et al. 2005, p. 15). Average seed output

for annual plants at the Idaho Army National Guard's (IDARNG) Orchard Combat Training Center (OCTC) was 125 seeds per plant in 1993 and 46 seeds per plant in 1994. In contrast, seed production of biennials at this site in 1993 and 1994 averaged 787 and 105 seeds per plant, respectively (Meyer et al. 2005, p. 16). Based on data collected from a 4-year demography study on the OCTC, survivorship of the annual form of slickspot peppergrass was demonstrated to be higher than survivorship of biennials (Meyer et al. 2005, p. 16). Meyer et al. (2005, p. 21) hypothesize that the reproductive strategy of slickspot peppergrass is a plastic response, meaning that larger plants will flower and produce seed in their first season, whereas smaller plants that stand less chance of successfully setting seed in their first season will delay reproduction until the following year. Thus, the biennial life form is maintained, despite the higher risk of mortality. Like many short-lived plants growing in arid environments, above-ground numbers of slickspot peppergrass individuals can fluctuate widely from year to year, depending on seasonal precipitation patterns (Mancuso and Moseley 1998, p. 1; Meyer et al. 2005, pp. 4, 12, 15; Palazzo et al. 2005, p. 9; Menke and Kaye 2006a, p. 8; Menke and Kaye 2006b, pp. 10, 11; Sullivan and Nations 2009, p. 44). Mancuso and Moseley (1998, p. 1) note that sites with thousands of above-ground plants one year may have none the next, and vice versa. Above ground plants represent only a portion of the population; the seed bank (a reserve of dormant seeds generally found in the soil) contributes the other portion and in many years, constitutes the majority of the population (Mancuso and Moseley 1998, p. 1). Seed banks are adaptations for survival in a "risky environment" because they buffer a species from stochastic (random) impacts, such as lack of soil moisture (Baskin and Baskin 2001, p. 160). Seed Viability and Germination: The seeds of slickspot peppergrass are found primarily within the slickspot microsites where the plants are found (Meyer and Allen 2005, pp. 5–6). Slickspots, also known as mini-playas or natric (high sodium content) sites, are visually distinct openings in the sagebrush-steppe created by unusual soil conditions characterized by significantly greater sodium and clay content relative to the surrounding area (Moseley 1994, p. 7). The vast majority of slickspot peppergrass seeds in slickspots have been located near the soil surface, with lower numbers of seeds located in deeper soils (Meyer et al. 2005, p. 19; Palazzo et al. 2005, p. 3). Slickspot peppergrass seeds have been found in slickspots even if no above-ground plants are present (Meyer et al. 2005, p. 22; Palazzo et al. 2005, p. 10). When above-ground plants are present, flowering usually occurs in late April and May, fruit set occurs in June, and the seeds are released in late June or early July. Seeds produced in a given year are dormant for at least a year before any germination takes place. Following this year of dormancy, approximately 6 percent of the initially viable seeds produced in a given year germinate annually (Meyer et al. 2005, pp. 17–18). When combined with an average annual 3 percent loss of seed viability, approximately 9 percent of the original seed cohort per year is lost after the first year. Thus, after 12 years, all seeds in a given cohort will likely have either died or germinated, resulting in a maximum estimated longevity of 12 years for seeds in the seed bank (Meyer et al. 2005, p. 18). The primary seed dispersal mechanism for slickspot peppergrass is not known (Robertson and Ulappa 2004, p. 1708), although viable seeds have been found outside of slickspots, indicating that some seed dispersal is occurring beyond slickspot habitat (Palazzo et al. 2005, p. 10). Slickspot peppergrass seeds located near the soil surface show higher rates of germination and viability (Meyer and Allen 2005, pp. 6–8; Palazzo et al. 2005, p. 10) and the greatest seedling emergence success rate (Meyer and Allen 2005, pp. 6–8). Viable seeds were more abundant and had greater germination rates from the upper 2 in. of soil (Palazzo et al. 2005, pp. 8, 10), while Meyer and Allen (2005, pp. 6–8) observed the upper 0.08 in. as optimal for germination. Deep burial of slickspot peppergrass seeds (average depths greater than 5.5 in.) can entomb viable seeds and may preserve them beyond the 12-year period previously

assumed as the maximum period of viability for slickspot peppergrass seeds (Meyer and Allen 2005, pp. 6, 9). However, seeds buried at such depth, even if they remain viable, are unlikely to regain the surface for successful germination. The effects of environmental factors, such as wildfire, on slickspot peppergrass seed dormancy and viability are unknown although slickspot peppergrass abundance is reduced in burned areas. Pollination: Slickspot peppergrass is primarily an outcrossing species requiring pollen from separate plants for more successful fruit production and has a low seed set in the absence of insect pollinators (Robertson 2003, p. 5; Robertson and Klemash 2003, p. 339; Robertson and Ulappa 2004, p. 1707; Billinge and Robertson 2008, pp. 1005–1006). Slickspot peppergrass is able to self-pollinate, with a selfing rate (rate of self-pollination) of 12 to 18 percent (Billinge 2006, p. 40; Robertson et al. 2006a, p. 40). In pollination experiments where researchers moved pollen from one plant to another, fruit production was higher when pollen from distant sources was used (4 to 12.4 miles (mi)) between patches of plants) than when pollen from plants within the same patch was used (246 to 330 feet (ft)) between plants within the same patch) (Robertson and Ulappa 2004, p. 1705; Robertson et al. 2006a, p. 3). Fruits produced from fertilized flowers reach full size approximately two weeks after pollination (Robertson and Ulappa 2004, p. 1706). Each fruit typically bears two seeds that drop to the ground when the fruit dehisces (splits open) in midsummer (Billinge and Robertson 2008, p. 1003). Known slickspot peppergrass insect pollinators include several families of bees (Hymenoptera), including Apidae, Halictidae, Sphecidae, and Vespidae; beetles (Coleoptera), including Dermestidae, Meloidae, and Melyridae; flies (Diptera), including Bombyliidae, Syrphidae, and Tachinidae; and others (Robertson and Klemash 2003, p. 336; Robertson et al. 2006b, p. 6). In slickspot peppergrass insect pollinator studies conducted at three study sites, seed set was not limited by the number of pollinators at any study site (Robertson et al. 2004, p. 14). Studies have shown a strong positive correlation between insect diversity and the number of slickspot peppergrass plants flowering at a site (Robertson and Hannon 2003, p. 8). Measuring fruit set per visit revealed considerable variability in the effectiveness of pollination by different types of insects, ranging from 0 percent in dermestid beetles to 85 percent in honeybees (Apis mellifera) (Robertson et al. 2006b, p. 15).

Habitat Type

Adult: Volcanic plains

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2016)

Habitat Narrative

Adult: The range of slickspot peppergrass is restricted to the volcanic plains of southwest Idaho, occurring primarily in the Snake River Plain and its adjacent northern foothills, with a single disjunct population on the Owyhee Plateau. The plant occurs at elevations ranging from approximately 2,200 to 5,400 ft in Ada, Canyon, Gem, Elmore, Payette, and Owyhee Counties (Moseley 1994, pp. 3–9). Based on differences in topography, soil, and relative abundance, we have divided the extant slickspot peppergrass populations into three physiographic regions: the Boise Foothills, the Snake River Plain, and the Owyhee Plateau. The nature and severity of factors affecting the species also vary between the three physiographic regions for the purposes of analysis. For example, urban and rural development, agriculture, and infrastructure development has been substantial in the sagebrush-steppe habitat of the Boise Foothills and the Snake River Plain regions, while very little of these types of development have occurred within

the Owyhee Plateau region. The biological soil crust, also known as a microbiotic crust or cryptogamic crust, is one component of quality habitat for slickspot peppergrass. Such crusts are commonly found in semiarid and arid ecosystems and are formed by living organisms, primarily bryophytes, lichens, algae, and cyanobacteria, that bind together surface soil particles (Moseley 1994, p. 9; Johnston 1997, p. 4). Microbiotic crusts play an important role in stabilizing the soil and preventing erosion, increasing the availability of nitrogen and other nutrients in the soil and regulating water infiltration and preventing the establishment of invasive plants (Brooks and Pyke 2001, p. 4 and references therein; Serpe et al. 2006, pp. 174, 176). These crusts are sensitive to disturbances that disrupt crust integrity, such as compression due to livestock trampling or off highway vehicle (OHV) use and are subject to damage by fire; recovery from disturbance is possible but occurs very slowly (Johnston 1997, pp. 10–11). Slickspot peppergrass occurs in slickspot habitat microsites scattered within the greater semiarid sagebrush-steppe ecosystem of southwestern Idaho. On a broad scale, the Snake River Plains and the Owyhee Plateau physiographic regions are volcanic in nature and underlain by Tertiary basalt or rhyolite; the adjacent Boise Foothill sites are underlain by Pliocene/Quaternary lacustrine deposits (Moseley 1994, p. 8). Slickspots are visually distinct openings characterized by natric soils and distinct clay layers; they tend to be highly reflective and relatively light in color, making them easy to detect on the landscape (Fisher et al. 1996, p. 3). Slickspots are distinguished from the surrounding sagebrush matrix as having the following characteristics: microsites where water pools when rain falls (Fisher et al. 1996, pp. 2, 4); sparse native vegetation, distinct soil layers with a columnar or prismatic structure, higher alkalinity and clay content, and natric properties (Fisher et al. 1996, pp. 15–16; Meyer and Allen 2005, pp. 3–5, 8; Palazzo et al. 2008, p. 378); and reduced levels of organic matter and nutrients due to lower biomass production (Meyer and Quinney 1993, pp. 3, 6; Fisher et al. 1996, p. 4). Fisher et al. (1996, p. 11) describe slickspots as having a “smooth, panlike surface” that is structureless and slowly permeable when wet, moderately hard and cracked when dry. Although the low permeability of slickspots appears to help hold moisture (Moseley 1994, p. 8), once the thin crust dries out, slickspot peppergrass seedling survival depends on its ability to extend its taproot into the argillic horizon (soil layer with high clay content) to extract moisture from the deeper natric zone (Fisher et al. 1996, p. 13). How long slickspots take to form is unknown, but is hypothesized to take several thousands of years (Nettleton and Peterson 1983, p. 193; Seronko 2006, in litt. p. 2). Climate conditions that allowed slickspot formation in southwestern Idaho are thought to have occurred during a wetter Pleistocene period. Holocene additions of wind-carried salts (often loess deposits) produced the natric soils characteristic of slickspots (Nettleton and Peterson 1983, p. 191; Seronko 2006, in litt., p. 2). Several hundred years may be necessary to alter or lose slickspots through natural climate change or severe natural erosion (Seronko 2006, in litt. p. 2). However, some researchers hypothesize that new slickspots are no longer being created given current climatic conditions (Nettleton and Peterson 1983, pp. 166, 191, 206). As slickspots in southwest Idaho appear to have formed during the Pleistocene and current climate conditions may not allow for the formation of new slickspots, the loss of slickspot microsites appears to be permanent. Some slickspots subjected to past light disturbance may be capable of reforming (Seronko 2006, in litt. p.2). However, disturbances that alter the physical properties of the soil layers, such as deep disturbance and the addition of organic matter, may lead to the destruction and permanent loss of slickspots. For example, deep soil tilling and adding organic matter and gypsum have been recommended for eliminating slickspots from agricultural lands in Idaho (Peterson 1919, p. 11; Rasmussen et al. 1972, p. 142). Slickspot soils are especially susceptible to mechanical disturbances when wet (Rengasamy et al. 1984, p. 63; Seronko 2004, in litt. pp. 1–2). Such disturbances disrupt the soil layers important to slickspot peppergrass seed

germination and seedling growth and alter hydrological function. Meyer and Allen (2005, p. 9) suggest that if sufficient time passes following the disturbance of slickspot soil layers, the slickspot soil layers may regain their pre-disturbance configuration yet not support the species. Thus, while the slickspot appears to have regained its former character, some essential component required to sustain the life history requirements of slickspot peppergrass has apparently been lost, or the active seed bank is no longer present. Most slickspots are between 10 and 20 square feet (ft2) in size although some are as large as 109 ft2 (Mancuso et al. 1998, p. 1). Slickspots cover a relatively small cumulative area within the larger sagebrush-steppe matrix, and only a small percentage of slickspots are known to be occupied by slickspot peppergrass. Slickspot peppergrass has infrequently been documented outside of slickspots on disturbed soils, such as along graded roadsides and badger mounds. These are rare observations and the vast majority of plants documented over the past 19 years of surveys and monitoring for the species were within slickspot microsite habitats (USFWS 2006b, p. 20). For example, in 2002, a complete census of an 11,070-ac area recorded approximately 56,500 slickspots (Air Force 2003 in litt., p. 15), of which approximately 2,450 (about 4.0 percent) were occupied by slickspot peppergrass plants (Bashore, pers. comm. 2003, p. 1). Of the approximately 11,300 slickspot peppergrass plants documented during the survey effort, only 11 plants (less than 1 percent) were documented outside of slickspots (Air Force 2002, summary attachment, entire). Not all potential slickspot peppergrass habitats in southwest Idaho have been surveyed, and additional slickspot peppergrass sites may be found outside of areas known to be occupied. Recent modeling was completed to develop a high-quality, predictive-distribution model of slickspot peppergrass to identify potential habitat (Colket 2008, p. 1). The Bureau defines potential habitat as areas within the known range of slickspot peppergrass that have certain general soil and elevation characteristics that indicate the potential for the area to support slickspot peppergrass although the presence of slickspots or the plant is unknown (USBLM 2009, p. B–2). Although surveys were conducted in 2008 in some areas identified as previously unsurveyed habitat with potential to contain the species, these surveys did not result in any new locations of the species (Colket 2008, pp. 4–6). Slickspot peppergrass has also been surveyed for in eastern Oregon, but the species has never been found there (Findley 2003 in litt., p. 1). We have no historical records indicating that slickspot peppergrass has ever been found anywhere outside of its present range in southwestern Idaho.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decline of 30 to 70 percent

Species Trends:

Declining

Resiliency:

The majority of slickspot peppergrass populations do not meet minimum viability criteria for population size (at least 1,000 plants) and minimum patch size (at least 500 acres) suggested in this SSA. However, some populations may be unique; and therefore, important for population representation and redundancy. For example, none of the populations in the Foothills geographic area met Service minimum population viability criteria due to their low acreages.

Due to the high levels of habitat fragmentation in the Foothills geographic area associated with wildfire, invasive nonnative plants, and development as well as the patchwork of land ownership, it likely would not be feasible to achieve the 500-acre patch size suggested for minimum viability criteria at slickspot peppergrass Foothills populations. As some Foothills populations represent the lower elevation extent of the species, their conservation would be important to preserve slickspot peppergrass genetic diversity and unique habitats despite smaller habitat patch sizes (and in some cases, lower plant numbers). A combination of habitat enhancement or threat reduction actions within populations considered to be unique, regardless of whether they meet suggested minimum population viability criteria, may be appropriate to maintain (and possibly increase) population representation and species redundancy over time. Although based on essentially the same type of baseline data and calculation as MVP, Population Viability Analysis (PVA) addresses the survival probability of specific populations. Viability of slickspot peppergrass populations is important as populations with higher viability also have higher resiliency, and have a higher likelihood of regaining plant numbers following random stochastic events such as drought or localized ground disturbance. PVA is not an absolute measure of whether a population is or is not viable, but rather is a tool used to assess how natural or man-caused changes in conditions may influence population viability. Using IDFG rangewide population assessments, we identified six groupings of good to fair viability populations in relatively close geographic proximity that are scattered across the species' range (Table 8, see also Figure 2). These groupings of higher viability populations are indicative of population strongholds, and may provide for genetic exchange among populations within the same grouping. EOs and subEOs identified as having higher population viability within these six groupings increase resiliency to stochastic events, and their distribution across the range of the species contributes to species representation and redundancy. With the exception of the two groupings within the Jarbidge geographic area, these groupings of higher viability populations are located too distant for insect pollinators to facilitate genetic exchange among the groupings. In addition, some lower viability EOs either within a grouping or in a more isolated location may also be important for population representation and redundancy due to their genetic uniqueness or other characteristics. (USFWS, 2020)

Representation:

While genetic studies suggest that representation of the disjunct Jarbidge geographic area populations is high, representation is more limited for smaller populations located in the Snake River Plain and Foothills geographic areas, where smaller populations separated by greater geographic distances have lower genetic diversity. Maintaining connectivity within and between populations to the extent possible would be important to continued genetic diversity of slickspot peppergrass populations (USFWS, 2020).

Redundancy:

Using these NatureServe protocols, IDFG assessment of individual EOs and subEOs resulted in EOs and subEOs ranked as having good viability (B-ranked) to poor viability (D-ranked) (Table 6). Overall, there appears to be a relatively high level of population redundancy, as good to fair viability populations (B-, BC-, and C-ranked EOs and subEOs) are well distributed across the range of the species (Table 6, see also Figure 2). The majority of the 115 extant populations (66 percent) ranked by IDFG fall within the good to fair population viability categories. When considering the combined acreage of populations rangewide, 83 percent (13,402 acres) of slickspot peppergrass EO and subEO acreage is ranked as having good viability (B-ranked) (Figure 13). No EOs or subEOs were ranked A (excellent viability) or AB (excellent to good viability)

(USFWS, 2020).

Number of Populations:
19 (USFWS, 2021)

Population Size:
45,569 (USFWS, 2016)

Population Narrative:
The number of above-ground plants fluctuates widely from year to year and is strongly correlated with spring precipitation (Menke and Kaye 2006). Seeds can remain viable in the seed bank for at least 12 years (USFWS 2007). The persistent seed bank appears essential for population persistence in this species (Meyer et al. 2006). Also, the species may rely on years with extremely favorable environmental conditions to restock this seed bank; if every year were average in its desert environment, the species might not persist (Meyer et al. 2006). In 2011, 2012, and 2013 the total number of Lepidium papilliferum plants counted was the lowest since 2005, when complete counts for this species were initiated (16,462 plants in 2011; 9,245 plants in 2012; and 6,351 in 2013) (Kinter 2012, in litt.; Kinter 2015, in litt.). In 2014, however, 45,569 total plants were counted, which represented the third highest number of plants observed over the 10 years of HIP monitoring (Kinter 2015, in litt.). Previously, the lowest total number of plants counted occurred in 2006, with 17,543 plants, and the highest count was in 2010, with 58,921 plants (Idaho Department of Fish and Game (IDFG) 2012, p. 5) (USFWS, 2016). Based on IDFG's 2016 assessment of slickspot peppergrass populations, 19 EOs and subEOs contained 1,000 or more slickspot peppergrass plants during IDFG assessment field reviews or during annual monitoring in at least one of the six years between 2010 and 2015. The Service considers these 19 EOs and subEOs (17 B-ranked and 2 BC-ranked) to have the highest viability of all slickspot peppergrass populations. Habitat patch sizes for these 19 slickspot peppergrass EOs and subEOs range from about 2 acres to 7,164 acres. Only 6 of these 19 populations are greater than 500 acres in area. The area of the remaining 13 EOs, documented to support 1,000+ plants, range from 2 to 91 acres. Relative to larger acreage populations, these smaller acreage populations are expected to be more vulnerable to stochastic or catastrophic events, such as ground disturbance or wildfire, respectively. (USFWS, 2021)

Threats and Stressors

Stressor: Increased Frequency and Intensity of Wildfire (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: The altered wildfire regime is one of the two primary causes of reduced quality of habitat for slickspot peppergrass. Across the intermountain west, increased frequency, severity, intensity, and extent of wildfire has converted vast areas of former sagebrush steppe ecosystem to nonnative annual grasslands. Invasive nonnative annual grasses, such as cheatgrass and medusahead, have contributed to increases in the amount and continuity of fine fuels across the landscape. As a result, the wildfire frequency interval of sagebrush steppe habitat has been drastically shortened from a historical range of approximately 60 to over 300 years (depending on the species of sagebrush and other site specific characteristics) to less than 5 years in many areas of the sagebrush steppe ecosystem (Billings 1990, pp. 307–308; Whisenant 1990, p. 4;

USGS 1999, in litt., pp. 1–9; West and Young 2000, p. 262; Bukowski and Baker 2013, p. 557). Not only are wildfires burning far more frequently, but these wildfires tend to be larger and burn more uniformly than those that occurred historically, resulting in fewer patches of unburned vegetation, which affects the post-fire recovery of native sagebrush steppe vegetation (Whisenant 1990, p. 4). However, because estimates of increased fire frequency are critically dependent on the spatial area and period over which authors use for their computations, each estimate of fire frequency in sagebrush steppe provides a perspective on the role of fire in the sagebrush ecosystem that must be interpreted using the appropriate scale (Miller et al. 2011, p. 165). (USFWS, 2020)

Stressor: Introduction and Spread of Invasive Nonnative Plants (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Invasive, nonnative annual grasses can alter various attributes of ecosystems including geomorphology, wildfire regime, hydrology, microclimate, nutrient cycle, and productivity (for a summary, see Dukes and Mooney 2003, entire). Additionally, invasive nonnative annual grasses can negatively affect native plants, including rare plants such as slickspot peppergrass, through competitive exclusion, niche displacement, hybridization, and competition for insect pollinators. Examples of these negative effects are widespread among different taxa, locations, and ecosystems (D'Antonio and Vitousek 1992, pp. 63–87; Olson 1999, p. 5; Mooney and Cleland 2001, p. 1). (USFWS, 2020)

Stressor: Highly Competitive Nonnative Seeded Species (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Highly competitive nonnative seeded species are considered separately from invasive nonnative unseeded species, which includes annual invasive nonnative grasses and perennial noxious weeds. Both native and nonnative deep-rooted perennial bunchgrasses can play key roles in the ecological resilience of habitat to disturbances (such as wildfire and improper livestock grazing) and of ecological resistance to invasive nonnative annual grass establishment. Established perennial plants with well-developed root systems (Figure 17) can effectively compete with invasive nonnative annual grasses for water and nutrients. Both established native and nonnative deep-rooted perennial grasses can limit the spread of invasive nonnative annual grasses such as cheatgrass (Davies and Johnson 2017, p. 748; Clements et al. 2017, pp. 179-180, Ott et al. In press, pp. 6, 10). Seeded deep-rooted nonnative perennial species, such as crested wheatgrass and forage kochia, have been extensively used for post-fire soil stabilization efforts in the Great Basin, including within the range of slickspot peppergrass, due to their ability to decrease soil erosion risk, exclude cheatgrass at a lower cost than native species, and their relative ease of establishment compared with native perennial bunchgrasses (Davies et al. 2013, p. 472). (USFWS, 2020)

Stressor: Development (USFWS, 2020)
Exposure:
Response:
Consequence:

Narrative: In the Service's 2009 listing rule, residential, commercial, and agricultural development was identified as a secondary threat to slickspot peppergrass in the Foothills and Snake River Plain geographic areas (74 FR 52036-52037). More recently, residential and commercial development, inclusive of infrastructure, was identified as one of the most extreme and widespread disturbances documented to impact the species within the Foothills and Snake River Plain geographic areas (Miller and Kinter 2018, p. 38). Development can affect slickspot peppergrass through direct destruction of populations and loss of slick spot microsites. Development can also have indirect impacts by contributing to nonnative plant invasions, particularly along associated utility lines and roads, which act as corridors for nonnative plant invasions (Forman and Alexander 1998, p. 210; Gelbard and Belnap 2003, pp. 424-425, 430-431; Bradley and Mustard 2006, p. 1142); increased human-caused ignition of wildfires, presumably by increasing the area of the urban-wildland interface (e.g., Keeley et al. 1999, p. 1829; Romero-Calcerrada et al. 2008, pp. 341, 351; Syphard et al. 2008, pp. 610-611); increased off road vehicle use; and increased habitat fragmentation, which can pose problems for slickspot peppergrass by creating barriers in the landscape to pollinators that prevent effective genetic exchange within or among populations (Robertson et al. 2004, pp. 2-4). (USFWS, 2020)

Stressor: Owyhee harvester ants (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: While effects of herbivory on slickspot peppergrass by mammals and most insects has not been identified as a significant stressor (IDFG in litt. 2018, p. 6), in recent years, concern has emerged over potential detrimental effects of seed predation by Owyhee harvester ants. Owyhee harvester ants are a native species that thrive in open grassy areas throughout southwest Idaho, including areas occupied by slickspot peppergrass where shrubs have been lost. These ants consume the seeds of small-seeded species (including slickspot peppergrass) preferentially over large-seeded species such as cheatgrass (Schmasow and Robertson 2016, p. 955). Studies have shown that Owyhee harvester ants can remove up to 90 percent of slickspot peppergrass fruits and seeds from individual plants, either directly from the plant or by scavenging seeds that drop to the ground (White and Robertson 2009b, p. 511; Robertson and Crossman 2012, pp. 14-15; Jeffries 2016, entire). The extent to which seed predation by harvester ants impacts slickspot peppergrass seed recruitment within slick spots and populations is currently under investigation. Slick spots with low numbers of flowering slickspot peppergrass plants are likely to suffer high levels of seed loss in a given year (based on the results of White and Robertson 2009b, Robertson and Crossman 2012, and Jeffries 2016), whereas slick spots with large numbers of plants may overwhelm the ants' capacity to consume seeds (Robertson 2018, personal communication). (USFWS, 2020)

Stressor: Improper Livestock Grazing (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Livestock use is widespread across the range of slickspot peppergrass. Livestock use in areas that contain slickspot peppergrass can result in both positive and negative effects on the species, depending on factors such as intensity, timing, and duration of use. Livestock grazing may be used as a tool to ameliorate the primary threats of wildfire and invasive annual grasses on slickspot peppergrass. Domestic cattle are not known to feed on slickspot peppergrass, and

domestic sheep have been observed uprooting but not consuming plants (D. Quinney and J. Weaver pers. comm. 1998). Although direct herbivory of slickspot peppergrass by livestock has not been documented to occur, livestock grazing can impact slickspot peppergrass through trampling and interactions with the nonnative invasive plant cycle. (USFWS, 2020)

Stressor: Climate Change (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Warmer temperature regimes and changes in precipitation associated with global climate change represent another risk factor for slickspot peppergrass. Consequences of climate change, if current projections occur, are likely to exacerbate existing primary threats (modified wildfire regime and invasive nonnative plants, particularly cheatgrass) to slickspot peppergrass conservation. Researchers confirmed "experimentally that, in an intact ecosystem, elevated carbon dioxide may enhance the invasive success of Bromus spp. in arid ecosystems,'' and suggest that this enhanced success will then expose these arid areas to accelerated wildfire cycles (Smith et al. 2000, p. 81). Chambers and Pellant (2008, p. 32) also suggest that higher carbon dioxide levels are likely increasing cheatgrass fuel loads due to increased productivity, with a resulting increase in wildfire frequency and extent. Furthermore, current climate change models predict future climatic conditions within the range of slickspot peppergrass will favor further invasion by cheatgrass (Smith et al. 1987, pp. 142-143; Smith et al. 2000, p. 81; Brown et al. 2004, p. 384; Neilson et al. 2005, pp. 150, 156; Chambers and Pellant 2008, pp. 31-32). These and other models (Littell et al. 2009, p. 1019; Abatzoglou and Kolden 2013, p. K; Westerling et al. 2014, p. 91; McKenzie and Littell 2017, p. 29) also project that wildfire frequency will continue to increase, and the extent and severity of wildfires may increase as well. Thus, the projected consequences of climate change are acting to exacerbate the primary threats of frequent wildfire and invasive nonnative plant species on slickspot peppergrass throughout its range. (USFWS, 2020)

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
Not available; a Recovery Plan has not been issued.

Recovery Actions:
- Not available; a Recovery Plan has not been issued.

Conservation Measures and Best Management Practices:
- Currently, there are six formalized plans that incorporate specific conservation measures for slickspot peppergrass: • The Candidate Conservation Agreement for Slickspot Peppergrass between the State of Idaho, BLM, Idaho Army National Guard and nongovernmental cooperators (private landowners who also hold livestock grazing permits on BLM lands) (State of Idaho et al. 2003, as updated in 2006); • The BLM and U.S. Fish and Wildlife Service Conservation Agreement for existing BLM land use plans (USBLM and USFWS 2006, as updated in 2009, 2013, and 2014). Once conservation measures of identical or greater conservation value are incorporated into all applicable

BLM land management plans, the term of this Conservation Agreement will be concluded. One applicable BLM land management plan where conservation measures have yet to be incorporated (the Four Rivers Resource Management Plan) remains. Conservation measures with identical or greater conservation value than this Conservation Agreement have been incorporated into two recent BLM land use plans: o The 2008 Morley Nelson Snake River Birds of Prey National Conservation Area Resource Management Plan (as contained within Appendix 8 of the 2008 Record of Decision), and o The 2015 Jarbidge Approved Resource Management Plan. • The Idaho Army National Guard's Integrated Natural Resource Management Plan for the Orchard Combat Training Center (National Guard 1991, as updated in 1997, 2004, 2008, and 2013); and • The Mountain Home Air Force Base's Integrated Natural Resource Management Plan, which includes the Juniper Butte Range (Air Force 2004, as updated in 2012 and 2018). (USFWS, 2020)

- The BLM's Jarbidge and the Paradigm fuel break projects have the potential to reduce the risk of wildfires within portions of the range of slickspot peppergrass. However, these fuel break projects do not address the co-occurring effects of existing invasive nonnative annual grasses, one of two primary threats identified for the species, or the conservation need for sagebrush steppe habitat restoration. Considering all of these factors, it is unlikely that these large fuel break projects on their own will adequately address threats such that future population viability is maintained or improved in this portion of the species range. Although fire suppression, including Rangeland Fire Protection Associations, and fuels management efforts currently in place are a positive conservation step for slickspot peppergrass and its habitat, they are not sufficient at this time to offset effects of current and future extent of invasive nonnative plants or other threats across the range of the species. Effective control of the most significant threats to slickspot peppergrass (wildfire and invasive nonnative plant species, especially invasive nonnative annual grasses) may require efforts that extend beyond the boundaries of slickspot peppergrass populations since these threats are naturally expansive and occur throughout the Great Basin at landscape levels. (USFWS, 2020)
- Approximately 45 percent of slickspot peppergrass habitat is currently located within RFPA or Mutual Aid boundaries, and 70 percent of EO acres located on State Endowment Trust Lands are within fire protection boundaries (1.015 of 1,454 acres) (IDL in litt. 2018, p. 1). However, these areas continue to be at a high risk of large catastrophic wildfires based on conditions associated with low ecological resistance and resilience areas (Chambers et al. 2014a, entire). In addition, while RFPAs have the potential to influence the overall effect of wildfires, they do not address the threat from existing invasive nonnative plant species, the second of two primary threats identified for the species, or the conservation need for sagebrush steppe habitat restoration. Therefore, while the formation of RFPAs are a positive conservation step for sagebrush steppe habitat, RFPAs have not yet shown to be sufficiently effective to offset the primary threat of wildfire to the species. (USFWS, 2020)
- While the Jarbidge and the Paradigm fuel breaks projects have the potential to reduce the risk of wildfires within portions of the range of slickspot peppergrass, these fuel break projects do not address the co-occurring effects of existing invasive nonnative plant species, one of two primary threats identified for the species, or the conservation need for sagebrush steppe habitat restoration. Addressing existing invasive nonnative plants and the restoration of sagebrush steppe habitat are not within the scope of these fuel breaks projects. Considering all of these factors, it is unlikely that these large fuel break projects on their own will adequately address threats such that rangewide future species viability is maintained or improved. Although wildfire suppression, including RFPAs, and fuels management efforts currently in place are a positive conservation step for slickspot peppergrass and its habitat, they are not sufficient at this time to offset effects of current and future extent of invasive nonnative plants or other threats across the range of the species. (USFWS, 2020)

- RECOMMENDATIONS FOR FUTURE ACTIONS Proceed with the development of a Recovery Plan and an associated Recovery Implementation Strategy for the slickspot peppergrass that includes specific, objective, and quantifiable recovery criteria and actions. • Collaborate with the Slickspot Peppergrass Technical Team and other experts to determine recovery requirements for the species. • Develop a strategy for maintaining or restoring Wyoming big sagebrush habitat within and adjacent to slickspot peppergrass element occurrences, which emphasizes the use of native shrubs, grasses, and forbs to benefit slickspot peppergrass and its insect pollinators. • Investigate rangewide population genetics using recent technologies to identify and prioritize conservation of slickspot peppergrass element occurrences essential for maintaining genetic diversity of the species into the future. (USFWs, 2021)

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SPECIES ACCOUNT: *Leptocereus grantianus* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 2/26/1993

Physical Description

A sprawling. suberect, nearly spineless cactus which may reach up to 2 meters in height and 3 to 5 centimeters in diameter. The elongated stems have 3 to 5 prominent ribs with broadly scalloped edges. Ribs of young joints are thin, and the small areoles may bear one to three minute, nearly black spines (less than 1 millimeter long) which disappear as the joints grow older and the ribs become thicker. The flowers are solitary at the terminal areoles, 3 to 6 centimeters long, and nocturnal. The ovary and flower tube bear distinct areoles. The outer perianth segments are linear, green, and tipped by an areole like those of the tube and ovary. The inner perianth segments are numerous, cream-colored, oblong-ovate, obtuse and about 8 millimeters long. Stamens are many and have yellow anthers. The stigma lobes are several and short. The fruit is subglobose to ellipsoid and about 4 centimeters in diameter (Britton 1933, Proctor 1991) (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Known only from one location on Culebra, an island off the northeastern coast of Puerto Rico. The one known population, which consists of approximately 50 individuals, occurs in dry thickets along a rocky shore near Punta Melones, on the southwestern part of the island (USFWS, 1994).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative reproduction (USFWS, 2015)

Reproduction Narrative

Adult: The species in the wild is apparently dependent of vegetative reproduction instead of sexual reproduction (USFWS, 2015). Little is known about the species' phenology, natural recruitment, and habitat requirements for seeds germination in the wild. The low number of individuals per population, absent of recruits, and its limited spatial distribution may suggest that the species currently depends on vegetative reproduction for population growth (C. Pacheco, Service, pers. obs., 2013). The species is able to produce flowers and fruits, and germination experiments have demonstrated that seeds are viable (M, Caraballo, University of Puerto Rico-Rio Piedras, pers. comm., 2012). However, no germination has been observed in the wild, and it is not clear if competition with exotic species (e.g., Megathyrsus maximus) is affecting the natural recruitment of L. grantianus. In addition, it has not been determined if the

species is missing a fruit disperser (e.g., bird, bat) (USFWS, 2015).

Habitat Type

Adult: Steep, rocky slopes (USFWS, 1994)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1994)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1994)

Site Fidelity

Adult: High (inferred from USFWS, 1994)

Habitat Narrative

Adult: Culebra and the surrounding small islands comprise an area of only 3,116 hectares (7,700 acres). Topography is irregular and the highest elevation is that of Monte Resaca (200 meters; 650 feet). Culebra and the cays adjacent to it are underlain by volcanic and intrusive rocks which are upper Cretaceous in age. Andesitic lava underlies most of the island, and the north coast is underlain by andesitic tuff. In north central Culebra this tuff and lava have been intruded by diorite. The diorite has weathered to round boulders which may reach more than a meter in diameter. Slopes in these areas are often greater than 60 percent (USFWS, 1994). On Culebra Leptocereus grantianus grows on rocky, steep slopes adjacent to the narrow beach. Associated species on this rocky slope are almacigo (Busera simaruba), ucar (Bucida buceras), sea grape (Coccoloba uvifera), sebucan (Pilosocereus royenii), and mesquite (Prosopis pallida). Adjacent uplands have been mostly deforested, historically for agricultural use and grazing, and more recently for proposed residential/tourist development (USFWS, 1994). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Dispersal

Adult: Low (inferred form USFWS, 1994)

Dispersal/Migration Narrative

Adult: Low dispersal and no immigration/emigration are inferred based on this species dependence on vegetative reproduction in the wild.

Population Information and Trends

Population Trends:

Increasing (USFWS, 2015)

Number of Populations:

Six (USFWS, 2015)

Population Size:

267 total individuals (USFWS, 2015)

Additional Population-level Information:

From 1996 to 2013, the Service produced over 360 individuals of L. grantianus from cuttings in tree nursery conditions, and has planted 193 of them in seven sites on private property with a landowner's conservation agreement and within the Culebra Island National Wildlife Refuge (CINWR) (e.g., Flamenco peninsula, Luis Pena Island, Culebrita Island). In 2013, the Service conducted a rapid assessment of the introduced population of L. grantianus and visited all planted individuals. Less than 5% had survived due to anthropogenic factors (i.e., intentional fires) and predation by exotic mammals (i.e., deer and goats) (R. Colon-Merced and C. Pacheco, Service unpubl. data, 2014; USFWS 2015). (USFWS, 2019). Recently, additional propagation and introduction efforts have been implemented on Culebra in partnership with Villa Mi Terruiio and CINWR. Since 2011, the Service and Fundaci6n Mi Terruiino, Inc. signed a Cooperative Agreement (F12AC01199) under the Coastal and Partners for Fish and Wildlife Programs, to conduct joint efforts for the recovery of the three populations currently located within Villas Mi Terruiio private land (USFWS 2015). Since the recovery plan was approved, five new populations of this species have been discovered on Culebra. Additionally, L. grantianus has been successfully propagated by cuttings and introduced in seven protected sites managed for conservation on the island (USFWS 2015). Propagation efforts have resulted in the following new populations within protected areas: 60 individuals in two new sites within Villa Mi Terruiio property, 20 individuals in two new patches within Punta Soldado natural reserve, 25 individuals within Punta Flamenco, 20 individuals within Resaca beach, 3 individuals within the Observation Point, and 2 individuals within Culebrita Island. (USFWS, 2019).

Population Narrative:

New information on L. grantianus indicates that the overall species abundance has increased since the recovery plan was approved in 1995. Since that year, five new populations of L. grantianus have been discovered along the southeast coast of Culebra Island. In addition, the species has been propagated and planted in seven sites in Culebra; including two offshore cays (Figure 1). Currently, the species' abundance is estimated at around 267 adult individuals (about 261 in natural populations; Table 1), and six in introduction sites (Table 2) (USFWS, 2015). The assessment on L. grantianus conducted by the Service in 2013 is the most up-to-date information on the status of the species on Culebra. Based on our observations and recorded data, the overall abundance of L. grantianus has increased. The current estimate for the species is now around 261 adult individuals in natural populations, 188 individuals in greenhouses, and 6 individuals planted (Tables 1 and 2, Monsegur and Pacheco, USFWS, unpublished data 2009) (USFWS, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals. As of 2019, individual locations are as follows: 191 individuals in three localities within Villas Mi Terruiino; 20 individuals in Playa Melones; and 50 individual in two sites within Punta Soldado (USFWS 2015). Of these sites, the three sites within Villas Mi Terruiio and one site in Punta Soldado are on private lands. One of the sites within Punta Soldado is located within the natural reserve managed by the Puerto Rico Department of Natural and Environmental Resources (PRDNER). The individuals at Playa Melones are located within the maritime zone also managed by the PRDNER. (USFWS, 2019).

Threats and Stressors

Stressor: Agricultural activities (USFWS, 2015)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural activities result in deforestation, which is a threat to this species habitat (USFWS, 2015).

Stressor: Urban development (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Deforestation for urban development is listed as a threat to this species (USFWS, 2015).

Stressor: Tourism (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Deforestation for tourism projects and trails used by tourists that are in or near this species habitat are listed as a threat to this species.

Stressor: Landscaping/deforestation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individual plants/Loss of habitat
Narrative: Landscaping has resulted in a more xeric environment and erosion in some areas that are still forested (USFWS, 2015). Individual plants have also been affected by landscaping in some areas.

Stressor: Exotic mammals (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/loss of individual plants
Narrative: Exotic mammals such as white-tailed deer and wild domestic animals such as feral goats modify the forest structure through over-grazing and are also a threat to individual plants due to trampling (USFWS, 2015)

Stressor: Predation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individual plants
Narrative: Predation of young stems by hermit crabs (Coenobita clypeatus) has been observed on the Island of Culebra (Ross 2002). Ross (2002) also reported black rats (Rattus rattus) feeding on the stems of introduced populations on the Island of Culebrita. Service biologists have also reported predation of the apex of young stems and flower buds during the evaluation of natural and introduced populations. Although we have no evidence of this predator, we suspect introduced goats or deer most likely caused the damage (Figure 3) (USFWS, 2015).

Stressor: Limited distribution (USFWS, 2015)

Exposure:
Response:
Consequence: Danger of extinction
Narrative: Leptocereus grantianus is vulnerable to extinction due to low population numbers and its limited distribution (i.e., only six populations and 267 individuals reported), coupled with habitat loss or alteration (R. Colón-Merced and C. Pacheco, Service unpubl. data, 2013). Ross (2002) reported landslides as one of the factors affecting the introduced individuals on the Island of Culebrita. Presently, about 38.5% of the known adult individuals are located along the shoreline, subject to coastal erosion and landslides. In addition, the limited distribution of the species may also have exacerbated its vulnerability to natural or anthropogenic factors such as hurricanes, wildfires, and genetic variation, compromising the continued existence of this species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Lack of genetic diversity
Narrative: Given the extremely limited geographic distribution of L. grantianus, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn, 2007). In order to safeguard the remaining genetic diversity, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the potential lack of genetic variation as a possible threat to the species (USFWS, 2015).

Stressor: Hurricanes/landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Due to the extremely limited range of L. grantianus, low number of individuals, and lack of information about its natural recruitment and habitat requirements, we believe that stochastic events such as severe tropical storms or hurricanes may have an adverse impact on the species. In the absence of such information, it is difficult to predict the recovery of the species after natural events such as hurricanes and tropical storms impacts. Therefore, since L. grantianus has only six known populations, we consider this threat as high in magnitude, but not imminent because the frequency and intensity of hurricanes passing over Culebra Island are not predictable (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Changes in climate can cause a number of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing "climate change" as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007; Glick et al. 2011). An expected

effect of the climate change is the increase in intensity of hurricanes and tropical storm followed by an extended period of drought (IPPCC 2012). This climate change may alter the microclimate and the surrounding vegetation around the populations of L. grantianus. Hurricane effects followed by extended period of drought may result in changes in soil conditions and microclimate and may allow other plants (native or nonnative, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. Megathyrsus maximus) may spread and colonize L. grantianus habitat, and they could alter microclimate and nutrient cycling of the habitat that the species depends on. Due to its limited distribution and number of natural populations, we consider the cumulative effects of hurricanes, genetic variation, and exotic and invasive species (plants and animals) to be detrimental to the L. grantianus as a whole. The population dynamics of the species is poorly known (e.g., depressed genetic variability and its competitive abilities), there are only few known natural populations, and there is a lack of information to determine what constitutes a viable population. Therefore, we consider the above mentioned threats as high in magnitude because the species has only a few known populations; but not imminent because threats (i.e. hurricanes, landslides, climate change, among others) are not likely to occur in the near future (USFWS, 2015).

Stressor: Low reproductive capacity (USFWS, 2015)
Exposure:
Response:
Consequence: Low genetic variability
Narrative: Little is known about the species' phenology, natural recruitment, and habitat requirements for seeds germination in the wild. The low number of individuals per population, absent of recruits, and its limited spatial distribution may suggest that the species currently depends on vegetative reproduction for population growth (C. Pacheco, Service, pers. obs., 2013). The species is able to produce flowers and fruits, and germination experiments have demonstrated that seeds are viable (M, Caraballo, University of Puerto Rico-Rio Piedras, pers. comm., 2012). However, no germination has been observed in the wild, and it is not clear if competition with exotic species (e.g., Megathyrsus maximus) is affecting the natural recruitment of L. grantianus. In addition, it has not been determined if the species is missing a fruit disperser (e.g., bird, bat). The above mentioned factors, coupled with habitat loss or alteration, may also exacerbate the vulnerability of L. grantianus to natural or anthropogenic events such as hurricanes and fires, compromising the continued existence of this species (R. Colón-Merced and C. Pacheco, Service unpubl. data, 2013). In the absence of knowledge on the natural recruitment capacity and habitat requirement of this species, it is difficult to predict its recovery (USFWS, 2015).

Stressor: Human-induced fires. (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
An Agreement among the Service, the municipality of Culebra, and the Puerto Rico Department of Natural and Environmental Resources (PRDNER) has been prepared and implemented for the

protection of the species (USFWS, 2015).

New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within the units of the CINWR (USFWS, 2015).

Delisting Criteria:
1. Existing three (3) populations on Culebra show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

2. Establish two (2) additional populations on Culebra offshore cays with a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor C and E). (USFWS, 2019).

3. Threat reduction and management activities (e.g. eradication and control of invasive predators) have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor C). (USFWS, 2019).

Recovery Actions:
- The first criterion has been partially met. Presently, five of the six known natural populations of L. grantianus occur within private lands, and one occurs within a Commonwealth land managed by the PRDNER. A Cooperative Agreement between the Service and PRDNER is in place since 1984 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico under Section 6 of the ESA. However, this agreement does not provide specific actions to protect and conserve the existing population of L. grantianus in Culebra. Currently, three L. grantianus populations are located within Villa Mi Terruño (VMT), private land subject to residential and tourism development (Dubón 2013). In 2011, the Service and Fundación Mi Terruño, Inc. signed a Cooperative Agreement (F12AC01199) under the Coastal and Partners for Fish and Wildlife Programs, to conduct joint efforts for the recovery of the species. Fundación Mi Terruño, Inc. is a scientific, educational and conservation partner of VMT. The agreement includes (1) the protection of L. grantianus within the VMT property, (2) planting 60 individuals of the species to establish at least 6 two populations within the VMT property, and (3) enhancement of 21 cuerdas (20.4 ac; 8.3 ha) of habitat for the species by planting 1,265 native trees. The other two populations occurring on private lands are not covered under any agreement with the landowner. Agreements should be established with the private landowners at Playa Melones and Punta Soldado to protect the existing L. grantianus populations in those areas. The agreement with the municipality of Culebra is not practical since the municipality does not manage or have jurisdiction of any of the currently known populations (USFWS, 2015).
- Criterion 2 has been partially met. This criterion states that new populations of L. grantianus should be established within protected areas in Culebra. Since the recovery plan was approved, five new populations of this species have been discovered in Culebra. Additionally, L. grantianus has been successfully propagated by cuttings and introduced in seven protected sites managed for conservation on the island (Figure 1). Presently, over 140 individuals of L. grantianus are maintained in pods at two shade houses in the Island of Culebra for this purpose. These individuals will be planted during the spring of 2015 in lands managed for conservation in Culebra. Hence, propagation and planting efforts of L.

grantianus should continue as suggested in the recovery plan. Once populations are established, long term monitoring is needed to ensure that they are self sustainable to fully meet the recovery criteria (USFWS, 2015).

- New in 2019: Develop and implement monitoring protocols to ensure that the cactus mealy bug does not pose a threat to unaffected L. grantianus populations. This recovery action will be coordinated with PRDNER, APHIS, and the Service's National Wildlife Refuge System. (USFWS, 2019).
- 1. We will work with partners (e.g., PRDNER) to update the recovery plan for L. grantianus as new information is available. Such collaboration should lead to establishing measurable criteria to delist the species (USFWS, 2015).
- 2. All populations, natural and introduced, should be monitored on a regular basis, and additional surveys should be conducted after hurricanes, landslides, fires, or other major disturbances. The natural populations should be monitored on a long-term basis to determine the species' trends (USFWS, 2015).
- 3. Conservation Agreements should be established between the Service and private landowners to protect natural populations in Playa Melones, Villa Mi Terruño and Punta Soldado on Culebra (USFWS, 2015).
- . Propagation efforts of L. grantianus should continue to enhance wild populations and establish additional self-sustainable populations in protected areas. Due to the current threat of infestation of wild populations with the Harrisia cactus mealybug, priority should be given to the establishment of a seed bank to ensure the availability of healthy plants for future recovery projects. Before taking this action, we will carefully evaluate and take into consideration the effects of seed and/or seedling removal on the species, existing threats, genetic variations, and consider ways to propagate by cuttings (USFWS, 2015).
- 5. Seeds and cuttings from the populations located along the shoreline of Culebra should be collected for propagation to preserve the genetic diversity of these populations. The selection of sites to establish new populations should be carefully evaluated considering coastal erosion and future sea level rise. Due to the small size of the populations, care must be taken to avoid over collection for scientific purposes. Seed collection should follow the Center for Plant Conservation (CPC) protocols, and some seeds should be preserved in a long-term seed storage facility approved by the CPC (USFWS, 2015).
- 6. A detailed demographic study of this plant's populations is needed since the ecology of the species, including pollinators, seed dispersers, germination requirements and habitat requirements is largely unknown (USFWS, 2015).
- 7. Genetic studies should be conducted to determine the patterns of genetic variation, genetic drift and its potential to affect the recovery of the species (USFWS, 2015).
- 8. The effects of competition with exotic plant species and predation by exotic animals need to be evaluated (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Recommendations included in the 2015 5-years status review and the 2019 Amended Recovery Plan (Service 2019) still apply. Additionally, in order to minimize herbivory by goat and deer populations, we recommend the installation of physical barriers around natural and planted populations of Leptocereus grantianus. (USFWS, 2021)

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SPECIES ACCOUNT: *Lespedeza leptostachya* (Prairie bush-clover)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/09/1987; Great Lakes - Big Rivers Region (R3) (USFWS, 2016). Recommended for delisting (2021a)

Physical Description

Herbaceous perennial; sericeous stems of mature plants are erect, up to a meter tall, and may be either simple or branched. The linea ror narrowly oblong leaflets of the trifoliate leaves are 2-4 cm long and 2-8 mm wide with appressed pubescence above and silky hairs below. The longer terminal leaflets are lss than half as wide as long, with petioles 2-10mm long. Petals of the chasmogamous (open, potentially outcrossing) flowers are white, or yellowish-white to light pink with a magenta mark in the center of the keel and are between 4 and 6 mm in length. The cream-colored petals of closed, obligately self-pollinating cleistogamous flowers develop within and are usually surrounded by the calyx, which reaches a length of 4.5 to 5 mm when fully developed. Both types of flowers may occur on a single plant or an individual plant may exhibit cleistogamous flowers only (USFWS, 1988).

Taxonomy

In the pea family (Fabaceae). There are 40 members o fthis genus, of which 12 are native to North America. Also known as slender-leaved bush clover (USFWS, 1988)

Historical Range

Former range included 27 counties in Minnesota, Wisconsin, Iowa, and Illinois (USFWS, 1988).

Current Range

Prairie bush-clover has been found across four states: Illinois, Iowa, Minnesota, and Wisconsin (Figure 1.2). Populations considered historical around the time of listing (1988) were documented in 28 counties across all four states (USFWS 1988, p. 4). The number of known extant populations has increased in Iowa, Minnesota, and Wisconsin. Additional populations were found in Minnesota as a result of increased survey effort post-listing. For example, seven new prairie bush-clover populations were discovered in 1990 (Sather 1991, p. 1). (USFWS, 2021)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (NatureServe, 2015)

Lifespan

Adult: 30 years (USFWS, 2021)

Breeding Season

Adult: July - September (NatureServe, 2015; USFWS, 1988), Seed germination begins in May and continues through July (USFWS 1988, p. 12; Figure 1.5), the production of chasmogamous flowers lasts until mid-August and the production of cleistogamous flowers occurs into September

Key Resources Needed for Breeding

Adult: Insect pollinators, possibly scarification/fire (NatureServe, 2015)

Other Reproductive Information

Adult: The longevity of prairie bush-clover seeds in the soil is relatively unknown; however, a study examining seed germination and the seed bank of prairie bush-clover found that the large majority (about 95%) of seeds germinated during the second year. Individual prairie bush-clover plants have been documented entering a period of dormancy that may last 1-2 years. Individual plants may enter dormancy in response to increased competition and/or lack of disturbance (grazing) (Bockenstedt 2002, p. 45). (USFWS, 2021)

Reproduction Narrative

Adult: Blooms mainly in mid-July. Lespedeza species produce both larger, showy chasmogamous flowers and greatly reduced cleistogamous flowers. The cleistogamous flowers are obligately self-pollinated. Clewell (1966a) demonstrated that the chasmogamous flowers of other members of the genus are more often self- pollinated than cross-pollinated, thus Lespedeza has a strong tendency towards autogamy. In one study, only 20% of pods contained seeds (Baskin pers. comm.). Pollinators for some other Lespedeza species are known: Bombus fraternus (L. capitata and L. virginica), Xylocopa micans (L. steuvei, L. angustifolia), Campsomeris plumipes (same species), and Epargyreus clarus (same species). Haugen and Fitch (1955) have suggested that surface fire might cause scarification in Lespedeza bicolor. Clewell (1966a) found that germination success of L. cuneata increased following heating in an oven 90C for 30 minutes. On the other hand, L. leptostachya has been germinated in both Illinois and Kentucky without scarification (Kurz and Bowles 1981, Baskin pers. comm.). Smith (pers. comm.) has observed germination in the absence of fire every year for four years at one site in Minnesota (NatureServe, 2015). Plants under cultivation have been observed to flower the same year they germinated, whereas wild plants may require 5 or more years to reach maturity. Mature plants have been observed to flower repeatedly over four sequential sampling seasons. It is estimated that individual plants frequently live ten years or more. Growth and development of terminal inflorescences continues into early September (USFWS, 1988).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry to mesic gravel and sandy prairie (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Possibly a disturbance regime (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: 0.3 - 1.9 per sq. m (USFWS, 1988)

Tolerance Ranges/Thresholds

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits dry gravel prairies and dry-mesic prairies in Illinois (Steyermark and Swink 1955, Kurz and Bowles 1981), dry-mesic prairies in Minnesota (Smith 1981) and Iowa (Huston 1981), dry prairie and sandy prairie in Wisconsin (Tans and Read 1975). Characteristics of dry gravel and dry-mesic prairies in Illinois include steep, well-drained, usually calcareous soil sites (White and Madany 1978). Smith (1981) noted that five of six Minnesota sites are north or northwest-facing slopes of 10 to 15 degrees, all well drained (the sixth site was on level ground). Apparently withstands moderate grazing. May require disturbance for reproduction and to reduce competition (NatureServe, 2015). Estimates of density in 1986 range from 0.3 to 1.9 plants per square meter (USFWS, 1988). Prairie bush-clover is endemic to Midwestern prairies in Illinois, Iowa, Minnesota, and Wisconsin. The majority of populations at the time of listing were found on gentle, north-facing slopes of 10-15 degrees. Surveys conducted over the last thirty years have found that the species can occur on north, west, and east-facing slopes. Plants are usually found around the edges of slopes or within barely concave areas that are not subject to nutrient or herbicide input from drain-tile discharge (Nancy Sather, Minnesota Department of Natural Resources (MNDNR), retired, pers. comm, June 30, 2021). Soil types include, but are not limited to fine silty loam, sand, fine sandy loam, or clay loam (USFWS 1988, p. 2; Cole and Biesboer 1992, p. 567). Prairie bush-clover also occurs at bedrock outcrop sites interspersed with upland prairie (USFWS 1988, p. 8). The species occurs on disturbed sites or prairie habitats that have been previously mowed, burned, cultivated, or grazed, in addition to undisturbed remnant prairie sites (USFWS 1988, p. 7, Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Prairie bush-clover can thrive in great numbers on actively grazed sites (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). The known range of prairie bush-clover overlapped with the bison (Bison bison) range and, as a result, the species co-evolved with grazing (Todd Bittner, Cornell Botanical Garden, pers. comm., June 22, 2021). Many sites that are currently protected in Minnesota are former pastures where the species was discovered only when systematic grassland surveys targeted them as potential habitat. At one heavily grazed pasture site in Minnesota, 1,117 prairie bush-clover plants shorter than 10 cm (3.9 inches) were discovered. The population was similar to other formerly grazed sites where flowering prairie bush-clover plants are visible approximately three years after the cessation of grazing (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). At formerly cultivated sites, the species was visible and widely dispersed across the site, rather than the patchy distribution common at southwestern Minnesota sites, a few years after cultivation ended. It is likely that prairie bush-clover seeds in the seed bank were spread across the site due to cultivation practices (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021) (USFWS, 2021).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Within the genus there are no special structures to aid in seed dispersal, and seed dispersal is probably via animals consuming the fruits and passing the seeds. Clewell (1966a) tested 108 seeds of other members of the genus that were consumed by bobwhite quail (Colinus virginianus) and obtained 100% germination success. He also tested 16 seeds that were consumed by small mammals, and obtained 89% germination success (NatureServe, 2015). Seed

dispersal mechanisms for prairie bush-clover are largely unknown; however, seeds are thought to be dispersed by either gravity or animal activity (for example, voles, small rodents) (Bockenstedt 2002, p. 4). (USFWS, 2021)

Population Information and Trends

Population Trends:

Increasing (USFWS, 2021a)

Resiliency:

Thirty-seven prairie bush-clover populations or 33% currently exhibit excellent or good resiliency across all four states in the geographic range. The 12 populations that are in excellent condition all have over 1000 individual prairie bush-clover plants and no evidence of significant and recent (defined as occurring over the last 20 years) decline. The majority (8 or 67%) of the populations ranked as excellent are composed of high-quality prairie with minimal threats due to persistent management and 10 or more acres of contiguous suitable habitat. Ten populations with excellent resiliency are owned by a conservation organization or are permanently protected for purposes of conservation. One population is owned privately or by an organization that is currently interested in conservation and one population is currently not protected. The 25 prairie bush-clover populations currently ranked as having good resiliency all have at least 10 individual plants, with the majority of those populations having 100 or more. All but two of these populations occur in areas with high or fair quality prairie habitat with minimal threats and/or persistent management. Two populations occur at sites with degraded prairie habitat and inconsistent management. The amount of suitable contiguous habitat at populations with good resiliency varies from less than 1 acre to 10 or more acres. The majority (18 or 72%) of prairie bush-clover populations exhibiting good resiliency are owned by a conservation organization and are permanently protected for purposes of conservation. Five populations are currently unprotected with no informal agreement in place. One population is owned privately or by an organization that is currently interested in conservation and one population has an informal agreement in place. The majority, 76 populations or 67%, of prairie bush-clover populations rangewide currently exhibit fair or poor resiliency. Populations with fair resiliency have 99 or fewer plants or have shown significant recent decline (as determined by state biologists and species experts), degraded habitat due to high impact grazing, brush encroachment and/or non-native, invasive species, with inconsistent management. These populations are generally characterized as having one to four acres of contiguous suitable habitat and the landowner has an informal conservation agreement in place. Thirty-five populations currently have poor resiliency. Populations exhibiting poor resiliency generally have fewer than 10 plants or have shown significant recent decline and are present in low quality habitat with no management. Non-native, invasive species are the dominant vegetation at these sites and suitable contiguous habitat is less than one acre. The sites are not protected from future land conversion. In addition, 12 populations are currently considered extirpated. (USFWS, 2021).

Representation:

The distribution of extant prairie bush-clover (Lespedeza leptostachya) by representative category. Representative Category. Dry Prairie. Number of Extant Populations: 52. Percent of Populations 46%. Representative Category. Dry-Mesic Prairie. Number of Extant Populations: 41. Percent of Populations 36%. Representative Category. Mesic Prairie. Number of Extant

Populations: 14. Percent of Populations 12%. Representative Category. Bedrock Prairie. Number of Extant Populations: 6. Percent of Populations 5%. (USFWS, 2021).

Redundancy:

Redundancy describes the ability of a species to withstand catastrophic events by maintaining multiple, resilient populations across the species' geographic range. The redundancy of prairie bush-clover is based on its 113 extant populations distributed across Illinois, Iowa, Minnesota, and Wisconsin and the four prairie habitat types that we define as representative categories. Individual populations in each of the four prairie habitat types (representative categories) are dispersed throughout the species' overall range, and, therefore, are distributed geographically. Thus, the number and resiliency of populations in each representative category also characterizes current distribution (redundancy) in terms of the spatial impact of a catastrophic event. (USFWS, 2021).

Number of Populations:

113 (USFWS, 2021)

Population Size:

24,530 (USFWS, 1998)

Population Narrative:

There are about 32 extant populations, and many of these are small (<150 stems) (NatureServe, 2015). Total population size in peripheral populations is 1,923 and 22,607 in core populations (USFWS, 1988). As of 2020 (over 30 years later), there are 113 known extant populations across the four states (USFWS, 2021). The number of known populations of prairie bush-clover has increased from 36 populations at the time of listing in 1987 (52 FR 783) to 113 populations today. The number of known extant populations has increased in Iowa, Minnesota, and Wisconsin. Additional populations were found in all four states as a result of increased survey effort post-listing. For instance, seven new prairie bush-clover populations were discovered in Minnesota in 1990 (Sather 1991, p. 1) (USFWS, 2021a).

Threats and Stressors

Stressor: Habitat loss and degradation (USFWS, 1988)
Exposure:
Response:
Consequence:
Narrative: Threatened by loss of habitat due to agriculture and urbanization, may be threatened by plant succession, lack of natural disturbance (which prevents shrub invasion) at individual sites, and slow germination and seedling establishment rates. Specific threats to occurrences include use of herbicides or run-off containing herbicides at Cihak Prairie (Jackson Co., Minnesota; Smith 1981). Quarry operations threaten the Morton Outcrop (Renville Co., Minnesota; Smith 1981) site and the Winnebago Co. (IL) site (Kurz and Bowles 1981). At least four sites are presently being grazed (USFWS 1987). Woody species invasion threatens two sites in Wisconsin and two in Minnesota (USFWS 1987). Roadside mowing and weedy vegetation is threatening a site near a housing development in Wisconsin (Richardson pers. comm.) (USFWS, 1988).

Stressor: Herbivory (USFWS, 1988)
Exposure:
Response:
Consequence:
Narrative: Herbivory by both insects and mammals may contribute to mortality. Insect herbivory has been reported for Illinois, Minnesota and Iowa populations. Young leaves and growing tips of young plants are damaged by insects throughout the summer. There is evidence of infestation by Cuculionid or Brucid beetles in Minnesota populations. At time, damage by mammals may reach significant proportions in localized areas (USFWS, 1988).

Stressor: Succession (USFWS, 1988)
Exposure:
Response:
Consequence:
Narrative: Tentative evidence suggest that L. leptostachya is detrimentally affected by woody invasion but no data are available adequately to evaluate the threats (USFWS, 1988).

Stressor: Hybridization (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Hybridization with L. capitata is known to have occurred at two sites in Minnesota, one in Iowa, and one in Illinois (USFWS 1988).

Stressor: Herbicide Use
Exposure:
Response:
Consequence:
Narrative: Incompatible use of herbicides at known population sites would directly impact an individual plant's ability to produce seeds and may disrupt connectivity across microhabitats. Seed dispersal may also be impacted due to a decline in pollinators, which are largely unknown for prairie bush-clover. Prairie bush-clover populations located near agricultural fields or adjacent to existing roadways may be at increased risk of exposure to herbicide use (USFWS 1988, p. 15). (USFWS, 2021).

Stressor: Habitat Conservation
Exposure:
Response:
Consequence:
Narrative: Conversion of documented prairie bush-clover sites to row crops and gravel quarries has destroyed at least two sites in Wisconsin and Illinois (USFWS 1988, p. 14). Agricultural activity resulting in a direct conversion to row-crops destroyed at least one known prairie bush-clover site in Wisconsin (USFWS 1988, p. 14). Conversion of documented populations to rock or gravel quarries has occurred at least once in Illinois (USFWS 1988, p. 15). One unprotected Illinois population was lost due to commercial development (Todd Bittner, Cornell Botanic Garden, pers. comm., June 22, 2021). Extant prairie bush-clover populations located on private land are at risk of conversion to row crop or rural residential development (USFWS 1988, p. 14), and populations located adjacent to existing rights of way are at risk due to potential roadway expansion in the

future (USFWS 1988, p. 15). (USFWS, 2021).

Stressor: Climate Change
Exposure:
Response:
Consequence:
Narrative: Climate change may act as a stressor on the species by promoting non-native vegetation growth and exacerbating drought conditions. Changes in precipitation regimes are anticipated with fewer, but larger events followed by prolonged dry periods and drought stress (Knapp et al. 2008, p. 816). These alterations may create novel ecosystems that suppress native plant species and promote expansion of invasive, non-native species into prairie bush-clover habitat (Knapp et al. 2008, p. 817). Climate change may also promote dominant, non-native vegetation growth and encroachment with the increase in CO2 and subsequent increase in plant biomass (Blumenthal et al. 2013, p. 1161). Increased biomass at sites with prairie bush-clover populations may lead to increases in thatch, or layer of organic plant matter, which makes seed germination increasingly difficult. Altered precipitation and temperature regimes may influence when management activities in prairie habitat can occur by increasing or reducing opportunities for the use of prescribed fire. Prolonged periods of warmer temperatures may allow for more opportunities for prescribed burning, while increased precipitation in the spring or early summer may constrain when prescribed burns may occur. Ultimately, the timing of prescribed burns may become increasingly unpredictable due to variable temperatures and changes in precipitation regimes (Wisconsin Initiative on Climate Change Impacts 2017). (USFWS, 2021).

Stressor: Dominant Vegetation Encroachment
Exposure:
Response:
Consequence:
Narrative: Prairie systems are reliant on natural disturbance regimes to maintain the structure of the prairie. Without fire, grazing, or other natural disturbances, prairie communities may transition to scrubshrub or early successional habitat types. Mature prairie bush-clover plants can succumb to prolonged competition with woody vegetation encroachment. This has been documented at populations in Wisconsin and Minnesota (Nancy Sather, MN DNR retired, pers. comm., June 30, 2021). There are a number of invasive, non-native plant species, including buckthorn, that currently pose a threat to prairie bush-clover populations with no active management or management plans in place. Native dominant woody plant species documented at sites include: Buckthorn species (Ceanothus species), Hawthorn species (Crataegus species), eastern red cedar (Juniperus virginiana), quaking aspen (Populus tremuloides), cherry species (Prunus species), burr oak (Quercus macrocarpa), black oak (Quercus velutina), smooth sumac (Rhus glabra), staghorn sumac (Rhus typhina), western snowberry (Symphoricarpos occidentalis), and riverbank grape (Vitis riparia) (USFWS 1988, p. 10). (USFWS, 2021).

Stressor: Drought
Exposure:
Response:
Consequence:
Narrative: Prairie bush-clover predominantly occurs in habitats with dry soil types (dry prairie, bedrock prairie) or characteristics (dry-mesic prairie), which makes the species relatively droughttolerant; however, populations at sites with mesic soil types (mesic prairie) may be

subjected to additional stress from prolonged drought periods (Knapp et al. 2008, p. 816). Prolonged drought events lasting multiple consecutive growing seasons may have long lasting impacts on populations. If conditions are not favorable, the prairie bush-clover may enter a state of dormancy for a year; however, if unfavorable conditions persist for two or more years, dormant plants may not survive. Non-dormant plants may produce fewer chasmogamous flowers which may further impact the genetic diversity of a population. A prolonged drought may also have a significant impact on seedling survival (Kevin Doyle, Wisconsin Department of Natural Resources, pers. comm., June 22, 2021). (USFWS, 2021).

Stressor: Hybridization
Exposure:
Response:
Consequence:
Narrative: There have been numerous documented reports of hybridization between prairie bush-clover and round-headed bush clover (Lespedeza capitata) in all four states (Fant et al. 2010, p. 2197). Both species are found in remnant prairie habitats and have overlapping flowering periods (USFWS 1988, p. 16). Hybrids have been documented at Minnesota sites since the early 1980s (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Numerous hybrid plants were observed at Jeffers Petroglyphs National Monument in 1995 (MN Natural Heritage Program 1995, p. 4). The number of prairie bush-clover populations with hybrids and the number of hybrid plants within populations has steadily increased since 1987, when only two Minnesota populations had documented hybrids (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Now hybrids are present in all four states in the prairie bush-clover range (Fant et al. 2010, p. 2197). No systematic documentation of hybrids has been conducted in Minnesota; however, biologists recently discovered that one of the first populations to support hybrids had been completely swamped by morphological hybrids (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Hybrid plants have vegetative traits (stem circumference, leaf width, and petiole length) that often are intermediate between the round-headed bush clover and the prairie bush-clover. Genetic testing indicated that prairie bush-clover acts as the seed-bearing parent (Fant et al. 2010, p. 2202). The hybrid plants may also be capable of self-fertilization, as both parent species produce cleistogamous flowers. At least one instance of back-crossing has been observed at a site in Minnesota. This occurs when a hybrid individual crosses with one of the hybridizing species (round-headed bush clover or prairie bush-clover) and produces an offspring that is morphologically and genetically similar to the parent, in this case, prairie bush-clover (Nancy Sather, MNDNR, retired, pers. comm., June 30, 2021). Prairie bush-clover is not a genetically diverse species, so genetic assimilation to round-headed bush clover may serve as a threat to the genetic diversity of prairie bush-clover (Fant et al. 2010, pp. 2203). For this report, we considered the potential impacts of hybridization qualitatively, rather than quantitatively as it's unclear how many populations have documented hybrid plants. (USFWS, 2021).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Protect and bring under appropriate management a minimum of twenty viable naturally-occurring populations of prairie bush-clover within the core habitat area (USFWS, 1988).

2. Protect and manage a minimum of fifteen viable naturally-occurring populations (representing the full range of habitat types) outside the core habitat area (USFWS, 1988).

Recovery Actions:

- Protect selected viable populations and their habitat. Initiate landowner awareness and permanent portection activities. Stabilize protection with long-term management plans and agreements (USFWS, 1988).
- Provide appropriate management at each protected site (USFWS, 1988).
- Inventory to locate additional populations. Search historical sites where prairie bush clover has been found and habitat is still present. Identify and search potential new sites (USFWS, 1988).
- Monitor population trends at known sites (USFWS, 1988).
- Establish artificial seed banks for selected populations (USFWS, 1988).
- Provide appropriate public information (USFWS, 1988).
- Conduct appropriate research. Determine important habitat parameters, including characterization of soils. Increase knowledge of species and population biology (life history, population structure and dynamics, competition, predation). Determine natural seed bank (USFWS, 1988).
- Study the response of populations to a variety of potential management techniques (fire, grazing, mowing, pesticides, shrub and tree removal) (USFWS, 1988).
- Determine genetic diversity within and between populations (USFWS, 1988).
- Management objectives should include maintaining population size in good condition occurrences and increasing population size in degraded occurrences. Monitoring should be used to track the accomplishment of these objectives. Monitoring will be critical at Anderson Prairie, Iowa, where the herbicides Banvel and 2,4,D were applied to an area with two stands of L. leptostachya in June 1985 (Roosa pers. comm.) (NatureServe, 2015).
- In Minnesota, Smith (pers. comm.) has been monitoring one population using a bi-coordinate system that enables workers to map and relocate individual plants and to record demographic data each year. Smith's method has also been adapted for use at another site in Minnesota (Sather 1987) and one in Iowa (Nekola 1985) (NatureServe, 2015).
- In Illinois, yearly stem counts are taken at sites being monitored for management response (Schwegman pers. comm., Packard pers. comm.) (NatureServe, 2015).
- In Wisconsin, stem counts are made each year (Martin, Richardson, pers. comm.) (NatureServe, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Over the next five-years, the following conservation actions are recommended to directly benefit and assist in the continued recovery of prairie bush-clover. • Coordinate survey efforts across the geographic range of the species and assess the status of populations that have not been monitored for over 10 years (2011 or earlier) with an emphasis on populations characterized as having excellent or good resiliency. • Increase the number of protected populations across representative categories. This may include implementing and/or increasing outreach efforts with private landowners. • Manage habitat to support prairie bush-clover populations through practices that duplicate the natural processes of the prairie ecosystem (prescribed burns, grazing, or other methods to manage non-native, invasive species and/or encroaching woody vegetation). • Encourage and support research focused on identifying and

documenting prairie bushclover pollinators, their abundance, and life histories. (USFWS, 2021a).

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SPECIES ACCOUNT: *Lesquerella congesta* (Dudley Bluffs bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/06/1990; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A small, cushion-shaped, herbaceous perennial, up to 3 cm in diameter, with a congested mass of bright yellow flowers and silvery leaves rising from a long, thin taproot (NatureServe, 2015).

Taxonomy

A member of the mustard family (USFWS, 1993). Renamed Physaria congesta (USFWS, 2008).

Historical Range

Known from Rio Blanco County, Colorado (NatureServe, 2015).

Current Range

It is found only along the Piceance and Yellow Creek drainages. Estimated range is 88 square kilometers (34 square miles), calculated in GIS by drawing a minimum convex polygon around the known occurrences (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2008)

Lifespan

Adult: 2+ years (NatureServe, 2015).

Breeding Season

Adult: April - May (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2008)

Reproduction Narrative

Adult: A perennial species (NatureServe, 2015). Pollinators reported for the bladderpod are Andrena hicksii and two other unidentified species of Andrena. These are native, solitary bees that nest in ground holes or in dead wood (USFWS, 2008). In late April to late May the Dudley Bluffs bladderpod is easy to spot when its bright yellow flowers bloom (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: White shale outcrops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Erosion from downcutting of streams (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits barren white shale outcrops of the Green River and Uinta Formations that have been exposed along drainages through erosion from downcutting of streams in the Piceance Basin. Grows on level surfaces at the points of ridges (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

7 (USFWS, 2008)

Population Size:

219,300-731,300 (USFWS, 2020a)

Adaptability:

High (inferred from USFWS, 2008)

Population Narrative:

Vulnerable to any surface disturbance. The long term popullation trend is unknown (NatureServe, 2015). There are seven known occurrences of bladderpod. The current estimated total occupied habitat is 201 to 207 ha (496 to 512 ac) on BLM, State, and private lands in the northern Piceance Basin in Rio Blanco County. The estimated total number of plants is 550,576 to 602,576 (CNHP 2006b). CNHP has assigned estimated viability ranks of A (excellent) to D (poor) for each recorded occurrence based on population size, condition of the plants, quality of habitat, viability, and defensibility. The average rank for the seven bladderpod occurrence was A-minus (USFWS, 2008). We currently estimate that there are 219,300-731,300 bladderpod individuals range-wide and 42,600-52,100 twinpod, yet threats to both species remain. (USFWS, 2020a)

Threats and Stressors

Stressor: Oil and gas development (NatureServe, 2015; USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Mining and oil and gas development are considered to be the primary threats to the species at this time (Rondeau et al. 2011). Mining of oil shale and/or nahcolite solution could impact up to 100% of the occupied habitat. A new nahcolite plant at Yankee Gulch, across from Dudley Bluffs was built in 2000. The lease may extend into Ryan Gulch. Additionally, a new drill pad was observed near Dudley Bluffs in 2000 (CNAP 2000) (NatureServe, 2015). Air pollution from diesel truck exhaust and from proposed coal-fired power plants for oil shale production could be a potential impact. Likewise, dust from heavy use of nearby roads may impede growth of the plants; information on likely impacts is not available (USFWS, 2008).

Stressor: Trampling (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The bladderpod has been trampled by horses and cows at the Duck Creek ACEC. Cattle trampling remains at a low level (BLM-WRFO 2002a). Monitoring in this ACEC from 1996 to 2002 shows fluctuations in plant numbers that are attributed to drought more than to livestock damage (BLM-WRFO 1990, BLM-WRFO 2002a) (USFWS, 2008).

Stressor: Produced water (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Overspray from a produced-water evaporation pond on private land has reached an adjacent BLM plant occurrence; effects on the plants have yet to be determined. Accidental release of produced water from gas wells has been observed to kill sagebrush and associated vegetation near a few well pads (USFWS, 2008).

Stressor: Loss of pollinators (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: These species rely exclusively on insect pollination. Increasing ground disturbance in the vicinity of occupied plant habitat may be curtailing nesting resources for ground nesting bee pollinators. Increasing vehicle traffic may cause mortality of pollinators. Available information regarding these potential threats is not sufficient to show that larger buffer areas would benefit the pollinators (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Drought years result in a loss of plants. When occurrences also are impacted by other factors during drought years, they may require several years to recover. Dislodging of plants while monitoring during drought years has been cited as a factor in population decline at two

ACEC sites (BLM-WRFO 1989; BLM-WRFO 2002b). Climate change may exacerbate the frequency and intensity of droughts in this area (USFWS, 2008).

Recovery

Delisting Criteria:

1. At least seven key conservation areas for bladderpod and eleven key conservation areas for twinpod are protected (Factors A, C, D, and E). A key conservation area includes all occupied habitat within an occurrence and the surrounding area of potential impact. The area of potential impact is the area where indirect effects may impact plants. For bladderpod and twinpod, we consider this to be the area within 1,970 ft (600 m) of occupied habitat. i. Protection of these sites means that the sites are owned or managed by an individual, agency, or organization that identifies conservation of bladderpod or twinpod as a management objective of the site, and that regulatory mechanisms or other conservation plans or programs reduce or ameliorate threats associated with habitat loss and degradation. ii. Long-term habitat protections are in place to protect key conservation areas from identified threats to the species and manage for surface disturbing activities. Habitat protection can be achieved via long-term management agreements, conservation agreements, or memoranda of understanding in accordance with landowner and agency authorities (Factor D). (USFWS, 2020)

2. Habitat within key conservation areas possesses all of the following qualities (Factors A, C, and E): i. Habitat is of the quality and quantity necessary to support a stable and selfsupporting occurrence of bladderpod or twinpod. In key conservation areas where both species are present, the area may be considered a key conservation area for both species, given that the habitat of the area is of the quality and quantity necessary to support stable and self-supporting occurrences of both bladderpod and twinpod. Unless a PVA or other science provides a more detailed definition of habitat quality, necessary habitat quality will be assumed if the occurrence has been stable in that habitat for ten years, as per criterion 3. ii. Adjacent habitat is available with conditions sufficient to support pollinating insects. iii. Habitat conditions at each key conservation area are stable or improving after 10 years of monitoring. (USFWS, 2020)

3. At least seven occurrences of bladderpod and eleven occurrences of twinpod within key conservation areas are stable and self-sustaining. To be deemed stable and selfsustaining, an occurrence must demonstrate a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive 10-year period and contain at least 4,824 plants at the end of the 10-year period. Plant abundance may fluctuate within individual sites and from year to year, but the defined occurrences should have a stable or increasing growth rate from year one to year ten. The ten-year period may start retroactively (Factors A, C, D, and E). (USFWS, 2020)

4. All populations of bladderpod and twinpod are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004). The ex-situ seed collection should contain existing levels of genetic diversity (representation) of bladderpod and twinpod across the ranges of the species and should take place over a 10-year period (Factor E). (USFWS, 2020)

5. Criteria 1 through 4 have been realized and demonstrated effective via monitoring efforts (Factors A, C, D, and E). (USFWS, 2020)

Recovery Actions:

- Inventory any remaining potential habitat (USFWS, 1993).
- Establish formal land management designations to maintain and protect existing populations on public land (USFWS, 1993).
- Protect sites on private land with land exchanges and/or conservation easements (USFWS, 1993).
- Conduct life history/ecology research and soil analysis (USFWS, 1993).
- Monitor trend of existing populations with permanent plots (USFWS, 1993).
- Publish a technical correction in the Federal Register noting the change in taxonomy from Lesquerella congesta to Physaria congesta, and correcting 50 CFR 17.12 (USFWS, 2008).
- Revise the recovery plan so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats meaningfully impacting the species. The recovery plan should also estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2008).
- Designate critical habitat for the species. “Critical habitat” is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. This could be done concurrently, in a single rule, with other neighboring plant species (USFWS, 2008).
- Recommend at least a 200 m (656 ft) buffer between occupied or suitable habitat and ground disturbance or other activities that may affect the plants or their habitat (USFWS, 2008).
- Develop and implement consistent conservation measures in the WRFO RMP revision that will avoid and minimize impacts from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures. Expand existing ACECs to include contiguous occupied and suitable habitat for the plants and their pollinators. Designate the Yellow Creek occurrence as an ACEC as was proposed in the recovery plan, plus contiguous occupied and suitable habitat (USFWS, 2008).
- Inventory remaining potential habitat on public and private lands. Report results to CNHP, BLM, and the Service (USFWS, 2008).
- Map all potential habitat, occupied habitat, and areas of existing and proposed leases, applications to drill, and development activities in GIS format (USFWS, 2008).
- Develop and implement permanent conservation agreements for occurrences on private lands (USFWS, 2008).
- Monitor the effects of development activities located within 200 m (656 ft) of plant occurrences on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2008).
- Conduct annual status evaluations including estimates of mean density and population sizes at all Element Occurrences for the duration of intense energy activities within the range of the species (USFWS, 2008).
- Research the function of pollinators in the life history needs of the species, determine the habitat requirements of key pollinators, and adjust energy development best management

practices accordingly (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Publish a technical correction in the Federal Register noting the change in taxonomy from Lesquerella congesta to Physaria congesta, and correcting 50 CFR 17.12. • Inventory remaining potential habitat on public and private lands. Report results to CNHP, BLM, and the Service. • Identify key conservation areas for both species. • Develop and implement permanent conservation agreements for occurrences on private lands. • Conduct annual status evaluations including estimates of mean density and population sizes at all key conservation areas. For more information about recommended future actions, refer to the 2019 recovery plan and implementation schedule (USFWS 2019a-b). (USFWS, 2020)

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SPECIES ACCOUNT: *Lesquerella kingii ssp. bernardina* (San Bernardino Mountains bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/24/1994; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb that forms a basal rosette of leaves. Stems, mostly 5-15 cm tall, arise from the rosette and bear yellow flowers, followed by round, plump seed pods (NatureServe, 2015).

Taxonomy

A member of the member of the (Brassicaceae) mustard family. The genus Lesquerella is now considered united with the genus Physaria. The name now recognized for San Bernardino Mountains bladderpod is Physaria kingii (S. Watson) O'Kane & Al-Shehbaz subsp. bernardina (Munz) O'Kane and Al-Shehbaz (Al-Shehbaz and O'Kane 2002, p. 319) (USFWS, 2009).

Historical Range

San Bernardino Mountains bladderpod is endemic to the San Bernardino Mountains, San Bernardino County, California. At the time of listing, San Bernardino Mountains bladderpod was known from two areas on either side of Bear Valley (USFWS 1994, p. 43654). One cluster of occurrences is on the north side of Bear Valley towards the east end of Bertha Ridge. The other cluster is on the north facing slope of Sugarlump Ridge to the south of the valley (USFWS 1994, p. 43654) (USFWS, 2009).

Current Range

Since listing, there have been no significant changes in the known range of the taxon. Recent assessments indicate that there is about 210 acres (85 hectares) of occupied habitat for San Bernardino Mountains bladderpod (USFS 2005a, p. 272) (USFWS, 2009).

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lesquerella kingii ssp. bernardina (San Bernardino Mountains bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat unit (CHUs), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for Lesquerella kingii ssp. bernardina includes two CHUs (4 subunits) in San Bernardino County, California (67 FR 78570-78610).

Unit 2: Bertha Ridge Unit, San Bernardino County, California (275 ha (685 ac)). The Bertha Ridge Unit includes four separate polygons encompassing important occurrences of the carbonate plants. This unit is located on the north side of Big Bear Lake adjacent to Big Bear City, California. It is near the east end of Bertha Ridge on its south facing slope. The majority of lands within this

unit contain soils derived from carbonate substrates (particularly dolomite) that are essential to the survival and conservation of both carbonate plant species. This unit contains important core occurrences of two of the five carbonate plants: Eriogonum ovalifolium var. vineum and Lesquerella kingii ssp. bernardina.

Sugarlump Ridge Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle map Moonridge, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lesquerella kingii ssp. bernardina critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from Bonanza King Formation and Undivided Cambrian parent materials that occur on hillsides or on large rock outcrops at elevations between 2,098 and 2,700 m (6,883 and 8,800 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil.

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2009)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: May - June (USFWS, 2009)

Key Resources Needed for Breeding

Adult: Possibly a soil seed bank (USFWS, 1997)

Reproduction Narrative

Adult: Flowers are borne in terminal racemes and bloom from May to June. The fruits are spherical, pubescent, two-chambered, and contain 2 to 4 seeds per chamber (Rollins 1993, p. 430) (USFWS, 2009). Anecdotal observations of increases in population size following drought suggest that a persistent seed bank may be necessary for this taxon's survival (USFWS, 1997). This is a perennial plant (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Pine-juniper woodlands, fir forests (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 2100 - 2700 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Occurs on dolomite substrates, typically on open, gentle to moderate slopes within pine-juniper woodlands and fir forests at 2100-2700 m elevation. Soils typically have little accumulation of organic material. It is tolerant of light disturbance: found on old roads and undeveloped lots. The environmental specificity is very narrow; it is a narrow carbonate endemic (NatureServe, 2015). The primary constituent elements of San Bernardino Mountains bladderpod designated critical habitat include: 1) soils derived primarily from Bonanza King Formation and Undivided Cambrian parent materials that occur on hillsides or on large rock outcrops at elevations between 6,883 and 8,800 feet (2,098 and 2,700 meters); 2) soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, re-contoured, or otherwise altered by ground-disturbing equipment); and 3) associated plant communities that have areas with an open canopy cover and little accumulation of organic material (e.g., leaf litter) on the surface of the soil (USFWS 1994, p. 78577) (USFWS, 2009).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Decline of 70-90% (NatureServe, 2015)

Species Trends:
30 - 50% decline (NatureServe, 2015)

Number of Populations:
2 (USFWS, 2022)

Population Size:
Uncertain; ~25,000 known (NatureServe, 2015)

Population Narrative:
This species has experienced a long term decline of 70-90%. The short term trend has been downwards (30 - 50%) for this plant due to development, OHV use, other recreational uses, grazing, mining and weeds. There are perhaps 25,000 plants known to the California Natural Diversity Database, but the actual total population size is uncertain. Of 8 total EO's, 5 are non-historic, and 3 are historic (NatureServe, 2015). The species is known from two areas, on either side of Bear Valley (USFWS, 1997). Distribution and Occurrence Status Since 2009, no studies have examined PHKIBE life history, biology, or genetics. No occurrence1 table was included in the previous review, but PHKIBE was known to occur from two areas on either side of Big Bear Valley. We have new information about these occurrences from site visits since 2009, including: 1. In 2010, the California Department of Fish and Wildlife (CDFW) collected seed for PHKIBE at California Natural Diversity Database (CNDDB) Element Occurrences (EOs) 1 and 4 (CDFW 2012, unpaginated). PHKIBE was found at both locations. 2. In 2011, California Botanic Garden (formerly Rancho Santa Ana Botanic Garden) completed a floristic survey of the Upper Santa Ana River watershed on the San Bernardino National Forest (SBNF). The effort included surveying for special status plant taxa (Fraga et al. 2011, p. 19). PHKIBE was found on carbonate outcrops near Coon Creek (Fraga et al. 2011, p. 34). 3. In 2015, the U.S. Forest Service (USFS) conducted emergency consultation on eight threatened or endangered species and critical habitat that may have been affected by the Lake Fire or associated response activities (USFS 2015, pp. 2–3). PHKIBE was found during site visits in the Coon Creek area (USFS 2015, pp. 84–90). Impacts to individual plants from fire suppression activities may have occurred, but no critical habitat was affected (see Fire Suppression Activities below). There are three new occurrences not previously considered in the 2009 review. These new occurrences do not represent a significant range extension for PHKIBE. They are: 1. EO 9 was reported by Stoughton and Ashbaker in 2010 (CDFW 2021). 2. Two occurrences were reported by the U.S. Forest Service (USFS) but have not been reported in the CNDDB. The first was observed during a biological assessment for the Lake Fire in 2015 (USFS 2015). This occurrence is approximately 2 miles (mi) [3.22 kilometers (km)] northeast of EO 9, and therefore represents a new EO. The second occurrence was reported in 2019 by USFS and is located approximately 0.67 mi (1.08 km) west of EO 1 and should also be considered a new EO. We have also updated several occurrences based on new information from State and Federal partners. Changes in occurrence status since 2009 are: 1. Three EOs (CNDDB EO 3,7, and 8) were determined to be erroneous.

The location of EO 3 was incorrectly recorded and is likely included in EO 1 (Eliason 2021, pers. comm.). EO 7 was erroneously mapped near the city of Sugarloaf. The herbarium record for EO 7 places it in EO 1 (CCH2 2021). EO 8 was determined to be erroneous because there is no reliable location information for this record (Eliason 2021, pers. comm.). 2. Two EOs (CNDDB EO 5 and 6) were considered extant in 2009. EO 5 has not been seen since 2008 despite suitable habitat, and EO 6 has not been seen since 2004. We now consider them presumed extant since they have not been observed in more than 10 years. In summary, since the 2009 review we have received new information about PHKIBE occurrences from site visits. We recorded three new occurrences and updated five occurrence statuses. Based on information from the 2009 review and new information, there are currently seven occurrences of PHKIBE (Figure 1, Table 1). We determined that two occurrences are presumed extant and five occurrences are extant (USFWS, 2022).

Threats and Stressors

Stressor: Off-highway vehicles (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Off-road (off-highway) vehicle use was identified as a threat in the final listing rule (USFWS 1994, p. 43659). Since listing, some level of impact from off-road vehicles continues to impact the species. About 2 acres (one hectare) of occupied habitat and 10 acres (4 hectares) of designated critical habitat overlap with roads and trails (USFWS 2005a, p. 273) (USFWS, 2009).

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The San Bernardino Mountains bladderpod populations on the east end of Bertha Ridge near Big Bear City were described in the final listing rule as being threatened by impacts associated with urban development (USFWS 1994, p. 43659). Habitat continues to be affected due to proximity with urban development through mountain biking off roads and trails, particularly in the area north of Whispering Forest, where several trails connect U.S. Forest Service and private lands (USFS 2005a, p. 313). An additional threat to the San Bernardino Mountains bladderpod described in the final listing rule was from the proposed addition of a downhill ski run to Sugarlump Ridge (USFWS 1994, p. 43660). On January 26, 1995, the Service issued a biological opinion for the Bear Mountain Ski Resort Expansion Project. This project involved the loss of 0.55 acres (0.22 hectares) of previously disturbed San Bernardino Mountains bladderpod habitat (USFWS 1995, p. 2) (USFWS, 2009).

Stressor: Mining (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Prospecting and working on gold mining claims continue to impact this species (USFS 2005a, p. 313). About 10 percent of San Bernardino Mountains bladderpod occupied habitat is under claim for gold mining (USFS 2005a, p. 313) (USFWS, 2009).

Stressor: Fire suppression activities (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Fire suppression activities, not identified as a threat in the final listing rule, can result in ground disturbance and other impacts to habitat through trampling, fire line construction, retardant and water drops, establishment of fire camps, and exposure to conditions favorable to nonnative invasive plants (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Among the threats identified in the final listing rule for this species was the potential for stochastic extinction resulting from random events, and this threat still exists. A significant drop in San Bernardino Mountains bladderpod populations occurred between 1980 and 1988 and may have been due to years of drought conditions (USFWS 1994, p. 43662). Because this species is restricted to certain, limited soils, it is likely that its population has always been small. The potential for stochastic extinction is enhanced by habitat loss and fragmentation. Habitat fragmentation can result in areas too limited and isolated to support pollinators or other seed dispersal agents (USFWS 1997, p. 16). Global climate change may further increase likelihood of stochastic extinction (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Some evidence suggests that global climate change may be a particular concern to montane species. Summary papers have cited studies documenting shifts in the distribution of various taxa in response to climatic warming trends. These shifts are often found from the southern and lower elevation ends of the species' range to the northern or higher elevation of the range (Field et al. 1999, pp. 38–39). San Bernardino Mountains bladderpod is endemic to isolated occurrences of dolomite and limestone derived soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the taxon into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction. To date, no species-specific monitoring has been conducted to detect an elevational shift in its range (USFWS, 2009).

Recovery

Reclassification Criteria:
1. The priority ranked habitat areas have been protected. Priority for protection shall be determined according, but not limited, to: 1) population size, 2) habitat quality, 3) manageability/defensibility of site, and 4) connectivity. The initial preserve area should be 2,000

hectares (5,000 acres) based on known areas occupied by the plants. To count toward reclassification of the plants, reserves must have been designed to minimize or eliminate indirect threats due to adjacent land uses. This includes protection of carbonate plant habitat from human disturbance to hydrology, soil integrity, fire ecology, habitat microclimates, and light regimes. Appropriate management and restorative measures should reduce habitat-degrading effects such as surface disturbances, windblown sediments, fugitive night lighting, and off-highway vehicle use (USFWS, 2009).

2. Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 1,860 hectares (4,600 acres) (USFWS, 2009).

3. Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available, including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology (USFWS, 2009).

Delisting Criteria:
The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become available, delisting criteria will be established (USFWS, 2009).

Recovery Actions:
- Protect significant extant populations by developing a system of reserves on Federally owned land. Initially, preserves covering about 2,000 hectares (5,000 acres) are needed, based on known areas occupied by the plants. The reserve system includes buffer zones and maintenance of selected habitat connections. The land managing agencies will conserve these plants in the context of applicable laws (including the mining laws) and regulations (USFWS, 1997).
- Restore habitat and conduct reintroductions and/or population enhancements where appropriate and feasible (USFWS, 1997).
- Identify and implement appropriate management measures (USFWS, 1997).
- Monitor populations (USFWS, 1997).
- Conduct limited surveys and taxonomic assessments to find new populations and resolve questions about the identity of several populations identified in the text (USFWS, 1997).
- Prepare a new threats-based recovery plan specific to San Bernardino Mountains bladderpod that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Physaria kingii subsp. Bernardina (USFWS, 2009).

- Work with the San Bernardino National Forest to conduct systematic monitoring of San Bernardino Mountains bladderpod throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change (USFWS, 2009).
- Work with partners, such as the San Bernardino National Forest, to help conserve San Bernardino Mountains bladderpod by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect San Bernardino Mountains bladderpod from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near San Bernardino Mountains bladderpod habitat (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years. Successful implementation of these actions will reduce threats to PHKIBE and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Study PHKIBE population genetics, including levels of genetic diversity and differentiation among and within occurrences. Determine levels of inbreeding, relatedness, and ploidy. This information will help us assess current levels of genetic diversity and gene flow and determine if genetic management is needed and assess appropriate seed sources for potential future reintroduction or augmentation activities. 2. Continue to collect additional seeds from PHKIBE occurrences to expand the conservation seed bank at the California Botanic Garden. 3. Continue working with the SBNF to monitor species occurrences and determine an appropriate monitoring frequency (USFWS, 2022).

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SPECIES ACCOUNT: *Lesquerella lyrata* (Lyrate bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 9/29/1990; Southeast Region (R4) (USFWS, 2015)

Physical Description

An annual made up of one to several, usually simple and erect stems of 1 to 3 decimeters (din) (4 to 12 inches) (in.) in length. Leaves and stems are shortly pubescent. The outer stems are usually decumbent at the base. Basal leaves are stalked and lyrate-shaped, 2 to 7 centimeters (cm). (0.8 to 2.8 in.) long and 6 to 15 millimeters (mm) (0.2 to 0.6 in.) wide. The terminal lobes are large and orbicular to elliptic in shape. The stem leaves are ovate to broadly oblong and obtuse, 5 to 20 mm (0.2 to 0.8 in.) long and 4 to 10 mm (0.2 to 0.4 in.) wide, and sessile with prominent ear-like projections (auricles) at the bases. The margins of the stems are nearly smooth to coarsely toothed. Inflorescences are dense. The flowers are ascending on densely pubescent stalks 1 to 1.5 cm (0.4 to 0.6 in.) long. Sepals are pubescent, yellowish, oblong, 3 to 4 mm (0.1 to 0.2 in.) long and 1.2 to 1.5 mm (0.1 in.) wide. Petals are yellow, broadly ovate, 5 to 7 mm (0.2 to 0.3 in.) long and 3.5 to 4 mm (0.1 to 0.2 in.) wide, and slightly rounded. The fruits are siliques, which are glabrous, globose in shape, 2.5 to 3.5 mm (0.1 in.) high and 3 to 4 mm (0.1 to 0.2 in.) broad. Seeds are flattened, brown, oval to nearly orbicular in outline, and margined, and range from 1.5 to 2.5 mm (0.1 in.) on the longest dimension (USFWS, 1996).

Taxonomy

Rollins (1955) considered L. lyrata to be an evolutionary link between L. densipila and L. auriculata, the somewhat closer relationship being with the former. Kral (1983) noted the close resemblance of L. lyrata and L. densipila, that the fruits of D. lyrata were slightly smaller and that both the fruit and the persistent styles are perfectly glabrous. McDaniel (1987) suggested that this difference, while consistent, was insufficient to justify recognition at the species level, and stated that assignment to varietal rank would be more appropriate. However, no worker has formally provided data to support such a change in taxonomic status (USFWS, 1996).

Historical Range

The current and historical distribution of D. lyrata is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama. (USFWS, 1996)

Current Range

The current and historical distribution of D. lyrata is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama. (USFWS, 1996)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: ~1 year (USFWS, 2009)

Breeding Season

Adult: March - April (USFWS, 2009)

Reproduction Narrative

Adult: The lyrate bladderpod is a winter annual with a long-lived seed bank. Flowering takes place usually from mid-March to April (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone outcropping/hill, glades (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Early successional habitats, disturbance (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Shading (USFWS, 2009)

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Inhabits red soils, limestone outcroppings and hills, disturbed cedar glades and glade-like areas (open pastures, cultivated fields, bottomlands, and roadsides in calcareous areas) (FNA 2010) (NatureServe, 2015). The lyrate bladderpod appears to be an early successional species that historically colonized the shallow soils on or adjacent to cedar glade habitats. This species slowly disappears as the soil layer develops and other competing plants establish themselves (U.S. Fish and Wildlife Service 1996). Shading causes decreased vigor and death and decreases the number of seeds at the site (Baskin and Baskin 1998, 2000). Disturbance is needed primarily to remove competing vegetation and also to bring seeds to the soil surface for germination (Baskin and Baskin 2000, U.S. Fish and Wildlife Service 1990, 1996; Webb and Kral 1986). The need for ground disturbance to maintain populations is evidenced in the fact that the best populations are those that are subject to some type of recurring disturbance such as grazing, plowing, and mowing (USFWS, 2009).

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2024)

Number of Populations:

3 (USFWS, 2019)

Population Narrative:

Currently, there are three sites in three different counties known for this species (USFWS, 2019). The species is limited to three populations in three counties in northwest Alabama. Two of the three populations are not protected and appear to be declining. The unprotected populations are located on disturbed remnants of cedar glades. Cedar glades have been fragmented by agriculture and development and mostly exist as remnants today (USFWS, 2024).

Threats and Stressors

Stressor: Herbicide Use (USFWS, 1996)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individual plants
Narrative: The use of pre-emergent herbicides on agricultural crops as well as the use of herbicides as part of road side/easement maintenance is listed as threat to this species (USFWS, 1996).

Stressor: Road improvement (USFWS, 1996)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Road improvement is listed a s a threat to this species (USFWS, 1996)

Stressor: Proposed rock quarry (USFWS, 1996)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of the 1996 Recovery Plan a proposed rock quarry was threatening the habitat of this species. It is unclear whether this quarry was ever developed (USFWS, 1996).

Stressor: Development/Urbanization (USFWS, 1996)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Development for commercial, industrial and housing are listed as a threat to this species (USFWS, 1996)

Stressor: Trash dumping (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Trash dumping has destroyed or negatively impacted this species habitat (USFWS, 2009).

Stressor: Woody succession (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Lack of disturbance can result in competition (and shade) from invading perennials (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individual plants
Narrative: There are no State laws in Alabama protecting the lyrate bladderpod and its habitat. Otherwise, protection is afforded to this species under Section 7 and Section 9 of the ESA. The majority of one of the populations is permanently protected and consistently managed due to its location in a Nature Conservancy preserve. An adjacent portion of this population is currently being managed for the lyrate bladderpod under a voluntary Wildlife Cooperative Extension Agreement (WCEA) until the year 2017 (Hurt 2008a). The management outlined in the WCEA has been beneficial for the species, however, it does not provide for the permanent protection and management of this site (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
Species will be considered for delisting when nine demonstrably secure and self-sustaining populations exist. A demonstrably secure population is defined as one for which legal protection and active, successful management have been established. A self-sustaining population is defined as a population that is shown by monitoring data to be reproducing and relatively stable for at least a 10-year period (USFWS, 1996).

Recovery Actions:
- Protect and manage known populations. Negotiate with State and local highway departments and landowners. Develop management plans for each population and site (USFWS, 1996).
- Search for new populations. Conduct searches for additional populations. Continue to re-examine historic occurrence localities. Search for potential relocation/establishment sites for possible use in the future (USFWS, 1996)
- Conduct ecological research. Conduct hybridization studies, studies on seedbank size and seed viability. Study germination relative to natural conditions and agicuultural practices (1996).
- Conduct long-term site and population monitoring. Implement population monitoring. Monitor management techniques and results (USFWS, 1996).
- Maintain seeds and plants ex situ. Maintain seeds and plants (USFWS, 1996).
- Provide information to the public. Conservation efforts with the greatest successes are those with the greatest amount of public support. Plans should be developed to disperse information on D. lyrata to the local public, particularly to agricultural landowners (USFWS, 1996).
- Continue management and monitoring on Lawrence County population (USFWS, 2009).

- Work to secure protection and implement appropriate management for all other populations, most likely through conservation easements (USFWS, 2009).
- Renew contact with State and county highway department to ensure proper protective measures are implemented for those areas where plants occur onto roadside rights-of-way (USFWS, 2009).
- Survey in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2009).
- Work with landowners to reintroduce some type of ground disturbance activity at historical sites during appropriate time of year and follow with survey of sites next flowering season (USFWS, 2009).
- Gather base-line data on all populations and initiate long-term monitoring as means to track population trends and evaluate management efforts (USFWS, 2009).
- Expand species' biology studies to include field experiments (USFWS, 2009).
- Ensure preservation of genetic material from all populations through long-term seed storage through coordination with USDA Seed Storage Laboratory in Fort Collins, Colorado (USFWS, 2009).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2009).
- Update recovery plan (USFWS, 2009).
- Recovery Priority Number: 8

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Recovery Plan (Service 1996). In the course of this status review new and/or targeted potential recovery activities were identified and are included below. These activities are recommended to support and promote recovery of lyrate bladderpod. Recovery Activities • Pursue protection of currently unprotected populations. o Work to renew landowner agreement for property adjacent to Prairie Grove Glade Preserve. o Work to renew contact with State and county highway departments to ensure proper protective measures are implemented for those areas where plants occur within roadside rights-of-way. • Conduct habitat management to control competing vegetation and promote population growth. • Work with landowners to reintroduce some type of ground disturbance activity at historical sites during appropriate time of year and follow with survey of sites next flowering season. • Continue surveys to locate additional populations. • Work with cooperators to expand ex situ (off-site) preservation of genetic material and produce plants for potential outplantings. • Create a management manual for landowners, farmers, and the local transportation departments. Monitoring and Research Activities • Gather baseline data on all populations and implement consistent and long-term monitoring of all populations to track population trends and evaluate management efforts. • Study efficacy and optimal application of various habitat management practices (e.g., mowing, herbicide, prescribed fire). • Define self-sustaining population (USFWS, 2024).

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SPECIES ACCOUNT: *Lesquerella pallida* (White bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/11/1987; Southwest Region (R2) (USFWS, 2016)

Physical Description

White bladderpod is an annual member of the Brassicaceae or Mustard Family. The plant overwinters as a tap-rooted, leafy rosette, reaching a maximum height of two feet as an erect plant or may be spreading. The white flowers appear in April and May and are composed of four one-half inch long petals. It produces pea shaped "bladderpods" that enclose the seeds before dying as its harsh habitat dries in the summer heat. Seed set occurs from late May to early June and the dormant stage begins in July and usually last until October.

Current Range

White bladderpods are known to occur only on the Weches Outcrops of San Augustine County, Texas.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Glades within pine-oak forests

Environmental Specificity

Adult: Very Narrow (inferred from NatureServe, 2015))

Habitat Narrative

Adult: The white bladderpod occurs in natural openings or glades within pine-oak forests on shallow, stony, calcareous sandy loam or sandy clay loam over glauconite or ironstone of the Weches Formation; in addition, these glades are seep-moistened during the winter and spring but become desiccated during the summer (Poole et al. 2007, p. 378). White bladderpod population numbers are heavily influenced by local environmental conditions, such as winter or spring moisture and spring frost, as well as invasion of woody and herbaceous plants that tend to out-compete the white bladderpod.

Dispersal/Migration

Population Information and Trends

Number of Populations:

Six extant or unknown abundance populations (USFWS, 2023).

Population Size:

112 - 10,000

Population Narrative:

Currently, there are eight known populations of the white bladderpod. Seven of the sites are located on private property, and the eighth site is located on private property and the adjacent road ROW of SH 21. Three of the populations were last surveyed in 2001 and found to have an extant population, four other populations were last surveyed in 2006 with extant populations, and the remaining population was surveyed in 2009 and found to have an extant population. White bladderpod population size varies drastically from year-to-year and appears to be due to differences in winter and spring moisture and spring frost or grazing by animals (Service 1992). The population numbers vary from 10,000 to 112 individual plants (see Table 1. for the most recent survey results for the known extant populations of the white bladderpod). Six extant or unknown abundance populations (USFWS, 2023).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The primary threats to white bladderpod are the invasion of woody and herbaceous plants into their limited habitat as well as overgrazing (Service 1992). Pasture improvement through the use of herbicides, plowing, and the introduction of non-native pasture grasses can destroy white bladderpod populations and habitat. Since all populations occur partly or wholly on private property, any major changes in land use are detrimental. In addition to home or other building construction, road construction is a threat to the populations of white bladderpod that occur within road ROWs. Rock quarrying poses a significant threat to the species since crushed rock from the Weches formation is used for gravel roads. Areas of suitable habitat within San Augustine County have already been lost to quarrying. Small populations could be prone to extirpation if a series of unfavorable years greatly reduces seed production and depletes the soil seed bank. Recolonization after a population has been lost would require long distance seed dispersal, which appears to be poor in white bladderpod (Service, 1992).)

Stressor: Surface Mining (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Mining of glauconite minerals may continue to threaten the white bladderpod within its range. As described in the species 2014 5-year status review, “two EO IDs are located adjacent to a glauconite mine. There has not been an opportunity to survey the sites and therefore it is unknown whether or not these two populations have been impacted by the mining activities.” New glauconite mines in the area have not been developed, however glauconite mining is unregulated and therefore forecasting when and/or where these activities will appear on the landscape is extremely difficult. Mining of glauconite in the vicinity of occupied and suitable moist, alkaline habitat remains a potential threat to the white bladderpod (USFWS, 2023).

Stressor: Oil and Gas (USFWS, 2023)
Exposure:

Response:
Consequence:
Narrative: Oil and gas development diminishes habitat quality and quantity through direct loss of habitat, introduction of nonnative species into modified areas of habitat, and an altered site hydrology. The white bladderpod is found atop glade habitats of East Texas's Hayensville Shale; since the white bladderpod can co-occur with the L. texana, (see the Texas golden gladecress SSA (Service 2022, pp. 41-44) for more detail). In San Augustine County in general, the majority of existing pipelines are located in the area north of State Highway (SH) 21 and west of the town of San Augustine. To the east of San Augustine, there are fewer pipelines, but of those that are located in this area, several are large gas transmission lines. The Railroad Commission of Texas (RRC) regulates the oil and natural gas industry in the state of Texas. The RRC has detailed information on all existing pipelines, but the agency has no way to predict future routes for new pipelines or wells. New pipelines and their routes are not displayed on the RRC website and although impacts from pipelines excavations could have an effect on the white bladderpod, specific locations of any future pipeline and any effects on the species and its suitable habitat are unknown. In addition to pipelines, associated oil and gas activities such as drilling and/or maintenance could also affect the white bladderpod and its habitat. Pipeline and well pad construction will continue to be a threat to the species as the demands for oil and gas production within San Augustine County continue. Since 2017, drilling permits issued by the RRC have generally increased over time and permits for 2023 are increasing (Figure 1; RRC 2023). In addition, projects that do not require consultation under Section 7 of the Act including maintenance and expansion associated with oil and gas wells, pads, roadways, etc. are occurring within existing known occupied sites of the white bladderpod. Since a federal nexus is often lacking in these cases, any coordination with the Service is not required (USFWS, 2023)

Stressor: Development – Transportation Projects (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: ROW that is managed by TxDOT. Observations from past site visits and TxDOT's online Project Tracker application as of April 2023, show resurfacing projects "underway or beginning soon" along SH 21 both east and west of the towns of San Augustine. On the west side of this town in the stretch of SH 21 where EO ID 12396 is located, the project is marked as ongoing. TxDOT is aware of the plants' presence and is avoiding the EO ID. Additional areas of exposed Weches glades occur within the ROWs within San Augustine County, but as of August 2023 none have been occupied by the white bladderpod (USFWS, 2023).

Stressor: Climate Change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: It is anticipated that effects from climate change could impact white bladderpod. The species is known from a single county known for its climatic extremes of temperature and precipitation (TNC 2003, ii; Diggs et al. 2006, p. 80) and native flora are well adapted to the region. White bladderpod is an edaphic (soil) specialist, restricted to soils with alkaline sediments with unique mineral and water retention properties described as seepy and saturated during the cool moist winter and spring months and dry during the summer (USFWS 1992, p. 4). These features may restrict the plant's capacity to spatially shift into surrounding habitat in response to

a changing climate (USFWS 2014, p. 15). Warnock (1992) documented the effects of its restricted nature with a high variability in population counts, attributing fluctuations to early year frosts and dry springs. The localized effects of climate change on white bladderpod are unknown, however The Intergovernmental Panel on Climate Change (2014, p. 26) projects that temperatures and the intensity and duration of heat waves will increase, which could make these populations less stable and persistent into the future (USFWS, 2023).

Recovery

Reclassification Criteria:
Recovery Priority Number: 2

Recovery Actions:

- The Recovery Plan requires the establishment of 12 self-sustaining populations of white bladderpod and the establishment of agreements for the protection and management of these populations in order to downlist the species from endangered to threatened. The Recovery Plan calls for the protection and management of the populations and habitat, the gathering of biological information necessary for management, establishing a botanical garden population, the search for new populations, and the establishment of new populations as necessary to meet downlisting criteria (Service, 1992). For more detailed information regarding recovery actions for the white bladderpod, please refer to White Bladderpod (Lesquerella pallida) Recovery Plan (Service 1992) (Recovery Plan). Shrub removal from three privately owned white bladderpod sites in 1995 proved to be beneficial, resulting in more plants being present the following spring. However, ongoing brush control is necessary to maintain suitable habitat at these sites. Three seed propagation facilities have been established and maintained, and the Nature Conservancy of Texas has developed a “Conservation Area Plan for the San Augustine Glades” under a Cooperative Agreement with the Service.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Future actions to aid in the recovery of the white bladderpod should focus on the implementation of the following actions: • Contact the land stewards and managers of all white bladderpod sites. • Work with land stewards to develop and implement management beneficial for the bladderpod. • Continue monitoring and surveys of known populations. • Implement projects and agreements through the Traditional Section 6 program with TPWD, the Service’s PFW Program, as well as cooperative agreements with state and federal agencies. • Continue to search for additional populations. • Continue reintroduction efforts. Implement a reintroduction program, adhering to the Service’s Controlled Propagation and Reintroduction Policy. • Acquire new conservation agreements with interested parties. • Continue conservation and recovery awareness through public and land steward outreach (USFWS, 2023).

References

USFWS 2016. Status of the Species and Critical Habitat: Lesquerella pallida (White Bladderpod). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

USFWS 2016. Status of the Species and Critical Habitat: Lesquerella pallida (White Bladderpod). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016. USFWS. 2023. 5-YEAR STATUS REVIEW White Bladderpod (Physaria pallida). Region 2. Texas Coastal Ecological Services Field Office, Clear Lake, Texas. 11 pages.

USFWS. 2023. 5-YEAR STATUS REVIEW White Bladderpod (Physaria pallida). Region 2. Texas Coastal Ecological Services Field Office, Clear Lake, Texas. 11 pages.

SPECIES ACCOUNT: *Lesquerella perforata* (Spring Creek bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/23/1996; Southeast Region (R4) (USFWS, 2015)

Physical Description

A herbaceous annual, stems several to many, outer ones usually decumbent (a plant that has its base lying on the ground and a stern that grows upward) at base, inner ones erect, simple or branched, 10 to 15 cm tall, stems and leaves are covered with fine or coarse hairs. Leaves at the base (rosette) have a petiole (leafstalk) and are lyrately (several lobes, which increase in size toward one large terminal lobe) lobed with pointed teeth on the margins. The stem leaves are sessile (stalkless and attached directly at the base), auriculate (ear shaped), oblong to obovate (egg shaped), with few to many teeth on the margins. The cross-shaped flowers are arranged in a raceme (stalked flowers arranged singly along an elongated unbranched axis), have white to pale lavender petals with a yellow base, and are 7 to 9 mm long. The fruits, or pods, are broadly obovoid (egg shaped) to pear-shaped, very inflated, 4 to 7 mm long, and divided into two halves. The outer surface of the pod is papery with very sparse hairs and the inside is densely hairy. The septum (the internal partition between the two halves) is perforated or nearly absent with only a small portion attached to the fruit wall. There are up to 10 round seeds in a pod measuring 1.5 to 2.5 mm long, strongly flattened and surrounded by a thin margin (USFWS, 2006)..

Taxonomy

Lesquerella is a genus of the Brassicaceae, the mustard family, named for the seventeenth century Swiss and American botanist Leo Lesquereux. There are approximately 75 taxa of Lesquerella with the majority occurring in the western states; only a few taxa are found in the Interior Low Plateau of Tennessee, Alabama, and Kentucky (Al-Shehbaz 1987). Only one species, Lesquerella lescurii (Nashville mustard), had been described in the eastern states prior to the 1950's work of Dr. Reed C. Rollins, a Harvard University expert on the Brassicaceae. From 1952 to 1955, Rollins described three new species of Lesquerella endemic to the Central Basin of Tennessee, L. densipila (Duck River bladderpod), L. stonensis (Stones River bladderpod), and L. perforata (Spring Creek bladderpod) (USFWS, 2006).

Historical Range

See current range/distribution.

Current Range

Known only from Wilson County, Tennessee (USFWS, 2006).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature (USFWS, 2006).

Reproduction Narrative

Adult: Lesquerella perforata is an annual that germinates between September and early October, overwinters as a small rosette of leaves, and fully develops and flowers the following spring. Full sunlight is required for optimum growth. Flowering usually occurs in March and April. The fruit splits open upon maturity in late April and early May, and the enclosed seeds are dispersed and lie dormant until autumn. The plant dies back soon after the fruits mature. Germination can only occur when the correct temperature coincides with adequate moisture (Pearson 1967). Upon germination, the cycle starts over again. The seeds of L. stonensis can remain viable in the seed bank for at least 6 years, and perhaps those of L. perforata can do the same (Rollins 1955, Kral 1983, Baskin & Baskin 1990, Fitch 2004) (USFWS, 2006).

Habitat Type

Adult: Limestone outcrops (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: This species is found mainly where sites have been disturbed by flooding or by cultivation, and tends to occur in areas of full sun on well-drained soils, as well as (rarely) on limestone rock outcrops. Most historic and current occurrences are on flood plains, where periodic flooding removes encroaching grasses and woody plants. Also occurs in places where other types of disturbances "substitute," such as on annually cultivated bottom land fields (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends

Number of Populations:

23 (USFWS, 2024)

Population Size:

Fluctuates widely from year to year (USFWS, 2006)

Population Narrative:

Known from four populations consisting of 13 extant sites in Wilson County, Tennessee. Three additional sites no longer support the species. (U.S. Fish and Wildlife Service 1996) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred by the low number of knownm populations and the specifici habitat requirements of this species. As of 2019, there are 23 extant occurrences of Spring Creek bladderpod. Of the extant occurrences, 8 are located within the Spring Creek watershed, 11 within the Barton's Creek watershed, and 4 within the Cedar Creek watershed. One occurrence (EO 35) was discovered on USACE lands in 2015. All other occurrences are located on privately or municipally owned land. Land management activities, compatible and otherwise, are a primary driver of trends in the species' distribution and abundance. Maintenance of fescue pasture or lawns and applications of winter cover crops and pre-emergent herbicides to agricultural fields are not conducive to annual germination, growth, and reproduction of Spring Creek bladderpod, but are prevalent land uses within the species' geographic range. Fragmentation is not known to be affecting the extant occurrences, but could become a significant threat if occurrences are extirpated as a result of development or changes in management of agricultural lands. (USFWS, 2019). The Spring Creek bladderpod is an annual plant endemic to Tennessee. The species currently occurs in only three HUC 12 watersheds in Wilson County, TN: Spring Creek, Barton's Creek, and Cedar Creek. Since the last status review, one additional occurrence of the species was discovered in the Spring Creek watershed, and one occurrence was designated as extirpated in the Barton's Creek watershed, resulting in a total of 23 extant populations across the range. The species primarily occurs on private land, with no management agreements currently in place (USFWS, 2024).

Threats and Stressors

Stressor: Cropland conversion to pasture (USFWS, 2006)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The conversion of cropland to pastures that contain grasses (e.g.) fescue poses a threat because of competition and lack of annual disturbance (USFWS, 2006).

Stressor: Urbanization/Development (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Those sites on private lands in the City of Lebanon, primarily in Barton's Creek drainage, remain at high risk of loss to urbanization (USFWS, 2011). This includes placing fill material on this species habitat and road building.

Recovery

Reclassification Criteria:

Spring Creek bladderpod will be considered for reclassification to threatened status when there are 15 protected occurrences, five of which are located within the floodplain of each of three creeks (Spring Creek, Barton's Creek, and Cedar Creek). These occurrences, located on either

public or private land, must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a five-year period, with no less than 100 plants in any given year (USFWS, 2011).

Delisting Criteria:
Spring Creek bladderpod will be considered for delisting when there are 25 protected occurrences, with at minimum five occurrences located within the floodplain of each of the three creeks (Spring Creek, Barton's Creek, and Cedar Creek). Each occurrence located on either public or private land must be protected by a permanent conservation easement with a management agreement. Each occurrence must consist of an average of 500 plants over a ten-year period, with no less than 100 plants in any given year (USFWS, 2011).

Recovery Actions:

- We have not met the criteria for reclassifying Spring Creek bladderpod to threatened. No occurrences are protected by conservation easement; though three are protected by non-binding cooperative management agreements. Spring Creek bladderpod abundance fluctuates considerably over time (Table 1). While 500 or more plants have been observed at most of the occurrences at some point in time, fewer than 100 have also been observed at most occurrences at some point in time (USFWS, 2011).
- Continued efforts to implement recovery actions identified in the species' recovery plan, improve monitoring techniques, and refine guidance for managing Spring Creek bladderpod are necessary. Specific emphasis should be placed on determining whether additional occurrences exist in the Cedar Creek drainage, and efforts should be redoubled to work with private and municipal landowners to ensure long-term protection of known occurrences through conservation easements (USFWS, 2011).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions The Service should continue working with partners to implement recovery actions identified in the species' recovery plan; in particular, attempts should be made to improve monitoring techniques and mapping of occurrences, search for new occurrences, protect habitat that can be owned or managed by a public entity in perpetuity, and work cooperatively with private and municipal land owners to manage habitat for the species. Emphasis should be placed on determining the current status of occurrences lacking current data, surveying for additional occurrences, establishing conservation easements with private and municipal landowners to ensure long-term protection of known occurrences, and cooperatively managing habitat with private and municipal land owners. The Service recommends carrying out the actions below in an attempt to achieve the recovery criteria for Spring Creek bladderpod: 1. Determine whether EOs 18, 24, and 25 are extant. If Spring Creek bladderpod is not found at these sites, they should be evaluated to determine whether habitat has been destroyed or could be restored by working cooperatively with willing land owners. Sites with restoration potential should be prioritized for determining whether landowners would be willing to cooperatively manage habitat for the species. Additional sites to prioritize for cooperative habitat management include EOs 17, 19, 20, 28, and 34. 2. Conduct annual monitoring, collecting data that can be used to determine whether the recovery standard (i.e., 5-year average of at least 500 plants with no less than 100 in any given year) has been met at a given EO. Sites that meet this standard should be prioritized for protection via land purchase, conservation easement, or cooperative management agreement. 3. Protect extant occurrences by acquiring occupied parcels or establishing conservation easements or agreements with private, state, and federal partners. The site on USACE lands should

be a priority for establishing a cooperative agreement, to ensure appropriate management and monitoring of Spring Creek bladderpod on federal lands. 4. Due to the difficulty of accessing private property, where occurrences are predominantly located, surveys to locate new occurrences should combine use of aerial imagery flown during the species' flowering period, drone surveys, and ground-based surveys (where landowner permission is granted) to accurately determine the extent of populations. Survey effort should be focused in the Cedar Creek watershed, the only watershed within the range of Spring Creek bladderpod where fewer than five occurrences, as required by recovery criteria, are known to exist. Where possible, surveys should target federal or state-owned properties. 5. Conduct experiments to determine whether removing and relocating topsoil containing the seed bank to a secure, protected location is an effective method for minimizing adverse effects of site destruction for development or other purposes. This practice should not at this time be considered avoidance of an adverse effect for purposes of Section 7 consultation, as this is an unproven method. If this practice is determined to be effective, prioritize the identification of watershed-based recipient sites for populations facing extirpation and proactively acquire lands in extant watersheds with this priority. (USFWS, 2019)

- RECOMMENDED FUTURE ACTIVITIES A detailed discussion of recovery actions and criteria are presented in the Spring Creek Bladderpod Recovery Plan (Service 2006). Renewing recently expired conservation agreements and/or identifying landowners with which to develop new management agreements would be supportive of recovery criteria and recovery actions identified in the recovery plan. The priority 1 actions identified in the recovery plan (e.g. establishing protection goals for EOs, pursuing easement or conservation agreements with landowners, developing management plans for EOs, etc.) are still very relevant. Actively engaging partners, and exploring opportunities for new partnerships, to implement these actions could be helpful in reinvigorating conservation efforts. Implementing these actions may also be facilitated by working proactively with landowners to balance the needs of the species within a sustainable working landscape and/or in the context of increased development pressures (USFWS, 2024).

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed April 2016.

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A." USFWS. 2019. Spring Creek bladderpod (Lesquerella perforata) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Tennessee Ecological Services Field Office Cookeville, Tennessee. 29 pp. USFWS. 2024. Spring Creek Bladderpod (Paysonia perforata) Status Review: Summary and Evaluation. Southeast Region. Tennessee Ecological Services Field Office. Cookeville, TN. 11 pp.

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USFWS. 2019. Spring Creek bladderpod (Lesquerella perforata) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Tennessee Ecological Services Field Office Cookeville, Tennessee. 29 pp.

USFWS. 2024. Spring Creek Bladderpod (Paysonia perforata) Status Review: Summary and Evaluation. Southeast Region. Tennessee Ecological Services Field Office. Cookeville, TN. 11 pp.

SPECIES ACCOUNT: *Lesquerella thamnophila* (Zapata bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/22/1999; Southwest Region (R2)

Physical Description

Zapata bladderpod is a pubescent, silvery-green, herbaceous perennial of the Brassicacea family, with sprawling stems 17 to 34 inches long. Basal leaves are narrowly elliptical to oblanceolate and acute, 1.5 to 4.8 inches long, and 0.3 to 0.6 inch wide, with entirely or slightly-toothed margins. Stems leaves are linear to narrowly elliptical and acute, 1 to 1.5 inches long and 0.1 to 0.3 wide, and have entire or slightly toothed margins. Cauline or stem leaves are linear to narrowly elliptical and acute, 3 to 4 cm (1 to 1.5 in) long and 2 to 8 mm (0.1 to 0.3 in) wide, with margins similar to basal leaves. The presence of stellate trichomes (small hair-like structures) on the leaves produces the plant's appearance of a whitish or silvery-green color. The inflorescence is a loose raceme of bright, yellow-petaled flowers. The flowers appear throughout the year depending upon temperature and rainfall, and are arranged along an axis with the lower flowers maturing first. Fruits are round and 4.5 to 6.5 mm (0.2 to 0.8 in) in diameter on short, downward curving pedicels (Poole 1989). (USFWS, 2004)

Taxonomy

Zapata bladderpod was first described as Lesquerella thamnophila Rollins and Shaw, based on specimens collected in Starr and Zapata counties (now EOs 1, 2, and 3) (Rollins and Shaw 1973). Al-Shehbaz and O'Kane (2002), citing molecular, morphological, cytological, biogeographic, and ecological data, transferred 91 taxa of Lesquerella to Physaria, including P. thamnophila. Genetic analyses, based on DNA sequences of the internal transcribed spacer of nuclear ribosomal DNA and length variation of inter-simple sequence repeat regions, revealed that Physaria, as previously recognized, was nested within and evolved more than once from Lesquerella. The former genus was polyphyletic, and the latter was paraphyletic. These authors united the two into a single monophyletic genus, conserving the earlier-published name of Physaria. This taxonomic revision is supported by the Flora of North America (O'Kane 2015), the Integrated Taxonomic Information Service (2015), Poole et al. (2007), and the Tropicos database (Tropicos 2015). (USFWS, 2015)

Historical Range

Starr and Zapata Counties, Texas.

Current Range

Starr and Zapata Counties, Texas. (USFWS, 2015)

Critical Habitat Designated

Yes; 1/22/2001.

Legal Description

On December 22, 2000, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective January 22, 2001) for Lesquerella thamnophila (Zapata bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in Texas (65 FR 81182-81212).

Critical Habitat Designation

The critical habitat designation for Lesquerella thamnophila includes eight CHUs in Starr County, Texas. This species critical habitat encompasses approximately 5,158 acres (ac) (2,088 hectares (ha)). Legal descriptions are presented below. Maps for general information purposes depicting the CH units are available in the Final Rule (65 FR 81182-81212).

Unit 1, Cuellar Tract (18 hectares (ha); 45 acres (ac))—(Segment 669). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by the National Geodetic Survey Triangulation Station ‘‘LABRA’’ (not found) having State plane coordinates of N = 331,881.065, E = 1,794,777.75. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard U.S. Fish and Wildlife Service (FWS) aluminum monument set for corner on the southeasterly line of Porcion No. 59 and the northeast corner of Share 35 and stamped ‘‘Tract 669, COR. No. 1, R.P.L.S. #4303’’ and having a State plane coordinate value of N = 320,083.51, E = 1,799,578.77, from which triangulation station ‘‘LABRA’’, bears N 22° 08' 38?W, 12,737.98 feet; thence, in a southwesterly direction along the common line of Porcion 59 and 60, S 54° 32' 24?W, 2,290.19 feet, to a standard FWS aluminum monument set for corner, being the common corner of Shares 35 and 26 and stamped ‘‘Tract 669, COR. No. 2, R.P.L.S. No. 4303; thence, in a northwesterly direction along the common line of Share 35 with Shares 26 and 27, N 35° 27' 36?W, 640.00 feet to a standard FWS aluminum monument set for corner, being the most southerly common corner of Shares 35 and 34 and stamped ‘‘Tract 669, COR. No. 3, R.P.L.S. No. 4303’’; thence, in a northeasterly direction along the common line of Shares 35 and 34; N 54° 32' 24?E, 2,290.19 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of shares 35 and 34 and stamped ‘‘Tract 669, COR. No. 4, R.P.L.S. No. 4303; thence, in a southeasterly direction along the common line of Shares 35 and 36 Parcel–A; S 35° 27' 36? E, 640.00 feet to the point of beginning and containing 33.648 acres of land. (Cuellar Tract—Segment 672). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by U.S. Fish and Wildlife Service GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set for corner on the common line between Porcions 59 and 60, and being the northeast corner of Share 26 and stamped ‘‘Tract 672, COR. No. 1, R.P.L.S. No. 3680’’ and having a State plane coordinate value of N = 318,737.64, E = 1,797,725.36, from which FWS GPS Monument No. 105 bears S 15° 22' 02? E, 7,920.94 feet; thence, in a southeasterly direction along the common line of Porcion 59 and 60, S 54° 27' 12?W, 806.50 feet to a standard FWS aluminum monument set for corner, being the southeast corner of said north one-half (1/2) of Share 26, same being the northeast corner of the south one-half (1/2) of Share 26 and stamped ‘‘Tract 672, COR. No. 2, R.P.L.S. No. 3680’’; thence, in a northwesterly direction along the common line of said north and south one-half (1/2) of Share 26; N 35° 27' 36? W, 463.31 feet to a standard FWS aluminum monument set for corner in the common line between Shares 26 and 27 and stamped ‘‘Tract 672, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northeast direction along the common line of Shares 26 and 27; N 54° 32Prime;; 24? E, 806.50 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of Shares 26 and 27 in the south line of Share 35 and stamped ‘‘Tract 672, COR. No. 4, R.P.L.S. No. 3680’’; thence, in a southeasterly direction along the common line of Shares 35 and 26; S 35° 27' 36? E, 462.09 feet to the point of beginning and containing 8.567 acres of land. (Cuellar Tract—Segment 673). Note: All bearings are based on the

Texas State Plane Coordinate System, South Zone, as referenced by FWS GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set for the common north corner of Shares 26 and 27, in the south line of Share 35 and stamped ‘‘Tract 672, COR. No. 4, R.P.L.S. No. 3680’’ and having a state plane coordinate value of N = 319,114.02, E = 1,797,457.29, from which FWS GPS Monument No. 105 bears S 16° 27' 21? E, 8,356.40 feet; thence, in a southwesterly direction along the common line of Shares 26 and 27, S 54° 32' 24? N, 806.50 feet to a standard FWS aluminum monument set for corner, being the southeast corner of said north one-half (1/2) of Share 27, same being the northeast corner of the south one-half (1/2) of Share 27 and stamped ‘‘Tract 672, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northwesterly direction along the common line of said north and south one-half (1/2) of Share 27; N 35° 27' 36? W, 592.30 feet to a standard FWS aluminum monument set for corner in the common line between Shares 27 and 28 and stamped ‘‘Tract 674, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northeasterly direction along the common line of Shares 27 and 28, N 54° 32' 24? E, 806.50 feet to a standard FWS aluminum monument set for corner, being the most northerly common corner of Shares 27 and 28 in the south line of Share 34 and stamped ‘‘Tract 674, COR. No. 2, R.P.L.S. No. 3680’’; thence, in a southeasterly direction along the common line of Shares 34 and 27, S 35° 27' 36? E, 592.30 feet to the point of beginning and containing 10.966 acres of land. (Cuellar Tract—Segment 672). Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by FWS GPS Monument No. 105 having State plane coordinates (NAD 27) of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a standard FWS aluminum monument set replacing a 1–inch iron pipe found for the common north corner of Shares 28 and 29, in the south line of Share 33 and stamped ‘‘Tract 674, COR. No. 1, R.P.L.S. No. 3680’’; and having a state plane coordinate value of N = 320,078.90, E = 1,796,770.06, from which FWS GPS Monument No. 105 bears S 18° 47' 11? E, 9,484.36 feet; thence, in a southeasterly direction along the common line of Share 28 and Shares 33 and 34, S 35° 27' 36? E, 592.30 feet to a standard FWS aluminum monument set for corner, being the common northerly corner of Shares 28 and 27 and stamped ‘‘Tract 674, COR. No. 2, R.P.L.S. No. 3680’’; thence, in a southwesterly direction along the common line of said Share 28 and 27; S 54° 32' 24? W, 806.50 feet to a standard FWS aluminum monument set for the southeasterly corner of said north one-half (1/2) of Share 28, same being the northeasterly corner of the south one-half (1/2) of Share 28 and stamped ‘‘Tract 674, COR. No. 3, R.P.L.S. No. 3680’’; thence, in a northwesterly direction along the common line of the north and south one-half (1/2) of Share 28, N 35° 27' 36? W, 592.30 feet to a standard FWS aluminum monument set for corner in the common line between Shares 28 and 29 and stamped ‘‘Tract 674, COR. No. 4, R.P.S. No. 3680’’; thence, in a northeasterly direction along the common line of Shares 28 and 29; N 54° 32' 24? E, 806.50 feet to the point of beginning and containing 10.966 acres of land.

Unit 2, Chapeno Tract (28 ha; 69 ac)— (Chapeno Tract—Segment 660). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation Station ‘‘LABRA.’’ The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 02° 08' 43? W, a distance of 9,020.47 feet to the northwesterly boundary line of said 44.900-acre tract for the northmost corner of said Share No. 17 and being corner No. 1 and the northernmost corner and place of beginning of the tract

herein-described; thence, along the northeasterly boundary line of Share No. 17 and the southwesterly boundary line of a 35-foot perpetual easement, S 32° 11' 36? E, 840.62 feet to the easternmost corner of said Share No. 17 and being corner No. 2 of this tract; thence, along the southeasterly boundary line of Share No. 17 and the northwesterly boundary line of Share No. 18, S 47° 29' 30? W, 293.59 feet to a said point on a fence line along the southwesterly boundary line of said 44.900-acre tract for the southernmost corner of said Share No. 17 and being corner No. 3 of this tract; thence, following said fence line along the southwesterly boundary line of Share No. 17 and the southwesterly boundary line of said 44.900-acre tract, N 30° 16' 28? W, 166.16 feet to a standard FWS aluminum monument stamped ‘‘Tract (660), R.P.S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 4 of this tract; thence, continuing along said fence line along the southwesterly boundary line of Share No. 17 and the southwesterly boundary line of said 44.900-acre tract, N 31° 04' 59? W, 684.02 feet to a standard FWS aluminum monument stamped ‘‘Tract (660), R. P. S. No. 4731’’ set for the westernmost corner of said 44.900-acre tract and being corner No. 5 of this tract, thence, following a fence line along the northwesterly boundary line of Share No. 17 and the northwesterly boundary line of said 44.900-acre tract, N 48° 42' 36? E, 273.46 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 661). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 00° 48' 20? E, a distance of 9,702.45 feet to the northernmost corner of said Share No. 18 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 18 and the southwesterly boundary line of Share No. 19, S 42° 40' 05? E, 623.01 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 18 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 18 and the southeasterly boundary line of said 44.900-acre tract, S 54° 58' 43? W, 14.82 feet to a standard FWS aluminum monument stamped ‘‘Tract (661), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 18 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 40? W, 442.61 feet to a standard FWS aluminum monument stamped ‘‘Tract (661), R. P. S. No. 4731’’ set for the southernmost corner of said 44.900-acre tract and being corner No. 4 of this tract; thence, following a fence line along the southwesterly boundary line of Share No. 18 and the southwesterly boundary line of said 44.900-acre tract, N 30° 16' 28? W, 581.86 feet to a point for the westernmost corner of said Share No. 18 and being corner No. 5 of this tract; thence, along the southeasterly boundary line of Share No. 17 and the northwesterly boundary line of Share No. 18, N 47° 29' 30? E, 329.16 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 662). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 00° 53' 22? E, a distance of 9,308.09 feet to the northernmost corner of said Share No. 19 and being corner No. 1 and the northernmost corner and the place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 19 and the southwesterly boundary line of Share No. 20, S 41° 14' 45? E, 941.54 feet to a point on a fence line along the

southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 19 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 19 and the southeasterly boundary line of said 44.900-acre tract, S 55° 22' 51? W, 8.49 feet to a standard FWS aluminum monument stamped ‘‘Tract (662), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 19 and the southeasterly boundary line of said 44.900-acre tract, S 54° 58' 43? W, 243.72 feet to the southernmost corner of Share No. 19 and being corner No. 4 of this tract; thence, along the northeasterly boundary line of Share No. 18 and the southwesterly boundary line of Share No. 19, N 42° 40' 05 W, 623.01 feet to a corner of Share No. 19 and being corner No. 5 of this tract; thence, along the northeasterly boundary line of a 35-foot perpetual easement and the southwesterly boundary line of Share No. 19, N 32° 08' 41? W, 293.64 feet to the westernmost corner of said Share No. 19 and being corner No. 6 of this tract; thence, along the southeasterly boundary line of a 35- ft. perpetual easement and the northwesterly boundary line of Share No. 19, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 663). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U. S. C. & G. S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 01° 55' 50? E, a distance of 9,166.26 feet to the northernmost corner of said share No 20, and being corner No. 1, and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 20 and the southwesterly boundary line of Share No. 21, S 44° 17' 45? E, 975.87 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 20 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 20 and the southeasterly boundary line of said 44.900-acre tract; S 55° 22' 51? W, 273.48 feet to the southernmost corner of Share No. 20 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 19 and the southwesterly boundary line of Share No. 20, N 41° 14’ 45’’ W, 941.54 feet to the westernmost corner of Share No. 20 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 20, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 664). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 03° 00' 15? E, a distance of 9,027.56 feet to the northernmost corner of said Share No. 21 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, along the northeasterly boundary line of Share No. 21 and the southwesterly boundary line of Share No 22, S 46 ° 18' 57’’ E, 1,008.60 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of Share No. 21 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 21 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 56.04 feet to a standard FWS aluminum monument stamped ‘‘Tract (664), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along said fence line along the southeasterly boundary line of Share No. 21 and the

southeasterly boundary line of said 44.900-acre tract, S 55° 22' 51? W, 202.51 feet to the southernmost corner of Share No. 21 and being corner No. 4 of this tract; thence, along the northeasterly boundary line of Share No. 20 and the southwesterly boundary line of Share No. 21, N 44° 17' 45? W, 975.87 feet to the westernmost corner of Share No. 21 and being corner No. 5 of this tract; thence, along the southeasterly boundary line of a 35-foot perpetual easement and the northwesterly boundary line of Share No. 21, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 665). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station ‘‘LABRA,’’ having coordinate values: x = 1794,777.75, y = 331,881.06; thence, S 04° 06' 38? E, a distance of 8,892.12 feet to the northernmost corner of said Share No. 22 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of Share No. 22 and the southwesterly boundary line of Share No. 23, S 47° 33' 31? E, 1,036.06 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of said Share No. 22 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 22 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 245.67 feet to the southernmost corner of Share No. 22 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 21 and the southwesterly boundary line of Share No. 22, N 46° 18' 57? W, 1,008.60 feet to the westernmost corner of Share No. 22 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-foot perpetual easement and the northwesterly boundary line of Share No. 22, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 666). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y =331,881.06; thence, S 05° 15' 03? E, a distance of 8,710.10 feet to the northernmost corner of said Share No. 23 and being corner No. 1 and the northernmost corner and place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of Share No. 23 and the southwesterly boundary line of said Share No. 24, S 48 ° 10' 23? E, 1,061.62 feet to a point on a fence line along the southeasterly boundary line of said 44.900-acre tract for the easternmost corner of Share No.23 and being corner No. 2 of this tract; thence, following said fence line along the southeasterly boundary line of Share No. 23 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 234.95 feet to the southernmost corner of Share No.23 and being corner No. 3 of this tract; thence, along the northeasterly boundary line of Share No. 22 and the southwesterly boundary line of Share No. 23, N 47° 33' 31? W, 1,036.06 feet to the westernmost corner of Share No. 23 and being corner No. 4 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 23, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land. (Chapeno Tract—Segment 667). Note: All bearings and distances are based on the International Boundary Commission Monuments as referenced by the U.S.C. & G.S. Triangulation station ‘‘LABRA.’’ The scale factor used is 00.9999252, and the theta angle is ¥00° 37' 32? (NAD 1927). All areas shown are true ground areas. Commencing for reference at the U.S.C. & G.S. Triangulation station ‘‘LABRA,’’ having coordinate values: x = 1,794,777.75, y = 331,881.06; thence, S 06° 25' 32? E, a

distance of 8,631.65 feet to the northeasterly boundary line of said 44.900-acre tract for corner No. 1 and the place of beginning of the tract herein-described; thence, following a fence line along the northeasterly boundary line of share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 51° 42' 47? E, 679.97 feet to a standard FWS aluminum monument stamped ‘‘Tract (667), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 2 of this tract; thence, continuing along the fence line along the northeasterly boundary line of Share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 01° 11' 48? E, 136.46 feet to a standard FWS aluminum monument stamped ‘‘Tract (667), R. P. S. No. 4731’’ set for a corner of said 44.900-acre tract and being corner No. 3 of this tract; thence, continuing along the fence line along the northeasterly boundary line of Share No. 24 and the northeasterly boundary line of said 44.900-acre tract, S 54° 15' 17? E, 309.21 feet to a standard FWS aluminum monument stamped ‘‘Tract (667), R. P. S. No. 4731’’ set on a fence line for the easternmost corner of Share No. 24 and being on the southeasterly boundary line of said 44.900-acre tract and being corner No. 4 of this tract; thence, following said fence line along the southeasterly boundary line of share No. 24 and the southeasterly boundary line of said 44.900-acre tract, S 54° 17' 59? W, 197.94 feet to the southernmost corner of Share No. 24 and being corner No. 5 of this tract; thence, following said fence line along the southwesterly boundary line of Share No. 24 and the northeasterly boundary line of Share No. 23, N 48° 10' 23? W, 1,061.62 feet to the westernmost corner of Share No. 24 and northernmost corner of Share No. 23 and being corner No. 6 of this tract; thence, along the southeasterly boundary line of a 35-ft. perpetual easement and the northwesterly boundary line of Share No. 24, N 48° 23' 35? E, 219.73 feet to the place of beginning and containing 5.396 acres of land.

Unit 3, Arroyo Morteros Tract (41 ha; 102 ac)—Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by FWS GPS Monument No. 105 having State plane coordinates of N = 311,099.90, E = 1,799,824.45. The scale factor used is 0.9999252, and the theta angle is ¥00° 37' 32?. All areas and distances are true surface measurements. Beginning at a 1/2-inch iron rod found for corner No. 1 on the common line between Porcions 59 and 60, and being the northwest corner of that certain 127.71-acre tract and having a State plane coordinate value of N = 315,746.07, E = 1,793,538.58, from which FWS GPS monument No. 105 bears S 53° 31' 49? E, 7,816.59 feet; thence, in a northeasterly direction along the common line of Porcion 59 and 60; N 54° 27' 12? E, 510.43 feet to a standard FWS aluminum monument set for corner replacing a 1/2-inch iron rod found, being the northwest corner of the herein described tract and stamped ‘‘Tract 670, Cor. No. 2, R. P. L. S. No. 3680’’; thence, in a easterly direction through the interior of said 536.485 acre tract; S 35° 20' 27? E, 3,621.01 feet to a standard FWS aluminum monument set for corner replacing a 1/2-inch iron rod found, being the northeast corner of the herein-described tract and stamped ‘‘Tract 670, Cor. No. 3, R.P.L.S. No. 3680’’; thence, in a southerly direction continuing through the interior of said 536.485 acre tract; S 61° 18' 54? W, 219.24 feet to a fence corner post found for a northwesterly corner of that certain 17.408 acre tract and being corner No. 4; thence, in a easterly direction along the common line between said 17.408 acre tract and the herein described tract; S 88° 47' 16? W, 110.41 feet to a fence post found for angle point and corner No. 5; thence, in a easterly direction continuing along said common line between a 17.408 acre tract and herein described tract; N 79° 11' 33? W, 67.63 feet to a fence post found for angle point and corner No. 6; thence, in a easterly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 71° 49' 04? W, 50.57 feet to a fence post found for angle point and corner No. 7; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 15° 40' 49? W, 44.43 feet to a fence post found for angle point

and corner No. 8; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 00° 18' 59? E, 253.83 feet to a fence post found for angle point and corner No. 9; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 06° 36' 21? W, 182.88 feet to a fence post found for angle point and corner No. 10; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 26° 38' 19? W, 125.18 feet to a fence post found for angle point and corner No. 11; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 67° 33' 26? W, 129.76 feet to a fence post found for angle point and corner No. 12; thence, in a southerly direction continuing along said common line between a 17.408-acre tract and herein described tract; S 45° 58' 19? W, 73.00 feet to a fence post found for angle point and corner No. 13; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 35° 10' 19? W, 113.60 feet to a fence post found for angle point and corner No. 14; thence, in a southerly direction continuing along said common line between a 17.408 acre tract and herein described tract; S 19° 34' 19? W, 42.80 feet to a fence post found for angle point and corner No. 15; thence, in a southerly direction continuing along said common line between a 17.408-acre tract and herein described tract; S 15° 23' 41? W, 28.84 feet to a 1/2-inch iron rod found on the apparent gradient boundary of the Rio Grande for the southeast corner hereof and corner No. 16; thence, in a westerly direction along said apparent gradient boundary of the Rio Grande; N 62° 26' 09? W, 81.47 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 7; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 36° 34' 14? W, 122.63 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 18; thence, in a northerly direction continuing along said apparent gradient boundary of the Rio Grande; N 20° 15' 10? W, 58.91 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 19; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 34° 02' 20? W, 118.95 feet to a point on said apparent gradient boundary of the Rio Grande for Corner No. 20; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 73° 36' 56? W, 17.73 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 21; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 43° 36' 30? W, 118.21 feet to a point on said apparent gradient boundary of the Rio Grande corner No. 22; thence, in a northerly direction continuing along said apparent gradient boundary of the Rio Grande; N 28°12' 58? W, 168.21 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 23; thence, in a northwesterly direction continuing along said apparent gradient boundary of the Rio Grande; N 49° 09' 29? W, 149.82 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 24; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 66° 23' 26? W, 123.27 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 25; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 77° 18' 49? W, 240.49 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 26; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 80° 06' 32? W, 129.98 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 27; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; N 79° 54' 48? W, 218.17 feet to a point on said apparent gradient boundary of the Rio Grande for corner No. 28; thence, in a westerly direction continuing along said apparent gradient boundary of the Rio Grande; S 81° 13' 28? W, 136.03 feet to a 1/2-inch iron rod found on said apparent gradient boundary of the Rio Grande for the southeast

corner of the aforementioned 127.71 acre tract, same being the southwest corner hereof and corner No. 29; thence, in a northerly direction along the common line between said 127.71-acre tract and the herein described tract; N 06° 09' 33? W, 237.00 feet to a fence post found for angle point and corner No. 30; thence, in a northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 05° 51' 34? W, 198.49 feet to a fence post found for angle point and corner No. 31; thence, in a Northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 07° 49' 27? E, 161.97 feet to a fence post found for angle point and corner No. 32; thence, in a Northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 07° 47' 00? E, 302.39 feet to a fence post found for angle point and corner No. 33; thence, in a northerly direction continuing along the common line between said 127.71 acre tract and the herein described tract; N 07° 17' 37? E, 493.82 feet to a fence post found for angle point and corner No. 34; thence, in a northeasterly direction continuing along the common line between said 127.71-acre tract and the herein described tract, as fenced; N 46° 28' 41? E, 643.50 feet to a fence post found for angle point and corner No. 35; thence, in a northwesterly direction continuing along the common line between said 127.71 acre tract and the herein described tract; N 47° 51' 47? W, 1,087.49 feet to a fence post found for angle point and corner No. 36; thence, in a northerly direction continuing along the common line between said 127.71-acre tract and the herein described tract; N 21° 22' 25? W, 375.05 feet to the point of beginning and containing 89.90 acres of land.

Unit 4, Las Ruinas Tract (104 ha; 256 ac)—Note: All bearings are based on the Texas State Plane Coordinate System, South Zone, as referenced by National Geodetic Survey (NGS.) Triangulation Station ‘‘GORGORA’’ having State plane coordinates (NAD 27) of N = 275,335.73, E = 1.833,217.01. The scale factor used is 0.9999421, and the theta angle is -00° 16' 22?. All areas and distances are true surface measurements. Beginning at a 2- inch iron pipe having State plane coordinates of N = 280,488.40, E = 1,804,584.01 for the northerly southeast corner of the herein described tract, from which said triangulation station ‘‘GORGORA’’ bears S 79° 47' 55? E, a distance of 29,092.93 feet, same being the southwest corner of Share 96, of said Porcion 66, and the southwest corner of a 1455.52-acre tract of land as described, same being in the north line of Share 94, of said Porcion 66, same being in the north line of Tract ‘‘K’’, a 26.82-acre tract of land as described, for corner No. 1 and point of beginning of the herein described tract of land. Thence, westerly along the common line between said northerly line of tract ‘‘K’’ and the southerly line hereof N 80° 30' 29? W, 871.09 feet to a 6? iron pipe found for corner No. 2, same being the northwest corner of said Tract ‘‘K’’; thence, southerly along the common line between the westerly line of said Tract ‘‘K’’ and the easterly line hereof S 09° 22' 35? W, 837.18 feet, to a 13/4? iron pipe found for the southwest corner of said tract ‘‘K’’ and the northwest corner of a 23.5131-acre tract of land at corner No. 3, thence, southerly along the common line between said 23.5131-acre tract and the most southerly easterly line hereof, S 09° 22' 35? W, 540.00 feet to a standard FWS aluminum monument set, said monument being in the north line of a 56.82-acre tract of land as described for corner No. 4 and stamped ‘‘Tract 630, Ref. No. 4, RPLS 3680’’; thence, westerly along the common northerly line between said 56.82 acre tract and the southerly line hereof, N 80° 31' 16? W, 3295.18 feet to the apparent gradient boundary of the Rio Grande, and passing a standard FWS aluminum monument set for reference at a distance of 3,210.08 feet and stamped ‘‘Tract 630, Ref. No. 5, RPLS 3680’’; thence, northerly along the apparent gradient boundary of the Rio Grande N 63° 00' 17? E, 192.97 feet to a point on the apparent gradient boundary of the Rio Grande for Corner No. 6; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 62° 39' 49? E, 398.99 feet to a point

on the apparent gradient boundary of the Rio Grande for Corner No. 7; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 60° 14' 39? E, 722.34 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 8; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 57° 28' 43? E, 416.75 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 9; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 57° 55' 40? E, 171.44 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 10; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 47° 49' 48? E, 287.44 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 11; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 43° 00' 00? E, 246.79 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 12; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 39° 40' 14? E, 295.08 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 13; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 35° 41' 43? E, 380.79 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 14; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 31° 28' 24? E, 370.58 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 15; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 33° 19' 15? E, 293.00 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 16; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 13° 43' 08? E, 146.31 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 17; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 11° 00' 57? E, 189.14 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 18; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 02° 10' 54? W, 305.51 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 19; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 01° 31' 51? W, 416.25 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 20; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 00° 01' 29? W, 441.45 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 21; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 03° 29' 26? E, 405.03 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 22; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 08° 08' 02? E, 308.09 feet to a point on the apparent gradient boundary of the Rio Grande for corner No. 23; thence, northerly continuing along said apparent gradient boundary of the Rio Grande N 39° 03' 01? E, 218.95 feet to a point on the apparent gradient boundary line of the Rio Grande, for corner No. 24 and northwest corner of this tract, same being the southwest corner of a 60.77-acre tract of land; thence, easterly along the common line between the south line of said 60.77- acre tract and the northerly line hereof S 80° 31' 16? E, 1942.92 feet to a standard FWS aluminum monument set and stamped ‘‘Tract 630, Ref. No. 25, RPLS 3680’’ for corner No. 25, same being the southeast corner of said 60.77- acre tract, same being in the west line of Share 339 of said Porcion 66, same being in the west line of said 1,455.52- acre tract of land, and passing a standard FWS aluminum monument set for Reference at a distance of 38.95 feet and stamped ‘‘Tract 630, Ref. No. 24, RPLS 3680’’; thence, southerly along the common line between the west line of said Share 339, Share 319, Share 227, Share 231, Share 230, Share 229, Share 518, Share 226, Share 225, Share 224, and said Share 96, same being the west line of said 1,455.52-acre tract and the east line hereof S 09° 28' 44? W, 3,845.12 feet and passing a 2-inch iron pipe found for the southwest corner of Share 339, same being the northwest corner of Share

319 at a distance of 315.48 feet, and being 0.46 feet easterly of and perpendicular to this line, and also passing a 1-1/2 inch iron pipe found for the southwest corner of Share 319, same being the northwest corner of Share 227 at a distance of 711.48 feet, and being 0.39 feet easterly of and perpendicular to this line, and also passing a 2-inch iron pipe found for the southwest corner of Share 231, same being the northwest corner of Share 230 at a distance of 1,320.71 feet, and being 0.09 feet easterly of and perpendicular to this line, to the point of beginning of the herein described tract and containing 254.42 acres of land.

Unit 5, Arroyo Ramirez Tract (273 ha; 675 ac)—Formal surveying of the tract has not been performed. Described as, ‘‘All of Share 79, Porcion 68, Abstract 191, Former Jurisdiction of Mier, Mexico, now Starr County, Texas, and all of Share 166, Porcion 69, Abstract No. 160, Former Jurisdiction of Mier, Mexico, now Starr County, Texas. Description by approximated latitude/ longitude coordinates (attached maps): Beginning at Latitude/Longitude 26° 24 00.9?N/099° 03' 23.9?W, westward to Latitude/Longitude 026° 24' 04.7?N/ 099° 03' 46.5?W, northward to Lat/Long 026° 24' 25.2?N/099° 03' 43.3? W, westward to Lat/Long 026° 24' 26.0? N/ 099° 03' 49.8? W, northward to Lat/Long 026° 25' 05.5? N/099° 03' 42.6? W, eastward to Lat/Long 026° 24' 56.6? N/ 099° 02' 40.3? W to the apparent gradient boundary of the Rio Grande River.

Unit 6, Los Negros Creek Tract (47 ha; 116 ac)—The following described tract of land is located in Starr County, Texas, about 1 mile northwest of the town of Roma, being 111.67 acres out of Share 13, Porcion 70, and being more particularly described as follows: Beginning at Cor. No. 1, an iron pin set for the northeast corner of Share No. 13 of Porcion No. 70 ; thence, along an old fence line and the dividing line between Share Nos. 13, 1–B and 12–A, S 09° 15' W, 2,694.00 feet to Cor. No. 2 an iron pin set on the Old High Bank of the Rio Grande and the southeast corner of this tract; thence leaving said fence line and along said Old High Bank with the following two courses, N 63° 17' 27? W, 1,161.54 feet to Cor. No. 3 and N 87° 10' 00? W, 612.00 feet to Cor. No. 4, a set iron pin and the southwest corner of this tract; thence leaving said Old High Bank and along the dividing line of Tract 2 and 3 of said Share 13 and an old fence line with the following three courses, N 09° 15' E, 841.30 feet to Cor. No. 5, a set iron pin; N 80° 45' W, 397.50 feet to Cor. No. 6, a set iron pin; and N 09° 15' E, 1,572.60 feet to Cor. No. 7 & iron pin set for the northwest corner of this tract; thence leaving said dividing line and along the north line of this tract and an old fence line, S 80° 45' E, 2,113.70 feet to Cor. No. 1 and the true place of beginning, containing 111.67 acres of land bounded on the West, North, and East by lands of unknown owner and on the South by the Rio Grande.

Unit 7, La Puerta Tract (1,577 ha; 3,895 ac) (Segment 590). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, as referenced by National Geodetic Survey (NGS) triangulation station ‘‘Fordyce 2’’ and NGS triangulation station ‘‘Monument’’. Scale factor used was 0.99993949; theta angle used was ¥00° 06' 15?. All areas are true ground measured areas. Beginning at corner No. 1, a standard U.S. Fish and Wildlife Service (FWS) aluminum monument stamped ‘‘TR 590 COR 1’’ set in the west boundary of Porcion 86, said point being at the southwest corner of the aforementioned 8,061-acre tract, and also being the northeast corner of a 160-acre tract recorded in volume 60, pages 47–48, Deed Records, Starr County, Texas, from which NGS triangulation station ‘‘Monument’’ bears N. 68° 59' 27? W, 8,477.20 feet; thence, from corner No. 1, along the western boundary line of said 8,061-acre tract and Porcion 86, N 09° 02' 27? E, 25,125.17 feet to corner No. 2, a standard FWS aluminum monument stamped ‘‘TR 590 COR 2’’, set at a fence corner from which NGS triangulation station ‘‘Monument’’ bears S 28° 34' 49? W, 24,795.18 feet; said corner No. 2 also being the northwest

corner of the herein described tract, thence, from corner No. 2, departing said western boundary line, with fence, S. 78° 52' 36? E, 1,889.04 feet, to corner No. 3, a standard FWS aluminum monument stamped ‘‘TR 590 COR 3’’ set at fence corner; thence, from corner No. 3, continuing with fence, N 06° 16' 07? E, 1,007.99 feet to corner No. 4, a standard FWS aluminum monument stamped ‘‘TR 590 COR 4’’ set at fence corner; thence, from corner No. 4, continuing with fence, S 78° 42' 12? E, 2,691.33 feet to corner No. 5, a standard FWS aluminum monument stamped ‘‘TR 590 COR 5’’ set for angle; thence from corner No. 5, continuing with fence, S 72° 35' 38? E, 2,000.57 feet to corner No. 6, a standard FWS aluminum monument stamped ‘‘TR 590 COR 6’’ set at fence corner, said point being a perpendicular distance of 20.20 feet from the eastern boundary line of Porcion 87, said point also being the Northeast corner of the herein described tract; thence, from corner No. 6, continuing with fence, S 09° 01' 08? W, 10,831.38 feet to corner No. 7, a standard FWS aluminum monument stamped ‘‘TR 590 COR 7’’ set for angle adjacent to a found 5/8-inch iron pin; thence, from corner No. 7, continuing with fence, S 08° 56' 57? W, 10,030.04 feet, to corner No. 8, a standard FWS aluminum monument stamped ‘‘TR 590 COR 8’’ set for angle point, said point being at the intersection of said fence with the east boundary line of Porcion 87; thence, from corner No. 8, departing said fence, along the east boundary line of Porcion 87, S 09° 02' 27? W, 4,824.69 feet to corner No. 9, a standard FWS aluminum monument stamped ‘‘TR 590 COR 9’’ set for corner; thence, from corner No. 9, departing said east line, N 80° 47' 09? W, 6,527.80 feet to the place of beginning and containing 3,844.674 acres. (La Puerta 590a). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by the National Geodetic Survey (NGS) Triangulation Station ‘‘Monument’’ having a coordinate value of N = 250,167.56; E = 1,912,489.81. Scale factor applied equals 0.99993949; theta angle equals ¥00° 06' 15?. All areas are based on true ground measurements. Beginning at corner No. 1, a standard FWS aluminum monument stamped ‘‘TR 590A COR 1’’ set over a 2-inch iron pipe found in the west boundary line of Porcion 87, east boundary line of Porcion 86, at the northwest corner of said Lot 22, also being the northeast corner of a 2.83-acre tract as described by deed recorded in Volume 516, Page 62, Official Records, Starr County, Texas and being in the south boundary line of USA Tract (590) as described by deed recorded in Volume 608, Page 309, Official Records, Starr County, Texas said point having a coordinate value of N = 246,550.96; E = 1,923,962.74 and bearing S 72° 30' 13? E, 12,029.47 feet from NGS Triangulation Station ‘‘Monument’’; thence from corner No. 1, with south boundary line of said USA Tract (590), the north boundary line of said Lot 22, S 80° 47' 09? E, 2,922.00 feet to corner No. 2, a standard FWS aluminum monument stamped ‘‘TR 590 COR 9’’ found at the southeast corner of said USA Tract (590), also being the northeast corner of said Lot 21, and being in the east boundary line of Porcion 87, west boundary line of Porcion 88 for the northeast corner of the herein-described tract of land; thence, from Corner No. 2, with the said east boundary line of Porcion 87, west boundary line of Porcion 88, and also being the east boundary line of said Lot 21, S 08° 18' 30? W, 1,130.60 feet to corner No. 3, a standard FWS aluminum monument stamped ‘‘TR 590A COR 3’’ set in the existing north right-of-way line of U.S. Highway 83 with the intersection of said east boundary line of Porcion 87, west boundary line of Porcion 88 for the southeast corner of the herein described tract of land; thence, from corner No. 3, with and along the said existing north right-ofway line of U.S. Highway 83, N 66° 14' 23? W, 18.20 feet to corner No. 4, a standard FWS aluminum monument stamped ‘‘TR 590A COR 4’’ set for an angle point; thence, from corner No. 4, continuing along said existing north right-of-way line, N 60° 31' 23? W, 100.39 feet to corner No. 5, a standard FWS aluminum monument stamped ‘‘TR 590A COR 5’’ set for an angle point; thence, from corner 5, continuing along said existing north right-of-way line, N 66° 14' 23? W, 499.97 feet to corner No. 6, a standard FWS aluminum monument stamped ‘‘TR 590A COR 6’’ set for an angle point; thence, from corner No.

6, continuing along said existing north right-of-way line, N 71° 57' 23? W, 100.39 feet to a corner No. 7, a standard FWS aluminum monument stamped ‘‘TR 590A COR 7’’ set for an angle point; thence, from corner No. 7, continuing along said existing north right-of-way line, N 66° 14' 14? W, 1,084.94 feet to corner No. 8, a 5/8-inch iron rod found at the intersection of the said existing north right-of-way line with the proposed north right-of-way line of U.S. Highway 83; thence, from corner No. 8, departing said existing north right-of-way line with and along the proposed north right-of-way line of U.S. Highway 83, N 60° 43' 04? W, 200.90 feet to corner No. 9, a 5/8-inch iron rod found for an angle point; thence, from corner No. 9, continuing along said proposed north right-of-way line, N 69° 54' 31? W, 300.83 feet to corner No. 10, a 5/8-inch iron rod found at the intersection of said proposed north right-of-way line with the existing north right-of-way line of U.S. Highway 83; thence, from corner No. 10, with the said existing north right-of-way line of U.S. Highway 83, N 66° 16' 51? W, 399.70 feet to corner No.11, a standard FWS aluminum monument stamped ‘‘TR 590A COR 11’’ set over a 1/2-inch iron rod found for an angle point; thence, from corner No. 11, continuing along said existing North right-of-way line, N 64° 31' 54? W, 335.45 feet to corner No.12, a standard FWS aluminum monument stamped ‘‘TR 590A COR 12’’ set at the intersection of said existing north rightof-way line with the west boundary line of Porcion 87, east boundary line of Porcion 86; thence, from corner No. 12, departing said existing north right-ofway line with the said west boundary line of Porcion 87, east boundary line of Porcion 86, N 08° 56' 59? E, 357.90 feet to corner No.1, the point of beginning and containing 50.033 acres of land. (La Puerta Tract—Segment 590b). Note: All bearings and distances are based on the Texas State Plane Coordinate System, South Zone, (NAD 27), as referenced by the National Geodetic Survey (NGS) Triangulation Station ‘‘Monument’’ having a coordinate value of N = 250,167.56' E = 1,912,489.81. Scale factor applied equals 0.00003040; theta angle equals ¥00° 06' 15?. All areas are based on true ground measurements. Beginning at corner No. 1, a 5/8-inch iron rod found at the intersection of the west boundary line of Porcion 87, east boundary line of Porcion 86 with the proposed south right-of-way line of U.S. Highway 83, said point bears S 08° 57' 33? W, 139.55 feet from a 5/8-inch iron rod found in the existing south right-of-way line of U.S. Highway 83, said point having a coordinate value of N = 245,880.85, E = 1,923,857.21 and bearing S 69° 20' 18? E, 12,148.81 feet from NGS Triangulation Station ‘‘Monument’’; thence, from corner No. 1, with the said proposed south right-of-way line, S 66° 14' 23? E, 3,043.33 feet to corner No. 2, a 5/8-inch iron rod found at the intersection of the east boundary line of Porcion 87, the west boundary line of Porcion 88 and the said proposed south right-of-way line, thence, from corner No. 2, with the said east boundary line of Porcion 87, west boundary line of Porcion 88, S 08° 59' 29? W, 2,925.70 feet to corner No. 3, a standard FWS aluminum monument stamped ‘‘TR 590B COR 3’’ set over a 1/2-inch iron rod found at the intersection of said east boundary line of Porcion 87, west boundary line of Porcion 88 with the north right-of-way line of the MissouriPacific Railroad; thence, from corner No. 3, with the said north right-of-way line of the Missouri-Pacific Railroad, N 52° 58' 07? W, 3,333.49 feet to corner No. 4, a standard FWS aluminum monument stamped ‘‘TR 590B COR 4’’ set over a 3/8-inch iron rod found at the intersection of the said north right-ofway line with the said west boundary line of Porcion 87, the east boundary line of Porcion 86, said point also being the southeast corner of a 39.492-acre tract, thence from corner No. 4, with the said west boundary line of Porcion 87, east boundary line of Porcion 86, N 08° 56' 13? E, 1,715.55 feet to corner No. 5, a standard FWS aluminum monument stamped ‘‘TR 590B COR 5’’ set over a 1/2- inch iron rod found at the southeast corner of a 2.0-acre tract, thence, from corner No. 5, continuing along said west boundary line of Porcion 87, east boundary line of Porcion 86, N 09° 08' 05? E, 418.93 feet to corner No. 1, the point of beginning and containing 170.950 acres of land.

Unit 8-Private ranch site comprises 0.552 hectares (1.36 acres) within the Universal Transverse Mercator, Zone 14 and begins at UTM 490706 E, 2929709 N; thence to 490729 E, 2929706 N; to 490748 E, 2929720 N; to 490762 E, 2929722 N; to 490767 E, 2929704 N; to 490767 E, 2929679 N; to 490769 E, 2929654 N; to 490770 E, 2929637 N; to 490770 E, 2929629 N; to 490760 E, 2929619 N; to 490743 E, 2929614 N; to 490732 E, 2929612 N; to 490720 E, 2929614 N; to 490709 E, 2929670 N; and thence to point of beginning.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lesquerella thamnophila critical habitat consists of three components (65 FR 81182-81212):

(a) Arid upland habitats of various soil types, including highly calcareous sandy loam to loamy sand, with low to moderate salinity levels on low sloping hills;

(b) Absence of substantial previous soil disturbance and seeding or sodding of exotic grasses; and

(c) A sparse overstory of shrub species typical of the Tamaulipan biotic province, but lacking a complete canopy as might be provided by a continuous overstory dominated by mesquite (Prosopis glandulosa).

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Zapata bladderpod blooms from April through September and produces bright yellow flowers. Plants will bloom throughout most of the year with adequate temperature and rainfall. Fruits are round, 0.2 to 0.8 inch in diameter, and are on short, downward curving pedicels (Poole 1989). Zapata bladderpod is known to be opportunistic, with the density of Zapata bladderpod plants and size of populations fluctuating with temperature levels and amount of rainfall. Zapata bladderpod is a perennial plant that sprouts above ground levels and produces stems more readily during periods of favorable weather. It can respond dramatically to rainfall events and increase from small, barely-detectable above-ground plants, to thousands of plants (USFWS 2004).

Habitat Type

Adult: Shrublands

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2004)

Habitat Narrative

Adult: Zapata bladderpod is endemic to South Texas, where it occupies cenizo and/or guajillo (Acacia berlandieri) shrublands. It can occur on graveled to sandy-loam, upland terraces above the Rio Grande flood plain. The soils on which the species is known to occur vary depending on location. In Starr County, documented populations occur within the Jimenez-Quemado soil association and on Catarina series soils. In Zapata County, they occur within the Zapata-

Maverick soil association and may also occur within the Copita-Zapata soils (USFWS 2004). Zapata bladderpod may occur within areas of sparse vegetation or under canopy of associated shrub species. The shrub species may serve as nurse plants for Zapata bladderpod, potentially reducing the amount of sunlight on the soil surface and helping to maintain moisture in the root area. Adjacent shrubs also provide protection from soil erosion and may serve as a deterrent to browsing animals. Associated plants include mesquite, granjeno, Spanish dagger (Yucca treculeana), lotebush, guayacan (Guaiacum angustifolium), cenizo (Leucophyllum frutescens), and blackbrush (Acacia ridgula) (USFWS 2004).

Dispersal/Migration

Population Information and Trends

Number of Populations:

8 extant populations; 2 populations of unknown status (USFWS, 2015)

Population Narrative:

The recovery plan stated that there are 7 extant populations, while the TXNDD now lists 8 extant populations and two of unknown status. Of the latter, EO 2 is a historic record north of Roma for which the precise location is unknown. EO17 was detected during a survey of private land in 1994, also north of Roma, and the site has not since been re-visited. The recovery plan also states that there are 11 documented occurrences, but this figure confounds known populations and designated areas of critical habitat. We believe the EOs reported by TXNDD correctly represent our current knowledge of the populations and distribution of Zapata bladderpod. (USFWS, 2015) Four of the seven populations known historically to occur in Starr County still support Zapata bladderpod plants (USFWS 2004). Two of these seven are in the highway ROWs between Zapata and Falcon, and one on private property in Siesta Shores subdivision. The populations that occur on the LRGV NWR tracts in Starr County continue to maintain the largest number of plants (USFWS 2004). Three refuge tracts and the private ranch have fairly large populations. These populations number in the thousands of individuals in rainy years but occur within a very restricted area covering only a few acres (Best 2006, personal comm.). In Zapata County, three of the four historically documented sites still support Zapata bladderpod. The predominance of private lands in South Texas limits access for surveys, therefore the species range may be more extensive than what is currently known. The size of populations fluctuates depending on rainfall and weather cycles increasing the difficulty in locating the plants (USFWS 2004).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: • Buffelgrass is more prevalent in disturbed soils; not highly competitive in Zapata bladderpod habitat. • Soils are extremely prone to erosion. Root- plowing and other forms of soil disturbance exacerbate erosion. • Overgrazing increases soil erosion. • Foot and ATV traffic associated with border security destroys plants by trampling and leads to soil erosion. • Rapid local population growth, highway construction between Laredo and Rio Grande City. • Petroleum

development and pipeline construction continues at rapid pace. (USFWS, 2015)

Stressor: The inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act (ESA) does provide some legal protection for federally-listed plants on land under federal jurisdiction, including the three populations on tracts of Lower Rio Grande Valley NWR. However, as described above, Endangered Species Act provisions, including section 7 consultation, can be waived by DHS to expedite construction of border barriers. Federally-listed plants occurring on private lands have very limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Therefore, Zapata bladderpod populations and habitats on private land are not subject to federal or state protection unless there is a federal nexus, such as provisions of the Clean Water Act or a federally-funded project. (USFWS, 2015)

Stressor: Other natural or man-made factors affecting its continued existence (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: • Some EOs within developed areas or along highway ROWs are vulnerable. • Periodic vegetation shredding along utility ROWs may have beneficial effect, provided that soil is not disturbed. • Small isolated populations subject to genetic drift and inbreeding. • Historic conversion of shrub savanna to dense shrubs and cessation of wildfire may have affected populations. • Potential impacts of climate changes. (USFWS, 2015)

Recovery

Reclassification Criteria:
1. Maintain or establish 12 geographically distinct, self-sustaining populations located within the species' historical range in the United States, with at least one population in each of the 3 geologic formations from which the species is currently known to occur. Each population should consist of at least 2,000 reproductive individuals (have flowered at least once or are capable of flowering) as determined during years when precipitation patterns have stimulated growth and reproduction. The numbers of reproductive individuals at each of the 12 population sites must be stable or increasing. (USFWS, 2019)

2. To count toward reclassification, all populations must be appropriately protected and actively managed to reduce or eliminate threats to the species. Agreements for the protection and appropriate management of the 12 self-sustaining populations must be in place. Perpetual protection on public land will be assured via Service-approved management plans (e.g. National Wildlife Refuge Comprehensive Conservation Plans). Formal stewardship agreements (e.g. conservation easements or similar instruments) must be in place to ensure perpetual long-term, species-appropriate management on privately-owned land. (USFWS, 2019)

Delisting Criteria:
1. Over a 30-year period following reclassification of the species to threatened, monitoring of 12 fully protected, self-sustaining populations consisting of at least 2,000 reproductive individuals

per population shows that the populations are stable or increasing. These populations will be located within the species' historical range in the United States, with at least one population in each of the three geologic formations from which the species is currently known to occur.

2. Populations continue to be protected through perpetual management agreements. Threats to each population have been reduced or eliminated through appropriate site management that may include such actions as limiting erosion by excluding vehicles, foot traffic, and/or overgrazing by livestock, diminishing woody vegetation using means that do not disturb the soil, or potentially controlling invasion by non-native grasses. The effectiveness of this management would be determined by monitoring the condition of habitat and the status of the species' such that it is stable or increasing in number

Recovery Actions:

- 1. Protect known bladderpod populations in the United States. The known populations of Zapata bladderpod must be protected from habitat destruction or degradation and other relevant threats. Relationships with private landowners, soil conservation district agencies, roadway construction agencies, oil and gas exploration/production agencies, and rural development agencies should be developed to raise awareness of and conserve the habitat where bladderpod populations are located. (USFWS, 2004)
- 2. Search for new populations. Surveys should be conducted to locate Zapata bladderpod populations in the United States and Mexico. Many areas of native habitat have not been surveyed for this species due to lack of access. This species is difficult to detect without an intensive search due to its ephemeral tendencies during drought conditions. Information on the Zapata bladderpod's appearance, rarity, and vulnerability should be provided to Federal, State, and private landowners. To ensure accuracy, surveys should be conducted at favorable times to locate the plants, (e.g., after rainfall) focusing on associated soil types. Federal (i.e. USFWS, USDA, etc.) and State (TPWD, TDA, etc.) agencies as well as non-governmental organizations (TNC) should increase efforts to form relationships with private landowners to search for and protect populations. (USFWS, 2004)
- 3. Conduct studies to gather information about Zapata bladderpod for management and recovery in the wild. Information on the ecology, life history, population biology, and pollination for the Zapata bladderpod in its native habitat is lacking. Efforts to understand and manage the species are therefore hindered. Studies conducted to gather basic biological information on the species should focus on factors that will enable a better understanding of habitat and provide insight into effective management for the species. Information obtained from the studies should be incorporated into management plans as appropriate to assist recovery of the species. New information should be incorporated into future recovery plan revisions. (USFWS, 2004)
- 4. Establish a botanical garden population and seed bank. Specimens from the known population(s) should be maintained at different institutions. A seed bank should be established for the species and maintained at the National Seed Storage Laboratory in Fort Collins, Colorado. The San Antonio Botanical Garden has indicated an interest in conducting research on propagation techniques and seedling production for the Zapata bladderpod, and to establish an educational botanical garden population (Cox 2002 pers. comm.). At least two refugia collections and seed bank reserves should be established and maintained to provide assurance against extinction if a loss of natural populations should occur. Cultivated plants could provide individual plants for research and provide a plant source for possible reintroductions. (USFWS, 2004)

- 5. Establish new populations as necessary to meet downlisting criteria. Due to the apparent rarity of the Zapata bladderpod within its range, reintroductions of the species may be necessary to aid recovery. The Service defines reintroduction as placing species in its historic range. As some of the collection data for this species is ambiguous, any reintroduction will need to be undertaken in areas of appropriate habitat within the historic range of the species. Reintroduction efforts could be implemented on Federal lands such as those within the LRGV Refuge Complex or on State or private lands volunteered for use. Any reintroduction efforts will follow Service policy on controlled propagation of endangered and threatened species, and incorporate the most recent reintroduction guidelines available (Falk et al. 1996). (USFWS, 2004)
- 6. Develop a public information and awareness program. Public awareness and cooperation are essential for the success of the Zapata bladderpod recovery program. An informative program about the Zapata bladderpod, threats to the species, the Recovery Plan, and the Endangered Species Act in general, should be developed for presentation to private landowners, agency personnel, and other interested groups. The program should include the identification of recovery tasks that the individuals or groups being addressed can accomplish to participate in recovery of the species. Additionally, information on the Zapata bladderpod should be included within any Lower Rio Grande or Mexico/United States Bi-national Ecosystem program so that a coordinated approach to recovery can be implemented. (USFWS, 2004)
- 7. Develop delisting criteria and a post-recovery monitoring plan. Once the needed information on distribution, life history, ecology, and genetics are obtained, delisting criteria and a post-delisting monitoring plan can be developed. Future criteria should be developed that incorporate measures to alleviate threats identified under the five listing factors and identify when the species will no longer be threatened with endangerment. All information needs for Zapata bladderpod that have been determined as critical during the course of recovery-oriented research must be evaluated prior to delisting. If the downlisting criteria are no longer being met, the species should be returned to the status of endangered. Post-delisting monitoring for a minimum of five years is required by the ESA. (USFWS, 2004)
- Revise the recovery plan and recovery criteria to define both down-listing and de-listing criteria. (USFWS, 2015)
- Consider revising criteria to allow larger numbers of smaller populations to contribute to recovery; use frequency of recruitment as a measure of demographic trends. • Conduct public outreach in Starr and Zapata counties to raise local awareness of Zapata bladderpod. Support conservation of wild populations on private lands with willing landowners through the USFWS Partners for Fish and Wildlife Program, section 6funded grants, cooperative efforts with Natural Resources Conservation Service, or nongovernmental partners. Establish a private landowner support group for conservation of Zapata bladderpod (and perhaps other plant species of concern known from that region), similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus). (USFWS, 2015)
- Support scientific investigation of the reproductive biology and pollination, genetic structure of the wild populations, response to shrub cutting and prescribed burning, and degree of tolerance or requirement for gypsum (gypsovagy versus gypsophily). (USFWS, 2015)
- Prohibit vehicle traffic, including ATVs, from Zapata bladderpod occupied habitats at LRGV NWR, and limit foot traffic to the greatest extent possible. (USFWS, 2015)

- Develop a potential habitat model based on geological and soil factors. Conduct expanded surveys based on this model on private lands (with landowner permission) in Texas as well as Tamaulipas and Nuevo León (pending the resolution of security issues on the Mexican side of the border). (USFWS, 2015)
- Collect seeds from the most vulnerable populations, develop propagation methods, and reintroduce the propagated Zapata bladderpod plants into suitable protected habitats to create refugia for the vulnerable populations.

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SPECIES ACCOUNT: *Lesquerella tumulosa* (Kodachrome bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/06/1993; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb that forms a low rounded clump, about 1-4 cm tall and 5 cm broad. The plants are covered with tiny yellow flowers in early summer, followed by a dense covering of globe-like fruits (NatureServe, 2015).

Taxonomy

Kodachrome bladderpod (Lesquerella tumulosa) is in the Mustard family (Cruciferae or Brassicaceae). Barneby (1966) described the plant as Lesquerella hitchcockii ssp. tumulosa, comparing the taxon with Lesquerella hitchcockii ssp. rubicundula (now Lesquerella rubicundula) from the nearby Paunsaqunt Plateau. James Reveal, in his taxonomic treatment of the Lesquerella hitchcokii complex of species, elevated Barneby's L. hitchcockii spp. tumulosa to species rank as L. tumulosa (Reveal 1970) (USFWS, 2009).

Historical Range

Rupert Barneby discovered the Kodachrome bladderpod in 1966 from a site in the Kodachrome Basin of the Paria River drainage in northern Kane County, Utah (USFWS, 2009).

Current Range

Kodachrome bladderpod is an endemic found only in Kane County, Utah (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2009)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: April - May (USFWS, 2009)

Reproduction Narrative

Adult: A perennial species (NatureServe, 2015). The fruit contains 2 - 4 seeds. The species' reproduction is sexual. Asexual reproduction is unknown. The species' pollinators are unknown. In most years, the plants begin flowering in late April and continue through May with seed dispersal occurring in June (Franklin 1990). Field observations in 2009 documented good flowering, presence of potential pollinators, and seed set (A. Hughes, pers. comm., 2009)

(USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bouteloua grassland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs ~5,700 feet elevation (USFWS, 2009); high vegetative cover (inferred from USFWS, 2009)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits extremely dry, sparsely vegetated, white shale knolls with thin soils derived from the Windsor Member of the Carmel Formation. Associated with scattered Utah juniper (Juniperus osteosperma) within a Bouteloua grassland (NatureServe, 2015). Kodachrome bladderpod is restricted to very xeric shale outcrops at about 1,740 meters (5,700 feet). Visually, occupied habitats contain harder, rockier soils than unoccupied habitats (A. Hughes, pers. comm., 2009). Kodachrome bladderpod occupies sites with very little vegetative cover (USFWS, 2009).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

3 (USFWS, 2021)

Population Size:

~45,000 (USFWS, 2021)

Population Narrative:

We estimate the total population comprising the three populations to be 45,000 individuals, approximately 25,000 more plants than we reported at the time of listing (Billings and Wheeler 2019; UNHP 2021). The Kodachrome Basin population is the largest of the three populations and contains approximately 75 percent of the total population (Table 1). (USFWS, 2021)

Threats and Stressors

Stressor: Off-highway vehicle use (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The largest threat to the Kodachrome bladderpod is illegal OHV use. The habitat of the species is characterized by low rolling hills with little native vegetation, providing easy access and preferred terrain for OHV users. Impacts from OHV users likely increased mortality rates at established monitoring sites (Van Buren 1999, 1999; Van Buren and Harper 2001, 2002) (USFWS, 2009).

Stressor: Cattle grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The BLM Dry Valley grazing allotment completely overlaps the range of the Kodachrome bladderpod. Grazing leases or permits existing at the creation of GSENM continue today and are subject to BLM's grazing regulations and other laws and regulations governing grazing on public lands (BLM 1999). While this allotment permits 699 Animal Unit Months or 166 cows, since 1999 it has run at about 75 percent of permitted levels. However, cattle grazing occurs outside of the flowering and seed setting period for Kodachrome bladderpod. Cattle are not known to feed on Kodachrome bladderpod; however, cattle may be a low threat to the species with occasional trampling, soil compaction, and erosion (Meiiji 1982, A. Hughes, M. Ulloa, pers. comm., 2007) (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The original listing (58 FR 52027, October 6, 1993) concluded that the species' existence in a single known population makes the species vulnerable to extinction due to a catastrophic event. Drought conditions likely resulted in high mortality (76 percent) and lower flower and fruit production at two Kodachrome bladderpod monitoring sites (Van Buren and Harper 2001, 2002). Although plants still occur at these monitoring sites, it is possible that extended and severe drought could cause the species to be lost in some areas (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Drought conditions led to a noticeable decline in survival, vigor and reproductive output of rare plants in the Southwest during the drought years of 2001 through 2004 (Clark and Clark 2007; Hughes 2005; Roth 2008 a, 2008 b; Van Buren and Harper 2002 and 2003). Effects related to climate change, such as persistent or prolonged drought conditions, are likely to reduce the frequency and duration of flowering and/or germination events, lower the recruitment of individuals, compromise the viability of the population, impact pollinator availability and, therefore, adversely affect the long-term persistence of Kodachrome bladderpod and lessen its recovery potential. Prolonged droughts combined with increases in the frequency of heavy rainfall events may increase erosion in Kodachrome bladderpod habitat (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available - recovery plan not developed.

Delisting Criteria:
Not available - recovery plan not developed.

Recovery Actions:

- Evaluate all known habitat components analyzing geospatial data and conduct range surveys including searches for additional occurrences in areas containing characteristics highly related to occupancy (USFWS, 2009).
- Identify sites in urgent need of habitat conservation, such as fencing, and increased protective actions. Areas particularly impacted by OHV use will be targeted (USFWS, 2009).
- Support research on Kodachrome bladderpod's life history and ecology, including soil needs and pollinators (USFWS, 2009).
- Encourage investigations that project Kodachrome bladderpod's response to climate changes in its habitat (USFWS, 2009).
- Not available

Conservation Measures and Best Management Practices:

- Recommended future actions: Based on recent discussions with Federal agencies and conservation partners, we recommend the following future actions to support the recovery of the species: (1) use genetic information to confirm the identification of the two new populations as Kodachrome bladderpod and evaluate the species' genetic fitness; (2) complete a final recovery plan for the species; (3) protect recovery populations and suitable habitat on Federal lands and, to the extent possible, on non-Federal lands; (4) continue systematic surveys of potential habitat for additional populations; (5) improve the protections for the Kodachrome Basin population against the effects of the nearby corral, campsite, and OHV use; (6) develop and implement standardized range-wide, long-term monitoring procedures for the species with special procedures for monitoring the species' response to severe and prolonged droughts; (7) evaluate the effect of climate change and drought on the species, including a resurvey of the known populations in 2022 after the severe drought in 2021; (8) establish a set of need-based research priorities into the species' biology and life history aimed at minimizing threats and supporting recovery; (9) implement ex-situ seed collection and preservation according to established protocols developed by the Center for Plant Conservation; (10) communicate with partners, stakeholders, and recreationists regarding the species' recovery needs and progress; and (11) develop strong habitat protections for energy and/or mineral development on KEPA lands. (USFWS, 2021)

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SPECIES ACCOUNT: *Lessingia germanorum (=L.g. var. germanorum)* (San Francisco lessingia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A slender annual herb, mostly 1-3 dm tall. The flower heads have bright yellow disk flowers; they lack rays (NatureServe, 2015).

Taxonomy

Lessingia germanorum is the type species for its genus (the first plant selected by taxonomists to represent the group; the exemplar for all related species). San Francisco lessingia is currently considered a distinct species, it was formerly thought to be most closely related to Lessingia glandulifera A. Gray var. pectinata Jeps. (Howell 1929, S. Markos, pers. comm. 1998) (USFWS, 2003). It is a member of the aster family (Asteraceae) (USFWS, 2012).

Historical Range

Historically, L. germanorum occurred within central dune scrub habitats throughout the San Francisco peninsula. At the time of listing in 1997, Lessingia germanorum was restricted to the Presidio area of the San Francisco peninsula (five occurrences), and the Hillside Park occurrence in Daly City near the base of San Bruno Mountain (one occurrence) (USFWS, 2012).

Current Range

Currently the species is known to occur at seven locations in the Presidio (M. Chassé, National Park Service, in litt., October 26, 2011, p. 1;M. Chassé in litt., September 29, 2011) and at one occurrence near Hillside Park in Daly City (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2012)

Lifespan

Adult: 1 year (USFWS, 2012)

Breeding Season

Adult: August - November (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Insect pollinators (USFWS, 2012); wind (USFWS, 2003)

Reproduction Narrative

Adult: L. germanorum is an annual plant typically flowers between August and November. Spence (1964) determined that Lessingia species are generally self-incompatible (infertile when restricted to self-fertilization) making the presence of appropriate pollinators necessary for seed production. Information on California pollinators which was published in 1979 (Krombein et al. 1979), lists five species of native bees that visit the Lessingia germanorum. They include Andrena baeriae, Hoplitis productus gracilis, Anthophora urbana urbana, Exomalopsis nitens, and Ashmeadiella californica californica (Krombein et al. 1979, pp. 1799, 2018, 2026, 2118, and 2164) (USFWS, 2012). Reproductive output of individual plants is highly variable. Pogge (1998) found a range from 1 to over 1,400 flowerheads per plant, depending on plant size. Large plants in sparsely vegetated areas may produce many hundreds of flowerheads, each bearing up to 40 florets (potential seeds; Lane 1993), but actual average number of seeds per flowerhead is about 26 (Pogge 1998), implying that the largest individuals may produce up to 36,400 seeds. Pollination is possibly achieved by wind as well (Spence 1964) (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dune scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 80 - 300 ft. elevation (USFWS, 2012); dense vegeation (USFWS, 2003)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2003)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2003)

Habitat Narrative

Adult: Inhabits dune scrub habitats; now restricted to remnant sand dunes and terraces (NatureServe, 2015). It grows in open areas with blowing sand at an elevation range between 24 to 91 m (80 to 300 ft). Most populations are found in vegetation gaps in stabilized old sand dunes or sandy soils derived from ancient sandy coastal deposits (USFWS, 2012). Spence (1964) observed that annual Lessingia species were typical of dry, open, and somewhat disturbed habitats, occurring in small, dense, disjunct populations. Nearly all historic collections of San Francisco lessingia with specific locality and habitat information have been made in areas with disturbed dune deposits. Undisturbed areas of dune scrub or nonnative grassland with high density and cover of vegetation show little tendency to become invaded by San Francisco lessingia, even when they are adjacent to source populations of this species (P. Baye, pers.

observ. 1997 to 1998). In contrast, San Francisco lessingia can spread vigorously under favorable climate conditions when extensive substrate disturbance occurs (USFWS, 2003).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2003)

Dispersal/Migration Narrative

Adult: The seeds, which are attached to a crown of hairlike bristles, are light and easily carried by the wind (USFWS, 2012). Seed dispersal distance has not been studied, but seedling distribution tends to be contagious around parent plants. Landscape barriers to dispersal, such as tree plantations, may be more significant barriers to dispersal than inherent dispersal ability of achenes. Seeds may also possibly be passively dispersed by humans, by adherence of seed to footwear or clothing (J. Cannon, pers. comm. 1997) (USFWS, 2003).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

8 (USFWS, 2012)

Population Size:

Variable depending on year; 500,000 - 2,000,000 overall range (USFWS, 2003)

Population Narrative:

Currently, there are seven known occurrences at the Presidio and one population near Hillside Park. The occurrences on the Presidio occupy 2.4 ha (6 ac) and consist of an estimated mean of 129,133 plants (M. Chassé, in. litt., October 18, 2011, p. 2). In any given year, however, the area occupied and the numbers of plants will vary due to factors such as vegetation changes and levels of stewardship (M. Chassé, in. litt., October 18, 2011, p. 2). Approximately 300 plants were found in a portion of the Hillside Park occurrence in 2011 (T. Corelli, in litt., September 14, 2011). Research by Markos and Baldwin (2002) indicates that there is distinct genetic variation between the Presidio populations and the Hillside Park population (USFWS, 2012). The overall rangewide number of San Francisco lessingia plants, though highly fluctuating and quantified with variable accuracy and precision, ranges over a magnitude around 500,000 to 2,000,000 plants (USFWS, 2003).

Threats and Stressors

Stressor: Nonntaive plants and succession (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Currently, nonnative annual grasses and forbs are still a threat to Lessingia germanorum on the Presidio; the most dominant nonnative grass within L. germanorum habitat

is Bromus diandrus (M. Chassé, in. litt., October 18, 2011, p. 2). In the absence of disturbance, back dunes on the Presidio that are capable of supporting Lessingia germanorum go through a succession to stable dune scrub which does not support the species. Large scale projects that result in the removal of dune scrub will need to be considered to maintain the L. germanorum over time (M. Chassé, in. litt., October 18, 2011, p 3) (USFWS, 2012).

Stressor: Urbanization (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The threats to L. germanorum from pedestrians, and hikers are considered to be low; digging dogs are a moderate threat. Since the time of listing, 0.3 acre of Lessingia germanorum habitat on the Presidio in the Lobos Dunes occurrence was adversely affected at the base of Landfill 10. Landfill 10 was in the process of remediation by the Presidio Trust when heavy rain storms in late 2009 and early 2010, eroded loose soil from the landfill, burying L. germanorum plants and habitat downslope. The owner of two parcels that support part of the Hillside Park occurrence recently submitted plans to the City of Daly City for development of a nine-lot subdivision, known as the Hillside Park Court Subdivision, on these parcels (J. Naughton, City of Daly City Planning and Zoning Department, pers. comm., December 6, 2011; K. McIntire, San Bruno Mountain Watch, in litt., November 29, 2011). In addition, a road to access the development is proposed to be constructed through a third parcel that is part of Hillside Park and is also occupied by L. germanorum (K. McIntire, in litt., November 29, 2011) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. Although there is uncertainty on the effects of climate change on this species, the vulnerability of the species to significant shifts in climate is increased by the natural and artificial barriers to dispersal (M. Chassé, in. litt., October 18, 2011, p 3) (USFWS, 2012).

Stressor: Loss of pollinators (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Habitat fragmentation increases the risk at all occurrences to reduced seedset from loss of pollinators. Two recent studies of bee diversity have been conducted at several sites in the Presidio (Wood et al. 2005, Van Den Berg et al. 2010). The study conducted in 2004 (Wood et al, 2005) established a baseline of species and numbers of bees found at nine sites on the Presidio. The study conducted in 2008 (Van Den Berg et al. 2010) resampled three of these sites and added a new previously unsampled site. A comparison of the results of the two studies at the three sites in common, Thompson Reach, Lobos Dunes (the site of a L. germanorum occurrence), and the World War II Memorial, revealed a number of differences between the studies. Overall, the average bee species richness and abundance at the three previously samples sites were greater in 2004 with 47 species and 1,283 individuals compared to 36 species and 878 individuals in 2008 (Van Den Berg et al. 2010, p. 4). At the World War II Memorial site; however, a different

trend was observed in 2008. Bee diversity increased from 15 species in 2004 to 26 species in 2008 although five species including the common bumblebee, Bombus vosnesenskii, had declined dramatically. Abundance of bees at this site more than doubled from 192 individuals in 2004 to 391 in 2008 (Van Den Berg et al. 2010, p. 5). The identity of the plants being visited by the pollinators monitored in these studies was not recorded (USFWS, 2012).

Recovery

Reclassification Criteria:

1. Long-term expansion of existing populations and reduction of nonnative vegetation occurs in dune reserves in the Presidio Recovery Unit (Lobos Creek, Battery Caulfield, Wherry, Rob Hill, and Public Health Services Hospital sites). The populations in these reserves are expected to fluctuate but should not decline below 50,000, 1,000, 5,000, 5,000, and 5,000, respectively. Cover of nonnative vegetation in these reserves should be less than 5 percent, 20 percent, 5 percent, 20 percent, and 20 percent, respectively. Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

2. The population of the Daly City reserve shows no net long-term decrease. Populations are expected to fluctuate but should not decline below 50,000 plants. Cover of nonnative vegetation should show no progressive increase over more than 2 years (USFWS, 2012).

3. Recreation management needs for maintenance of a dune scrub community in the Fort Funston Reserve are established through sitespecific studies, and a reintroduced population has persisted over a full precipitation cycle. The population is expected to fluctuate but should achieve a minimum self-sustaining population size of approximately 500,000 plants within the first ten years after founders are transplanted (USFWS, 2012).

4. At least 1,000 seeds representing both the existing Presidio and Daly City populations are stored and maintained in qualified botanical gardens as insurance against extinction in the wild (USFWS, 2012).

5. The Lobos Dunes unit has expanded to Battery Caulfield Road and upper Baker Beach (USFWS, 2012).

Delisting Criteria:

1. Expanded, restored reserves with natural vegetation and dune dynamics are established in the Presidio Recovery Unit. The area including Baker Beach dunes, Lobos Dunes and nearby conifer groves, Wherry Dunes and Housing sites, and the Battery Caulfield Road site must be restored to a contiguous dune field (approximately 44 hectares [110 acres]) with unobstructed wind fetch to the Golden Gate, locally steep dune slopes, and a natural successional mosaic of active and stabilizing dune blowouts (population at least 500,000 plants; nonnative vegetative cover must not exceed 5 percent during the first 10 years of restoration and must decline over the first 15 years). Dune habitat at the Rob Hill reserve area must increase to 2 hectares (5 acres) and the southwest slope of Rob Hill must be restored to dune scrub (population at least 100,000 plants; nonnative vegetative cover must not exceed 5 percent). At least 3 hectares (7 acres) of the Public Health Services Hospital dune area above the slope must be restored to native dune vegetation (population at least 50,000 plants; nonnative vegetative cover must not

exceed 5 percent). Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

2. At least 1.2 hectares (3 acres) of Daly City Reserve in the Southern Recovery Unit are cleared of nonnative vegetation and intensively managed (population at least 50,000 plants; no increases in nonnative vegetation (USFWS, 2003).

3. Dune restoration and vegetation management should be done on 30 hectares (75 acres) at Fort Funston Reserve in the Southern Recovery Unit sufficient to establish ecosystem function and support a self-sustaining population of San Francisco lessingia. Site-specific studies of recreational use management compatible with maintenance of a dune scrub community must be completed to further define the restoration and management strategies. Buffers of landscape vegetation around all historic structures and buffer management needs will also need to be identified. A population should be reintroduced from the Daly City seed source (population at least 10,000 plants after 5 years; must reach 500,000 plants after 10 years; new colonies must spontaneously establish within 10 years). Nonnative woody vegetative cover must be below 1 percent; iceplant and European beachgrass cover must decline and be below 10 percent after 10 years. Research and monitoring are expected to determine the most efficient methods for control of nonnative vegetation and may result in modification of these recovery criteria (USFWS, 2003).

4. Populations must be introduced in the Satellite Recovery Unit (should reach 100,000 plants within 10 years, with minimum size of 5,000 plants). This criterion is preliminary subject to additional information. The locations of dune areas suitable for management within this Recovery Unit are scattered around the western half of San Francisco County. The specific size, number, and configuration of reserves needs to be determined on the basis of more detailed site-specific information (USFWS, 2003).

Recovery Actions:

- Protect and restore a series of ecological urban wildland reserves (USFWS, 2003).
- Promote population increases of target species within urban wildland reserves and reintroduce target species to restored habitat (USFWS, 2003).
- Long-term removal (local eradication) or suppression of invasive, nonnative vegetation within and around all reserves and subsequent reestablishment of native communities compatible with endangered species within the ecological reserves (USFWS, 2003).
- Identify a lead organization to monitor and manage the Hillside Park occurrence in Daly City. Encourage a volunteer weeding program at this site with coordination and assistance from City of Daly City, San Bruno Mountain Watch, California Native Plant Society, other environmental groups, landowners, and school groups (USFWS, 2012).
- Continue control of invasive plants, particularly annual grasses and forbs, through ongoing stewardship on the Presidio (USFWS, 2012).
- Expand Lessingia germanorum habitat in the Presidio through implementation of the Presidio Vegetation Management Plan objectives, particularly in the Wherry Reserve area (USFWS, 2012).
- Collect seed from all populations for accession at approved seed banking facilities and for outplanting within the Presidio and at other suitable habitat within the historic range of the

species (USFWS, 2012).

- Formulate adaptive management strategies for native dune scrub succession that would mimic natural disturbance where such natural processes have been reduced or eliminated entirely (USFWS, 2012).

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SPECIES ACCOUNT: *Liatris helleri* (Heller's blazingstar)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/19/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial herb that grows from a cormlike rootstock (underground stem) 2.0 to 5.0 centimeters (cm) (0.8 to 2.0 inches (in)) broad. One or more erect or arching stems arise from a tuft of narrow pale green basal (growing from the base of a stem) leaves. The stems reach up to 15.7 in in height and are topped by a showy spike of lavender flowers 7.0 to 20.0 cm (2.8 to 7.9 in) long. (USFWS, 2013).

Taxonomy

Nesom (2005) has questioned whether Liatris helleri T.C. Porter (1891) and L. turgida Gaiser (1946) are valid and distinct species, proposing that these should be treated as a single taxon (L. helleri, because this name has nomenclatural seniority). This issue has not been resolved; the Service expects to reach resolution on this issue in the next five year review for this species (USFWS, 2013).

Historical Range

Endemic to summits in the northern Blue Ridge Mountains in the North Carolina counties of Ashe, Avery, Burke, Caldwell, Mitchell, and Watauga counties (USFWS, 2013).

Current Range

Extant populations occur in the following North Carolina counties: Ashe, Avery, Burke, Caldwell, and Watauga (USFWS, 2013).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (USFWS, 1999)

Lifespan

Adult: 15 - 34 years (USFWS, 1999)

Dependency on Other Individuals or Species

Adult: Possibly insect-pollinated (USFWS, 1999)

Breeding Season

Adult: July to September (flowering); late September to mid-October (fruiting) (USFWS, 1999)

Reproduction Narrative

Adult: Reproduction is thought to be abiotic or by insect. Life span is 15 to 34 years, with first reproduction around 9 years. Flowering is from July to September, with fruiting from late September to mid-October (USFWS, 1999).

Habitat Vegetation or Surface Water Classification

Adult: Rock outcrops, ledges, cliffs, and balds (USFWS, 1999)

Geographic or Habitat Restraints or Barriers

Adult: High elevations (3,500 to 5,999 feet) (USFWS, 1999)

Spatial Arrangements of the Population

Adult: Clumps (USFWS, 2013)

Environmental Specificity

Adult: Very Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Habitat is rock outcrops, ledges, cliffs, and balds at high elevations (3,500 to 5,999 feet) (USFWS, 1999); species grows in clumps (USFWS, 2013), in shallow, acidic soils that form on and around exposed granite ledges, outcrops, and balds at high elevations. In full sun with grasses, sedges, and other composites (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2013)

Dispersal/Migration Narrative

Adult: The seeds are transported primarily by the wind, germinating (sprouting) and growing only when they land in locations with suitable habitat (USFWS, 1999). This is a narrow-ranging endemic with limited dispersal capabilities (USFWS, 2013).

Population Information and Trends

Population Trends:

Decline of 10-50% (NatureServe, 2015)

Species Trends:

Declining (USFWS 2013)

Population Growth Rate:

Unknown (USFWS 2013)

Number of Populations:

11 extant populations (USFWS, 2013)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

Population decline of 10-50%; In 1996 about 3,000 clumps or rosettes were known, not counting populations augmented by greenhouse grown plants. Approximately 11 extant populations remain (USFWS, 2013) representing 1000 - 2500 individuals (NatureServe, 2015). Species status is declining; remaining extant populations continue to be threatened by recreational use or poaching (USFWS, 2013).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Recreating public and the construction of facilities for the public are principal sources of habitat destruction affecting L. helleri. Trampling compacts the plant's rhizome and can shear plants from the rocks in which they are anchored. Soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites (by this or other species) exceedingly difficult. Numerous populations of the species exist in extremely close proximity to boardwalks or roped trails; maintenance of facilities must be conducted in a manner that does not damage the plants found immediately adjacent to the boardwalk or trail. Landowners should discourage the construction of trails directing visitors to the populations. (USFWS, 2013)

Stressor: Inadequacy of existing regulatory mechanism (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: State laws protecting rare plant species have limited authority, and North Carolina rare plant statutes do not protect the species from habitat destruction from recreational use on federal lands (where many populations occur and remain vulnerable to this threat). (USFWS, 2013)

Stressor: Accelerated global climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Accelerated global climate change is likely to disrupt patterns of climate variability to which Liatris helleri has become adapted, and as such is likely to exacerbate threats already mentioned. In 2010, NPS (Blue Ridge Parkway) personnel reported significant mortality of adult plants, seemingly as a result to prolonged and extreme drought. The higher temperatures expected under most global climate change models would appear likely to exacerbate this threat. However, the current scale of most global models of climate change offers little insight into the changes that will likely occur on southern Appalachian high peaks. (USFWS, 2013)

Stressor: Invasive Species (USFWS, 2020)
Exposure:
Response:
Consequence:

Narrative: The listing rule and 2013 5-year review do not identify exotic, invasive species as a threat to Heller's blazing star (Service 1987, Service 2013); however, more than ten different species have been documented throughout the LGW (Wild South 2012). The three species that pose the most serious threat are: princess tree (Paulownia tomentosa), Chinese silver grass (Miscanthus sinensis), and mullein (Verbascum thapsus). These species are prolific colonizers of disturbed land, and the area's high propensity for wildfire has made it especially susceptible to invasion. If left unchecked, these species can crowd and reduce sunlight to Heller's blazing star. Kuppinger et al. (2010) studied the invasion of princess tree, a disturbance-dependent invasive plant, across three burns in the southern Appalachian Mountains, including a burn at the LGW. Following initial widespread establishment after fire, princess tree only persisted on more exposed and xeric sites (Kuppinger et al. 2010). The lack of competition within this habitat suggests that princess tree may be able to further reproduce and increase in dominance. Although fire is beneficial to Heller's blazing star and habitat conditions, additional burning could also increase the abundance and extent of princess tree (Kuppinger et al. 2010). The control of princess tree in rare species habitat may require special attention from land managers. (USFWS, 2020)

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
1. The eight extant populations are protected (USFWS, 1999).

2. Any necessary management actions have been undertaken for these populations by the landowners or cooperating agencies and it has been documented that this management is successfully ensuring the continued survival of these populations (USFWS, 1999).

3. Through introduction and/or discovery of new populations, at least one additional self-sustaining population exists within the species' historical range (it is believed that at least nine populations are required to ensure that the species will not become endangered in the foreseeable future) (USFWS, 1999).

4. All nine populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with their survival (USFWS, 1999).

Recovery Actions:
- Survey suitable habitat for additional populations (USFWS, 1999).
- Monitor and protect existing populations (USFWS, 1999).
- Conduct research on the biology of and threats to the species (USFWS, 1999).
- Establish new populations or rehabilitate marginal populations to the point where they are self-sustaining (USFWS, 1999).
- Investigate and conduct necessary management activities at all key sites (USFWS, 1999).
- Obtain public and landowner support through educational outreach (USFWS, 1999).
- Numerous populations of the species exist in extremely close proximity to boardwalks or roped trails; maintenance of these facilities must be conducted in a manner that does not

damage the plants found immediately adjacent to the boardwalk or trail. Landowners should discourage the construction of trails directing visitors to the populations.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTION The 2013 5-year review included a list of recommendations to improve recovery of the species. These actions, listed below, remain applicable to species recovery. x Continue support for the ongoing genetic analysis being conducted by Appalachian State University (ASU), assisting with identification of sample sites and refinement of questions to be addressed. Ensure that relevant field observations made during the collection of genetic samples are reported to the NCNHP for incorporation into site records. x Assist landowners or other knowledgeable sources in reporting existing backlogs of relevant observation data to the NCNHP, so that this repository of data contains the most accurate, complete and current information. x Specifically work with GMSF and Atlanta Botanical Garden to determine the number of Heller's blazing star plants placed at Hang Glide Cliff subpopulation, and evaluate the success of previous augmentation trials conducted there. x Ensure that monitoring data is sufficient to assist in evaluating the relative stability of populations and the effectiveness of implemented management actions. x Work with USFS and BLRI to explore options for augmenting the subpopulations poached in 2009, to minimize the potential for population bottlenecks and long-term genetic implications. The following future actions are recommended to improve recovery of the species. x Continue support for the most recent genetic analysis conducted by ASU. Work with ASU and species experts to determine implications of the study on recovery. x Work with and support partners to quantify visitor use and identify visitor use patterns to prioritize management that would minimize recreational impacts to the species. x Work with and support partners to monitor or census populations every five years using a standardized protocol, prioritizing sites that have not been monitored or censused in at least five years. Explore a partnership with the recreational climbing community to inventory sites with difficult access. x Coordinate with partners and an appropriate botanical garden to collect and bank seeds. Highest priority sites should be those with purest genetics and no prior seed collection. x Work with the USFS and support efforts to complete an EA for prescribed burning in fire-adapted habitats across all Wilderness areas, including the LGW. x Work with the USFS and support efforts to complete an EA for control of exotic, invasive species across all Wilderness areas, including the LGW. x Work with and support the USFS, Wild South, and other CFLRP partners, to continue exotic, invasive species inventory and management projects at the LGW. x As staff time and office resources allow, consider the need to reevaluate the recovery criteria and amend the recovery plan. If deemed necessary, work with the Regional Office to include recovery plan updates and/or amendments into the regional workplan. x Heller's blazing star co-occurs with other federally listed species. Impacts from monitoring could inadvertently occur if field staff conducting monitoring are unaware of other species present or how to identify them. Pre-monitoring, tailgate meetings should occur prior to each monitoring event when species co-occur. Field staff should be briefed on species present, how to identify them, and strategies for avoidance. (USFWS, 2020)

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SPECIES ACCOUNT: *Liatris ohlingerae* (Scrub blazingstar)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4)

Physical Description

The scrub blazing star (Liatris ohlingerae), a member of the aster family, is a long-lived perennial herb having a thickened, cylindric root. Its stems are erect, usually unbranched, and it can grow up to 1 m tall. Its leaves are fleshy and narrow (1 to 2.5 mm), and generally 3 to 8 cm long (Wunderlin et al. 1980). Flower heads are well separated on the stem with individual disc flowers up to 1 cm broad; the inflorescences are up to 3 cm across. The corollas are bright purplish-pink in color. The broad flower heads and narrow leaves distinguish L. ohlingerae from the eight other Liatris species in central Florida. (USFWS, 1999)

Taxonomy

Blake (1923) placed L. ohlingerae in the blazing star genus, naming it Lacinaria ohlingerae. Small (1924) created a new genus for this plant, which became Ammopursus ohlingeri. Robinson (1934) reinstated the scrub blazing star in the large genus of the blazing stars as Liatris ohlingerae. Gaiser's (1946) treatment of Liatris, and Cronquist's (1980) floristic treatment of the aster family in the Southeast retains this plant in the genus Liatris, although Lakela (1964) argued in favor of reinstating Ammopursus as a genus containing only one species. (USFWS, 1999)

Historical Range

Highlands and Polk Counties, Florida (USFWS, 1999)

Current Range

Southern Lake Wales Ridge of southern Polk and Highlands Counties, Florida (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: pollinators

Breeding Season

Adult: Peak flowering of scrub blazing star is from June through August.

Other Reproductive Information

Adult: The growth of new basal leaves begins in March and the elongation of stems begins in April. Flowering and fruiting occurs from summer through fall. Flowering begins in May and June, but the peak occurs in August with a rapid decline toward the middle of September. The seeds start to disperse in August and peak in October. Each plant produces approximately eight

filled (presumably viable) seeds a year. The plant's above ground parts die back in October to November or by the first freeze. Liatis ohlingerae can remain in a dormant state through at least one growing season. The seedling growth rate for L. ohlingerae is slow compared to most other scrub endemics. Many others grow to reproductive maturity in only one season, while the juvenile stage for L. ohlingerae was found to be at least 2 years. Interestingly, cultivated L. ohlingerae mature to flowering in 8 months. Limited water and nutrients are believed to be responsible for the difference between wild populations and cultivated plants. (USFWS, 1999)

Reproduction Narrative

Adult: Liatris ohlingerae requires cross-pollination to reproduce. Butterflies, especially skippers (Hesperiidae), are thought to be the primary pollinators, although other insects may also contribute to pollination (FWS 1996). Flowering and fruiting in this species all more abundant in shaded microhabitats. Individuals in open and edge habitats only produce one-quarter as many mature flower heads (Herndon 1996). The seeds of this species are short-distance wind dispersers, with bristles and hairs that assist in "planting" the seeds correctly. Low germination on leaf litter-covered soil suggests that many seeds in shade (the favored microhabitat) may get trapped in the leaf litter and fail to sprout or die shortly after sprouting (Herndon 1996). (USFWS, 1999)

Habitat Type

Adult: Rosemary bald habitats and adjoining scrubby flatwoods

Environmental Specificity

Adult: Narrow (USFWS, 2019)

Habitat Narrative

Adult: The species is found in rosemary scrub and also along the ecotone between rosemary scrub and scrubby flatwoods. It can also be found scattered in surrounding scrub. Scrub blazing star has important microhabitat requirements, particularly its preference for shade. Unlike most other scrub endemics, scrub blazing star appears to thrive in lightly shaded areas and does not specialize in open microsites (Herndon 1999, Weekley et al. 2008b). Both rosemary scrub and scrubby flatwoods are pyrogenic (fire-maintained) communities. Historical FRIs in rosemary scrub ranged from 20 to 100 years, while scrubby flatwoods have a 5 to 20 year average FRI. (USFWS, 2019)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends

Population Trends:

Only 6 populations are considered stable, 7 are estimated to be declining, and 32 have an unknown status mostly due to lack of recent surveys (USFWS, 2021)

Number of Populations:

~45 extant (USFWS, 2021)

Population Narrative:

Scrub blazing star is extant on the Lake Wales Ridge (roughly 90 to 100 occurrences) and Winter Haven Ridge (one occurrence) in Highlands and Polk Counties. Its range extends from Lake Blue in Polk County south along the Lake Wales Ridge to ABS at the south end of the Ridge in Highlands County (FNAI 2009a). The last FNAI Element Tracking Summary (FNAI 2015) reported 70 extant occurrences, 45 of which were on managed areas. This was a significant decrease (approximately 23 percent) from the last 5-year status review (Service 2010a), which reported 91 extant occurrences. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of L. ohlingerae, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the rosemary bald of the xeric oak scrub community to support L. ohlingerae (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species (USFWS, 1999)

Delisting Criteria:
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of L. ohlingerae. This species is difficult to survey. It is easily overlooked when not in bloom and does not grow in the typical open gaps of scrub. A thorough survey is needed to determine the distribution for this species. Survey efforts should be focused from August through October. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Conduct research on life history characteristics. Though recent work has greatly increased the base of knowledge for this species, more work on its basic biology and ecology is necessary for effective recovery. (USFWS, 1999)
- Monitor existing populations of L. ohlingerae. (USFWS, 1999)
- Provide public information about L. ohlingerae. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific location information. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of L. ohlingerae and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Develop delisting criteria. Once reclassification is achieved, research and monitoring results may provide data necessary to develop delisting criteria. (USFWS, 1999)
- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review, new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support scrub blazing star. • Work with private landowners to acquire or conserve extant populations and restore scrub habitat on these sites. • Ensure representation of scrub blazing star at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. Monitoring/Research Activities • Determine the condition of populations on private land whose status is currently unknown. • Continue demographic monitoring at ABS and LWRSF and expand to additional populations throughout the range to evaluate population trends. • Conduct monitoring to document presence on protected lands at least every five years (Menges et al. 2019). • Conduct presence/absence surveys in areas of suitable habitat within and north of the current range to discover new populations, expand extent of known populations, or to verify the species is not likely present. • Determine the factors responsible for low seedling recruitment. Specifically, examine potential impacts from changes in the timing and amount of precipitation expected with climate change. • Evaluate the overall threat posed by herbivory across the range and at various life stages. (USFWS, 2021)

References

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USFWS. 2021. Scrub blazing star (Liatris ohlingerae) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service South Atlantic-Gulf Region Florida Ecological Services Field Office Vero Beach, Florida. 25 pp.

SPECIES ACCOUNT: *Lilaeopsis schaffneriana var. recurva* (Huachuca water-umbel)

Species Taxonomic and Listing Information

Listing Status: Endangered; 1997, Southwest Region (R2)

Physical Description

Lilaeopsis schaffneriana ssp. recurva is a semi-aquatic to fully aquatic herbaceous perennial in the carrot family (Apiaceae). The root system is comprised of both long horizontal rhizomes and connected shorter vertical rhizomes. Hollow linear leaves that taper to a point are produced singly or in clusters at the top of short rhizomes. The leaves vary greatly in length from 2.5 to 33 centimeters (cm) (0.98 to 12.99 inches (in)) depending on their habitat, with shorter leaves typically found in dryer environments and longer when submerged in water. Umbels (umbrella-like flower structures) are born on stalks shorter than the leaves and contain three to ten 1.0 to 2.0 mm (0.04 to 0.08 in) wide perfect flowers with five white to slightly maroon tinted petals and maroon anthers. Fruits are spherical and dry, 1.6 to 2.3 mm (0.6 to 0.09 in) long by 1.2 to 2.0 mm (0.04 to 0.08 in) broad, with five distinct spongy ribs that make the seed buoyant and easily dispersed by water.

Taxonomy

Lilaeopsis schaffneriana ssp. recurva is a member of the carrot family (Apiaceae). Within the Apiaceae, Lilaeopsis is in tribe Oenantheae and subfamily Apioideae. In general, researchers consider plants west of the Continental Divide in Sonora to be ssp. recurva and those to the east, ssp. schaffneriana (64 FR 37441, p. 37442). Genetic analysis is warranted to better understand the relationship of occurrences within and between localities in southeastern Arizona, northern Sonora, and northwestern Chihuahua, Mexico (USFWS, 2017).

Historical Range

The type specimen of L. schaffneriana ssp. recurva was collected in the Santa Cruz Valley of southern Arizona near Tucson on May 19, 1881, in an area that is now encompassed by the City of Tucson and no longer provides suitable habitat for the species.

Current Range

Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, we are aware of 17 locations supporting extant occurrences of L. schaffneriana ssp. recurva, 8 locations where all L. schaffneriana ssp. recurva occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years. Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting L. schaffneriana ssp. recurva occurrences, though most of these locations have not been revisited in recent years (USFWS, 2017).

Critical Habitat Designated

Yes; 7/12/1999.

Legal Description

On July 12, 1999, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lilaeopsis schaffneriana var. recurva (Huachuca water-umbel) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Arizona(64 FR 37441-37453).

Critical Habitat Designation

The critical habitat designation for Lilaeopsis schaffneriana var. recurva includes seven CHUs in Cochise and Santa Cruz counties, Arizona. Designated habitat includes a total of 83.2 kilometers (km) (51.7 miles (mi)) of streams or rivers (64 FR 37441-37453).

Unit 1. Santa Cruz County, Arizona. From USGS 7.5' quadrangle map Sonoita, Arizona. Gila and Salt Principal Meridian, Arizona: T. 20 S., R. 16 E., beginning at a point on Sonoita Creek in sec. 34 at approx. 31°39'19'' N latitude and 110°41'52'' W longitude proceeding downstream (westerly) to a point in sec. 33 at approx. 31°39'07'' N latitude and 110°42'46'' W longitude covering approx. 2 km (1.25 mi.).

Unit 2. Santa Cruz County, Arizona. From USGS 7.5' quadrangle map Lochiel, Arizona. That portion of the Santa Cruz River beginning in the San Rafael De La Zanja Grant approx. at 31°22'30'' N latitude and 110°35'45'' W longitude downstream (southerly) to Gila and Salt Principal Meridian, Arizona, T. 24 S., R. 17 E., through secs. 11 and 14, to the south boundary of sec. 14 covering approx. 4.4 km (2.7 mi.). Also, a tributary that begins in T. 24 S., R. 17 E., sec. 13 at approx. 31°21'10'' N latitude and 110°34'16'' W longitude downstream (southwesterly) to its confluence with the Santa Cruz River covering approx. 3 km (1.9 mi.).

Unit 3. Cochise County, Arizona. From USGS 7.5' quadrangle map Huachuca Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Scotia Canyon beginning in T. 23 S., R. 19 E., sec. 3 at approx. 31°27'19'' N latitude and 110°23'44'' W longitude downstream (southwesterly) through secs. 10, 9, 16 and to approx. 31°25'22'' N latitude and 110°25'22'' W longitude in sec. 21 covering approx. 5.4 km (3.4 mi.).

Unit 4. Cochise County, Arizona. From USGS 7.5' quadrangle map Huachuca Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Sunnyside Canyon beginning in T. 23 S., R. 19 E., on the east boundary of sec. 10 downstream (southwesterly) to the south boundary of sec. 10 covering approx. 1.1 km (0.7 mi.).

Unit 5. Cochise County, Arizona. From USGS 7.5' quadrangle map Miller Peak, Arizona. That portion of Garden Canyon in the Fort Huachuca Military Reservation beginning at approx. 31°27'13'' N latitude and 110°22'33'' W longitude downstream (northwesterly) to approx. 31°28'45'' N latitude and 110°20'11'' W longitude covering approx. 6.1 km (3.8 mi.).

Unit 6. Cochise County, Arizona. From USGS 7.5' quadrangle map Miller Peak, Arizona. Gila and Salt Principal Meridian, Arizona: That portion of Bear Canyon beginning at a point in T. 24 S., R. 19 E., sec. 1 at approx. 31°22'30'' N latitude and 110°21'47'' W longitude upstream through T. 23 S., R. 19 E., sec. 36 to a point in sec. 31 at approx. 31°23'18'' N latitude and 110°21'22'' W longitude covering approx. 1.7 km (1.0 mi.). Also, continuing up an unnamed tributary beginning at a point in T. 23 S., R. 19 E., sec. 31 at approx. 31°23'18'' N latitude and 110°21'22'' W longitude upstream (northerly) to a point in T. 23 S., R. 19 E., sec. 30 at approx. 31°23'44'' N latitude and 110°21'14'' W longitude covering approx. 0.9 km (0.5 mi.). Also, that portion of Lone Mountain

Canyon beginning at its confluence with Bear Creek at a point in T. 23 S., R. 19 E., sec. 36 at approx. 31°22'54'' N latitude and 110°21'43'' W longitude to a point in sec. 36 at approx. 31°23'26'' N latitude and 110°21'58'' W longitude, thence up an unnamed tributary northwesterly into sec. 25 thence northerly to a point at approx. 31°24'13'' N latitude and 110°21'54'' W longitude covering approx. 2.7 km (1.7 mi.). Also that portion of Rattlesnake Canyon beginning at its confluence with Lone Mountain Canyon in T. 23 S., R. 19 E., sec. 36 upstream northeasterly into sec. 25 to a point at approx. 31°22'08'' N latitude and 110°21'31'' W longitude covering approx. 1.5 km (1.0 mi.).

Unit 7. Cochise County, Arizona. From USGS 7.5' quadrangle maps: Hereford, Ariz.; Tombstone SE, Ariz.; Nicksville, Ariz.; Lewis Springs, Ariz.; Fairbank, Ariz.; Land, Ariz. Gila and Salt Principal Meridian, Arizona: That portion of the San Pedro River beginning in the San Rafael Del Valle Grant at a point approx. 200 meters upstream (south) of the Hereford Road bridge at approx. 31°26'16'' N latitude and 110°06'24'' W longitude continuing downstream (northerly) through the San Rafael Del Valle Grant; T. 21 S., R. 22 E.; T. 21 S., R 21 S.; through the San Juan De Las Boquilla y Nogales Grant to a point at approx. 31°48'28'' N latitude and 110°12'32'' W longitude covering approx. 54.2 km (33.7 mi.).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lilaeopsis schaffneriana var. recurva critical habitat consists of four components (64 FR 37441-37453):

(1) Sufficient perennial base flows to provide a permanently or nearly permanently wetted substrate for growth and reproduction of Lilaeopsis;

(2) A stream channel that is relatively stable, but subject to periodic flooding that provides for rejuvenation of the riparian plant community and produces open microsites for Lilaeopsis expansion;

(3) A riparian plant community that is relatively stable over time and in which nonnative species do not exist or are at a density that has little or no adverse effect on resources available for Lilaeopsis growth and reproduction; and

(4) In streams and rivers, refugial sites in each watershed and in each reach, including but not limited to springs or backwaters of mainstem rivers, that allow each population to survive catastrophic floods and recolonize larger areas.

Life History

Food/Nutrient Resources

Food Source

Adult: Substrate nutrients

Food/Nutrient Narrative

Adult: Organic, perenially wet (or nearly so) soils comprised of silt or clay (Titus and Titus 2008) provide the nutrients needed for growth.

Reproductive Strategy

Adult: Vegetative (clonal), experiments suggest that most if not all Lilaeopsis spp. are self-compatible.

Dependency on Other Individuals or Species

Adult: Although the pollinator(s) of this taxon is unknown, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of Lilaeopsis schaffneriana ssp. recurva flowers along the San Pedro River in both 2012 and 2013; he believes this may be an important pollinator for the taxon.

Breeding Season

Adult: Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren et al. 1991, p. 15). Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3) and flowering can begin within three months of germination.

Key Resources Needed for Breeding

Adult: Hydrologic regime; intermediate level of flooding (not scouring)

Reproduction Narrative

Adult: Although Lilaeopsis schaffneriana ssp. recurva is capable of reproducing both sexually, through seed, and asexually, through rhizomes, vegetative reproduction is likely the primary form of reproduction. Never-the-less, natural seed banks are important for the persistence of rare species and observations in the field suggest L. schaffneriana ssp. recurva seed may remain viable for 5 to 10 years, an important survival strategy during times of drought. Another important survival strategy of L. schaffneriana ssp. recurva are its rhizomes, which enable occurrences to rapidly expand or contract in size between years, seasons, or both, in response to local environmental conditions including temperature and water availability. The taxon can re-root if clumps of rhizomes are dispersed via floods to new habitats. Periodic low to moderate flooding provides disturbed open space for re-colonization, reduces competition (FWS 1999), and acts as a dispersal mechanism for seeds and dislodged clumps (Titus and Titus 2008, FWS 1997). Dislodged clumps only survive if they are deposited in sites that provide the necessary habitat (see sheltering) (Titus and Titus 2008). Flowering has been observed episodically between March and October, peaking in July and occurring with abundance irregularly (Warren et al. 1991, p. 15). Germination occurs one to two weeks after seeds disperse (Gori 1995, p. 3). Although the pollinator(s) of this taxon is unknown, Radke (pers. comm. April 22, 2014) documented a formica ant species feeding on the nectar of Lilaeopsis schaffneriana ssp. recurva flowers along the San Pedro River in both 2012 and 2013; it is believed this may be an important pollinator for the taxon (USFWS, 2017).

Habitat Type

Adult: Cienegas (marshes), rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content; generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods. The taxon occurs in both full sun and understory shade of Fremont cottonwood-Goodding willow forests. Found between 610 to 2,170 m (2,001-7,060 ft) elevation in the US, the range of the taxon crosses the Sierra Madrean Region of

southeastern Arizona and adjacent portions of Sonora, Mexico (USFWS, 2017).

Habitat Vegetation or Surface Water Classification

Adult: (1) Forest & Woodland, (2) Shrubland & Grassland, (3) Semi-desert, (5) Aquatic Vegetation

Dependencies on Specific Environmental Elements

Adult: Yes; see key resources needed

Environmental Specificity

Adult: High

Tolerance Ranges/Thresholds

Adult: Low

Site Fidelity

Adult: None

Habitat Narrative

Adult: Lilaeopsis schaffneriana ssp. recurva is restricted to cienegas, rivers, streams, and springs in permanently wet (or nearly so) muddy or silty substrates with some organic content (64FR 37441, pp. 37441-37442). The taxon is generally found in shallow and slow-flowing waters that are relatively stable, or in active stream channels containing refugial sites where the plants can escape the effect of scouring floods (62FR 665 p. 667; 64FR 37441, p. 37442). Through both rhizomes and seeds, the taxon can survive short periods without water, though is generally considered a taxon of perennial water environments. Found between 855 and 2,170 meters (m) (2,805 and 7,120 feet [ft]) in elevation, the range of the taxon crosses the Sierra Madrean Region of southeastern Arizona and adjacent portions of Sonora, Mexico (Titus and Titus 2008c, p. 459; Vernadero Group and the Desert Botanical Garden 2012, p. 1).

Dispersal/Migration

Motility/Mobility

Adult: Low

Dispersal

Adult: Usually through flood waters, but long-distance despersal of seeds or rhizonmes by birds or other vectors might be responsible for geographically distant occurrences.

Dispersal/Migration Narrative

Adult: Surface and groundwater development has disrupted aquatic habitat connectivity that once provided opportunities for expansion of the population into new, downstream habitats after flood events. After a flood, Lilaeopsis can rapidly expand its population and occupy disturbed habitat until interspecific competition exceeds its tolerance. In rivers and streams, the expansion and contraction of Lilaeopsis populations appears to depend on the presence of ‘‘refugia’’ where the species can escape the effects of scouring floods, a watershed that has an unaltered flow regime, and a healthy riparian community that stabilizes the channel. (USFWS 1999). At present, the known populations are largely isolated from other waterways. Long-

distance despersal of seeds or rhizonmes by birds or other vectors might be responsible for geographically distant occurrences.

Population Information and Trends

Population Trends:
Declining

Species Trends:
Stable or declining across range

Number of Populations:
30 naturally-occurring locations in the U.S. and 21 in Sonora, Mexico.

Population Size:
Individual L. schaffneriana ssp. recurva plants are difficult to identify due to their clonal reproduction and clustered growth habit. In addition, the taxon is difficult to detect due to its diminutive size.

Additional Population-level Information:
The clonal nature of the taxon may also reduce genetic diversity, increasing vulnerability to extinction. Occurrences are in many cases isolated which makes the chance of natural recolonization after extirpation less likely (USFWS, 2017).

Population Narrative:
Within the Santa Cruz, San Pedro, and Rio Yaqui watersheds in southern Arizona, we are aware of 17 locations supporting extant occurrences of L. schaffneriana ssp. recurva, 8 locations where all L. schaffneriana ssp. recurva occurrences are considered extirpated, and 6 locations where historical occurrences have not been seen in recent years. Within the Santa Cruz, San Pedro, Rio Yaqui, Rio Sonora, and Rio Concepcion watersheds in Sonora, Mexico, we are aware of 21 locations supporting L. schaffneriana ssp. recurva occurrences, though most of these locations have not been revisited in recent years. The greatest quantities of L. schaffneriana ssp. recurva are found within the San Pedro River, the western Huachuca Mountains and Cienega Creek (USFWS, 2017).

Threats and Stressors

Stressor: Aquatic habitat degradation
Exposure: Not assessed; see narrative
Response: Not assessed; see narrative
Consequence: Not assessed; see narrative
Narrative: Human activities that contribute to aquatic habitat loss and degradation within the historical range of L. schaffneriana ssp. recurva include: groundwater overdrafts, surface water diversions, impoundments, channelization, improper livestock grazing, agriculture, mining, sand and gravel operations, road building, non-native species introductions, urbanization, wood cutting, wildfires, and recreation (Hendrickson and Minckley 1984, p. 161; Bahre 1991, pp. 177-178; Hereford 1993, p. 2). Flood control projects that permanently alter stream flow characteristics may reduce or eliminate stream sinuosity and associated pool and backwater

habitats that are critical to L. schaffneriana ssp. recurva. Ground water pumping may lead to perennial reaches becoming intermittent or ephemeral and to springs drying out, resulting in the loss of L. schaffneriana ssp. recurva occurrences (Warren et al. 1991, p. 7; 60FR 16836, p. 16838; Service 2014b, pp. 148-149). Such activities are widespread in Arizona.

Stressor: Wildfire and associated sedimentation and scouring
Exposure:
Response:
Consequence:
Narrative: Fire would generally not burn the wetland habitat of L. schaffneriana ssp. recurva due to high humidity; however it has the potential to burn adjacent upland habitats causing indirect effects on L. schaffneriana ssp. recurva and its habitat throughout the range of the taxon (Service 2009a, p. 21). Effects include increased runoff of floodwaters, deposition of debris and sediment originating in the burned area, and potential for scouring of L. schaffneriana ssp. recurva individuals and habitat (Service 2014b, p. 145). Since the mid-1980s, wildfire frequency in western forests has nearly quadrupled compared to the average of the period 1970 to 1986 (Westerling et al. 2006, p. 941). The timing, frequency, extent, and destructiveness of wildfires are likely to increase (Westerling et al. 2006, p. 943) and with them changes in vegetation community composition and structure, increased presence of invasive exotic plants, and alterations in the hydrologic and nutrient cycles (Griffis et al. 2000, p. 243; Crawford et al. 2001, p. 265; Hart et al. 2005, p. 167; Smithwick et al. 2005, p. 165; Stephens et al. 2014, p. 42). Post-fire flooding and associated sedimentation can strip out, bury, or stunt growth of L. schaffneriana ssp. recurva patches, or transform habitat from wet or marshy to dry, sandy, or gravelly (Service 2009a, p. 24; Service 2013a, p. 4). At lower elevations, the spread of non-native invasive grasses has been increasing in recent decades and these non-native grasses not only out-compete native grassland species, but they have a completely different fire regime than the native grasses, tending to form dense stands that promote higher intensity fires more frequently (USFWS, 2017).

Stressor: invasive, non-native plant competition
Exposure:
Response:
Consequence:
Narrative: Lilaeopsis schaffneriana ssp. recurva are most abundant in areas with ample sunlight and low competition with other native and non-native species (Titus and Titus 2008c, p. 459). The best available scientific and commercial information indicates that invasive exotic plants have increased their presence within aquatic habitat of southeastern Arizona, and this invasion and expansion of infestations are expected to continue. Because L. schaffneriana ssp. recurva is sensitive to competition from both native and non-native herbaceous plants, the continued increase in such species as S. halepense, C. dactylon, N. officinale, and R. discolor can only lead to a decrease in the presence of L. schaffneriana ssp. recurva throughout the range of the taxon (USFWS, 2017).

Stressor: Livestock grazing
Exposure:
Response:
Consequence:
Narrative: Lilaeopsis schaffneriana ssp. recurva are affected by livestock grazing in the following ways: 1) trampling, 2) direct impacts from construction of range improvement projects, 3)

changes in stream geomorphology that lead to erosion, sedimentation, and downcutting, 4) watershed degradation and resulting adverse effects to stream hydrology, and 5) consumption (Service 1999, p. 237; Anderson 2006, p. 28). Observations of L. schaffneriana ssp. recurva response to grazing indicate the taxon is capable of experiencing light to moderate grazing with negligible impact (Simms pers. comm. October 26, 2011; Anderson 2006, pp. 22, 31; Edwards pers. comm. February 21, 2001; Rorabaugh 2013, entire). However, grazing during dry periods when cattle spend a disproportionate amount of their time, if not controlled, in riparian areas, may result in harmful effects to L. schaffneriana ssp. recurva and other riparian obligates (Edwards pers. comm. February 21, 2001; Service 2002a, pp. 76-77; Krueper 1996, p. 287; Malcom and Radke 2008, p. 81; Service 2014a, pp. 3, 6-7). In such instances, severe and widespread trampling may occur; roots and soil structure can be damaged; vegetation species composition and structure can shift; soil can become compacted; stream banks can be degraded; runoff and soil erosion from storm events may increase with higher peak flows; and stream entrenchment may occur; all of which would have harmful effects on L. schaffneriana ssp. recurva habitat and existing occurrences (Service 2002a, p. 138; Krueper 1996, pp. 287-288; Simms pers. comm. October 26, 2011). In instances where natural disturbance is low or infrequent, occasional trampling and grazing by domestic livestock could improve habitat for L. schaffneriana ssp. recurva; poorly managed livestock use, however, can be detrimental to the taxon and its habitat (USFWS, 2017).

Stressor: Dought and climate change
Exposure:
Response:
Consequence:
Narrative: Lilaeopsis schaffneriana ssp. recurva evolved in the Southwest and has persisted in many locations throughout its range through historical droughts such as those of the 1950s. However, given the severity and persistence of the present multi-year drought, it is unknown how long L. schaffneriana ssp. recurva will maintain viability in de-watered habitat. It has been suggested that seed from this taxon may persist for 5 to 10 years in such situations (Titus and Titus 2008a, p. 319; Titus and Titus 2008b, p. 398; Titus and Titus 2008c, p. 463). There is a reasonable likelihood that the current drought and rise in temperatures will continue for many more years throughout the range of L. schaffneriana ssp. recurva. It is unknown how long L. schaffneriana ssp. recurva can remain dormant during an extended drought. The projected drought will likely contain periods of high year-to-year precipitation variability characteristic of Southwest climate. Rise in temperature is also likely to continue for many more years. Whether this variability will be enough to preserve occurrences L. schaffneriana ssp. recurva remains unknown.

Stressor: Recreation
Exposure:
Response:
Consequence:
Narrative: Recreational activities, such as hiking and camping, if poorly managed, can result in soil compaction, streambank destabilization, erosion and sedimentation, increases in the presence of invasive non-native plant species, and trampling of L. schaffneriana ssp. recurva and other riparian plant species, thus reducing habitat quality (USFWS 2017).

Recovery

Reclassification Criteria:
A minimum cumulative extent of 2,000 square meters (0.2 ha / 0.5 ac) of naturally occupied habitat exists in the San Pedro Watershed, 20 percent of which occurs in tributary streams, springs, or cienegas; and a minimum of 2,000 square meters (0.2 ha /0.5 ac) in the Santa Cruz Watershed, 90 percent of which occurs in tributary streams, springs, or cienegas, distributed among the areas of Cienega Creek (35 percent), Sonoita Creek (10 percent), the San Rafael Valley uplands and mainstem (10 percent), and the western Huachuca Mountains (35 percent); and a minimum of 125 square meters (0.01 ha / 0.03 ac) exists in the Rio Yaqui Watershed; this level of occupancy is sustained or improved for a minimum of 10 years over a 15 year period. (USFWS, 2017)

At least 3 separate introduced occurrences with a minimum cumulative extent of 150 square meters (0.015 ha / 0.037 ac) of occupied habitat are placed in each of the three United States watersheds and are stable or increasing over a 10 year period (USFWS, 2017).

Threats to the taxon and its habitat have been managed and reduced, and management is in place for a minimum of 20 years to ensure the persistence of occurrences with minimum cumulative extent (as reflected by the achievement and maintenance of downlisting criteria 1 and 2) in each of the three United States watersheds (USFWS, 2017).

A living collection of as many plugs as resources allows, collected from genetically distinct regions (e.g. Fort Huachuca / SPRNCA north; San Rafael / Las Cienegas / Sonoita; SPRNCA south / San Bernardino), from both the San Pedro and the Santa Cruz watersheds is maintained in at least one botanical garden in southern Arizona for recovery and educational purposes (USFWS, 2017).

Seeds of L. schaffneriana ssp. recurva are collected following Center For Plant Conservation guidelines, which include collecting from no more than 10 percent of the standing seed crop from 50 individual seed bearing plants per population (if the population size permits), and collecting from a variety of microsites and physical characteristics within the stand of plants. These seeds are stored at both the Agricultural Research Service National Center for Genetic Resources Preservation in Fort Collins, Colorado and stored according to protocols at a local facility such as the Desert Botanical Gardens in Phoenix, Arizona, for long-term conservation and recovery purposes (USFWS, 2017).

Delisting Criteria:
To delist L. schaffneriana ssp. recurva, the criteria for down-listing must be met and the level of occupancy in the downlisting criteria is sustained or increasing for a minimum of 20 years over a 30 year period (USFWS, 2017).

Recovery Actions:
- Maintain or enhance groundwater hydrography, as measured by both well observations and stream gages, by reducing water withdrawal and increasing water conservation and recharge (USFWS, 2017).
- Conserve historical, existing, newly discovered, and newly established L. schaffneriana ssp. recurva occurrences and their seedbanks through the protection of occupied habitat, unoccupied corridors, and habitat quality; augment existing and establish new L.

schaffneriana ssp. recurva occurrences in appropriate habitat using appropriate genetic stock to increase the redundancy (number of occurrences) and resiliency (size of occurrences) of the taxon to help ensure the long-term survival of the taxon in southern Arizona; establish plants at botanical gardens and other Service approved facilities for research, recovery, and educational purposes; and maintain seeds for conservation and recovery at seed storage facilities (USFWS, 2017).

- Remove stressors related to invasive plants and poorly managed livestock grazing to historical, existing, newly discovered, and newly established L. schaffneriana ssp. recurva occurrences and their habitats (USFWS, 2017).
- Work toward a standardized monitoring technique and continue monitoring occurrences (USFWS, 2017).
- Conduct research and monitoring that will facilitate better understanding of: a) the distribution and genetics of the taxon in both the United States and Mexico, b) population and metapopulation dynamics and trends, c) life history, d) response to threats, and e) other relationships key to recovery of the species (USFWS, 2017).
- Develop collaborative partnerships with Federal and State land managers, private landowners, museums and botanical gardens, seed storage facilities, and others; provide outreach to the public as needed to accomplish recovery; promote the achievement of conservation and recovery in Mexico, resulting in long-term protection of L. schaffneriana ssp. recurva and its habitat; in coordination with stakeholders, revise this plan as needed as new information comes to light so that the recovery strategy and actions implement recovery in as efficient a manner as possible (USFWS, 2017).
- The principal recovery strategy is to conserve the habitat of L. schaffneriana ssp. recurva by decreasing groundwater pumping, increasing water conservation and recharge, and protecting L. schaffneriana ssp. recurva occurrences and their seed banks (USFWS, 2018).
- Monitoring, surveying, scientific study, outreach and partnership development, augmentation and introduction, and reduction or removal of stressors (USFWS, 2018).
- Introduction and Augmentation of occurrences: There has been success in establishing L. schaffneriana ssp. recurva into locations with suitable habitat within the historical range of the taxon (e.g. Audubon Research Ranch, Las Cienegas National Conservation Area, Fort Huachuca, and on the San Pedro Riparian National Conservation Area). Other attempts to establish this taxon have ultimately failed (e.g. Leslie Canyon National Wildlife Refuge and Sonoita Creek). Still other attempts have had mixed results (e.g. San Bernardino National Wildlife Refuge).
- Easements: Since 1990, the Nature Conservancy has held a conservation easement on one private property on Sonoita Creek which supports L. schaffneriana ssp. recurva (Killeen pers. comm. April 29, 2014). Although the easement was created for a purpose other than the protection of L. schaffneriana ssp. recurva, the taxon benefits from this land protection. Several additional conservation easements on the Babacomari River are held by The Nature Conservancy, Fort Huachuca, and the Bureau of Land Management; collectively these easements protect several miles of perennial water in the Babocomari River (Duncan pers. comm. April 29, 2014).
- In 1999, Arizona State Parks purchased 1,440 ha (3,557 ac) of land in the San Rafael Valley including the Santa Cruz River which supports small occurrences of L. schaffneriana ssp. recurva. The land is rested from livestock grazing, protected from development through an easement, and is managed to minimize the impacts of non-native species. In 2013, the Arizona Land Trust protected 3.2 km (2 mi) of Sonoita Creek on the Circle Z Ranch, including

perennial stretches.

- In Sonora, Mexico, Rancho El Aribabi is a federally designated private reserve, which recognizes ecological values and also precludes mineral entry. The Ranch, which contains L. schaffneriana ssp. recurva, is managed for its ecological values and ecotourism. Similarly, Rancho los Fresnos, which also supports an occurrence of L. schaffneriana ssp. recurva, is owned and managed for its ecological values by the conservation organization Naturalia. Livestock have been removed from the property and management includes the use of prescribed burning. At Rancho San Bernardino, in Sonora, the Cuenca los Ojos Foundation actively manages lands known to have historically supported and may currently support L. schaffneriana ssp. recurva. Management includes extensive restoration of grasslands and waterways, resulting in the many-fold increase in extent of perennial water in Rio San Bernardino creating habitat for the taxon.
- Conservation and Management Plans: There are three conservation plans currently in place that provide some benefit to L. schaffneriana ssp. recurva. First, the 2008 Malpai Borderlands Habitat Conservation Plan ensures that no cattle grazing occurs within San Bernardino National Wildlife Refuge, thereby protecting L. schaffneriana ssp. recurva from trampling and overgrazing impacts (MBHCPTWG and Lehman 2008, p. 105). Second, the 2009 Leslie Canyon Watershed Safe Harbor Agreement incorporates management actions related to the recovery of the taxon, including its propagation and establishment in existing aquatic habitats, the maintenance of wetland levels, and the exclusion of humans and livestock that may excessively trample the taxon (Service 2009b, p. 7). Lastly, although most L. schaffneriana ssp. recurva occur outside of Pima County, the Draft Pima County Multi-Species Conservation Plan includes monitoring of a) L. schaffneriana ssp. recurva every 2 to 3 years, b) habitat conditions at Bingham Cienega, and c) post restoration efforts (Pima County 2012, pp. 70, 81).
- Fort Huachuca participates in water conservation efforts, effluent reuse or recharge, the purchase of conservation easements, and storm water recharge; all which benefit L. schaffneriana ssp. recurva and its habitat (Service 2014b, p. 21). In addition, Fort Huachuca personnel monitor L. schaffneriana ssp. recurva both on the Fort and on the San Pedro National Conservation Area regularly (Service 2014b, p. 20). There is no livestock grazing allowed on Fort Huachuca, eliminating the threat L. schaffneriana ssp. recurva of overgrazing and measures are taken to ensure recreational trampling does not occur (Service 2014b, p. 21). In addition, transplanting of plugs has occurred in the past and may continue in the future (Service 2014b, p. 21).
- Conservation Areas: The Bureau of Land Management manages the Las Cienegas National Conservation Area which encompasses much of the upper Cienega Creek watershed, an area supporting multiple patches of L. schaffneriana ssp. recurva. The area was set aside to conserve, protect, and enhance this resource and is managed under a comprehensive management plan which includes assurance that riparian and wetland sites are properly functioning (Bureau of Land Management 2003, pp. 7-9). The Bureau of Land Management also conducts periodic monitoring of L. schaffneriana ssp. recurva along upper Cienega Creek and has plans for introducing plugs at up to 11 locations over a 10 year period (Service 2008, p. 3). In addition, to protect these sensitive riparian and wetland habitats, the Bureau of Land Management designated this area as the Empire-Cienega Area of Critical Environmental Concern. The goal of the designation is to protect and enhance watershed, grassland, and threatened/endangered wildlife resources, emphasizing total ecosystem management (Bureau of Land Management 2003, p. A6-1).

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SPECIES ACCOUNT: *Limnanthes floccosa ssp. californica* (Butte County meadowfoam)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/08/1992; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A densely pubescent, winter annual herb. Stems from 3-25 cm in length, generally prostrate with tips curved upward. Flowers are white with dark yellow veins at the base of each of 5 petals (Fish and Wildlife Service 1992) (NatureServe, 2015).

Taxonomy

Before 1973, Butte County meadowfoam was not differentiated from the more widespread woolly meadowfoam (Limnanthes floccosa ssp. floccosa). An alternative common name, Shippee meadowfoam, is derived from the type locality (California Department of Fish and Game 1987a, Ornduff 1993c). Limnanthes floccosa ssp. californica is a member of the meadowfoam or false mermaid family (Limnanthaceae), which is a small family comprising only 2 genera and 10 species (Ornduff 1993c) (USFWS, 2005).

Historical Range

Endemic to California, only known from Butte County (Skinner 1997) (NatureServe, 2015). Known historically and currently to occur only in Butte County within the Northeast Sacramento Valley Vernal Pool Region (USFWS, 2008).

Current Range

At least eight new occurrences of Limnanthes floccosa ssp. californica have been discovered since 1988 (USFWS, 2005). The range of Butte County meadowfoam lies entirely within Butte County, California. Butte County meadowfoam is found primarily on the margins of vernal swales and to a lesser extent on the margins of vernal pools located on alluvial terraces in annual grasslands and mima mound topography. Mima mounds are soil mounds of unknown origin that are a few feet in height. The species is restricted to a narrow 28-mile strip along the eastern flank of the Sacramento Valley from northwestern to central Butte County and occurrences are found at 120 to 1,200 feet in elevation (USFWS, 2023).

Critical Habitat Designated

Yes; 2/10/2006.

Legal Description

On August 11, 2005, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Limnanthes floccosa ssp. californica (Butte County meadowfoam) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in California (70 FR 46924-46999).

Critical Habitat Designation

The critical habitat designation for Limnanthes floccosa ssp. californica includes four CHUs in Tehama and Butte Counties, California. This species critical habitat encompasses approximately

16,363 acres (71 FR 7118-7316).

Unit 1: Tehama and Butte Counties. (i) Unit 1A: Tehama and Butte Counties, California. From USGS 1:24,000 scale quadrangles Richardson Springs NW, Campbell Mound, Richardson Springs. (ii) Unit 1B: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs.

Unit 2: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs.

Unit 3: Butte County, California. From USGS 1:24,000 scale quadrangle Richardson Springs, Paradise West, Chico.

Unit 4: Butte County, California. From USGS 1:24,000 scale quadrangles Oroville, Shippee.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Limnanthes floccosa ssp. californica critical habitat consists of two components (70 FR 46924-46999):

(i) Topographic features characterized by isolated mound and intermound complex within a matrix of surrounding uplands that result in continuously, or intermittently, flowing surface water in the depressional features including swales connecting the pools described in PCE (ii), providing for dispersal and promoting hydroperiods of adequate length in the pools.

(ii) Depressional features including isolated vernal pools with underlying restrictive soil layers that become inundated during winter rains and that continuously hold water or whose soils are saturated for a period long enough to promote germination, flowering, and seed production of predominantly annual native wetland species and typically exclude both native and nonnative upland plant species in all but the driest years. As these features are inundated on a seasonal basis, they do not promote the development of obligate wetland vegetation habitats typical of permanently flooded emergent wetlands.

Special Management Considerations or Protections

Existing manmade features and structures, such as buildings, roads, railroads, airports, runways, other paved areas, lawns, and other urban landscaped areas do not contain one or more of the primary constituent elements. Federal actions limited to those areas, therefore, would not trigger a consultation under section 7 of the Act unless they may affect the species and/ or primary constituent elements in adjacent critical habitat.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (USFWS, 2008)

Lifespan

Adult: One year (USFWS, 2008)

Breeding Season

Adult: February - April (USFWS, 2008)

Key Resources Needed for Breeding

Adult: Insect pollinators, based on closely related species (USFWS, 2008)

Reproduction Narrative

Adult: This is an annual plant. Limnanthes floccosa ssp. californica typically begins flowering in February, reaches peak flowering in March, and may continue into April if conditions are suitable. Nutlets are produced in March and April, and the plants die back by early May (Jokerst 1989, Dole and Sun 1992). Limnanthes floccosa ssp. californica has floral adaptations that allow for cross-pollination by insects, but self-pollination mechanisms take over to ensure seed set if insect pollination is unsuccessful. The particular pollinators of L. floccosa ssp. californica have not been identified; however, other meadowfoam species are pollinated by the native burrowing bees Andrena limnanthis and Panurginus occidentalis (Thorp and Leong 1998) and by honeybees (Kesseli and Jain 1984), beetles, flies, true bugs (order Hemiptera), butterflies, and moths (Mason 1952, Thorp and Leong 1998) (USFWS, 2008).

Habitat Type

Adult: Wetland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Valley and foothill grasslands, ephemeral drainages, vernal pool depressions (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Mima mound topography (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: 165 - 1,167 ft. elevation (USFWS, 2008)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from USFWS, 2008)

Habitat Narrative

Adult: Inhabits valley and foothill grasslands (mesic soils) (Skinner 1997). Associates are Limnanthes alba ssp. alba, L. douglasii var. rosea, and L. floccosa ssp. floccosa. Grows in three types of seasonal wetlands: ephemeral drainages, vernal pool depressions in ephemeral drainages, and occasionally around the edges of isolated vernal pools (Fish and Wildlife Service 1992) (NatureServe, 2015). This species occurs on alluvial terraces in annual grasslands with mima mound topography. The occurrences are found at 165 to 1,167 feet in elevation (McNeill and Brown 1979, CNDDB 2007). Limnanthes floccosa ssp. californica occurs in different soils on Tuscan-Igo-Anita Complex Fan terraces of 0-3 percent slope, 0-50 percent rock cobble with an underlying clay durapan. According to the 2006 Butte Area Soil Survey, L. floccosa ssp. californica is found on 32 different "Musym" classes of soil, but always with an underlying

durapan, rock cobble and common hydrological factors (J. Marr, CDFG, in litt. January 2007, Natural Resource Conservation Service 2006). Limnanthes floccosa ssp. californica has also been found occasionally in disturbed areas, such as drainage ditches, firebreaks, and graded sites (McNeill and Brown 1979, Jokerst 1989, Kelley and Associates Environmental Sciences 1992b, BioSystems Analysis, Inc. 1993, Kelley and Associates Environmental Sciences 1993a) (USFWS, 2008).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Nutlets of L. floccosa ssp. californica are apparently dispersed by water and can remain afloat for up to 3 days (Hauptli et al. 1978). Most meadowfoam nutlets are dispersed only short distances. Birds and livestock are potential sources of long distance seed dispersal, but specific instances of such dispersal have not been documented (Jain 1978) (USFWS, 2008).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2008)

Number of Populations:

20 (USFWS, 2023)

Population Narrative:

In 1989, less than 200,000 plants likely existed in the censused populations (Fish and Wildlife Service 1992) (NatureServe, 2015). There are 20 total extant natural occurrences. Quantitative information on the numbers of plants and area occupied by Limnanthes floccosa ssp. californica has not been collected in a consistent and systematic manner at all occurrences since the time of listing; therefore, definitive range-wide abundance and population trend information is not yet available (USFWS, 2008). At the time of listing in 1992, the species was known from 18 extant populations and 3 extirpated populations within a narrow 25-mile strip along the eastern flank of the Sacramento Valley from central Butte County to the northern portion of the city of Chico (Service 1992, p. 24193). The 2005 Recovery Plan and the 2008 status review reported 21 natural occurrences (20 extant and 1 extirpated prior to listing) and 1 introduced occurrence (Service 2005, p. II-34; Service 2008, p. 2). Sixteen of these occurrences were reported in the Diversity Database in 2007 when the occurrence records were reviewed for the 2008 status review (Service 2008, p. 1). Seven of the natural occurrences were discovered after the 1992 listing (North Table Mountain, Upper Rock Creek, and the five localities on Dove Ridge Conservation Bank that were recorded as one occurrence in the Diversity Database) (Service 2008, p. 2–7), but the range of the species remained largely unchanged. The 2005 Recovery Plan also reported that many of the occurrences revisited since listing had been reduced in extent while the boundaries of other occurrences had expanded due to identification of additional occupied habitat (Service 2005, p. II-34). The introduced experimental population on the Tuscan Preserve in northwestern Butte County was established just outside of the historical range of the taxon using seed from the Doe Mill occurrence (occurrence number 20) and thus marginally

increased the range of the species (Service 2005, p. II-36). The Shippee (occurrence number 6) and the North of Skyway/Bruce Road (occurrence number 20) occurrences, which were presumed extirpated at listing (Service 1997, p. 24193), were considered extant at the time of the 2008 status review as the species had been rediscovered at both locations following listing (Service 2008, pp. 6, 8). The current distribution of Butte County meadowfoam is similar to that described in the 2005 Recovery Plan (Service 2005, pp. II-34–36) and 2008 status review (Service 2008, pp. 5–7). The Diversity Database currently reports a total of 20 occurrences including 19 natural occurrences and the introduced occurrence at the Tuscan Preserve (Table 1; Diversity Database 2023, entire). All occurrences of the species are currently presumed extant. The Diesel occurrence (occurrence 39), which was thought to be extirpated prior to listing, is now presumed extant as 16 individuals were observed at the site in 2010 (Diversity Database 2023, entire). Seven occurrences (occurrence numbers 44, 45, 46, 47, 48, 50, and 51) have been added to the Diversity Database since the 2008 status review. Two of these occurrences (occurrence numbers 50 and 51) were discovered after 2008, while the other five occurrences were known prior to 2008 but were not added to the Diversity Database until recently (Diversity Database 2023). Occurrence number 50 is located in proximity to the North Table Mountain Ecological Reserve and occurrence number 42, and the occurrence expands the eastern extent of the species' range by 0.3 miles (Diversity Database 2023). Occurrence number 51 is located within the previously known range of the species in proximity to occurrence number 20. Additionally, three occurrence records (occurrence numbers 34, 41, and 43) have been combined in the Diversity Database with other previously known occurrences. Furthermore, an additional occurrence south of Chico Regional Airport was identified by Sloop et al. (2011), but this occurrence has not yet been added to the Diversity Database (Sloop et al. 2011, p. 315; Diversity Database 2023, entire). Overall, the distribution of Butte County Meadowfoam remains largely unchanged since the 2005 Recovery Plan and the 2008 status review (USFWS, 2023).

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: 11 occurrences are located on privately owned land and are unprotected. Habitat loss or degradation from urbanization continues to be the greatest threat to all occurrences of the subspecies, even to those that are protected from development. Habitat degradation results from changes in the amount of surface and subsurface water hydrology, introduction of invasive plants, and in areas adjacent to agricultural or residential uses, introduction of pesticides and herbicides. In addition to the threats from development projects that have already been proposed, rapid population growth is predicted for all of Butte County and its urban areas. The City of Chico predicts the construction of approximately 20,000 new housing units and a 61 percent increase in population by 2030 (Butte County Association of Governments 2006). The population of Butte County is expected to increase by 48 percent by 2030 (Butte County Association of Governments 2006). The need for additional housing and associated development will likely threaten the remaining unprotected occurrences of Limnanthes floccosa ssp. californica which are mostly located in or near existing urban areas or roads (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)
Exposure:

Response:
Consequence:
Narrative: he Draft Land Management Plan for the Doe Mill Preserve (Center for Natural Lands Management 1996) noted that the occurrence of Limnanthes floccosa ssp. californica was "healthy" in 1991 but was reduced in numbers in 1996 and stressed from competition with the nonnative grass, Taeniatherum caput-medusae (medusa-head). Glyceria declinata (waxy manna grass) is a nonnative, perennial grass which may become a threat to Limnanthes floccosa ssp. californica. Glyceria declinata forms dense stands and is able to invade vernal pool habitat and displace native plants (The Nature Conservancy 2006) (USFWS, 2008).

Stressor: Drought and climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Maintenance of the natural hydrology of these wetlands is necessary for the survival and recovery of this subspecies. Drought or flood conditions will place additional strains on the vernal pool ecosystems supporting L. floccosa ssp. californica occurrences. Climate is predicted to change in California during the 21st century (Lenihan et al. 2006, Cayan et al. 2005, Field et al. 1999). Even modest changes in warming could result in a reduction of the spring snowpack, earlier snowmelt, and more runoff in winter with less runoff in spring and summer, more winter flooding, and drier summer soils (Cayan et al. 2005, Field et al. 1999). Although the specific effects of climate change on L. floccosa ssp. californica are not yet known, the predicted shift in precipitation of increased winter runoff and reduced spring and summer rainfall have the potential to adversely affect this subspecies (USFWS, 2008).

Stressor: Off-road vehicles (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Impacts from off-road vehicles continue to threaten to the subspecies. In 2006, a vehicle driving off-road in Bidwell Ranch became stuck in the mud near an area supporting L. floccosa ssp. californica (B. Vlamis, pers. comm., 2007). Vehicles can crush the plants and seeds, and compact the soil, thus making germination more difficult, and alter the hydrology of the habitat. Portions of many L. floccosa ssp. californica occurrences are located adjacent to roads and are unfenced thereby exposing them to potential damage from off-road driving (USFWS, 2008).

Recovery

Reclassification Criteria:
See delisting criteria.

Recovery Priority Number: 3C

Delisting Criteria:
1. Suitable vernal pool habitat within each prioritized core area for the species is protected (USFWS, 2008).

2. Species occurrences distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there (USFWS, 2008).

3. Reintroductions must be carried out and meet success criteria established in the recovery plan (USFWS, 2008).

4. Additional occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. Any newly found occurrences may count towards recovery goals if the occurrences are permanently protected as described in the recovery plan (USFWS, 2008).

5. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

6. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected (USFWS, 2008).

7. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of criterion 1 - 5 (USFWS, 2008).

8. Monitoring indicates that ecosystem function has been maintained in the areas protected under criterion 1 - 4 for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

9. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2008).

10. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2008).

11. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated (USFWS, 2008).

12. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both

specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions (USFWS, 2008).

13. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document, described previously in criterion 1 - 5 (USFWS, 2008).

14. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2008).

15. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts (USFWS, 2008).

16. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts (USFWS, 2008).

17. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria (USFWS, 2008).

Recovery Actions:

- Establish a range-wide recovery implementation team (USFWS, 2005).
- Establish working groups and develop participation plans for each vernal pool region (USFWS, 2005).
- Develop and implement adaptive management plans based on monitoring data and best available science (USFWS, 2005).
- Assist local governments in developing habitat conservation plans and developing land use protection measures (USFWS, 2005).
- Assist private landowners in developing landowner agreements (USFWS, 2005).
- Acquire habitat, where necessary (USFWS, 2005).
- Track losses and protection of suitable habitat and occurrences within core areas (USFWS, 2005).
- Ensure mechanisms are in place to provide for the perpetual management and monitoring of core areas, vernal pool regions, or for each management unit within a vernal pool region, as appropriate (USFWS, 2005).
- Permanently protect remaining occurrences through conservation easements, fee title, or other protective methods. Implement existing approved management plans for Limnanthes floccosa ssp. californica. Develop and implement management plans for all occurrences for which management plans have not yet been developed (USFWS, 2008).
- Conduct a status survey of all recorded locations of Limnanthes floccosa ssp. californica to verify the identity of the plants and determine the status, area occupied, micro-site and hydrology analysis, pollinators, and threats of plants present. Many of the occurrences in CNDDB have not been thoroughly surveyed for over 15 years. The one presumed extirpated

site should also be revisited and surveyed (USFWS, 2008).

- Conduct surveys on potential Limnanthes floccosa ssp. californica habitat in Butte County for additional occurrences, including the area northeast of Highway 99 between the City of Chico and the intersection of Highways 70 and 149 (USFWS, 2008).
- Conduct studies to determine the effects of grazing and burning on Limnanthes floccosa ssp. californica and appropriate management at each L. floccosa ssp. californica occurrence based on individual conditions of each location such as soil type and grass species present (USFWS, 2008).
- Conduct a study to determine the effects of nonnative, invasive plants on Limnanthes floccosa ssp. californica and appropriate management at L. floccosa ssp. californica occurrences (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of Butte County meadowfoam. These recommendations have been previously discussed in the 2008 status review (Service 2008, p. 21) and remain valid. 1. Permanently protect remaining occurrences through conservation easements, fee title, or other protective methods. Implement existing approved management plans for Butte County meadowfoam. Develop and implement management plans for all occurrences for which management plans have not yet developed. 2. Conduct a status survey of all recorded locations of Butte County meadowfoam to verify the identity of the plants and determine the status, area occupied, micro-site and hydrology analysis, pollinators, and threats of plants present. Many of the occurrences in the Diversity Database have not been thoroughly surveyed in recent years. 3. Conduct surveys on potential Butte County meadowfoam habitat in Butte County for additional occurrences, including the area northeast of Highway 99 between the City of Chico and the intersection of Highways 70 and 149. 4. Conduct studies to determine the effects of grazing and burning on Butte County meadowfoam and appropriate management at each Butte County meadowfoam occurrence based on individual conditions of each location such as soil type and grass species present. 5. Conduct studies to determine the effectiveness and survival rates of transplanted Butte County meadowfoam. 6. Conduct studies to learn more about seed bank dynamics and length of time that seeds can survive in the soil before germination for Butte County meadowfoam. 7. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the Butte County meadowfoam and develop stepdown success parameters, if appropriate, that reflect the species' life history and narrow range (USFWS, 2023).

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SPECIES ACCOUNT: *Limnanthes floccosa ssp. grandiflora* (Large-flowered woolly Meadowfoam)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/9/2002; Pacific Region (R1)

Physical Description

an upright annual herb with simple stems that occasionally branch near the base. The plants reach 5 to 10 centimeters (2 to 4 inches) high, are mostly glabrous throughout, and have pinnate leaves which are divided into five to nine divisions. The plant's petals are 7.5 to 8 millimeters (0.30 to 0.31 inches) long and equal the sepal length (Figure II-10). The petals are glabrous with the exception of two rows of inside hairs. Each flower produces three to five nutlets. The flowers are white in color with an occasional slight yellow tinge at the base of the petals. (USFWS, 2010)

Taxonomy

Limnanthes pumila ssp. pumila, a member of the false mermaid family (Limnanthaceae), was first collected from the top of Table Rock, Jackson County, Oregon, and then described by Howell in 1897 as Limnanthes pumila. M.E. Peck revised the name to Limnanthes bellingeriana in 1937 (Abrams 1951), but C. T. Mason reassigned the name to Limnanthes pumila (Mason 1952). Arroyo (1973) treated the taxon as a subspecies within Limnanthes floccosa, but it is currently assigned to Limnanthes pumila ssp. pumila based on hybridization trials and molecular data (Chambers and Meyers 2011) (USFWS, 2010). In recognition of recent taxonomic changes, on June 23, 2015, we published a technical correction in the Federal Register officially changing the name of the species from Limnanthesfioccosa ssp. grandiflora to Limnanthes pumila ssp. grandijiora (80 FR 35860, p. 35863) (USFWS, 2019).

Historical Range

Endemic to the Middle Rogue River of Jackson County, Oregon. (USFWS, 2010)

Current Range

Endemic to the Middle Rogue River of Jackson County, Oregon. (USFWS, 2019)

Critical Habitat Designated

Yes; 8/20/2010.

Legal Description

On July 21, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective August 20, 2010) for Limnanthes floccosa ssp. grandiflora (Large-flowered woolly Meadowfoam) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight critical habitat units (CHUs), in Oregon (75 FR 42490-42570).

Critical Habitat Designation

The critical habitat designation for Limnanthes floccosa ssp. grandiflora includes eight CHUs in Jackson County, Oregon. This species critical habitat encompasses approximately 5,840 acres (ac) (2,363 hectares (ha)). All critical habitat units in Jackson County are located within the Middle

Rogue River Basin or “Agate Desert.” Brief descriptions are presented below. Detailed coordinates of and maps depicting the CH units are available in the Final Rule (USFWS, 2010).

Unit RV1 for Limnanthes floccosa ssp. grandiflora: Shady Cove, Jackson County, Oregon. (i) Unit RV1 consists of approximately 8 ha (20 ha) of intact vernal pool– mounded prairie habitat. The unit is located 460 m (1,500 ft) west of Highway 62 and parallels a 430-m (1,411-ft) stretch of the highway. The unit is 0.8 km (0.5 mi) south of Shady Cove, 1.3 km (0.8 mi) northeast of Takelma Park, and 122 m (400 ft) east of the Rogue River.

Unit RV2 for Limnanthes floccosa ssp. grandiflora: Hammel Road, Jackson County, Oregon. (i) Unit RV2 is composed of four subunits and comprises approximately 69 ha (169 ac) of vernal pool–mounded prairie. The unit is located 1.2 km (0.75 mi) northeast of the confluence of Reese Creek and the Rogue River, 1.3 km (0.8 mi) west of Highway 62, and 430 m (1,400 ft) east of the Rogue River.

Unit RV3 for Limnanthes floccosa ssp. grandiflora: North Eagle Point, Jackson County, Oregon. (i) Unit RV3 is composed of four subunits and totals 490 ha (1,210 ac) of intact vernal pool habitat. The unit is located southwest of Mosser Mountain and northeast of Long Mountain. The four subunits loosely follow a 6.9-km (4.3-mi) stretch of Hog Creek beginning at its origin. Originating 3.8 km (2.4 mi) east of Highway 62 in subunit RV3D, Hog Creek runs through RV3C, crosses Highway 62, flows between RV3B (located 100 m (328 ft) west of Highway 62) and RV3A (located 600 m (1,970 ft) west of Highway 62), before emptying into the Rogue River after 2.4 km (1.5 mi). Subunit RV3A is located 560 m (1,837 ft) southeast of the confluence of Reese Creek and the Rogue River. Subunit RV3B is located 100 m (328 ft) west of Highway 62 at the intersection of Ball Road and extends along an 835- m (2,740-ft) stretch of Hog Creek. Subunit RV3C is located 2 km (1.2 mi) north of Eagle Point (see Index map) and extends 2.6 km (1.6 mi) south of the junction of Ball Road and Reese Creek Road. Subunit RV3D is located 3.2 km (2 mi) east of Long Mountain and is 2.4 km (1.5 mi) southeast of the junction of Highway 62 and Ball Road. It extends along a 1.8-km (1.1-mi) stretch of Hog Creek.

Unit RV4 for Limnanthes floccosa ssp. grandiflora: Rogue Plains, Jackson County, Oregon. (i) Unit RV4 consists of 243 ha (600 ac) of partially intact vernal pool– mounded prairie habitat. The unit is located 122 m (400 ft) southeast of the junction of Highway 234 and Modoc Road. It extends 2 km (1.2 mi) south along Modoc Road from the intersection, is located 1.4 km (0.87 mi) southwest of Dodge Bridge, and is 1.0 km (0.6 mi) northwest of Rattlesnake Rapids on the Rogue River.

Unit RV5 for Limnanthes floccosa ssp. grandiflora: Table Rock Terrace, Jackson County, Oregon. (i) Unit RV5 includes 49 ha (122 ac) of intact vernal pool–mounded prairie habitat. The unit is located on privately owned land 670 m (2,200 ft) north of the junction of Modoc and Antioc Roads, is 1.4 km (0.9 mi) east of Upper Table Rock, and is 650 m (2,300 ft) west of the Rogue River. This unit follows along an 800-m (2,600-ft) stretch of Modoc Road to the east of the unit and along a 700- m (2,300-ft) stretch of Antioc Road to the west of the unit.

Unit RV6 for Limnanthes floccosa ssp. grandiflora: White City, Jackson County, Oregon. (i) Unit RV6 for Limnanthes floccosa ssp. grandiflora consists of eight subunits totaling 740 ha (1,829 ac) in size and includes intact vernal pool– mounded prairie and swale habitats. The unit is located around White City, is 1.6 km (1.0 mi) southwest of Eagle Point, and is 440 m (1,444 ft) southeast of the confluence of the Rogue River and Little Butte Creek. Subunit RV6A is located north of

Whetstone Creek and is 500 m (1,200 ft) west of the junction of Highway 62 and Antelope Road. Subunits RV6B, RV6C, RV6D, and RV6E are located north of Avenue G in White City, south of Little Butte Creek, and 670 m (2,200 ft) southwest of Antelope Creek. Subunits RV6F and RV6G are located approximately 500 feet west of Dry Creek and are east of Highway 62 in White City. Subunit RV6H is located north of Whetstone Creek and south of Antelope Road. Subunit RV6H roughly encircles the Hoover Ponds, east of Highway 62, and is 850 m (2,790 ft) east of subunit RV6A.

Unit RV7 for Limnanthes floccosa spp. grandiflora: Agate Lake, Jackson County, Oregon. (i) Unit RV7 consists of 421 ha (1,039 ac) of intact vernal pool–mounded prairie and swale habitat. The unit is located 500 m (1,640 ft) east of the Agate Reservoir, lies along a 5.4-km (3.4-mi) stretch roughly parallel and between Dry Creek and Antelope Creek, is 330 m (1,080 ft) north of Tater Hill, and is 1.4 km (0.9 mi) southeast of the confluence of Dry Creek and Antelope Creek.

Unit RV8 for Limnanthes floccosa ssp. grandiflora: Whetstone Creek, Jackson County, Oregon. (i) Unit RV8 consists of 344 ha (850 ac) of intact vernal pool–mounded prairie and swale habitat. The unit is located approximately 1.4 km (0.9 mi) southeast of the confluence of the Rogue River and Whetstone Creek, 2.2 km (1.4 mi) southwest of Tou Velle State Park, and 2.9 km southeast of the confluence of Bear Creek and the Rogue River. The unit roughly parallels a 2.6-km (1.6-mi) stretch of Whetstone Creek to the south.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Limnanthes floccosa ssp. grandiflora critical habitat consists of the following habitat components (75 FR 42490-42570):

(i) Vernal pools or ephemeral wetlands and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain Limnanthes floccosa ssp. grandiflora germination, growth, and reproduction, occurring in the Rogue River Valley vernal pool landscape. These vernal pools or ephemeral wetlands are seasonally inundated during wet years but do not necessarily fill with water every year due to natural variability in rainfall, and support native plant populations. Areas of sufficient size and quality are likely to have the following characteristics: (A) Elevations from 372 to 469 m (1,220 to 1,540 ft); (B) Associated dominant native plants including, but not limited to: Alopecurus saccatus, Deschampsia danthonioides, Eryngium petiolatum, Lasthenia californica, Myosurus minimus, Navarretia leucocephala ssp. leucocephala, Phlox gracilis, Plagiobothrys bracteatus, Trifolium depauperatum, and Triteleia hyacinthina. (C) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(ii) The hydrologically and ecologically functional system of interconnected pools, ephemeral wetlands, or depressions within a matrix of surrounding uplands that together form vernal pool complexes within the greater watershed. The associated features may include the pool basin or depressions; an intact hardpan subsoil underlying the surface soils up to 0.75 m (2.5 ft) in depth; and surrounding uplands, including mound topography and other geographic and edaphic features, that support these systems of hydrologically interconnected pools and other ephemeral wetlands (which may vary in extent depending on site-specific characteristics of pool size and depth, soil type, and hardpan depth).

(iii) Silt, loam, and clay soils that are of alluvial origin, with a 0 to 3 percent slope, primarily classified as Agate– Winlo complex soils, but also including Coker clay, Carney clay, Provig–Agate complex soils, and Winlo very gravelly loam soils.

(iv) No or negligible presence of competitive, nonnative, invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow Limnanthes floccosa ssp. grandiflora to continue to survive and recover.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and that may require special management considerations or protection. All areas we are designating as critical habitat require some level of management to address current and future threats to Limnanthes floccosa ssp. grandiflora, to maintain or enhance the physical or biological features essential to their conservation, and to ensure the recovery and survival of these species. The major threats to the PCEs in the areas identified as critical habitat for Limnanthes floccosa ssp. grandiflora include: development on private lands; mining activities; ground disturbance that affects surface hydrology, including ORV use and road construction or maintenance activities; incompatible agricultural and grazing practices; garbage dumping; the succession of meadow habitat to forested habitat due to fire suppression; and encroachment and displacement by nonnative plants. In all of the units in Jackson County, special management is needed to reduce or eradicate the threats posed by development, habitat fragmentation, ground disturbance that affects surface hydrology, and incompatible grazing practices. In all of the units in Josephine County, special management is needed to reduce or eradicate the threats posed by development, ORV use, mining activities, garbage dumping, and woody vegetative succession. Please refer to the unit descriptions in the Critical Habitat Designation section for further discussion of special management considerations or protection of the PCEs related to geographically specific threats to Limnanthes floccosa ssp. grandiflora. In addition, for all units, special management is needed to control and monitor the encroachment of nonnative, invasive plant species to maintain intact vernal pool–mounded prairies and wet meadow ecosystems such that they can continue to support populations of Limnanthes floccosa ssp. grandiflora. Special management considerations or protection of the vernal pool– mounded prairies and wet meadow habitats that may be needed to support reproduction and growth of Limnanthes floccosa ssp. grandiflora include: controlled burning and vegetation clearing to maintain early seral stages (early stages of plant succession in the progression toward a climax community); control of nonnative, invasive plant species; grazing management; the reestablishment of hydrology; re-seeding with native plants; monitoring; and protection from development (Borgias 2004, pp. 47–53; ONHDB 1994, pp. 13– 20). (USFWS, 2010)

Life History

Food/Nutrient Resources

Breeding Season

Adult: Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable (USFWS, 2016).

Reproduction Narrative

Adult: Meadowfoam produces one to three flowers per flower stalk; each flower will produce a cluster of 1 to 5 hard nutlets by mid-May that will quickly drop in the drying mud. Over much of its range, meadowfoam is restricted to the relatively wetter, inner fringe of vernal pools in the Rogue Valley plains. Meadowfoam typically begins flowering in March, reaches peak flowering in April, and may continue into May if conditions are suitable. Nutlets are produced in late April, and the plants begin to die back by mid-May or when the soil becomes dry (Borgias 2004). Nutlets of meadowfoam apparently are dispersed by water; they can remain afloat for up to three days (USFWS 2012). However, the nutlets of the plant are normally dispersed only short distances. Thus, meadowfoam nutlets would not be expected to disperse beyond their pool or swale of origin. Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978) (USFWS, 2016).

Habitat Type

Adult: Vernal pools (USFWS, 2016)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (Natureserve, 2015)

Habitat Narrative

Adult: Meadowfoam is endemic to vernal pool habitats within Jackson County, Oregon. The majority of the extant and historical sites for meadowfoam in the Rogue Valley occur on soil formations characterized by Agate-Winlo silty clay loam series (deep, poorly drained soils present in depressions in alluvial stream terraces) at elevations of 366 to 400 m (1,200 to 1,310 feet) (USFWS 2012). According to Arroyo (1973), the plant occurs generally near the wetter, inner edges of pools, as opposed to the drier outer fringes, which harbor the slightly more common L. floccosa ssp. floccosa (USFWS 2012). However, meadowfoam has been observed on the outside edges of vernal pools, sympatric with L. floccosa ssp. floccosa, and has even been observed in some areas on low upland mounds. The deeper basins are dominated by Plagiobothrys stipitatus, Eryngium petiolatum, Navarretia leucocephala ssp. leucocephala, and Myosurus minimus. Alopecurus saccatus (Pacific foxtail), and Deschampsia danthonioides are also common plant associates. The inner vernal pool edges occupied by meadowfoam often have up to 10 to 15% exposed soil, due partly to gopher or vole foraging activity (USFWS< 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Birds and livestock are potential sources of long-distance seed dispersal, but specific instances of dispersal have not been documented (Jain 1978) (USFWS, 2016).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2016)

Population Growth Rate:

Suspected. Decline of 30-50% (NatureServe, 2015)

Number of Populations:

18 (USFWS, 2019)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015; USFWS, 2016))

Population Narrative:

Since the adoption of the 20 12 recovery plan, Limnanthes pumila ssp. grandiflora remains at 18 known populations (or occurrences) with two new populations documented and one population (Eagle Point) lost since 201 1 (Table 1) (Figure 1). In addition, a new population of 160 individual plants t the PacificCorps Substation was discovered on City of Medford owned land, but also quickly became extirpated during this period. The east Agate Desert, Whetstone Savannah, Highway 140, ODOT Dutton Road site, and Jackson Sports Park populations previously considered separate are combined herein due to their close proximity. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Nearly 50% of Limnanthes pumila ssp. grandiflora sites have been severely altered (Meyers 2008). In 1999, a function and value assessment of vernal pool quality, abundance, and distribution determined that habitat with intact hydrology and only moderately altered vegetation accounted for just 3,600 acres or 17.6% of the original landform; approximately 2,104 acres of this contained well-distributed and abundant vernal pools (Oregon Natural Heritage Program 1999) (USFWS, 2016).

Stressor: Development (USFS, 2016).
Exposure:
Response:
Consequence:
Narrative: Road construction, housing, industrial and commercial development are listed as threats to this species. Other development in Medford, occurring in 2006, resulted in the loss of habitat (USFWS, 2016).

Stressor: ORV use (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Off-road vehicle use is listed as a threat to this species. Recreational off-road vehicle activities have also impacted two meadowfoam populations in the White City area (USFWS, 2016).

Stressor: Dumping (USFWS, 2016)
Exposure:
Response:
Consequence:

Narrative: Fill and contaminant dumping are listed as threats to this species (USFWS, 2016). Since 2002, a known meadowfoam population in the Agate Desert near Table Rocks Road was partially impacted due to disposal of contaminants (perhaps herbicide) that removed native vegetation from a 0.75 acre portion of vernal pools. The source of the spill was not determined (USFWS, 2016).

Stressor: Non-native plants (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Invasion of non-native annual grasses and herbs is listed as a threat to this species (USFWS, 2016).

Stressor: Herbicide spraying (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Herbicide spraying is listed as a threat to this species (USFWS, 2016).

Stressor: Livestock grazing (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Poorly managed livestock grazing is listed as a threat to this species (USFWS, 2016).

Stressor: Predation (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: There is a potential threat of predation by meadowfoam fly (Scaptomyza apicalis) larvae (USFWS 2012). The meadowfoam fly, which occurs in northern California and Southern Oregon, is the only insect pest of significance on species of meadowfoam. The larvae of the meadowfoam fly have been known to cause severe damage to both vegetative and reproductive tissue in Limnanthes alba and may be present on meadowfoam in the Agate Desert, though the fly has not been observed (USFWS 2012) (USFWS, 2016).

Recovery

Reclassification Criteria:
Reclassification from Endangered to Threatened status may be considered for Limnanthes pumila ssp. grandiflora when the following criteria are met: a. At least 16 of the 18 documented and extant occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

b. At least 90 percent of suitable vernal pool habitat acreage within the four Rogue Valley Priority 1 core areas has been protected, and at least 85 percent of suitable vernal pool habitat acreage within the five Rogue Valley Priority 2 core areas has been protected (see Tables IV-2 and IV-4 of the Recovery Plan). All suitable vernal pool habitat must include soils and hydrology that support Limnanthes pumila ssp. grandiflora. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations. (USFWS, 2010)

c. Management plans for each protected area are developed for species protection and conservation and implemented as soon as feasible. The management plans should address vegetation control, include a set of methods to reduce thatch buildup and noxious weed control, set a monitoring schedule to assess population levels to quantitatively determine trends, include a set of methods to maintain hydrological functions, outline an outreach plan for neighboring landowners, and set a plan to deter garbage dumping. Management plans should take an ecosystem approach to management, conserving associated wetland and upland species. (USFWS, 2010)

d. Additional Limnanthes pumila ssp. grandiflora occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined necessary to recovery are protected. (USFWS, 2010)

e. Achievement of self-sustaining Limnanthes pumila ssp. grandiflora populations within core areas will be determined through species monitoring and status surveys in each protected occurrence. In order to be considered self-sustaining, populations should demonstrate evidence of reproduction by seed set or presence of seedlings and exhibit population trends that are stable, increasing or show only minor declines from high population levels for 10 years prior to consideration for reclassification. (USFWS, 2010)

f. Seed collection is accomplished within each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4 of the Recovery Plan). (USFWS, 2010)

Delisting Criteria:
Delisting may be considered for Limnanthes pumila ssp. grandiflora when all downlisting criteria plus the following criteria are met: (USFWS, 2010)

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (e.g., evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats. (USFWS, 2010)

b. At least 17 of 18 Limnanthes pumila ssp. grandiflora occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support Limnanthes pumila ssp. grandiflora. Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4). (USFWS, 2010)

d. A post-delisting monitoring plan has been developed for Limnanthes pumila ssp. grandiflora . (USFWS, 2010)

Recovery Actions:

- 1. Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses. Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery core areas, while lower priority actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions. (USFWS, 2010)
- 2. Manage, monitor, and restore vernal pool and wet meadow habitat. Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation; monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known Limnanthes pumila ssp. grandiflora populations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species. (USFWS, 2010)
- 3. Conduct rangewide population status surveys. A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site. (USFWS, 2010)

- 4. Conduct research essential to the conservation of these species. In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. Study pollination vectors between and among populations. Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors. Evaluate techniques to reduce impacts from encroachment of native woody plant succession. Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses. Refine research on appropriate grazing practices. Research genetic and morphologic traits among individuals and populations. Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill. Determine incidence of herbivory or predation on Limnanthes pumila ssp. grandiflora populations. Develop offsite and onsite cultivation and propagation techniques for Limnanthes pumila ssp. grandiflora. Research associated soil crusts as indicators for vernal pool health and function. (USFWS, 2010)
- 5. Enhance public awareness and participation in recovery of the species. Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the species. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans. Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved. Complete post-delisting monitoring plan for Limnanthes pumila ssp. grandiflora. (USFWS, 2010)
- Recommended Future Actions: Develop conservation easements or conservation programs for existing occurrences on private lands . Assist Jackson County School District #9 with habitat management for Limnanthes pumila ssp. grandiflora . Augment Limnanthes pumila ssp. grandiflora on protected habitat in the Rogue Airfield and North Eagle Point core areas • Assist the Bureau of Reclamation with Limnanthes pumila ssp. grandiflora habitat restoration • Conduct best management practices studies for Limnanthes pumila ssp. grandiflora. (USFWS, 2019)
- All of the General Plant Conservation Measures (Section 3.13.1) apply for meadowfoam. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by large-flowered meadowfoam, unless approved by the local Service office. Also, this plant can be associated with vernal pool habitats, which can support Cook's desert parsley and vernal pool fairy shrimp (other listed species), and additional PDC, restrictions, and conservation measures may apply for vernal pool fairy shrimp (USFWS, 2016).

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USFWS. 2016. STATUS OF THE SPECIES AND CRITICAL HABITAT, Large-flowered Woolly Meadowfoam (Limnanthes floccosa ssp. grandiflora). U.S. Fish and Wildlife Service, Portland, Oregon. Provided to FESTF from Chris Mullens 9/30/2016.

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SPECIES ACCOUNT: *Limnanthes vinculans* (Sebastopol meadowfoam)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/02/1992; Pacific Southwest (R8)

Physical Description

An annual herb of the false meadowfoam family (Limnanthaceae) with weak, somewhat fleshy, decumbent stems up to 30 cm (11.8 in) long (stems grow longest when the plant is submerged while actively growing). The seedlings are unusual among Limnanthes species in that they have entire leaves. Leaves of mature plants are up to 10 cm (3.9 in) long and have 3 to 5 leaflets that are narrow and unlobed with rounded tips. Although the first leaves are narrow and undivided, leaves on the mature plant have three to five undivided leaflets along each side of a long stalk (petiole). The length of the petiole also appears to be promoted by submergence. The shape of the leaves distinguishes L. vinculans from other members of the Limnanthes genus. Limnanthes vinculans has fragrant, white flowers during April and May. The flowers are borne in the leaf axils (upper angle between leaf and stem), are bell- or dishshaped, with petals 12 to 18 mm (0.47 to 0.71 in) long. The sepals (green outermost whorl of flower parts that enclose the bud) are shorter than the petals, which turn outward as the nutlets (small, dry nuts) mature. The nutlets are dark brown, 3 to 4 mm (0.12 to 0.16 in) long, and covered with knobby pinkish tubercles (small wartlike projections) (Ornduff 1969a, Brown and Jain 1977, Hauptli et al. 1978, Wainwright 1984, Patterson et al. 1994, Ornduff and Morin 2012). The seeds of L. vinculans germinate after the first significant rains in fall. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. (USFWS< 2016)

Taxonomy

The earliest collection of Limnanthes vinculans was made in 1946 “between Bodega and Petaluma, south of Sebastopol” but this record most likely represents a site near Sebastopol (Wainwright 1984). The species was not described until 1969, when Ornduff (1969a) officially published the name L. vinculans. Another common name for this species is Cunningham Marsh meadowfoam (Wainwright 1984, Patterson et al. 1994). The type locality for L. vinculans is Todd Road, just west of the intersection with Llano Road, which is near Sebastopol in Sonoma County (Ornduff 1969a). Limnanthes vinculans is similar to L. douglasii var. nivea (snowy meadowfoam) and L. alba (white meadowfoam) in flower characteristics, and to L. bakeri (Baker’s meadowfoam) in leaf characteristics. However, seedlings of L. douglasii and L. alba have lobed leaves and the mature leaves have more, deeper lobes called leaflets (5 to 13 leaflets as compared to 3 to 5 leaflets in L. vinculans). In addition, the petals of white meadowfoam curve inward as the nutlets mature. L. bakeri has smaller flowers than L. vinculans, occasionally has two or three lobes on the leaflets, and occurs only in Mendocino County (Ornduff and Crovello 1968, Ornduff 1969a, Brown and Jain 1977, Wainwright 1984, Ornduff and Morin 2013). (USFWS, 2016)

Historical Range

In California, in Sonoma and Napa Counties. (USFWS, 2016)

Current Range

In California, in Sonoma, Napa, and Lake Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2016)

Lifespan

Adult: One year (USFWS, 2016)

Dependency on Other Individuals or Species

Adult: Pollinators such as Conophorus flies and Limnanthes bees (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Seed bank (USFWS, 2008); fall rains, insect pollinators (USFWS, 2016)

Reproduction Narrative

Adult: According to Patterson et al. (1994), the seeds of Limnanthes vinculans germinate after the first significant rains in fall, although late initiation of rains may delay seed germination. L. vinculans plants grow slowly underwater during the winter, and growth rates increase as the pools dry. Repeated drying and filling of pools in the spring favors development of large plants with many branches and long stems. L. vinculans begins flowering as the pools dry, typically in March or April. The largest plants can produce 20 or more flowers. Flowering may continue as late as mid-June, although in most years the plants have set seed and died back by then. Each plant can produce up to 100 nutlets. Nutlets of Limnanthes vinculans likely remain dormant in the soil, as has been noted in other species of Limnanthes (Patterson et al. 1994). For example, in the late 1980s and early 1990s, a site in Cotati remote from other L. vinculans occurrences was surveyed for several years by independent qualified botanists. None of these botanists identified flowering occurrences of L. vinculans on the project site. Conditions of the pools on the site were highly degraded by wallowing hogs (Sus scrofa) and subsequent eutrophication (over enrichment by nutrients) of the pools. Following several years of negative surveys, 12 plants of Sebastopol meadowfoam emerged simultaneously in one pool in the first year following removal of hogs. (USFWS, 2016)

Habitat Type

Adult: Wetland (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Northern Basalt Flow and Northern Hardpan vernal pools (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 50 - 380 ft. elevation (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Linear, patchy (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: This species grows in northern basalt flow and northern hardpan vernal pools (Sawyer and Keeler-Wolf 1995), wet swales and meadows, on the banks of streams, and in artificial habitats such as ditches (Wainwright 1984; CNDDB 2002). Limnanthes vinculans grows in both shallow and deep areas, but is most frequent in pools 25 to 51 cm (10 to 20 in) deep (Patterson et al. 1994). The species is most abundant in the margin habitat at the edge of vernal pools or swales (Pavlik et al. 2000, 2001). Most confirmed occurrences of L. vinculans on the Plain grow on Wright loam or Clear Lake clay soils (Patterson et al. 1994, CNDDB 2002). A few occurrences are on other soil types, including Pajaro clay loam, Cotati fine sandy loam, Haire clay loam (Patterson et al. 1994) and Blucher fine sandy loam (Wainwright 1984). (USFWS, 2016)

Dispersal/Migration

Dispersal

Adult: Low, based on closely related species (USFWS, 2016)

Dispersal/Migration Narrative

Adult: Mechanisms for dispersal of nutlets in this species have not been studied. Likely dispersal agents include water (Wainwright 1984), birds, and livestock (Jain 1978). Jain (1978) studied dispersal of nutlets similar to those of L. vinculans in two species of meadowfoam, L. bakeri (Baker's meadowfoam) and L. striata (striped meadowfoam). Nutlets of L. bakeri did not disperse beyond the point where they were placed. Nutlets of L. striata moved a short distance within the same pool where they were placed but did not disperse to other pools (Hauptli et al. 1978, Jain 1978). (USFWS, 2016)

Population Information and Trends

Population Trends:

90% of vernal pool habitat destroyed (NatureServe, 2015)

Species Trends:

Primarily unknown or decreasing (USFWS, 2008)

Number of Populations:

10 hydrologically separate (USFWS, 2008); 37 occurrences (USFWS, 2016)

Population Size:

1 - 1000 individuals (NatureServe, 2015); variable from year to year (USFWS, 2008)

Population Narrative:

The available vernal pool habitat is limited as 90% of the vernal pool habitat has been destroyed by urbanization or agricultural development (CPC 2006) (NatureServe, 2015). Populations can vary greatly in size from year to year. Patterson et al. (1994) estimated only 10 hydrologically separate populations of L. vinculans exist. The CNDDB (2008) reports 32 extant occurrences,

with the trend for most occurrences either unknown or decreasing. The genetic variability of Limnanthes vinculans is low compared to other Limnanthes species (Jain 1984). However, populations of this species do differ in genetic makeup (Jain in litt. 1980) (USFWS, 2008). The current status of numerous Limnanthes vinculans occurrences is unknown; however, the most current information from CNDDB, from survey data collected by the Adopt-a-Vernal Pool program, and from species experts indicates that there are 37 occurrences of L. vinculans that are presumed extant of which at least three have been introduced (USFWS, 2016).

Threats and Stressors

Stressor: Development and conversion to agriculture (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Today, the largest continuing threats to this species are urban development and land conversion to agriculture (such as vineyards) and associated agricultural activities and wastewater irrigation. The most recent estimates from the California Department of Conservation (2002) are that about 71,000 acres of Sonoma County have been converted to urban uses (Sonoma County Permit and Resource Management Department 2014). The threat of urban development to these species in the Santa Rosa Plain is expected to continue. In addition to urban development, land conversion to agriculture and associated agricultural activities has reduced occurrences of these plants (CNDDB 2014). In 1991, at the time of the listing, approximately 34,500 acres of land were in wine grape production in Sonoma County (Sonoma County Agricultural Commissioner 1991). As of 2012, the acreage of wine grapes in Sonoma County had increased to approximately 58,400 acres (Sonoma County Agricultural Commissioner 2013). Additionally, irrigation with recycled water, a practice that began in the Santa Rosa Plain in the 1970s, has emerged as a major threat. Although the California Regional Water Quality Control Board regulations (Water Quality Control Plan for the North Coast Region) prohibit discharge of recycled water to surface waters during the summer, the regulations did not contemplate that recycled water would be used to irrigate vernal pools and other types of seasonal wetlands (J. Short, pers. comm., 2007). Recycled water, as opposed to wastewater, is tertiary-treated (City of Santa Rosa, in litt. 2015** [comment letter]). Wastewater, however, can come from many sources including livestock waste ponds and runoff from agricultural fields (City of Santa Rosa, in litt. 2015** [comment letter]). (USFWS, 2016)

Stressor: Alteration of hydrology (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Some actions, such as runoff from irrigation or irrigation with recycled water, can result in increased water on the landscape. The vernal pool habitat may receive more water than it normally would or receive it at an inappropriate time, resulting in flooding and death of listed plant seedlings. If water from urban or agricultural runoff continues to fill pools during spring and summer months, the listed plants will disappear because they cannot tolerate permanent inundation; invasion by plant species adapted to permanent inundation will occur. Additionally, irrigation with recycled water and runoff from irrigation can contain chemicals, such as herbicides, and other nutrients (Pereira et al. 1996) that can alter the vernal pool plant community, prevent germination, or kill seedlings. Nitrogen deposition from automobile traffic

may also modify habitat by increasing soil nutrients, thus posing a continuing threat to remnant habitat that might otherwise be suitable for these species. Weiss and Luth (2003, p. 1) conducted research on the effects of nitrogen deposition along a highway south of the San Franciscan peninsula in San Francisco County. They found that nitrogen deposition within 100 m to 400 m from the highway was correlated with increased nonnative grass cover within these areas, resulting in competition for space with native plants. An increase in nonnative grass cover through changed habitat conditions could threaten the three plant species by competing for soil moisture and nutrients and inhibiting successful germination. (USFWS, 2016)

Stressor: Off-highway vehicles (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Damage by off-highway vehicles was noted as a threat to this species. Currently, on Department-owned properties that support the listed plants, some damage to preserves from vehicle trespass does occur, but without damage to the vernal pools. The most significant damage to vernal pools from vehicles has resulted from a Mosquito Vector Control vehicle driving through the vernal pools to spray for mosquitoes during the time when the pools were wet in 2014. Disturbance to the pools included physical damage to the pools and swales from tire ruts and crushing and uprooting the plants (S. Martinelli, CDFW, in litt. 2014). The level of this threat is likely to be variable and is difficult to predict or monitor. (USFWS, 2016)

Stressor: Grazing managment and thatch accumulation (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Appropriate levels of grazing may provide some control of weedy plants, reduce competition between native plants and invasive plants, and can provide some bare soil for germination of native plants, all of which may provide opportunities for native plants to germinate. Cessation of cattle grazing has been found to exacerbate the negative effects of invasive nonnative plants on vernal pool inundation period. If grazing is removed, areas of bare soil can be quickly occupied by nonnative, invasive plants. Removal of grazing from vernal pool grasslands where grazing is the traditional land use practice may have devastating impacts on vernal pool habitat, particularly on upland habitat surrounding vernal pools (G. Cooley, in litt., 2014). For example, non-native grasses increased and native grasses decreased in vernal pools when grazing was discontinued at a site in the Southeastern Sacramento Valley, resulting in a 50 to 80 percent reduction in vernal pool inundation (Marty 2005). Since the time of listing, grazing has been removed at many locations and has resulted in thatch build-up. Anecdotal evidence supports the theory that thatch build-up of nonnative vegetation has caused a reduction in the size of extant populations of the listed plants. The Department is re-establishing appropriate grazing practices on some Department-owned lands to reduce thatch build-up and nonnative competitors to the three listed plants (e.g., Todd Road Unit Ecological Preserve). However, reintroduction of grazing may not return a site to its former condition because nonnative plants may continue to occupy the once-vacant niches. For example, harding grass (Phalaris aquatica), a robust, invasive perennial grass, can be present in a grazed field, and not be obvious. If grazing is removed, however, the suppressed harding grass can become vigorous and dominate the entire field within a year or two and grazing will not remove this species once it is established (G. Cooley, in litt. 2014). We recognize that there is disagreement among biologists as to the extent

of the threat of inappropriate grazing on the three species. As the final rule concluded, we believe that although the effect of well-managed livestock grazing may be beneficial to vernal pool ecosystem. (USFWS, 2016)

Stressor: Loss of Genetic Diversity / Inappropriate Mixing of Populations(USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: An additional potential threat to these three plants is the disruption of normal gene flow due to population restoration efforts that may mix populations, which may cause unanticipated adverse effects such as disruption of locally adapted gene complexes and outbreeding depression (when offspring from individuals from different populations have lower health/fitness than progeny from individuals from the same population). Several sites are proposed as Preserves in the Santa Rosa Plain and include proposals to seed/inoculate created or restored vernal pools. Seed from a limited number of donor occurrences has already been used for several years to inoculate multiple created or restored sites, creating a risk of overrepresentation of a small gene pool (swamping). The threat level of this activity is unknown; however, the 2007 Programmatic Biological Opinion (Service 2007) includes measures to reduce this potential threat as well as the requirement to obtain a collection permit from the Department. (USFWS, 2016)

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Narrative: Since the 1950s, the Northern Hemisphere has experienced warmer air temperatures and decreased snowfall (Ackerly et al. 2010, IPCC 2013). By the end of the 21st century, climate change is predicted to result in more intense precipitation events in the form of rain, increased summer continental drying, extreme weather events, and increased wildfire (Ackerly et al. 2010, IPCC 2013). However, current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2013). Climate simulations have shown that California temperatures are likely to increase by 2.7 degrees Fahrenheit (1.5 degrees Celsius) to 8.1 degrees Fahrenheit (4.5 degrees Celsius) depending on the emissions scenario (Cayan et al. 2008). The predicted impacts on California's ecosystems projected with a high certainty include (1) higher sea level and (2) decreased suitable habitat for many terrestrial species as climate change intensifies human impacts [for example isolated patches of vernal pools can be so poorly connected with other patches that migrations required by climate change may be difficult or impossible without human intervention (Field et al. 1999)]. Climate change threatens to increase the loss of pollinators if the abundance of flowers preferred by pollinators decreases. Pollinator emergence times may also be altered by a warming climate. If this occurs, the synchrony of bloom periods and pollinator emergence could be disrupted. The loss of pollinators would further reduce the amount of seed produced by the listed plants because of the plants' limited ability to self-pollinate. Although there currently are no data available regarding changes in plant bloom periods or emergence dates of pollinators in the Santa Rosa Plain in response to climate change, Forister and Shapiro (2003) found that over a period of 31 years, warmer and drier winter conditions were associated with earlier butterfly appearance in the Central Valley of California. Although the loss of seed produced in a single year

would not likely lead to the extirpation of the species, the continued reduction of the seed crop or dependence on self-pollination would reduce the seedbank, genetic variation, and the potential for population expansion. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including B. bakeri, L. burkei, and L. vinculans. (USFWS< 2016)

Stressor: Extirpation due to Stochastic Events, Isolated Occurrences, and Small Size of Occurrences (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Chance events constitute a serious threat to Blennosperma bakeri. Because the known occurrences of B. bakeri are limited in number and in range, the species are vulnerable to stochastic (random) events—natural but damaging environmental perturbations and catastrophes such as droughts, storm damage, disease outbreaks, and fires, from which large wide-ranging populations can generally recover, but may lead to extirpation of small isolated populations (Gilpin and Soule 1986). The majority of the remaining habitat associated with the three species is vernal pools and swales in the Santa Rosa Plain. The nature of the vernal pool and swale habitat associated with the three plants may also increase the effects of drought. Vernal pools and swales are inundated only briefly and may not fill during dry years. As a result, we consider stochastic events to be of significant concern for these species. Isolated, small occurrences may also be at risk from a decrease in reproductive rate resulting from decreasing population density. The correlation of reproductive rate with population density, called the Allee effect, may be the result of either increased density or quality of compatible mates, or increased pollination, or both (Stephens et al. 1999). In small populations, if either the plants or their pollinators decline, consequences on the reproductive output of the other may result in an extinction vortex in which each generation is more likely to go extinct (Gilpin and Soulé 1986, Soulé and Mills1998). (USFWS, 2016)

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The Service found that many existing regulatory mechanisms were not sufficient to protect plants, including section 404 of the Clean Water Act, the protections of the California Endangered Species Act, and the California Environmental Quality Act. The 1991 final rule also found that listing the plants under the Federal Endangered Species Act would provide better protection by requiring the Army Corps of Engineers (and other Federal agencies) to consult with the Service prior to final determinations on a proposed activity. (USFWS, 2016)

Stressor: Non-native invasive species (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Creating a drier habitat and facilitating the invasion of non-native upland species, may permanently change the plant community and the non-native plants may outcompete the listed species (Bauder 2000, Marty 2005, competition discussed further below). With insufficient water,

the distribution of plant species that are normally found higher on the edge of the vernal pools may shift downward along the moisture gradient in response to the introduction of invasive plants that now flourish at pool edges. Non-native grasses maintain dominance at pool edges, sequestering light and soil moisture, promoting thatch build-up, and shortening inundation periods. Species strongly associated with vernal pools may disappear from shallow pools as a result of invasion by upland non-native plants. In addition, the invasive species can further alter the hydrology of the site by reducing the inundation period (Marty 2005). Reduction in inundation period is thought to be due to increased evapo-transpiration associated with dense cover of nonnative plants at the vernal pools (Marty 2005). Once non-native, invasive plants are introduced to vernal pools, competition with native species can come from several interactions including root competition (roots of one species are more efficient at absorbing moisture and nutrients from the soil) and pollination success (one species will set more seed and produce more plants). Plant size can also confer superiority when competing with smaller plants. A larger plant can shade smaller or shorter plants and seedlings, depriving them of adequate sunlight which is necessary for plant and seedling growth and survival, and in some cases necessary for seed germination (Barbour et al. 1987). (USFWS, 2016)

Recovery

Reclassification Criteria:
A/1: Of all extant, native occurrences in the Plain not protected as of December 2014, 75 percent of the Limnanthes vinculans Northern Core Area occurrences, and 80 percent of the Limnanthes vinculans Southern Core Area occurrences are permanently protected to maintain the current geographic, elevational, and ecological distribution of the species. Priority should be given to occurrences that have been shown to be isolated and/or genetically unique. (USFWS, 2016)

A/2: New preserves protect a total of 500 ac in two general areas: 200 ac in the Limnanthes vinculans Northern Core Area and 300 ac in the Limnanthes vinculans Southern Core Area. These preserves consist of occupied habitat that was not protected as of December 2014. The ecological integrity (e.g., water quality, hydrology, and uplands condition) of these areas is not threatened by adverse habitat modification. Buffers between the protected habitat and incompatible land uses is sufficient to ensure that there are no significant adverse effects to Limnanthes vinculans, such as changes in hydrology or contamination by pesticides or herbicides, currently and into the foreseeable future (USFWS, 2016).

A/3: New preserves (comprised of restored or created habitat) must be 10 ac or greater; however, preserves with existing native occurrences may be less than 10 ac. The preserves should be as near to new or existing preserves as possible. (USFWS, 2016)

A/4: The total new preserve acreage among all core areas consists of a minimum of 70 ac of vernal pools and swales (40 ac in the Limnanthes vinculans Northern Core Area and 30 ac in the Limnanthes vinculans Southern Core Area). However, new preserves are no more than 35 percent wetland which is based on general wetland to upland percentages. (USFWS, 2016)

A/5: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of invasive plants are developed and are being effectively implemented. (USFWS, 2016)

A/6: Service shall work with Mosquito Abatement Districts so that their practices in the core and management areas are implemented to avoid impacts to the species. (USFWS, 2016)

E/1: All native occurrences, extant as of December 2014, in the Limnanthes vinculans Northern Core Area as well as the Theiller (owned by CDFW) and Haroutounian (owned by Sonoma County Open Space) sites in the southern portion of the Limnanthes vinculans Southern Core Area, are replicated at 1:3 (quadrupled in numbers of occurrences) in permanently protected appropriate sites. The remaining occurrences in Limnanthes vinculans Southern Core Area are replicated at 1:1 because they are genetically similar. Replication is accomplished by collecting seed or inoculum from a natural occurrence and planting it at additional sites. For example: collecting seed or inoculum at one site and planting it at two additional sites increases the original single occurrence to 3 occurrences (1:2); planting it at three additional sites increases the original occurrence to 4 occurrences (1:3). (USFWS, 2016).

E/2: The preserves noted in Factor A are occupied by Limnanthes vinculans at a density of 1,500 seeds per square meter when measured on a 25-year moving average which includes at least one above average and one average rainfall year, and a multi-year drought. A multi-year drought is defined as a period of 3 or more years of below average local rainfall. (USFWS, 2016)

E/3: Service-approved conservation and management plans that protect vernal pool habitat and upland habitat and address effects of small occurrences of the listed plants and climate change, are developed and are being effectively implemented. (USFWS, 2016)

Delisting Criteria:
A/1: At least ninety percent of all known occurrences of Limnanthes vinculans that are extant as of December 2014, have been protected in perpetuity. (USFWS, 2016)

E/1: In addition to replication noted in criterion 7 of the downlisting criteria for Limnanthes vinculans, all occurrences in management areas have been replicated at 1:2 at permanently protected at appropriate locations. (USFWS, 2016)

E/2: All replicate occurrences in management areas have achieved the same density (1,500 seeds per square meter) as the core area occurrences. (USFWS, 2016)

E/3: If Limnanthes vinculans is found at the Knights Valley site, the northernmost location, this occurrence should be replicated at 1:2 in permanently protected appropriate locations. (USFWS, 2016)

E/4: All genetically unique and isolated unprotected sites in management areas are permanently protected in situ. Identification of some genetically unique occurrences is not yet known but will be determined during research listed in Table 6 of the Recovery Plan. (USFWS, 2016)

Recovery Actions:

- 1. Protect extant occurrences and potential habitat for Limnanthes vinculans. Natural areas that are known to contain species covered in this recovery plan should be protected in perpetuity through land acquisition, conservation easements, or other means. Protection of these areas will need to be followed by identification of threats and application of

appropriate and adaptive management to ensure abatement of these threats. In addition to areas that currently support the species, two other types of natural areas also need to be protected or secured: areas where the endangered plants have been found in the past but not been seen recently, and that retain habitat that can be readily restored so that plants can be reintroduced successfully; and areas where the plants have not been found but are appropriate for vernal pool creation, and subsequent introduction of the endangered plants. (USFWS, 2016)

- 2. Develop a central database for survey data from all natural and created occurrences of Limnanthes vinculans including information on protection status. Data should include numbers of plants; area occupied by the species; presence of invasive species; site condition; land ownership; level of management; disturbance; whether the site is natural, restored, or created; and degree of genetic uniqueness. If the site has been seeded, the origin of the seed should be identified by name and location of parcel where seed was collected, location of specific pools where seed was collected, and date of seed collection. Any observations of pollinators, such as species or type of pollinator, should also be recorded. This information will serve as the current baseline for evaluating progress of the Factor A and Factor E comparative downlisting and delisting recovery criteria for each of the three plant species. This database should be updated regularly and should be available to all management agencies (USFWS, 2016). In addition, the database should track the location of source seed for sites with created occurrences (USFWS, 2019).
- 3. Collect and store seed from all occurrences of Limnanthes vinculans. Seed collections for each plant taxon should be representative of both population- and species-level genetic diversity; seeds should be collected from multiple plants at each occurrence. Seed collection guidelines published by the Center for Plant Conservation (1991) should be followed. Seed collection should be conducted with caution to ensure that donor populations are not adversely affected by the collection. No more than 5 percent of the reproductive output should be removed from donor populations. Store seeds at two storage facilities certified by the Center for Plant Conservation. Seeds should be collected every 5 years to ensure that seeds in storage are viable. Permits will be required for collecting federally-listed plant seed on federal lands. (USFWS, 2016)
- 4. Survey historical locations and other potential habitat (not previously surveyed) where Limnanthes vinculans may occur. (USFWS, 2016)
- 5. Conduct research necessary to develop a population viability analysis for Limnanthes vinculans. Table 2 of the Recovery Plan lists research tasks needed for the development of a population viability analysis for all three species in the Recovery Plan. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species in the Recovery Plan via the same experiment. (USFWS, 2016)
- 6. Conduct necessary biological research on Limnanthes vinculans and use results to guide recovery efforts. Table 6 of the Recovery Plan the needed research tasks for the recovery of Blennosperma bakeri, Lasthenia burkei, and Limnanthes vinculans. All research tasks need to be performed for each of the three species. To maximize efficiency, it may be possible to study the effects of an experimental factor on all three species via the same experiment. (USFWS, 2016)
- 7. Habitat management for Limnanthes vinculans. Develop adaptive management plans and implement appropriate management actions for all protected sites. Work with local agricultural commissions to track conversion of agricultural uses to vineyards or other non-

suitable agricultural uses. Decrease acreage of vernal pool habitat within priority preservation and restoration areas that are subjected to altered hydrologic regimes through irrigation practices. Develop treatment protocol with mosquito abatement district to avoid impacts to listed species and vernal pool habitat during treatment. (USFWS, 2016)

- 8. Restore or create vernal wetlands, followed by reintroduction of the species per a restoration techniques white paper and a Reintroduction and Genetic Management Plan. As noted in the Factor A discussion, much of the habitat and occurrences of the three listed plants has been destroyed or fragmented by urban development and conversion to agricultural use. Restoration or creation of habitat, when appropriate, will be necessary to maintain the numbers of plants and occurrences at levels sufficient for survival of the species. Restoration and creation of vernal pool habitat has been conducted for many years in the Santa Rosa Plain for the three plants. To better understand these processes and their rates of success, a white paper and a Reintroduction and Genetic Management Plan should be developed. (USFWS, 2016)
- 9. Monitor all protected occurrences. Monitoring plans should be developed and implemented for all protected natural and replicated occurrences. Protected occurrences should be monitored annually for plant density, area occupied by the listed species, site condition, changes in hydrology, application of recycled water and wastewater, effects of grazing, invasive species, vandalism, and whether management is appropriate for the listed species' needs. The responsible party for monitoring should also keep an ongoing record of management activities and precipitation on the site, so that changes in rare plant populations can be related to changes in management activities. Monitoring efforts for co-occurring species (e.g. Blennosperma bakeri and Limnanthes vinculans at Wright Mitigation Bank) should be coordinated to increase efficiency and reduce costs. (USFWS, 2016)
- 10. Engage and educate the public about Limnanthes vinculans recovery. Public education and outreach is important to inform residents and land managers in the Santa Rosa Plain and other areas that support habitat for the species about the significance of the plants and the importance of management and protection of habitat for their persistence. Education and outreach activities should include: (1) develop a public outreach plan, (2) outreach to enhance public understanding of vernal wetlands in general and of imperiled vernal wetland species in particular, (3) information on regulatory responsibilities with regard to endangered species, (4) programs to encourage local interest and involvement in site stewardship, and (5) programs including conservation easements and incentive programs that are available to landowners who may have the vernal pool species on their land. (USFWS, 2016)
- 13. Agency coordination. Partner with California Department of Fish and Wildlife, Army Corps of Engineers, Regional Water Quality Control Board, Sonoma County, Marin/Sonoma Mosquito and Vector Control District, and Cities of Santa Rosa, Cotati, Rohnert Park, and Windsor to ensure resource management practices are aligned with species conservation needs. Resource management practices to be addressed include: irrigation of vernal pool habitat with recycled water and wastewater within priority preservation and restoration areas; protection of habitat buffers; stream ordinances, grading ordinances, and water quality regulations; and vineyard conversion or other agricultural conversion of areas adjacent to vernal pool habitat that contribute to hydrologic regime and/or provide upland habitat for sustaining the Sonoma County California tiger salamander. Provide legal assurances to willing landowners who implement projects that provide a net conservation benefit. (USFWS, 2016)

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SPECIES ACCOUNT: *Lindera melissifolia* (Pondberry)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/31/1996; Southeast Region (R4) (USFWS, 2015)

Physical Description

A deciduous, aromatic shrub. 0.5 to 2 meters tall. Plants are stoloniferous and generally grow in clones of numerous, usually unbranched, stems. The species is dioecious. and the flowers of both sexes are small and pale yellow. Pistillate flowers are less conspicuous than staminate flowers. Fruits are about 1 centimeter long at maturity and are bright red (USFWS, 1993).

Taxonomy

In the order Laurales, family Lauraceae (Laurel family) (NatureServe, 2015).

Historical Range

Alabama, Arkansas, Florida, Georgia, Louisiana, Mississippi, Missouri, North Carolina, and South Carolina (USFWS, 2014).

Current Range

Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Possibly insects (USFWS, 1993)

Breeding Season

Adult: February-March (flowering); March - fall (fruiting)

Key Resources Needed for Breeding

Adult: Possibly seasonal floods (USFWS, 2014)

Reproduction Narrative

Adult: flowering occurs from February to March, with fruiting from March to the fall (USFWS, 1993). Seeds are tolerant of prolonged flooding and may not be able to form a seed bank without seasonal floods. The seeds do not germinate while submerged, but readily germinate once they are no longer submerged (USFWS, 2014).

Habitat Type

Adult: Seasonally flooded wetlands (USFWS, 2014)

Habitat Vegetation or Surface Water Classification

Adult: Carolina bays, limestone or limesink ponds, sand ponds, and lowland sand prairie depressions (USFWS, 2014); on the bottoms and edges of shallow seasonal ponds in old dune fields, along the margins of ponds and depressions in pinelands, around the edges of sinkholes in coastal areas with karst topography, and along the borders of Sphagnum bogs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Needs closed canopy and standing water during some part of the year (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Lindera melissifolia occurs in seasonally flooded wetlands, sandy sinks, pond margins (Radford et al. 1968) and swampy depressions (Steyermark 1949). In the southern floodplain forest (Bailey 1976) or in the Mississippi alluvial plains (Fenneman 1938) of Missouri, Arkansas, and Mississippi. pondberry is found on sites with perched water tables and with vegetation similar to that found in bottomland hardwood habitats. In the coastal sites of North and South Carolina, pondberry is associated with the margins of sinks, ponds, and depressions in the pinelands. Pondberry is shade-tolerant. Although growth is vigorous when shade is reduced or eliminated, McCartney (in litt.) indicated that the species' competitors would probably respond more vigorously than it does to the increased light. (USFWS, 1993)

Dispersal/Migration

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Dispersal

Adult: Catharus guttatus (hermit thrush) (USFWS, 2014)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms of pondberry remain poorly understood. Pondberry's bright red fruits suggest that animals (including black bears) may play an important role in the dispersal of the species. While numerous animals have been associated with pondberry plants, only the hermit thrush (Catharus guttatus) has been confirmed as a dispersal agent of pondberry (USFWS, 2014).

Population Information and Trends

Population Trends:

Decline of 30 - 70% (NatureServe, 2015a)

Species Trends:

Stable to declining (USFWS, 2014)

Number of Populations:

up to 73 (USFWS, 2021)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015b)

Population Narrative:

Since listing, new colonies and populations have been discovered in Alabama, Arkansas, Georgia, Mississippi, Missouri, North Carolina, and South Carolina. However, while new colonies/populations have been discovered in each of these states, with the exception of Alabama, populations have also been extirpated from these states during this time (USFWS, 2014). Flower and fruit production can be highly variable. This species appears to require some sort of pollinator (bagged flowers do not set fruit), but does not appear limited by pollinator supply (supplemental pollination does not improve fruit set) (Devall et al. 2001). Even when flower production is high, fruit production may be limited because female clones are absent from many stands, and many sites are isolated. Furthermore, even when fruit production is significant, seedlings are rarely observed (Devall et al. 2001). In combination, these observations suggest a very low rate of sexual reproduction in the wild. Moreover, natural dispersal appears limited (at least in current times), as many populations occur in small habitat patches surrounded by an unsuitable matrix (e.g. agricultural fields), limiting colony establishment opportunities. In the past, seeds could have been disseminated by floodwater, but floodwaters are controlled throughout the species' range today. Devall et al. (2001) believe it unlikely that new colonies will be established without human intervention. This species has probably always been [relatively] rare (Devall et al. 2001). Nevertheless, occurrences of the habitat types in which it is known to thrive have been greatly reduced in number and quality in recent and historic times (USFWS 1985). When this species was proposed for Federal listing in 1985, the US Fish and Wildlife Service noted that "almost all populations known in 1985 had declined since their discovery, some severely." Rangewide, 17 occurrences are thought to be extirpated. A decline of 30-70% is reported. Census figures for many extant populations are lacking. At least 12 extant sites scattered throughout the range report several hundred to several thousand stems (ramets); one Arkansas site has "tens, if not hundreds of thousands of stems; dominant shrub on 100+ acres." Consistent with this information, the Missouri Natural Heritage Program notes that the species "can occur by the tens of thousands at the best [rangewide] sites." Nevertheless, although some of these populations appear quite large, many of the plants may be clones rather than different genetic individuals. Also, many of the other sites appear to have only small populations; McCue (2002) reports that "the number of stems at any given site varies from a few to several hundred" and Devall et al. (2001) indicate that "many of the existing colonies are small, and occupy only a portion of the apparently suitable habitat." Approximately 99 extant occurrences are currently mapped, of which 2-3 are reintroductions (2 in Missouri and possibly 1 in Arkansas). An additional 17 occurrences are likely extirpated. However, the true number of extant populations may be less than 99, as some currently-mapped occurrences are in close proximity. For example, 19 EOs in Mississippi derive from one USFS inventory of the Delta National Forest, and 18 EOs in Arkansas derive from one status survey in Jackson and Lawrence counties. If more data on these occurrences were available, perhaps they could be delineated as a smaller number of populations (NatureServe, 2015a). Based on the population definition presented in the 2014 5-year review, there are currently up to 73 natural populations potentially extant. However, only 35 of these populations have been confirmed extant by recent observations and the statuses of the remaining 38 are uncertain, of which 4 in Mississippi may

have been extirpated while 1 population in North Carolina may be historical. In addition, one population in Arkansas no longer exists in the wild (i.e., extirpated in the wild) and is therefore not included in the total number of extant populations, but propagules from this population's only remaining plant are safeguarded ex situ (off-site). Two transplanted populations are also extant (one population each in Georgia and South Carolina) while the current status of a third such population (in North Carolina) is unknown. No new information is available for pondberry in Louisiana or Florida and, as such, pondberry's status in both states remains historical. Pondberry's current status and new information for states within the species' extant range are summarized below. (USFWS, 2021)

Threats and Stressors

Stressor: Small population sizes and inbreeding depression (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Inbreeding depression or the low number of genetically different individuals (genets) in most or all eastern populations may reduce pondberry's ability to cope with environmental stochasticity, disease, and ultimately threaten the existence of these populations (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). The specific impacts of climate change to pondberry populations are poorly understood; however, a variety of impacts are possible (USFWS, 2014).

Stressor: Habitat destruction, fragmentation, altered hydrology, and encroaching vegetation (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Geographically isolated wetlands that once sustained pondberry have been cleared for agriculture or timber operations. Similarly, agricultural and silvicultural activities adjacent to some pondberry sites have deleteriously affected these sites by altering hydrological regimes. Other sites have been extirpated by or are threatened by hogs or domestic cattle. Encroaching vegetation can reduce the suitability of some sites for pondberry (USFWS, 2014)

Stressor: Disease (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: All populations are susceptible to the lethal laurel wilt disease, which has spread rapidly since its discovery in 2003 and is likely to continue spreading (USFWS, 2014).

Stressor: Domestic animal and wildlife disturbance (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Trampling by domestic cattle (Service 1993; NatureServe 2012) and hog disturbance (Service 2007; Gustafson 2011; NatureServe 2012; Pittman 2012, in litt.) pose an apparently small risk to pondberry range-wide, but may pose a severe, highly localized threat to some colonies and populations (e.g., Service 1993). (USFWS, 2014)

Recovery

Reclassification Criteria:
The protection of 15 self-sustaining populations (USFWS, 1993)

Delisting Criteria:
The permanent protection of 25 self-sustaining populations (USFWS, 1993).

Recovery Actions:

- Search for new populations and protect and monitor existing populations (USFWS, 1993).
- Study the species and its habitat (USFWS, 1993).
- Determine the management requirements of the species and implement actions essential for recovery and protection (USFWS, 1993).
- Place selected material into cultivation and place seeds from all populations into seed banks (USFWS, 1993).
- Conduct a public education program (USFWS, 1993).
- Further study and characterize potential threats posted by laurel wilt disease. Identify methods and management practices to limit this disease's potential to negatively impact pondberry and its associated habitats (USFWS, 2014).
- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed (USFWS, 2014).
- Form recovery team to update the recovery plan, which will incorporate and address recent advances in our knowledge and understanding of pondberry genetics, physiology, ecology, threats, and management needs (USFWS, 2014).
- Define what characterizes a "self-sustaining" pondberry population (USFWS, 2014).
- Update existing and develop new monitoring and habitat management methods (USFWS, 2014).
- Continue and expand conservation genetics work to include all populations and determine effective population sizes (USFWS, 2014).
- Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock to represent all populations with increased emphasis placed on preserving and safeguarding individual genets within and across populations (USFWS, 2014).
- Study the feasibility of and necessary methodology to augment genetically depauperate and sexually limited populations (USFWS, 2014).
- Develop guidelines to efficiently establish plants and seedlings in natural habitats (USFWS, 2014).

- Further study the effects of various types of disturbance (e.g., fire, prolonged flooding, overstory disturbance, etc.) on pondberry survivorship and reproduction (USFWS, 2014).

Conservation Measures and Best Management Practices:

- . RECOMMENDATIONS FOR FUTURE ACTIONS The following actions are recommended to support and promote recovery of pondberry. Use of a numbered list for these recommendations is for convenient reference and does not necessarily imply prioritization of any action over others. 1. Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. 2. Manage habitat—particularly on conservation lands—to promote pondberry population growth and persistence throughout the species' range, including removal of competing vegetation, control of invasive species (plants and animals, such as wild hogs), and experimental manipulations of overstory canopy to determine optimal light conditions. 3. Further study and characterize potential threats posed by laurel wilt disease. Identify methods and management practices to limit this disease's potential to negatively impact pondberry and its associated habitats. 4. Continue and expand conservation genetics work to include all populations and determine effective population sizes. 5. Define what characterizes a "self-sustaining" pondberry population. 6. Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock to represent all populations, with increased emphasis placed on preserving and safeguarding individual genets within and across populations. 7. Study the feasibility of and necessary methodology to augment genetically depauperate and sexually limited populations. 8. Form recovery team to update the recovery plan, which will incorporate and address recent advances in our knowledge and understanding of pondberry genetics, physiology, ecology, threats, and management needs. (USFWS, 2021)

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SPECIES ACCOUNT: *Linum arenicola* (Sand flax)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2016; Southeast Region (R4)(USFWS, 2017)

Physical Description

Linum arenicola is a small, perennial herb that is 35 to 53 cm (14 to 21 in) tall with yellow flowers that are similar in appearance those of a buttercup (Ranunculus spp.). When not in flower, it resembles a short, wiry grass. Plants have one to several stems arising from their base. Leaves are linear in shape, 7– 10 millimeters (mm) (0.3–0.4 in) long, 0.6–1 mm (0.02–0.04 in) wide, and arranged alternately along stems, and they have glands scattered along their edges. Flowers are produced on stems consisting of a few slender, spreading branches. The individual flowers are on small stalks 2 mm (0.08 in) long or shorter. The flowers have five yellow, egg-shaped petals that are 4.5–5.5 mm (0.18–0.22 in) long, and five green, lance-shaped to egg-shaped sepals that are 2.4–3.2 mm (0.09–0.13 in) long. The seeds are ovate, 1.2– 1.4 mm (0.05–0.06 in) long, and 0.7- 0.8 mm (0.027–0.031 in) wide (Rogers 1963, pp. 103–104) (USFWS, 2015). The fruit is an elongate pod, roughly similar to that of a pea, 33–45 millimeters (mm) (1.3–1.8 inches (in)) long and 4.5–5.0 mm (0.19–0.17 in) wide, with a soft fuzzy texture, which turns gray with age and eventually splits open to release seeds (Irwin and Barneby 1982, p. 757; Small 1933, pp. 662–663) (USFWS, 2016).

Taxonomy

Linum arenicola was first described by Small in 1907 as Cathartolinum arenicola from plants he collected in Miami-Dade County in 1904. This treatment was consistently followed by Small (1913a, p. 69; 1913b, p. 96; 1933, p. 752). In 1931, Winkler included Cathartolinum within the genus Linum, renaming the plants Linum arenicola (Winkler 1931, p. 30). Others have followed this treatment, including Rogers (1963, p. 103), Long and Lakela (1971, p. 505), Robertson (1971, p. 649), Wunderlin (1998, p. 100), and Wunderlin & Hansen (2003, p. 100) (Hodges and Bradley 2006, p. 37). Synonyms include Cathartolinum arenicola Small (Wunderlin and Hansen 2004, p. 5). The Integrated Taxonomic Information System (2015, p. 1) uses the name Linum arenicola and indicates that this species' taxonomic standing is accepted. The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2008, p. 1) uses the name L. arenicola. There is consensus that L. arenicola is a distinct taxon. We have carefully reviewed the available taxonomic information to reach the conclusion that the species is a valid taxon (USFWS, 2015).

Historical Range

The historical range of Linum arenicola consists of central and southern Miami-Dade County and Monroe County in the lower Florida Keys (Bradley and Gann 1999, p. 61). In Miami-Dade County, records for the species were widespread from the Coconut Grove area to the southern part of the County, close to what is now the main entrance to Everglades National Park and Turkey Point (Bradley and Gann 1999, p. 61). In the Florida Keys (Monroe County), there are records of the species from Big Pine Key, Ramrod Key, Upper and Lower Sugarloaf Keys, Park Key, Boca Chica Key, Middle Torch Key (Bradley and Gann 1999, p. 61), and Big Torch Key (Hodges 2010, p. 10) (USFWS, 2015).

Current Range

The current range of Linum arenicola consists of eight extant populations in Miami-Dade County and four islands in the Florida Keys: Big Pine Key, Upper and Lower Sugarloaf Keys, and Big Torch Key (USFWS, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual

Breeding Season

Adult: Flowers are produced from February to September, with a peak around March and April

Reproduction Narrative

Adult: Little is known about the life history of Linum arenicola, including pollination biology, seed production, or dispersal. Reproduction is sexual, with new plants generated from seeds. The species produces flowers from February to September, with a peak around March and April. L. arenicola population demographics or longevity have not been studied (Bradley and Gann, 1999, p. 65; Hodges and Bradley 2006, p. 41; Hodges 2007, p. 2).

Habitat Type

Adult: Temporary pools; Forest/Woodland, Old field, Woodland - Conifer, Woodland - Mixed

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2015)

Habitat Narrative

Adult: Pine Rocklands: Linum arenicola occurs in pine rocklands, disturbed pine rocklands, dry marl prairie, and disturbed areas on rocky soils adjacent to these habitats (Bradley and Gann 1999, p. 61; Hodges and Bradley 2006, p. 37). L. arenicola grows in thin soil over limestone or in small soil patches caught in surface irregularities of exposed limestone (Kernan and Bradley, 1996, p. 2). Sites most likely to support L. arenicola have a grass- and herbdominated understory, abundant pine regeneration, and high cover of exposed rock (Ross and Ruiz 1996, pp. 5–6). The pine rocklands and marl prairies where this species occurs require periodic fire to maintain an open, shrub-free subcanopy, and to reduce litter levels (Bradley and Saha 2009, p. 4). Pine rocklands habitat is described in detail for Chamaecrista lineata var. keyensis, above. Roadsides and Other Disturbed Sites: While pine rocklands historically were the primary habitat of Linum arenicola, the species is currently rare in relatively undisturbed pine rocklands, with the exception of plants on Big Pine Key. Several occurrences are in scraped (scarified) pine rocklands remnants that are dominated by native pine rocklands species, but have little or no pine canopy or subcanopy (Bradley and Van Der Heiden 2013, pp. 9–12). Two populations in Miami-Dade County occur entirely on levees composed of crushed oolitic limestone that are surrounded by sawgrass marsh (Bradley and Gann 1999, p. 61; Bradley and Van Der Heiden 2013, pp. 7–9). Roadsides and other disturbed sites are important habitat for L. arenicola

because they imitate upland herbaceous habitat (Hodges and Bradley 2006, p. 40). The most robust roadside populations occur in areas adjacent to pine rocklands or rockland hammocks (Hodges 2010, p. 3). Where L. arenicola is found on roadsides, the ground cover is dominated mostly by native herbs and grasses where exotic lawn grasses have not been planted (Bradley 2006, p. 37). Infrequent mowing of some roadsides, and of disturbed sites such as Homestead Air Reserve Base (HARB) and U.S. Special Operations Command South Headquarters (SOCSOUTH), a unified command of all four services in the Department of Defense (DOD) has likely allowed the species to persist by preventing these sites from being taken over by hardwoods. Because Linum arenicola seems to only rarely occur within intact pine rocklands, but more frequently adjacent to this habitat, developing conservation and management plans for this species is exceptionally difficult. Its persistence on roadsides is not fully understood. L. arenicola was at one time more common in pine rocklands in Miami-Dade County, but a lack of periodic fires in most pine rocklands fragments over the last century have pushed this species into more sunny, artificial environments (Bradley and Gann 1999, p. 61). It is also possible that the species has evolved to persist along roadsides as fire regimes and natural areas were altered and destroyed over the last century (Hodges and Bradley 2006, p. 41). Dry Marl Prairie: Marl prairie is a sparsely vegetated, grass-dominated community found on marl substrates in South Florida. Marls are fine, white, calcareous muds formed from calcite precipitated by a mixture of green algae, blue green algae, and diatoms, known as periphyton. It is seasonally inundated (2 to 4 months) to a shallow depth averaging about 20 cm (8 in). Marl prairie is a diverse community that may contain over 100 species. Marl prairie normally dries out during the winter and is subject to fires at the end of the dry season (FNAI 2010, p. 1). Occurrences reported from marl prairie are at sites that have been artificially drained (Bradley and Van Der Heiden 2013, p. 11), or are scraped pine rocklands that function more like marl prairie (Kernan and Bradley 1996, p. 11). As with roadside populations of Linum arenicola, it is possible that dry marl prairies have become refugia for the species as fire regimes and natural areas were altered and destroyed over the last century. Accordingly, the Service does not consider marl prairie to be a primary habitat for L. arenicola (USFWS, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

In the 5 populations where data are sufficient to assess trend, 3 appear stable and 2 appear declining

Number of Populations:

15 extant; 14 presumed extant (USFWS, 2024)

Population Narrative:

The large area of potential habitat and scarcity and diminutive size of L. arenicola make thorough surveys for this species difficult (Hodges and Bradley 2006, p. 37). Based on a compilation of all survey work through 2013, including Austin (1980), Kernan and Bradley (1996, pp.1– 30), Bradley and Gann (1999, pp. 61– 65), Hodges and Bradley (2006, pp. 37– 41), Bradley and Saha (2009, p. 10), Bradley (2009, p. 3), Hodges (2010, pp. 4–5, 15), Bradley and van der Heiden (2013, pp. 6–12,19), and Bradley et al. (2015, pp. 28–29), of 26 historical population records for Linum arenicola, 12 populations are extant and 14 are extirpated, a loss of roughly

54 percent of known populations, from the early 1900s to the present. reliable population trends can be derived from past surveys for 5 of the 12 extant populations. Populations on Big Pine Key and Big Torch Key have shown clear declines. Three populations appear to be stable (data suggest they have not declined appreciably). Data are insufficient to determine trends for the remaining seven populations. The data also show that 5 of the 12 extant populations are rather small, having fewer than 100 plants. Currently there are 15 extant populations and 14 presumed extirpated populations (USFWS, 2024).

Threats and Stressors

Stressor: Habitat loss, fragmentation, and degradation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Habitat loss, fragmentation, and degradation, and associated pressures from increased human population, are major threats; these threats are expected to continue, placing these plants at greater risk. The species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitat conditions. Any populations of this species found on private property could be destroyed by development; the limited pine rocklands, rockland hammock, and coastal berm habitat on public lands can also be affected by development of recreational facilities or infrastructure projects. Although efforts are being made to conserve publicly and privately owned natural areas and apply prescribed fire, the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat. Therefore, based on the best information available, we have determined that the threats to the species from habitat destruction, modification, or curtailment are occurring throughout the entire range of the species and are expected to continue into the future (USFWS, 2015).

Stressor: Disease or Predation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: No diseases or incidences of predation have been reported for Chamaesyce deltoidea ssp. serpyllum or Argythamnia blodgettii. Key deer are known to occasional browse plants indiscriminately, including Chamaecrista lineata var. keyensis and Linum arenicola. Key deer do not appear to feed on Argythamnia blodgettii, probably due to potential toxicity (Hodges and Bradley 2006, p. 19). Seed predation by an insect occurs in Chamaecrista lineata var. keyensis, and seems to be exacerbated by habitat fragmentation. Individuals at the urban edge suffer higher insect seed predation than those inside the forest (Liu and Koptur 2003, p. 1184). While seed predation and occasional Key deer browsing may be a stressor, they do not appear to rise to the level of threat at this time. Therefore, the best available data do not indicate that disease or predation is a threat to Chamaecrista lineata var. keyensis or Linum arenicola (USFWS, 2015).

Stressor: The Inadequacy of Existing Regulatory Mechanisms (USFWS, 2015)
Exposure:
Response:

Consequence:
Narrative: Currently, Chamaecrista lineata var. keyensis, Chamaesyce deltoidea ssp. serpyllum, Linum arenicola, and Argythamnia blodgettii are found on Federal, State, and County lands; however, there is no regulatory mechanism in place that provides substantive protection of habitat or protection of potentially suitable habitat at this time. NPS and USFWS Refuge regulations provide protection at ENP and the Florida Keys Wildife Refuge Complex, respectively. The Act provides some protection for candidate species on NWRs and during intraService section 7 consultations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The NFC program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations (as described above) that reduce its ability to protect the four plants and their habitats. Although many populations of the four plants are afforded some level of protection because they are on public conservation lands, existing regulatory mechanisms have not led to a reduction or removal of threats posed to these plants by a wide array of sources (see discussions under Factor A, above, and Factor E, below) (USFWS, 2015).

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: We have analyzed threats from other natural or manmade factors including: nonnative, invasive plants; management practices used on roadsides and disturbed sites (such as mowing, sodding, and herbicide use); pesticide spraying and its effects on pollinators; environmental stochasticity; effects from small population size and isolation; and the effects of climate change, including SLR. The related risks from hurricanes and storm surge act together to impact populations of all four plants. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and county land managers. Many of the remaining populations of these plants are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants (USFWS, 2015).

Recovery

Reclassification Criteria:
Not available- this species does not have a recovery plan.

Recovery Priority Number: 5

Conservation Measures and Best Management Practices:

- Recovery Activities • Work with land managers to incorporate conservation mowing regimes beneficial to the species. • Conduct or continue to conduct habitat restoration on all occupied sites, including (a) removal of native hardwoods and non-native invasive plants and (b) establish a prescribed burn or mowing regimen. • Coordinate with the South Florida Water Management District (SFWMD) and other partners conducting Everglades restoration projects in and around the L-31E and nearby intersecting canals to ensure that sand flax is not impacted or that mitigation occurs. • Develop a captive propagation and reintroduction plan for the species that assesses risks

and guides future introductions. o Determine if translocations may be beneficial to occupy suitable habitat. o Assess reintroduction locations where sand flax has been extirpated. o Consider prioritizing augmenting populations that have less than ten plants to ensure population survival and genetic exchange. o Assess collections currently in seed banks and prioritize new locations for collection for seed banking with a focus on those that are not yet represented or are under-represented in storage. • Establish best horticultural practices for ex situ cultivation. • Acquire land or develop conservation agreements in occupied habitat or unoccupied suitable habitat. • Rescue sand flax in cases where development is scheduled. • Discuss potential for reducing pesticides use in and around areas with this species with local mosquito control districts. Monitoring and Research Activities • For all populations with fewer than 100 individuals, monitor at least once per year. • Research the possibility of hybridization with other species of Linum, namely L. medium and L. floridanum before reintroduction to northern portions of the range. • Conduct genetic research to determine the amount of genetic variation between and within populations. • To determine how long viability is retained in storage, re-test seeds that Fairchild has banked at 5 years and repeat tests every 5 years thereafter. • Further investigate impacts of pesticides on pollination rates. Outreach Activities • Increase public awareness and appreciation for native plants and habitats. o Attend public events when appropriate to improve community understanding of management techniques and policies, such as prescribed fire, in pine rockland habitats (USFWS, 2024).

References

USFWS. 2015. Endangered Species Status for Chamaecrista Lineata Var. Keyensis (Big Pine Partridge Pea), Chamaesyce Deltoidea Ssp. Serpyllum (Wedge Spurge), and Linum Arenicola (Sand Flax), and Threatened Species Status for Argythamnia Blodgettii (Blodgett's Silverbush)

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USFWS. 2024. Sand Flax (Linum arenicola) 5-Year Status Review: Summary and Evaluation. Southeast Region. Florida Ecological Services Field Office. Vero Beach, Florida. 16 pp.

SPECIES ACCOUNT: *Linum carteri carteri* (Carter's small-flowered flax)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/06/2014; Southeast Region (R4) (USFWS, 2015)

Physical Description

Annual or short-lived perennial herb with an erect stem, 230–360 millimeters (mm) (9.0–14.2 inches (in)) tall, commonly branched near the base and puberulent (covered with minute hairs). Its leaves are slender (18–26 mm (0.7–1.0 in) long and 0.8–1.2 mm (0.03– 0.05 in) wide), entire, alternate, and closely overlap at the base of the plant. This variety has stipules with paired dark glands. Its inflorescence is an ascending or spreading cyme (usually flat-topped or convex flower cluster in which the main axis and each branch end in a flower that opens before the flowers below or to the side of it), with yellow petals that are broadly obovate (egg-shaped), 9–17 mm (0.35– 0.67 in) long, and quickly deciduous. The fruit is straw-colored, ovoid, 4.1– 4.6 mm (0.16–0.18 in) long, 3.4–3.7 mm (0.13–0.15 in) in diameter, and dehisces (opens spontaneously at defined places) into five two-seeded segments; seeds are narrowly ovoid-elliptic, 2.3–2.8 mm (0.09–0.11 in) long, 1.0–1.3 mm (0.04– 0.05 in) wide. In habit and flower, the plant closely resembles Piriqueta cistoides ssp. caroliniana (pitted stripeseed) in the family Turneraceae (USFWS, 2014).

Taxonomy

In the order Laurales, family Lauraceae (Flax family). Linum carteri was named by Small in 1905; in 1907, he put it in a segregate genus, calling it Cathartolinum carteri. In 1963, Rogers renamed the plants as a variety of Linum rigidum, noting the close relationship of Florida plants to those in the Western United States. In 1968, he split the taxon into two varieties, calling pubescent plants Linum carteri var. carteri, and segregating the glabrous plants as Linum carteri var. smallii, basing the division on new genetic data from Mosquin and Hayley (1967) and his own morphological data (Bradley and Gann 1999). L. c. var. carteri was treated as endemic to Miami-Dade County, while L. c. var. smallii was slightly more widespread in southern Florida . ITIS (2013) uses the name Linum carteri var. carteri and indicates that this species' taxonomic standing is accepted. Based upon the best available scientific information, Linum carteri var. carteri is a distinct taxon, endemic to Miami-Dade County in Florida. (USFWS, 2013)

Historical Range

First collected in 1903 between the Coconut Grove and Cutler areas of Miami, Florida, and since that time, it has been found in pine rocklands from as far north as the Brickell Hammock area to as far south as the Naranja area (USFWS, 2013).

Current Range

Currently found in eastern Miami-Dade County, Florida, from R. Hardy Matheson Preserve (near Pinecrest) southwest to Naranja/ Modello, with a distance of approximately 27.3 km (17 mi) between the farthest locations (USFWS, 2013).

Critical Habitat Designated

Yes; 9/16/2015.

Legal Description

On August 17, 2015, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 16, 2015) for Linum carteri carteri (Carter's small-flowered flax) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in Florida (80 FR 49846-49886).

Critical Habitat Designation

The critical habitat designation for Linum carteri carteri includes seven CHUs (49 sub-units) in Miami-Dade County, Florida. This species critical habitat encompasses approximately 2,706 acres (ac) (1,095 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (80 FR 49846-49886)

Unit LCC1: Trinity Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit LCC1 consists of 19 ac (48 ha) in Miami-Dade County. Within Unit LCC1, there are three subunits—LCC1A and LCC1B (primarily County-owned), and LCC1C (combination of State lands and private ownership). The unit is comprised of State lands within Trinity Pineland County Park (4 ac (10 ha)); County lands primarily within Tropical Park and A. D. ‘‘Doug’’ Barnes Park (7 ha (18 ac)); and parcels in private ownership (8 ha (19 ac)). This unit is bordered on the north by SW 24 Street, on the south by the Snapper Creek Expressway (State Road (SR) 878), on the east by SW 67 Avenue, and on the west by SW 87 Avenue.

Unit LCC2: Nixon Smiley Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit LCC2 consists of approximately 113 ha (278 ac) of habitat in MiamiDade County. Within Unit LCC2, there are six subunits (LCC2A–LCC2F) comprising primarily conservation lands and including four larger areas plus two smaller areas. The unit is comprised of State lands within Camp Matecumbe, Tamiami Pineland Complex Addition, and Rockdale Pineland (53 ha (131 ac); County/local lands within Nixon Smiley Pineland Preserve, Tamiami #8 (Nixon Smiley Addition) Pineland, Pine Shore Pineland Preserve, Ron Ehman Park, and Rockdale Pineland Addition (59 ha (147 ac)); and parcels in private or other ownership (<1 ha (<1 ac)). This unit is bordered on the north by SW 104 Street, on the south by SW 152 Street (Coral Reef Drive), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit LCC3: USDA Subtropical Horticultural Research Station and Surrounding Areas, Miami-Dade County, Florida: Unit LCC3 consists of approximately 128 ha (316 ac) of habitat in MiamiDade County. Within Unit LCC3, there are nine subunits (LCC3A–LCC3I), including two larger areas (USDA and Deering Estate at Cutler) plus seven smaller areas surrounding these. The unit is comprised of Federal lands within the USDA Subtropical Horticultural Research Station (59 ha (145 ac)); State lands within the R. Hardy Matheson Preserve, Ludlam Pineland, Deering Estate at Cutler, and Deering Estate South Addition (45 ha (112 ac)); County/local lands within Coral Reef Park, Ned Glenn Nature Preserve, and Bill Sadowski Park (15 ha (38 ac)); and parcels in private ownership (8 ha (21 ac)). This unit is bordered on the north by SW 112 Street, on the south by the intersection of Old Cutler Road and Franjo Road (County Road (CR) 977), on the east by the Atlantic Ocean, and on the west by U.S. 1 (South Dixie Highway).

Unit LCC4: Richmond Pinelands and Surrounding Areas, Miami-Dade County, Florida: Unit LCC4 consists of approximately 386 ha (952 ac) in Miami-Dade County. Within Unit LCC4, there are four subunits (LCC4A–LCC4D), primarily within the Richmond Pinelands complex (made up of Federal and County-owned lands, as well as land owned by the University of Miami). The unit is comprised of Federal lands owned by USCG, ACOE, U.S. Prison Bureau, and NOAA (75 ha (185

ac)); County/local lands within and adjacent to Larry and Penny Thompson Park, Martinez Pineland, Zoo Miami, and Eachus Pineland (240 ha (592 ac)); and parcels in private or other ownership (71 ha (175 ac)). This unit is bordered on the north by SW 152 Street (Coral Reef Drive), on the south by SW 200 St (Quail Drive/SR 994), on the east by U.S. 1 (South Dixie Highway), and on the west by SW 177 Avenue (Krome Avenue).

Unit LCC5: Quail Roost Pineland and Surrounding Areas, Miami-Dade County, Florida: Unit LCC5 consists of approximately 98 ha (242 ac) in Miami-Dade County. Within Unit LCC5, there are 10 subunits (LCC5A–LCC5J), including 4 larger areas plus 6 smaller areas surrounding these. The unit is comprised of State lands within Quail Roost Pineland, Goulds Pineland and Addition, and Silver Palm Groves Pineland (39 ha (97 ac)); County/ local lands including Medsouth Park, Black Creek Forest, Rock Pit #46, and lands owned by the School Board of Miami-Dade County (18 ha (44 ac)); and parcels in private ownership (41 ha (101 ac)), including Porter-Russell Pineland owned by the Tropical Audubon Society. This unit is bordered on the north by SW 200 St (Quail Drive/SR 994), on the south by SW 248 Street, on the east by the Florida Turnpike, and on the west by SW 194 Avenue.

Unit LCC6: Camp Owaissa Bauer and Surrounding Areas, Miami-Dade County, Florida: Unit LCC6 consists of approximately 128 ha (315 ac) of habitat in MiamiDade County. Within Unit LCC6, there are 21 subunits (LCC6A–LCC6U), composed of 1 larger area (Camp Owaissa Bauer and its addition) and 20 smaller areas surrounding it. The unit is comprised of State lands within Owaissa Bauer Pineland Addition, Ingram Pineland, West Biscayne Pineland, and Fuchs Hammock Addition (20 ha (51 ac)); County/local lands including Camp Owaissa Bauer, Pine Island Lake Park, Seminole Wayside Park, and Northrop Pineland (63 ha (156 ac)); and parcels in private ownership (44 ha (109 ac)), including the private conservation area, Pine Ridge Sanctuary. This unit is bordered on the north by SW 248 Street, on the south by SW 312 Street, on the east by SW 112 Avenue, and on the west by SW 217 Avenue.

Unit LCC7: Navy Wells Pineland Preserve and Surrounding Areas, Miami-Dade County, Florida: Unit LCC7 consists of approximately 201 ha (497 ac) of habitat in MiamiDade County. Within Unit LCC7, there are seven subunits (LCC7A–LCC7G), including one larger area (Navy Wells Pineland Preserve) and six smaller outlying areas. The unit is comprised of State lands within Palm Drive Pineland, Navy Wells Pineland #39, Navy Wells Pineland Preserve (portion), and Florida City Pineland (53 ha (132 ac)); County/ local lands including primarily Sunny Palms Pineland and Navy Wells Pineland Preserve (portion) (125 ha (309 ac)); and parcels in private ownership (23 ha (56 ac)). This unit is bordered on the north by SW 320 Street, on the south by SW 368 Street, on the east by U.S. 1 (South Dixie Highway), and on the west by SW 217 Avenue.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Linum carteri carteri critical habitat consists of three components (80 FR 49846-49886):

(i) Areas of pine rockland habitat that contain: (A) Open canopy, semi-open subcanopy, and understory; (B) Substrate of oolitic limestone rock; and (C) A plant community of predominately native vegetation that may include, but is not limited to: (1) Canopy vegetation dominated by Pinus elliottii var. densa (South Florida slash pine); (2) Subcanopy vegetation that may include, but is not limited to, Serenoa repens (saw palmetto), Sabal palmetto (cabbage palm),

Coccothrinax argentata (silver palm), Myrica cerifera (wax myrtle), Myrsine floridana (myrsine), Metopium toxiferum (poisonwood), Byrsonima lucida (locustberry), Tetrazygia bicolor (tetrazygia), Guettarda scabra (rough velvetseed), Ardisia escallonioides (marlberry), Psidium longipes (mangroveberry), Sideroxylon salicifolium (willow bustic), and Rhus copallinum (winged sumac); (3) Short-statured shrubs that may include, but are not limited to, Quercus pumila (running oak), Randia aculeata (white indigoberry), Crossopetalum ilicifolium (Christmas berry), Morinda royoc (redgal), and Chiococca alba (snowberry); and (4) Understory vegetation that may include, but is not limited to: Andropogon spp.; Schizachyrium gracile, S. rhizomatum, and S. sanguineum (bluestems); Aristida purpurascens (arrowfeather threeawn); Sorghastrum secundum (lopsided Indiangrass); Muhlenbergia capillaris (hairawn muhly); Rhynchospora floridensis (Florida white-top sedge); Tragia saxicola (pineland noseburn); Echites umbellata (devil's potato); Croton linearis (pineland croton); Chamaesyce spp. (sandmats); Chamaecrista deeringiania (partridge pea); Zamia integrifolia (coontie); and Anemia adiantifolia (maidenhair pineland fern).

(ii) A disturbance regime that naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat described in paragraph (2)(i) of this entry.

(iii) Habitats that are connected and of sufficient area to sustain viable populations of Linum carteri var. carteri in the pine rockland habitat described in paragraph (2)(i) of this entry.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of Linum carteri var. carteri may require special management considerations or protection to reduce threats related to habitat loss, fragmentation, and modification primarily due to development; inadequate fire management; nonnative, invasive plants; and sea level rise. Destruction of the pinelands for economic development has reduced pine rockland habitat on the Miami Rock Ridge outside of ENP by over 98 percent, and remaining habitat in this area is highly fragmented. Linum carteri var. carteri occurs on a mix of private and publicly owned lands, only some of which are managed for conservation. Populations of the plants that occur on private land or non-conservation public land are vulnerable to habitat loss, while populations on conservation lands are vulnerable to the effects of habitat degradation if natural disturbance regimes are disrupted (e.g., through inadequate fire management). Prolonged lack of fire in pine rockland typically results in succession to rockland hammock, and displacement of native species by invasive, nonnative plants often occurs. Further development and degradation of pine rocklands increase fragmentation and decrease the conservation value of the remaining functioning pine rockland habitat. In addition, pine rocklands are expected to be further degraded and fragmented due to anticipated sea level rise, which would fully or partially inundate some pine rocklands along the coast and in the southern portion of Miami-Dade County (near Navy Wells Pineland Preserve), and cause increases in the salinity of the water table and soils resulting in vegetation shifts in additional pine rocklands across the Miami Rock Ridge. Many existing pine rockland fragments are also projected to be developed for housing as the human population grows and adjusts to changing sea levels. Special management considerations and protections that will address these threats include increased coordination and conservation of these plants and their habitat on

Federal lands, and improved habitat restoration and management efforts (including fire management and nonnative plant treatments) of high-priority and high-elevation sites. (USFWS, 2013)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2013)

Lifespan

Adult: 1 - 2 years (USFWS, 2013)

Breeding Season

Adult: Flowers year-round (USFWS, 2013)

Key Resources Needed for Breeding

Adult: May be pollinated by Insects (USFWS, 2013)

Reproduction Narrative

Adult: The reproductive ecology and biology of Linum carteri var. carteri is not well understood, but reproduction is sexual. This species is capable of flowering throughout the year, but tends to have most abundant flowering and fruiting following rain. While specific pollinators are unknown, flower morphology suggests this variety may be pollinated by butterflies, bees, or both; self-pollination has also been suggested. For adult reproductive plants, average plant growth was fairly constant from July through October, flowering and fruit production were most abundant in July, and plant mortality increased during the fall months (USFWS, 2013).

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Pine rocklands that have undergone some sort of substrate disturbance (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Disturbed areas (e.g. firebreaks, canal banks, edges of railway beds) (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: Elevations of approximately 1.6–4.8 m (USFWS, 2013)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2013)

Habitat Narrative

Adult: Linum carteri var. carteri habitat are areas of pine rockland habitat that contain open canopy, semi-open subcanopy, and understory, a substrate of oolitic limestone rock, and a plant community of predominately native vegetation. A disturbance regime is also present that

naturally or artificially duplicates natural ecological processes (e.g., fire, hurricanes, or other weather events) and that maintains the pine rockland habitat (USFWS, 2014). Its known populations are found at elevations ranging from approximately 1.6–4.8 m (5.2 - 15.9 ft) (USFWS, 2013).

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Unknown (USFWS, 2013)

Dispersal/Migration Narrative

Adult: Dispersers are unknown, although historically water may have played a role in dispersal when summer high- water conditions in adjacent wet prairies may have inundated portions of pine rocklands (USFWS, 2013).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Declining (USFWS, 2014)

Population Growth Rate:

Low (inferred from USFWS, 2014)

Number of Populations:

6 (USFWS, 2023)

Population Size:

~2000 individuals (USFWS, 2023)

Population Narrative:

Only small and fragmented occurrences of L. c. var. carteri remain. Four of the seven remaining populations have fewer than 20 individual plants. There are great differences in plant numbers from year to year, probably because individuals typically live 1–2 years and grow from seed. This trait makes them more vulnerable than perennials to changes in environment. Viable plant populations for small, short-lived herbs may consist of tens of thousands of plants. Indications are that most existing populations are at best marginal (USFWS, 2014). Carter's small-flowered flax is currently known from six occurrences in Miami-Dade County (Table 1). The total number of individual plants during peak months (spring/summer) is approximately 2000 (USFWS, 2023).

Threats and Stressors

Stressor: Habitat loss, fragmentation, and degradation (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Habitat modification caused by development (i.e., conversion to both urban and agricultural land uses) is a primary threat, in addition to habitat modification and degradation through inadequate fire management, which includes both the lack of prescribed fire and suppression of natural fires. Habitat fragmentation reduces the size of plant populations, and increases spatial isolation of remnants (USFWS, 2013)

Stressor: Competition from nonnative invasive plants (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Nonnative plants have significantly affected pine rocklands, and threaten all occurrences of Linum carteri var. carteri to some degree. Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which responds positively to open conditions; the invasive plants also affect the characteristics of a fire when it does occur (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Extreme weather events could be catastrophic on isolated, small populations. The narrow distribution makes them more susceptible to extirpation from a single catastrophic event (USFWS, 2013).

Stressor: Incompatible management practices (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Incompatible management practices (such as no mowing or too-frequent mowing), fire suppression, accidental impacts to populations that grow along preserve edges, illegal dumping, invasive non-native plants, factors stemming from small population sizes, and climate change (USFWS, 2023).

Recovery

Reclassification Criteria:
Not available.

Recovery Priority Number: 6

Delisting Criteria:
Not available.

Recovery Actions:
- Not available.
- Not available

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES In additional to standard monitoring and assessment of the species' status, the highest priority actions recommended for Carter's small-flowered flax are: • Conduct or continue to conduct habitat restoration on all occupied sites, including (a) removal of native hardwoods and non-native invasive plants and (b) establish a prescribed burn regimen. • Acquire and restore habitat at Old Dixie Pineland. • Restore habitat at the Montgomery Botanical Center pineland and the Gifford Arboretum pineland sites. Monitor whether plants emerge from the soil seed bank, and if so, develop a long-term management plan for the sites. • Convert the portion of the USDA Chapman Field Station where the species is found into a managed nature preserve. • Work with land managers to incorporate conservation mowing regimes beneficial to the species • Ensure that populations which are maintained through mowing are not mowed between January and July but are mowed between August and December. • Bank seeds from wild populations, with a focus on those whose seeds were last banked over a decade ago. Additional recommended actions are: • Conduct studies to determine whether Manila grass has negative effects on the species' reproduction or growth. • Conduct additional studies (following Maschinski and Walters 2008) to determine optimal mowing regimes. • Fine-tune horticultural methods for ex situ cultivation. • Research the pollination biology of the species. • Conduct genetic research to determine the amount of genetic variation between and within populations. • Introduce additional metapopulations to suitable habitat at the Deering Estate. • Introduce plants to suitable habitat at Camp Owaissa Bauer. • Determine whether there is potential for additional reintroductions or augmentations (USFWS, 2023).

References

USFWS. 2015. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/speciesProfile/. Accessed April 2016

USFWS. 2013. Proposed Endangered Status for Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax)

Proposed Rule. 78 FR 61273 - 61293 (October 3, 2013). USFWS. 2015. Designation of Critical Habitat for Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax)

Final Rule. 80 FR 49846 - 49886 (August 17, 2015).

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USFWS, 2013. Proposed Endangered Status for Brickellia mosieri (Florida Brickell-bush) and Linum carteri var. carteri (Carter's Small-flowered Flax)

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SPECIES ACCOUNT: *Lipochaeta fauriei* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/25/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Lipochaeta fauriei is a perennial herb with somewhat woody, erect or climbing stems. This short-lived perennial species differs from other species on Kauai by having a greater number of disk and ray flowers per flower head, longer ray flowers, and longer leaves and leaf stalks (Gardner 1976, 1979; Service 1995; Wagner et al. 1985, 1990). (USFWS, 2003)

Taxonomy

Lipochaeta fauriei has been moved into the genus Melanthera by Wagner and Robinson (2001). The five-year review recognized the new generic term, but the official listing has not yet caught up and still uses Lipochaeta. (USFWS, 2010)

Historical Range

Lipochaeta fauriei is restricted to the island of Kauai. It was historically found in Olokele Canyon, but has not been seen in that valley since 1910. Several other populations of M. fauriei have never been relocated, including Hikimoe Valley observed in 1969, the lower drainage of Kawaiiki Valley observed both in 1987 and 1990, and Poopooiki Valley observed in 1987 (Wood 2008). (USFWS, 2010)

Current Range

Lipochaeta fauriei is now known from northwest Kauai at Haeleele Valley, Kalalau Valley, Kawaiiki, Koaie Canyon, Kuia Valley, Mahanaloa, Pohakuao, Poomau Canyon, and Waialae, Wood, 2008). Perlman also reports an occurrence on Waimea Canyon Rim (Perlman 2008). (USFWS, 2010). Island Distribution: Found on Kauai (USFWS, 2021c)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Lipochaeta fauriei on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for Lipochaeta fauriei includes two units totaling 1,609 acres in Kauai County, Hawaii. The units are Kauai 11—Lipochaeta fauriei—a, b.

Kauai 11—Lipochaeta fauriei—a: This unit is critical habitat for Lipochaeta fauriei and is 106 ha (262 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for two populations of 300 mature, reproducing individuals of the short-lived perennial Lipochaeta fauriei and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained

in this unit that are essential for this species include, but are not limited to, sides of steep gulches in diverse mesic forests. This unit is geographically separated from the other unit designated as critical habitat for this island-endemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event. Kauai 11—Lipochaeta fauriei—b: This unit is critical habitat for Lipochaeta fauriei and is 545 ha (1,347 ac) on State land (Kuia NAR). This unit contains portions of Mahanaloa and Kuia Valleys. This unit provides habitat for four populations of 300 mature, reproducing individuals of the shortlived perennial Lipochaeta fauriei and is currently occupied with 70 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, sides of steep gulches in diverse mesic forests. This unit is geographically separated from the other unit designated as critical habitat for this islandendemic species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Although we do not feel that there is enough habitat that currently exists to reach the recovery goal of 8 to 10 populations for this species, this unit is at an appropriate distance from the other unit to avoid their destruction by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Moderate shade to full sun on the sides of steep gulches in diverse lowland mesic forests and containing one or more of the following native species: Acacia koa, Carex meyenii, Carex wahuensis, Dicranopteris linearis, Diospyros spp., Dodonaea viscosa, Euphorbia haeleeleana, Hibiscus waimeae, Kokia kauaiensis, Myrsine lanaiensis, Nestegis sandwicensis, Pleomele aurea, Psychotria greenwelliae, Psychotria mariniana, or Sapindus oahuensis; and

(ii) Elevations between 438 and 948 m (1,438 and 3,108 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrosser (USFWS, 2021c)

Lifespan

Adult: Unknown (USFWS, 2003). Short (USFWS, 2021c)

Dependency on Other Individuals or Species

Adult: Unknown pollinators (USFWS, 2003)

Reproduction Narrative

Adult: Little is known about the life history of Lipochaeta fauriei. Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors are unknown (Service 1995). (USFWS, 2003)

Habitat Type

Adult: Diverse mesic forests (USFWS, 1995)

Habitat Vegetation or Surface Water Classification

Adult: Hardwood forest and woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Specific environmental requirements unknown (USFWS, 1995)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1995)

Environmental Specificity

Adult: Narrow (inferred by limited distribution in USFWS, 1995)

Site Fidelity

Adult: High (inferred from USFWS, 1995)

Habitat Narrative

Adult: This species most often grows in moderate shade to full sun and is usually found on the sides of steep gulches in diverse lowland mesic forests at an elevation of about 480 to 900 meters (1,570 to 2,950 feet). The associated native plant taxa include lama and Hibiscus waimeae (kokio keokeo) and associated alien plants include basketgrass, kukui and lantana (USFWS 1994a). (USFWS, 1995)

Dispersal/Migration

Dispersal

Adult: Unknown (USFWS, 2003)

Dispersal/Migration Narrative

Adult: The seed dispersal agents for Lipochaeta fauriei are unknown (USFWS, 2003)

Population Information and Trends

Population Trends:
Apparently stable (USFWS, 2010)

Species Trends:
Apparently stable (USFWS, 2010)

Number of Populations:
3 (USFWS, 2022)

Population Size:
~150 (USFWS, 2022)

Adaptability:
Low (USFWS, 2010)

Population Narrative:
Melanthera [=Lipochaeta] fauriei is now known from 10 populations with an estimated total of 185 to 240 individuals, based on the last survey dates ranging from 1991 to 2010 for the various populations. An increase in population numbers and individuals since listing is attributable to increased surveys. The overall numbers of individuals remain low, where in some locations there are less than 10 individuals; the largest population is 50-70 individuals. (USFWS, 2010). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • Melanthera fauriei has been reported from one new location on Kauai since the time of the last 5-year review in 2010; an occurrence of ten individuals in Makaha Valley (NTBG 2014a, c). Current populations at four previously known sites are Koaie (two individuals), Kuia (two individuals), Waialae (about 30 individuals), and Waimea Canyon Rim (southeast of Kukui Peak) (more than 50 individuals) (NTBG 2011, 2013ab, 2014a-e, 2015a-c; PEPP 2015). There are no current reports regarding populations at Haeleele, Kalalau, Kawaiiki, Mahanaloa, Pohakuao, and Poomau. • Walsh (2015) reports ten "subpopulations" (considered as populations or occurrences by USFWS) totaling 222 individuals, with the largest population consisting of 50 individuals. It is uncertain how many are mature. • In 2001, Wagner and Robinson transferred 14 Hawaiian Lipochaeta to the genus Melanthera, including Lipochaeta fauriei. This change in genus has been recognized in the most recent treatment of the Hawaiian flora (Wagner and Herbst 2003; Wagner et al. 2012) (USFWS, 2017). Currently, there are estimated to be 150 wild individuals of Lipochaeta fauriei on Kaua'i. NTBG and PEPP monitor the areas where L. fauriei occurs. 3 populations (USFWS, 2022)

Threats and Stressors

Stressor: Non-native invasive species (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The major threats to Lipochaeta fauriei are degradation of its habitat by feral goats and competition with invasive alien plant taxa, especially lantana. Feral pigs pose a potential threat to the species. (USFWS, 1994)

Stressor: Small numbers (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: The small total number of individuals comprises a threat of stochastic extinction and/or reduced reproductive vigor to this species (USFWS 1994a). (USFWS, 1995)

Stressor: Fire (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Fire is a significant threat because Lipochaeta fauriei occurs with molasses grass, a fire-adapted alien grass. (USFWS, 1995)

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Melanthera fauriei is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.82 (on a scale of 0 to 1). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:
A total of five to seven populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Number of populations and individuals needed to meet Preventing Extinction Stage based on population and life history characteristics. Number of Populations 3. Mature Individuals per Population 100. (USFWS, 2021c) Number of populations and individuals needed to meet Interim Stage based on population and life history characteristics. Number of Populations 3. Mature Individuals per Population 600. (USFWS, 2021c) Number of populations and individuals needed for Downlisting based on population and life history characteristics. Number of Populations 10. Mature Individuals per Population 1,000. (USFWS, 2021c)

Recovery Priority Number: 5

Delisting Criteria:
A total of eight to ten populations should be documented on Kauai. (USFWS, 1995)

Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1995)

Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1995)

Number of populations and individuals needed for delisting based on population and life history characteristics. Number of Populations 10. Mature Individuals per Population 1,000. (USFWS, 2021c)

Recovery Actions:
- Protect current populations, control threats and monitor. (USFWS, 1995)
- Expand current populations. (USFWS, 1995)
- Conduct research essential to conservation of the species. (USFWS, 1995)
- Establish new populations as needed to reach recovery objectives. (USFWS, 1995)
- Validate and revise recovery objectives. (USFWS, 1995)
- Devise and implement a public education program. (USFWS, 1995)
- New Management Actions: • Population viability monitoring and analysis—PEPP is surveying for new populations and monitoring known populations on Kauai (PEP 2015). • Captive propagation for genetic storage and reintroduction—There are 24 plants from one collection at the Kokee Rare Plant Facility (DOFAW 2016). There are seeds in the NTBG seed bank from two different collections (NTBG 2017) (USFWS, 2017).
- Recommendations for Future Actions: The following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey formerly identified locations for current status of the species. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Continue to construct and maintain fenced exclosures around all populations. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Predator and herbivore monitoring and control— o Study Melanthera fauriei populations to determine level of threat from invertebrate herbivory, including the black twig borer, and any additional recovery actions needed. o Control rodents around existing populations. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Reintroduce individuals into protected suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study Melanthera fauriei populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Fire monitoring and control—Develop and implement fire-management plans for all wild and reintroduced populations. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts

from landslides. • Federal Register updates—Update the listed entity on 50 CFR 17.12 to match the currently recognized taxonomy as Melanthera fauriei (USFWS, 2017).

- Protect all occurrences against trampling, browsing, and disturbances from feral ungulates. (USFWS, 2010)
- Control introduced invasive plant species around wild plants. (USFWS, 2010)
- Survey formerly identified locations for current status of species. (USFWS, 2010)
- Assess the genetic variability of extant populations. (USFWS, 2010)
- Work with Hawaii Division of Forestry and Wildlife and Hawaii State Parks to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2010)
- Investigate techniques to improve natural recruitment. (USFWS, 2010)
- Update the listed entity on 50 CFR 17 to match the currently recognized taxonomy. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No new threats and no significant new information regarding the species' biological status have been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated or updated for the 5-year review for 2022. • Surveys and inventories—Continue to survey for populations of Lipochaeta fauriei in areas of potentially suitable habitat and monitor known populations to determine their current status. • Ungulate monitoring and control—Continue to construct and maintain exclosures to protect all occurrences from habitat disturbance and herbivory by feral ungulates. • Nonnative invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with L. fauriei at all populations. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to impacts of climate change. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Predator and herbivore monitoring and control— o Implement effective control methods for rodents at all known populations. o Determine level of threat from invertebrate herbivory and the need for additional recovery actions. • Captive propagation for genetic storage and reintroduction—Continue collection of seeds and propagative materials for storage and for maintenance of genetic stock. • Reintroduction and augmentation—Reintroduce individuals into protected suitable habitat within historic range that is being managed for known threats to this species. • Population biology and genetic research—Study L. fauriei populations to determine viable population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal mechanisms, longevity, specific environmental requirements, limiting factors, and threats. • Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historical range to reduce impacts from landslides and hurricanes through reintroduction and habitat restoration to increase the species' viability. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species.

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SPECIES ACCOUNT: *Lithophragma maximum* (San Clemente Island woodland-star)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/07/1997; Pacific Southwest (R8)

Physical Description

Lithophragma maximum flowers from April to June (California Native Plant Society 2001). It is a rhizomatous (bearing horizontal subterranean stems), perennial herb with basal leaves and two or three stout flowering stems from 40 to 60 centimeters (cm) (16-24 inches (in.)) high. Each flower bearing stem produces 20 or more white to pinkish, bisexual, campanulate (bell shaped) flowers, each about 1 cm (0.5 in.) in length (Bacigalupi 1963; Junak and Wilken 1998). The fruit is a 3-valved capsule with numerous seeds (Bacigalupi 1963). The leaves are palmately compound (with the blade divided into leaflets that radiate from a common point) and arise from the base on slender petioles 15 cm. (6 in.) long. (USFWS, 2007)

Taxonomy

A member of the saxifrage family (Saxifragaceae). The species was described in 1963 from a single pressed herbarium specimen (Bacigalupi 1963). In 1978, living plants were rediscovered in Eagle and Bryce Canyons. (USFWS, 1984) Lithophragma maximum is the only species within its genus known to occur on San Clemente Island (U. S. Department of the Navy 2001) (USFWS, 2007).

Historical Range

In California (Los Angeles County), endemic to the east side of San Clemente Island, only in canyons (US Navy land) (USFWS, 2007).

Current Range

On San Clemente Island, Los Angeles County, California. Restricted and dissected distribution with one major concentration of plants in the branched canyons north of Mosquito Cove Canyon, a small to moderate sized population in Mosquito Cove Canyon, and three very small peripheral populations in the canyons at the southern and northern limits of its range. (USFWS, 2007)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015); asexual: vegetative (USFWS, 2007)

Lifespan

Adult: 2+ years (NatureServe, 2015)

Breeding Season

Adult: April - June (USFWS, 2007)

Key Resources Needed for Breeding

Adult: Insect pollinators, especially moths, based on closely related species (USFWS, 2007)

Reproduction Narrative

Adult: This species is a perennial. Nectary disk often present in the family. Seeds are numerous and small. Reproduction is sexual (NatureServe, 2015). It flowers from April to June (California Native Plant Society 2001). Most of what is known is inferred from studies of other species in the genus. White, sometimes scented flowers within Lithophragma suggest plants may rely on moths for pollination (Taylor 1965; Kellogg and Kellogg 1994). During three years of field work, one genus of moth (Lampronia) and four genera of bees (Andrena, Apis, Osmia and Chloralictus) were collected during a study of several species of Lithophragma (Taylor 1965). Based on its growth habit and knowledge of vegetative reproduction in other Lithophragma, L. maximum is likely capable of vegetative reproduction via rhizomes and bulblets (Bacigalupi 1963; Taylor 1965; U. S. Department of the Navy 2001). Studies to characterize sexual reproduction in the genus found that of seven species studied (including two subspecies of one species, for a total of eight taxa), four were entirely self-incompatible and the remaining species were partially so, with just 12-50 percent seed set resulting from self-pollination (Taylor 1965). Evidence that a self-incompatibility system operates within the genus suggests that L. maximum may also be partially or completely self-incompatible (Taylor 1965; Junak and Wilken 1998). Helenurm (1998) found seed germination and seedling survival rates under greenhouse conditions to be very low. A 1998 effort at the Rancho Santa Ana Botanic Gardens to grow plants from seed obtained about 3 percent germination success, resulting in the propagation of 6 plants from 350 seeds (C. Ames pers. comm. 2006) (USFWS, 2007).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal bluff scrub and coastal scrub (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 400 - 1,200 ft. elevation (USFWS, 2007)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Possibly Lyonothamnus floribundus ssp. aspleniifolius (USFWS, 2007)

Habitat Narrative

Adult: Inhabits coastal bluff scrub and coastal scrub. Persists on moist, shaded, north-facing canyon walls. The plants may also have occupied a plateau area before the introduction of non-native grasses. The environmental specificity is very narrow; it is only known from three canyons on San Clemente Island (NatureServe, 2015). Plants are generally found in shady conditions on

ledges on canyon walls and on gentle north-facing slopes in moist canyon bottoms between elevations of 120 to 366 meters (m) (400-1200 feet (ft.)) (Junak and Wilken 1998; Junak 2006; S. Junak pers. comm. 2006). Soils are usually at least vernally moist and are generally loams of varying depth that are derived from rock of volcanic origin (Ferguson and Beauchamp 1981; Junak pers. comm. 2006). A number of populations are found downslope from sizable groves of Lyonothamnus floribundus ssp. aspleniifolius (Santa Cruz Island ironwood), suggesting a possible association with this species (Junak and Wilken 1998; S. Junak pers. comm. 2006) (USFWS, 2007).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are assumed wind dispersed (NatureServe, 2015).

Population Information and Trends

Number of Populations:

33 (USFWS, 2020)

Population Size:

2 - 363 (USFWS, 2020)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

The most-recently compiled survey data show that 33 distinct point localities have been identified since 1979 within eight canyons with a highly variable number of plants being observed over time. Site-visits have been conducted on an irregular basis with most sites being visited fewer than five times (SERG 2016, p. 35). Reports from 1979 to 2016 suggest that Lithophragma maximum is patchily distributed on steep canyon slopes and total annual census numbers across the range varied between 2 and 363 plants (SERG 2016, p. 35). Plants were more consistently observed at a smaller subset of these point localities (most plants reported from 5 of these 33 localities); most survey results report no plants being found (SERG 2016, p. 35). It is unclear whether null values represent true extirpation from a locality or merely that plants were unobserved as they are very difficult to detect when not flowering. We have little demographic information on this species; the age of plants has often been recorded as an adult or mature age-class, although young plants have also been observed indicating that plants grow from seed on occasion. Therefore, although increasingly more plants have been found since 1978, all populations are small, ranging from 4 to a maximum of approximately 100 individuals (Furches et al. 2009, p. 117). However, census numbers may not reflect actual population sizes given the inability to make a population- wide census due to terrain and low-detectability of plants. Due to difficulty in accessing the terrain, infrequent and irregularly conducted surveys, and difficulty in detecting plants, it is not possible to draw conclusions from the available information about demographic status of population trajectory. (USFWS, 2020)

Threats and Stressors

Stressor: Erosion (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The decline of L. maximum and the decline of all of San Clemente's endemic flora is primarily attributed to the introduction of non-native animal and plant species by Euro-Americans during the last 200 years (62 FR 42692). Goats (Capra hircus) were present on San Clemente Island as early as 1827 (Dunkle 1950), and sheep (Ovis aries) were introduced around 1868 (Kellogg and Kellogg 1994). Other large-stature herbivores historically introduced to San Clemente Island included cattle (Bos taurus), pigs (Sus scrofa), and mule deer (Odocoileus hemionus) (62 FR 42692). In particular, ranching of sheep and, following their removal, proliferation of goats led to severe overgrazing, trampling of vegetation, and denudation of the island (O'Malley 1994; Dunkle 1950). With intensive grazing pressure leading to near complete consumption of grasses, sheep and goats fed on less palatable shrubs and trees causing a tremendous loss of shrub and tree cover (Kellogg & Kellogg 1994; O'Malley 1994). Creation of bare trails and denuded areas led to severe erosion causing the stripping of vegetation and soil. Accelerated erosion was likely exacerbated by reduction in vegetation cover associated with periods of drought and fire (Johnson 1980). Loss of soil within island woodlands along the eastern escarpment where L. maximum occurs has led to much root exposure and subsequent death of trees (Kellogg and Kellogg 1994) (USFWS, 2007).

Stressor: Nonnative plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Exotic species have potential to compete with L. maximum for space or other resources such as light, water, and nutrients. Exotic invasives can also alter habitat structure, ecological processes such as nutrient cycling (Zink et al. 1995), and the prevalence of fire (Brooks 1999). By 1992, 99 exotic species were documented as occurring on San Clemente Island (Kellogg and Kellogg 1994), with many of them having become naturalized and a significant component of island habitats. Since then, new exotics continue to be discovered, which may represent new introductions from military personnel, vehicles, and/or equipment (e.g., Schismus sp., Brassicae tournefortii) (J. Dunn pers. comm. 2006; E. Kellogg pers. comm. 2006; S. Junak pers. comm. 2006). Although no single invasive non-native plant species has been identified as posing a specific competitive threat to this species, invasive annual grasses may pose the biggest threat over the long term (S. Junak pers. comm. 2006) due to their ability to rapidly colonize and exploit many different microhabitats. Ripgut grass (Bromus diandrus) is one of several exotic plant species that have been found to co-occur with L. maximum (Junak and Wilken 1998) (USFWS, 2007).

Stressor: Military training activities (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: San Clemente is owned by the U. S. Department of the Navy. With its associated offshore range complex, it is the primary maritime training area for the Navy Pacific Fleet Navy Sea, Air, and Land (SEALS), and it supports training by the U. S. Marine Corps, the U. S. Air Force, and others. As the last range in the eastern Pacific Basin where many training operations are

performed prior to troop deployments, portions of the island receive intensive use. Associated with training operations is an elevated risk of fire (e.g. 117 wildfires that burned 10,645 ha/26,304ac. were recorded on San Clemente Island between 1990 and 2001: U. S. Department of the Navy 2001). The distribution of L. maximum occurs entirely within the Shore Bombardment Area (SHOBA) on San Clemente Island. SHOBA encompasses approximately the southern one-third of the island and supports a variety of training operations involving both live and non-live munitions fire (U. S. Department of the Navy 2001) (USFWS, 2007).

Stressor: Stochastic events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Because L. maximum is an insular endemic species that is narrowly distributed within only five canyons on San Clemente Island, the species is vulnerable to a number of stochastic factors such as demographic stochasticity, environmental stochasticity, genetic stochasticity, and natural catastrophes (Shaffer 1981) (USFWS, 2007).

Stressor: Access to SHOBA (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Because SHOBA is used for ship-to-shore bombardment, as well as other munitions training exercises, access to this area is often restricted for non-military personnel. These restrictions can influence both the timing and locations where access is granted. This access limitation and the lead time needed for range scheduling can undermine the effectiveness of surveys and invasive species control efforts by limiting the ability to time these activities during optimal times in the life cycle of target organisms (e.g., spraying herbicide prior to an invasive plant setting seed) (USFWS, 2007).

Recovery

Reclassification Criteria:
Downlisting of San Clemente Island woodland star may be considered when all of the following criteria have been met to address threats to the species: (USFWS, 2019)

A.1: Habitat loss from invasive herbivores is effectively managed and recovery of native vegetation is evident where San Clemente Island woodland star occurs. (USFWS, 2019)

A.2: A survey methodology is developed which identifies encroaching vegetation and allows tracking of persistence of San Clemente Island woodland star over time and relative changes in abundance at some selected number of occurrences; the locations will be determined based upon feasibility of maintaining consistent access. Information is quantitative in nature and includes a standardized estimate of abundance at occurrences that can be tracked over time, and indicators of demographic status (e.g., flowering; production of viable seed; relative estimated age of plants within the monitored occurrence; evidence of fruit or seed depredation; potential pollinators). (USFWS, 2019)

A.3: The response of San Clemente Island woodland star to fire is assessed and monitored post burn to measure persistence. (USFWS, 2019)

E.1: A minimum of five canyons support San Clemente Island woodland star as demonstrated with persistence of at least one occurrence per canyon for a minimum of 10 years through consistent monitoring. Grove, Keco, and Mosquito canyons are included as three of the five canyons addressed by this criterion. At least one occurrence within each of the five canyons is managed for long-term persistence. (USFWS, 2019)

E.2: A Fire Management Plan is developed and implemented to ensure the persistence of San Clemente Island woodland star in the canyons along the eastern escarpment where the species occurs. (USFWS, 2019)

E.3: Erosion potential from anthropomorphic activities is assessed at localities selected in Criterion E.1 (e.g., comparative assessment of on-site slope, aspect, vegetation cover, landuse, and fire-history) and managed, as feasible, to ensure long-term persistence of the species. (USFWS, 2019)

Delisting Criteria:
Delisting of San Clemente Island woodland star may be considered when all of the following additional criteria have been met to address threats to the species: (USFWS, 2019)

A.5: Changes to land use (e.g. training) are addressed through an INRMP, management program, or consultation in cooperation with the Service, such that training expansion does not directly or indirectly pose a threat to the persistence of San Clemente Island woodland star. (USFWS, 2019)

E.4: Consistent with the downlisting criteria, a minimum of five canyons support San Clemente Island woodland star as demonstrated with consistent monitoring at each site for 20 years. A subset of the occurrences within each canyon is managed for long-term persistence through implementation of A.2 above. (USFWS, 2019)

Recovery Actions:
- Recommended Action from 2007 5-Year Review: Study the reproductive ecology and mating system of L. maximum to determine whether populations suffer from low pollinator visitation and/or have a self-incompatibility mechanism (e.g. have genes that preclude mating among closely related individuals) that limits sexual reproduction in the species (USFWS, 2007).
- Recommended Action from 2007 5-Year Review: Perform additional genetic studies on L. maximum using randomly amplified polymorphic DNA (RAPDs) or other appropriate genetic markers to see if there is any detectable genetic variation in the species that will allow for inferences about relatedness of adjoining individuals, trends in genetic variation, patterns of gene flow, or other evolutionary processes (USFWS, 2007).
- Recommended Action from 2007 5-Year Review: Use existing or new seed collections to propagate and establish additional populations of L. maximum in appropriate habitat to help safeguard the species. Results from the prior two recommended actions should be used to select seed from the most genetically diverse source populations and to determine if transplantation into existing populations should be used to improve seed production and

fitness of populations (USFWS, 2007).

- Recommended Action from 2007 5-Year Review: Work with the military to adopt a set of access policies for the shore bombardment area on San Clemente Island to facilitate effective management and monitoring of L. maximum. These policies should allow for greater flexibility in the timing of study and survey efforts and should prioritize providing access during critical times in the life cycle of L. maximum and invasive weeds (USFWS, 2007).
- Recommended Action from 2007 5-Year Review: Work with the military to incorporate into the proposed Fire Management Plan an active commitment to use back-fires or other appropriate techniques to prevent wildfires from spreading east of Ridge Road (USFWS, 2007).
- 1. Habitat restoration: To restore habitat to provide a more suitable environment for these E/T species, revegetation, control of erosion, and removal of exotic species will be necessary. (USFWS, 1984)
- 2. Implement management recommendations for E/T species. Numerous actions have been proposed to maintain and restore populations of these E/T species. Re-establish listed plant species on San Clemente Island revegetation. Modify existing management plans to minimize habitat disturbance. (USFWS, 1984)
- 3. Habitat protection. Survival and eventual recovery of these species is dependent on adequate protection of their habitat. Regardless of other management actions to conserve these E/T species, if habitat is not properly managed, recovery will not be possible. (USFWS, 1984)
- 4. Develop delisting criteria (i.e., the size of populations and amount of suitable habitat necessary before reclassification can be considered). Before consideration can be given for reclassifying a species (either upgrading to threatened status or delisting) it is necessary to determine the number of organisms, the size of the secure habitat, or the number of such populations/habitats required to support viable, self-sustaining populations. To obtain this information and to properly manage these taxa, additional research studies are necessary. (USFWS, 1984)
- 5. Evaluate success of management actions. All E/T taxa must be monitored throughout the course of the recovery program to assess its success and determine if additional actions or modifications of activities are necessary. (USFWS, 1984)
- 6. Increase public support. Public support for the conservation of these E/T species can be enhanced by increasing the public's awareness of the sensitivity and uniqueness of the island's ecosystems. (USFWS, 1984)
- 7. Use existing laws and regulations protecting E/T species. All Federal and State laws pertaining to the protection and conservation of E/T species should be used to further the recovery effort. (USFWS, 1984)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Since listing, efforts have been made to reduce erosion and fire on the eastern escarpment where Lithophragma maximum occurs. Obtaining baseline occurrence trends and maintaining high quality habitat is important help conserve the species. Recovery will require stabilizing five resilient canyon scale occurrences so that they are self-sustaining and can withstand stochastic events associated with steep canyon slopes. We have identified these recommendations to aid recovery of the San Clemente Island woodland star: 1. Work with the U.S. Navy to develop baseline abundance and any demographic processes (especially

seed production) to determine what types of management efforts may be needed for recovery. Work with the U.S. Navy to get access during critical times in the life cycle of L. maximum and monitor for invasive weeds. 2. Identify the conditions and areas necessary to support all of the necessary biotic interactions (e.g. pollination, seed dispersal, population movement) for L. maximum. 3. Monitor restored/enhanced habitat to determine their suitability and impact in furtherance of recovery of L. maximum. 4. Investigate impacts of fire in canyons along the eastern escarpment where L. maximum occurs. Evaluate feasibility of fire suppression within the Ship to Shore Bombardment Area. 5. Study the reproductive ecology and mating system of L. maximum to determine whether populations suffer from low pollinator visitation and/or have a self-incompatibility mechanism (e.g. have genes that preclude mating among closely related individuals) that limits sexual reproduction in the species. 6. Perform additional genetic studies on L. maximum using randomly amplified polymorphic DNA (RAPDs) or other appropriate genetic markers to see if there is any detectable genetic variation in the species that will allow for inferences about relatedness of adjoining individuals, trends in genetic variation, patterns of gene flow, or other evolutionary processes. 7. Use existing or new seed collections to propagate individuals to augment or establish populations of L. maximum within appropriate habitat on San Clemente Island. Use genetic results to inform seed selection and inform translocations into existing or new populations to improve seed production and fitness of populations. (USFWS, 2020)

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SPECIES ACCOUNT: *Lobelia monostachya* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

A prostrate woody shrub with stems 15 to 25 cm (6 to 10 in) long. The species is distinguished from others in the genus by its narrow, linear leaves without stalks and its short pink flowers (USFWS, 2003).

Taxonomy

In the bellflower family (Campanulaceae) (USFWS, 2003).

Historical Range

Historically known from the Koolau Mountains of Oahu (USFWS, 2003).

Current Range

Southern Koolau Mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lobelia monostachya under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Lobelia monostachya (77 FR 57648-57862). The critical habitat designation includes 4 critical habitat units, which encompass approximately 1,939 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Lobelia monostachya includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Lobelia monostachya includes 4 critical habitat units, covering one ecosystem type, which encompasses approximately 1,939 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on

the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lobelia monostachya critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Lobelia monostachya occurs within the indicated ecosystem in the Koolau Mountain caldera complex:

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (E) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Lobelia monostachya to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed in flower in May and June (R. Fenstenmacher, pers. comm. 1998). (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, grassland/herbaceous, savanna, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers steep slopes and sparsely vegetated cliffs; found at elevations of about 290 meters (USFWS, 1998)

Environmental Specificity

Adult: Medium to high, with several key requirements (USFWS, 1998)

Habitat Narrative

Adult: Lobelia monostachya is found on dry to moist cliffs and steep slopes with native grasses and shrubs. This species occurs on steep, sparsely vegetated cliffs in mesic shrubland at an elevation of about 290 meters (950 feet) (USFWS 1996b). Associated plants include ahinahina, Carex meyenii, Psilotum nudum (moa), and kawelu (USFWS 1996b).(USFWS, 1998; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

2 (USFWS, 2019)

Population Size:

4 (USFWS, 2019)

Population Narrative:

In 2008, the population located at Wailupe Valley contained 10 mature healthy individuals. During the same year, the second population located at Waialae Nui Ridge consisted of a single mature and two immature individuals. None of the individuals observed at these locations contained mature fruit at the time (Perlman 2012). Three additional individuals were found in Wailupe Valley, bringing the current number of naturally occurring individuals up from eight reported in the last five-year reviews to 13 (Plant Extinction Prevention Program [PEPP] 2012b). (USFWS, 2012). Currently there two mature and two immature individuals of Lobelia monostachya in two populations. Fortini et al. did not conduct a landscape-based assessment of climate change vulnerability for L. monostachya; however, four other endangered Lobelia species are extremely vulnerable to the effects of climate change, and L. monostachya may also require management to prevent extinction. Dozens of individuals are propagated from seeds and cuttings and are reintroduced to historical and new habitat, and handpollination is used to increase seed viability. (USFWS, 2019)

Threats and Stressors

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change - Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC)

funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected to be available sometime in 2013. (USFWS, 2012)

Stressor: Drought (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Drought is considered a threat at both Wailupe and Waialae Nui Ridge populations (Oahu PEPP 2012). (USFWS, 2012)

Stressor: Rats (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Rats (Rattus sp.) are also considered a threat to Lobelia monostachya (Oahu PEPP 2012). (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 1998; USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The major threats to Lobelia monostachya include competition with invasive introduced plant species (Christmas berry, Hamakua pamakani, air plant, and molasses grass). All seven individuals of the species occur on steep cliffs where removal of invasive plants is virtually impossible (Oahu Plant Extinction Prevention Program 2007). (USFWS, 1998; USFWS, 2008)

Stressor: Small population size (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: In addition to all of the other threats, species like Lobelia monostachya that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes and disease outbreaks. (USFWS, 2008)

Stressor: Landslides (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Landslides are a threat to Lobelia monostachya, given their precarious location on cliffs. (USFWS, 2008)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:
- Control competing alien plant species. The remaining population should be weeded and protected immediately. (USFWS, 1998)
- Reduce threat of rat predation. The only population of Lobelia monostachya may be seriously threatened by rat predation. (USFWS, 1998)
- Continue weed control as possible. (USFWS, 2008)
- Continue reintroducing individuals into protected suitable habitat. (USFWS, 2008)
- Continue collecting fruit from any additional individuals that set seed to add to the genetic diversity of the ex situ material. (USFWS, 2008)
- Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2012)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Continue to conduct thorough surveys of all suitable habitats where Lobelia monostachya was historically seen. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use results to determine future landscape needed for the recovery of the species. (USFWS, 2012)
- Explore measures to mitigate the effects of drought. (USFWS, 2012)
- Study populations of Lobelia monostachya with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. (USFWS, 2012)
- Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and inventories—Continue to conduct thorough surveys of suitable habitat where Lobelia monostachya was historically seen. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with Lobelia monostachya, at all populations. • Site and habitat protection—Develop and implement effective measures to reduce the impact of landslides. • Drought—Explore measures to mitigate the effects of drought. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Rodent predation and herbivory—Implement effective control methods for rodents at all known populations. • Population biology research—Study Lobelia monostachya populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Captive propagation for genetic storage and reintroduction— o Continue to collect cuttings and seeds from all existing populations keeping records of maternal source for use in ex situ propagation. Distribute collections to several facilities for storage. o Continue hand-pollination efforts. • Reintroduction and translocation—Continue reintroduction efforts, establish new populations and augment existing populations with genetically appropriate individuals within suitable habitat to increase numbers. • Alliance and partnership development—Continue to work with the U.S. Army and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)
- New Management Actions: • Captive propagation for genetic storage and reintroduction— o Three of the seven founders from the Kului population have been collected from: one founder from the Kapakahi population and an unreported number of founders from the Wailupe population (PEPP 2017). o Lyon Arboretum Micropropagation Laboratory reports 181 explants from two populations (six individuals) are in storage (Lyon Arboretum 2018). In addition, the Lyon Arboretum Seed Conservation Laboratory reports more than 14,000 seeds are in storage representing four individuals from populations at Wailupe and Kapakahi (Lyon Arboretum 2018). o The Pahole Rare Plant Facility (PRPF) reports propagation of 30 plants for storage, and 171 individuals for outplanting (PRPF 2018). o PEPP reports collection of seeds and cutting from populations of L. monostachya at Waialae Nui and Wailupe. PEPP also has been working to hand-pollinate individuals at Wailupe (using pollen from nursery stock) to produce more viable seeds. PEPP is has reintroduced 74 plants at Kulepeamoa-Kupaua, Hawaii Loa-Kului, and Pia Valley (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2019). (USFWS, 2019)

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SPECIES ACCOUNT: *Lomatium cookii* (Cook's lomatium)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/9/2002; Pacific Region (R1)

Physical Description

A perennial herb that grows 15 to 50 centimeters (6 to 20 inches) tall with a slender, twisted taproot (Figure II-3). The base often branches at or below ground level, forming multiple stems. The leaves are glossy bluish-green, minutely interdivided, and strictly basal (growing directly from the root crown, out of the ground, not along the stems). The pale yellow flowers are clustered into 5- centimeter (2-inch) umbels (umbrella-like formation of flower clusters). Each flowering stalk produces either primarily male or female umbels. Through one flowering season, L. cookii may produce up to eight male or female (sometimes both) flowering stalks. The bracts found below the umbels are thin, lance-shaped and have an entire margin. An umbel of female flowers will develop boat-shaped fruits 8 to 13 millimeters (0.3 to 0.5 inch) long with thickened margins. The flowering stalk very rarely forms leaves, unlike the closely associated L. utriculatum (foothills desert parsley). The single umbel bracts best distinguish L. cookii from L. bradshawii (Bradshaw's lomatium), indigenous to wet prairies from the southern Willamette Valley in Oregon to southwest Washington, and L. humile (alkali desert parsley), found in vernal pools in northern California (Kagan 1986). The umbel bracts can be used to distinguish L. cookii from the much wider, toothed, and overlapping umbel bracts of L. utriculatum. (USFWS, 2010)

Taxonomy

In the parsley family (Apiaceae). Lomatium cookii was first collected in 1981 and subsequently described from vernal pools in the Agate Desert, Jackson County, Oregon (Kagan 1986). Additional populations were found at French Flat in the Illinois Valley, Josephine County, Oregon in 1988 (Oregon Natural Heritage Information Center 2008). Slight morphological differences exist between L. cookii populations in the Agate Desert and French Flat, but these differences are not considered significant enough to separate the species into subspecies (M. Gitzendanner, pers. comm. 2002). (USFWS, 2010)

Historical Range

In southwestern Oregon, in Jackson and Josephine Counties. (USFWS, 2010)

Current Range

In Oregon, known from the Agate Desert, just north of the City of Medford in Jackson County's Rogue Valley, and from the French Flat or Illinois Valley sites in Josephine County. (USFWS, 2019)

Critical Habitat Designated

Yes; 8/20/2010.

Legal Description

On July 21, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective August 20, 2010) for Lomatium cookii (Cook's lomatium) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes sixteen critical habitat units (CHUs), in Oregon (75 FR 42490-42570).

Critical Habitat Designation

The critical habitat designation for Lomatium cookii includes sixteen CHUs in Jackson and Josephine Counties, Oregon. This species critical habitat encompasses approximately 6,289 acres (ac) (2,545 hectares (ha)) (75 FR 42490-42570). All critical habitat units in Jackson County are located within the Middle Rogue River Basin or "Agate Desert." Brief descriptions are presented below. Detailed coordinates of and maps depicting the CH units are available in the Final Rule (USFWS, 2010).

Unit RV6, subunits A, F, G, and H, for Lomatium cookii: White City, Jackson County, Oregon. (i) Unit RV6, subunits A, F, G, and H for Lomatium cookii comprises 546 ha (1,349 ac) of vernal pool–mounded prairie and swale habitats. RV6 is located around White City, is 1.6 km (1.0 mi) southwest of Eagle Point, and is 440 m (1,444 ft) southeast of the confluence of the Rogue River and Little Butte Creek. Subunit RV6A is located north of Whetstone Creek and is 500 m (1,200 ft) west of the junction of Highway 62 and Antelope Road. Subunits RV6F and RV6G are located approximately 500 feet west of Dry Creek and are east of Highway 62 in White City. Subunit RV6H is located north of Whetstone Creek and south of Antelope Road. Subunit RV6H roughly encircles the Hoover Ponds, east of Highway 62, and is 850 m (2790 ft) east of subunit RV6A.

Unit RV8 for Lomatium cookii: Whetstone Creek, Jackson County, Oregon. (i) Unit RV8 for Lomatium cookii consists of 344 ha (850 ac) of vernal pool–mounded prairie and swale habitat. Unit RV8 is located approximately 1.4 km (0.9 mi) southeast of the confluence of the Rogue River and Whetstone Creek, 2.2 km (1.4 mi) southwest of Tou Velle State Park, and 2.9 km southeast of the confluence of Bear Creek and the Rogue River. The unit roughly parallels a 2.6-km (1.6-mi) stretch of Whetstone Creek to the south.

Unit RV9, subunits A, B, C, D and E, for Lomatium cookii: Medford Airport, Jackson County, Oregon. (i) Unit RV9, subunits A through E, consists of 34 ha (83 ac) of slightly degraded vernal pool–mounded prairie habitat. The five subunits of RV9 are located mostly within the Rogue Valley International–Medford Airport, approximately 2 km (1.2 mi) west of Coker Butte and 1.5 km (0.9 mi) northeast of Bear Creek. Subunit RV9A is located 1.4 km (0.9 mi) north of the Rogue Valley International–Medford Airport and is 300 m (980 ft) east of the junction of Vilas Road and Table Rock Road. Subunits RV9B through E are located between Upton Slough and Bear Creek, 2 mi (1.2 km) southeast of the junction of Vilas Road and Table Rock Road, and 1.7 km northeast of the junction of Interstate 5 and Highway 62.

Unit IV1 for Lomatium cookii: Anderson Creek, Josephine County, Oregon. (i) Units IV1A and B comprise 35 ha (85 ac) of wet meadow and sloped mixed conifer habitat. Unit IV1A is located 3.5 km (2.2 mi) north of Selma, and 14 km (8.8 mi) north of Cave Junction; it is along a 1.0-km (0.6-mi) stretch of Anderson Creek and Highway 199, 2.0 km (1.2 mi) southwest of Hays Hill Summit. It is also 1.7 km (1.0 mi) northwest of the junction of Draper Valley Road and Indian Creek Road. Unit IV1B is located 3.5 km (2.2 mi) north of Selma, 3.4 km (2.1 mi) southwest of Hays Hill Summit, and 0.8 km (0.5 mi) west of the junction of Draper Valley Road and Highway 199.

Unit IV2 for Lomatium cookii: Draper Creek, Josephine County, Oregon. (i) Unit IV2 is composed of 28 ha (70 ac) of intact wet meadow habitat. It is located 2.7 km (1.7 mi) northeast of Selma and 13.5 km (8.4 mi) north of Cave Junction; it is along a 900-m (2,900-ft) stretch of Draper Creek, and is located 800 m (2,600 ft) east of Anderson Creek. The unit is 800 m (2,600 ft) north-

northwest of the confluence of Draper Creek and Davis Creek and is 200 m (650 ft) southeast of the junction of Draper Valley Road and Indian Creek Road.

Unit IV3 for Lomatium cookii: Reeves Creek North, Josephine County, Oregon. (i) Unit IV3 consists of 152 ha (374 ac) of sloped, mixed-conifer and shrubby habitat. The unit is located 1.4 km (0.9 mi) east of the confluence between Reeves Creek and the Illinois River and extends along a 2.0-km (1.2-mi) stretch of Reeves Creek, beginning 800 m (2,600 ft) northeast of the junction of Highway 199 and Reeves Creek Road.

Unit IV4 for Lomatium cookii: Reeves Creek East, Josephine County, Oregon. (i) Unit IV4 consists of 83 ha (204 ac) of sloped, partially open, mixed-conifer and shrubby habitat. It is located 6.2 km (3.9 mi) south of Selma and 5.3 km (3.3 mi) northwest of Cave Junction. It occurs along a 500-m (1,640-ft) stretch of Reeves Creek located 700 m (2,300 ft) southeast of Unit IV3.

Unit IV5 for Lomatium cookii: Reeves Creek South, Josephine County, Oregon. (i) Unit IV5 consists of 165 ha (407 ac) of sloped, partially open, mixed-conifer and understory shrub habitat. The unit is roughly parallel to Highway 199 for 2.5 km (1.6 mi), which is 500 m (1,640 ft) west of the unit. The unit is located 1.6 km (1.0 mi) north of Cave Junction, 1 km (0.6 mi) southeast of Sauers Flat, 800 m (2,600 ft) east of Kerby, and 1.2 km (0.7 mi) east of the confluence between Holton Creek and the Illinois River.

Unit IV6 for Lomatium cookii: Laurel Road, Josephine County, Oregon. (i) Unit IV6 totals 182 ha (449 ac) of intact wet meadow habitat. It is located west and alongside of the base of Lime Rock, 1.2 km (0.7 mi) east of the city of Cave Junction; it follows along Highway 46 for 1.5 km (0.9 mi). Subunit IV6A is located 1.2 km (0.7 mi) west of Lime Rock summit, 1.0 km east of the junction of Laurel Road and Highway 199; it is also roughly parallel to Highway 199 for 1.3 km (0.8 mi). Highway 199 lies approximately 1.0 km (0.6 mi) west of the subunit. Subunit IV6B is 2.7 km (1.7 mi) east of the confluence of the east and west forks of the Illinois River and from the intersection of Holland Loop Road and Highway 46; it extends approximately 1.8 km (1.1 mi) to the northeast and 2.7 km (1.7 mi) to the north.

Unit IV7 for Lomatium cookii: Illinois River Forks State Park, Josephine County, Oregon. (i) Unit IV7 consists of 55 ha (136 ac) of intact wet meadow habitat. The unit is located 500 m (1,640 ft) west of the city of Cave Junction and 600 m (1,970 ft) southeast of Pomeroy Dam; it is also 230 m (750 ft) east of the confluence of the east and west forks of the Illinois River. The unit occurs along a 2.8-km (1.7-mi) stretch of the West Fork Illinois River.

Unit IV8 for Lomatium cookii: Woodcock Mountain, Josephine County, Oregon. (i) Unit IV8 consists of 234 ha (579 ac) of wet meadow and shrubby habitat. The unit is located 2.4 km (1.5 mi) southwest of the city of Cave Junction, 5.3 km (3.3 mi) north of O'Brien, and 140 m (ft) west of the confluence of Woodcock Creek and the West Fork Illinois River. It occurs along a 3.3-km (2.0-mi) stretch of West Side Road. Unit IV7 is 400 m (ft) west of Highway 199 and roughly parallels the highway for 5.0 km (3.1 mi).

Unit IV9 for Lomatium cookii: Riverwash, Josephine County, Oregon. (i) Unit IV9 consists of 12 ha (30 ac) of intact wet meadow and streambank habitat. It is located 4.2 km (2.6 mi) south of Cave Junction and 6.1 km (3.8 mi) north-northeast of O'Brien. It is located along the east bend of the West Fork Illinois River, 700 m (2,300 ft) south (upstream) of the confluence between Woodcock

Creek and the West Fork Illinois River.

Unit IV10 for Lomatium cookii: French Flat North, Josephine County, Oregon. (i) Unit IV10 consists of 45 ha (110 ac) of intact wet meadow habitat. The unit is located 3.7 km (2.3 mi) south of Cave Junction, 900 m (2,950 ft) north of the intersection of Sherrier Drive and Raintree Drive, and 1.7 km (1.1 mi) southwest of the confluence of Althouse Creek and the East Fork Illinois River. It parallels a 300-m (980-ft) stretch of Rockydale Road.

Unit IV11 for Lomatium cookii: Rough and Ready Creek, Josephine County, Oregon. (i) Unit IV11 consists of 118 ha (292 ac) of intact wet meadow habitat. The unit roughly follows along and is adjacent to a 1.9-km (1.2-mi) stretch of Airport Drive. It is located 3 km (1.9 mi) north of O'Brien, 900 m (2,950 ft) west of the Rough and Ready Forest Wayside State Park, and 122 m (400 ft) east of the confluence with the Illinois River and Rough and Ready Creek.

Unit IV12 for Lomatium cookii: French Flat Middle, Josephine County, Oregon. (i) Unit IV12 consists of 492 ha (1,216 ac) of intact wet meadow habitat. The unit is located 4.5 km (2.8 mi) east of Cave Junction, 3.7 km (2.3 mi) northeast of O'Brien, 140 m (460 ft) north and 560 m (1,830 ft) west of Esterly Lakes, 1.4 km (0.9 mi) northeast of Indian Hill, and 300 m (960 ft) east of the confluence of Rough and Ready Creek and the West Fork Illinois River. It also follows along a 1.6-km (1.0-mi) stretch of Rockydale Road until the junction with Waldo Road.

Unit IV13 for Lomatium cookii: Indian Hill, Josephine County, Oregon. (i) Unit IV13 consists of 22 ha (54 ac) of intact wet meadow habitat. The unit is located adjacent to and lies east of a 900-m (2,950-ft) stretch of the West Fork Illinois River. It is located approximately 300 m south (upstream) of the confluence of Rough and Ready Creek and the West Fork Illinois River. The unit is 1.8 km (1.1 mi) northeast of O'Brien and 350 m (1,150 ft) northwest of Indian Hill.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lomatium cookii critical habitat consists of the following components (75 FR 42490-42570): (USFWS, 2010)

(i) In the Rogue River Valley: (A) Vernal pools and ephemeral wetlands and depths and the adjacent upland margins of these depressions that hold water for a sufficient length of time to sustain Lomatium cookii germination, growth, and reproduction. These vernal pools or ephemeral wetlands support native plant populations and are seasonally inundated during wet years but do not necessarily fill with water every year due to natural variability in rainfall. Areas of sufficient size and quality are likely to have the following characteristics: (1) Elevations from 372 to 411 m (1,220 to 1,350 ft); (2) Associated dominant native plants including, but not limited to: Alopecurus saccatus, Achnatherum lemmonii, Deschampsia danthonioides, Eryngium petiolatum, Lasthenia californica, Myosurus minimus, Navarretia leucocephala ssp. leucocephala, Phlox gracilis, Plagiobothrys bracteatus, Trifolium depauperatum, and Triteleia hyacinthina; and (3) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(B) The hydrologically and ecologically functional system of interconnected pools or ephemeral wetlands or depressions within a matrix of surrounding uplands that together form vernal pool complexes within the greater watershed. The associated features may include the pool basin and

ephemeral wetlands; an intact hardpan subsoil underlying the surface soils up to 0.75 m (2.5 ft) in depth; and surrounding uplands, including mound topography and other geographic and edaphic features that support systems of hydrologically interconnected pools and other ephemeral wetlands (which may vary in extent depending on sitespecific characteristics of pool size and depth, soil type, and hardpan depth).

(C) Silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 3 percent slope, classified as Agate–Winlo or Provig– Agate soils.

(D) No or negligible presence of competitive, nonnative invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow Lomatium cookii to continue to survive and recover.
(ii) In the Illinois River Valley: (A) Wet meadows in oak and pine forests, sloped mixed-conifer openings, and shrubby plant communities that are seasonally inundated and support native plant populations. Areas of sufficient size and quality are likely to have the following characteristics: (1) Elevations from 383 to 488 m (1,256 to 1,600 ft); (2) Associated dominant native plants including, but not limited to: Achnatherum lemmonii, Arbutus menziesii, Arctostaphylos viscida, Camassia spp., Ceanothus cuneatus, Danthonia californica, Deschampsia cespitosa, Festuca roemeri var. klamathensis, Poa secunda, Ranunculus occidentalis, and Limnanthes gracilis var. gracilis; (3) Occurrence primarily in bottomland Quercus garryana–Quercus kelloggii–Pinus ponderosa (Oregon white oak–California black oak– ponderosa pine) forest openings along seasonal creeks; and (4) A minimum area of 8 ha (20 ac) to provide intact hydrology and protection from development and weed sources.

(B) The hydrologically and ecologically functional system of streams, slopes, and wooded systems that surround and maintain seasonally wet alluvial meadows underlain by relatively undisturbed ultramafic soils within the greater watershed.

(C) Silt, loam, and clay soils that are of ultramafic and nonultramafic alluvial origin, with a 0 to 40 percent slope, classified as Abegg gravelly loam, Brockman clay loam, Copsey clay, Cornutt–Dubakel complex, Dumps, Eightlar extremely stony clay, Evans loam, Foehlin gravelly loam, Josephine gravelly loam, Kerby loam, Newberg fine sandy loam, Pearsoll–Rock outcrop complex, Pollard loam, Riverwash, Speaker–Josephine gravelly loam, Takilma cobbly loam, or Takilma Variant extremely cobbly loam.

(D) No or negligible presence of competitive, nonnative invasive plant species. Negligible is defined for the purpose of this rule as a minimal level of nonnative plant species that will still allow Lomatium cookii to continue to survive and recover.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain the features that are essential to the conservation of the species and that may require special management considerations or protection. All areas we are designating as critical habitat require some level of management to address current and future threats to Lomatium cookii, to maintain or enhance the physical or biological features essential to their conservation, and to ensure the recovery and survival of these species. The major threats to the PCEs in the areas identified as critical habitat for Lomatium cookii include: development on private lands; mining activities; ground disturbance

that affects surface hydrology, including ORV use and road construction or maintenance activities; incompatible agricultural and grazing practices; garbage dumping; the succession of meadow habitat to forested habitat due to fire suppression; and encroachment and displacement by nonnative plants. Herbivory by voles may also affect Lomatium cookii in the Illinois River Valley. In all of the units in Jackson County, special management is needed to reduce or eradicate the threats posed by development, habitat fragmentation, ground disturbance that affects surface hydrology, and incompatible grazing practices. In all of the units in Josephine County, special management is needed to reduce or eradicate the threats posed by development, ORV use, mining activities, garbage dumping, and woody vegetative succession. Please refer to the unit descriptions in the Critical Habitat Designation section for further discussion of special management considerations or protection of the PCEs related to geographically specific threats to Limnanthes floccosa ssp. grandiflora and Lomatium cookii. In addition, for all units, special management is needed to control and monitor the encroachment of nonnative, invasive plant species to maintain intact vernal pool–mounded prairies and wet meadow ecosystems such that they can continue to support populations of Lomatium cookii. Special management considerations or protection of the vernal pool– mounded prairies and wet meadow habitats that may be needed to support reproduction and growth of Lomatium cookii include: controlled burning and vegetation clearing to maintain early seral stages (early stages of plant succession in the progression toward a climax community); control of nonnative, invasive plant species; grazing management; the reestablishment of hydrology; re-seeding with native plants; monitoring; and protection from development (Borgias 2004, pp. 47–53; ONHDB 1994, pp. 13– 20). (USFWS, 2010)

Life History

Food/Nutrient Resources

Habitat Type

Adult: Seasonally wet (vernal soil) (USFWS, 2016)

Environmental Specificity

Adult: Very Narrow (USFWS, 2016)

Habitat Narrative

Adult: Desert parsley in the Illinois Valley grows on seasonally wet soils. For much of its range in the Rogue River Valley, the plant occurs on upland mounds, at the bottom of rocky vernal pools, and on vernal pools flanks. It occurs in either strongly expressed or weakly expressed vernal pool formations and appears to tolerate various types of disturbance. In the Rogue River Valley, populations of desert parsley are found in shallow Agate-Winlo complex in sparse prairie vegetation. Common plant associates include Lupinus bicolor (bicolor lupine), Colinsia sparsiflora (sparse-flowered collinsia), Clarkia purpurea (purple clarkia), Erodium cicutarium (filaree), foothills desert-parsely, Achnatherum lemmonii (Lemmon's needlegrass), Poa bulbosa (bulbous bluegrass), Brodiaea elegans (elegant brodiaea), Madia spp (tarweed), Lasthenia californica (goldfields), Hemizonia fitchii (Fitch's tarweed), and Plagiobothrys spp (popcornflower). In the Illinois Valley, desert parsley occurs in open wet meadows and along roadsides adjacent to meadows on Brockman clay loam, Josephine gravelly loam, Pollard loam, Eightlar extremely stony clay, Takilma cobbly loam, Abegg clay loam, and Newberg loam soils. Brockman clay loam soils in the French Flat area average 61 to 89 cm (24 to 35 inches) in depth.

These seasonally wet soils have the ability to block water permeability through the soil, similar to the Agate Desert vernal pools, but lack that region's distinctive mound and swale topography. Soils in the Illinois Valley are partially derived from serpentine formations that occur on surrounding slopes and hilltops. Common species in the Illinois Valley associated with desert parsley include Danthonia californica (California oatgrass), Chlorogalum pomeridianum (soap plant), Plagiobothrys bracteatus (bracted popcornflower), Hesperichiron californica (hesperichiron), Horkelia californica (California horkelia), Calochortus uniflorus (short-stemmed mariposa lily), and wedge-leaved buckbrush. Two rare plants that may occasionally occur with desert parsley in the Illinois Valley are Senecio hesparius (western senecio) and Microseris howellii (Howell's microseris) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

36 (USFWS, 2019)

Population Size:

10,000 - 1,000,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Based on representative population assessments at the monitored locations provided in the 2019 5-Year Review, as well as assuming the other known populations are still occupied by Lomatium cookii, we conclude the overall distribution remains unchanged. Lomatium cookii remains concentrated within the Illinois and Rogue River Valleys of southwestern Oregon and within its known historical range. Even with the extirpation of one population and the addition of one populations, range contraction or expansion of the species has not occurred. (USFWS, 2019)

Population Narrative:

There are a total of 36 populations of Lomatium cookii, 11 in the Rogue Valley and 25 in the Illinois Valley. Here we present the most recent information available through the individual monitoring programs for most of the 36 sites that have been assessed since the last census. This includes information for one new population record of Lomatium cookii (Waldo Road in the Illinois Valley). Information is not available for 15 known occurrences of the species (Table 1). It should be noted that L. cookii population parameters fluctuate annually depending on seasonal precipitation and temperature; therefore, it is not unexpected that the species population size estimate will vary from year to year. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat or population loss due to development (USFWS, 2011)
Exposure:
Response:

Consequence:
Narrative: Factor A listing threats include habitat or population loss due to development, either through present or threatened destruction, modification or curtailment of habitat or range (USFWS 2002). Factor A threats to Lomatium cookii in the Rogue and Illinois River valleys include habitat impacts resulting from residential, urban, and commercial development; aggregate and mineral mining; agricultural development (including leveling, ditching, tilling, and stock pond construction or water impoundments); road construction and maintenance; off-road vehicle (ORV) use that affects surface hydrology; incompatible grazing practices; and encroachment by nonnative plants (ONHDB 1994; USFWS 2002). The adverse effects of residential, urban, and commercial development are more evident in the Rogue River Valley while the threat of mining is a more conspicuous threat in the Illinois River Valley (USFWS 2002; USFWS 2010). Factor A impacts resulting from residential, urban, agricultural, industrial, and commercial development between 1940 to present, resulted in over 60 percent loss of the vernal pool landscape in the Rogue River Valley due to removal of habitat, altered hydrology, or altered topography (ONHP 1997; Wille and Petersen 2006). (USFWS, 2011)

Stressor: Vandalism (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Vandalism are Factor A threats in the form of intentional disregard or dismantling of signage or fencing intended to protect certain wetland areas from unauthorized ORV use, and subsequent damage resulting from that use, has resulted in negative effects on the hydrology of the habitat for Lomatium cookii (for example, by altering the surface hydrology, resulting in excess or a lack of hydrology in otherwise suitable habitat). (USFWS, 2011)

Stressor: Grazing (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The effect of grazing on suitable habitat depends on how the grazing is managed. There are various reports showing how grazing practices can positively or negatively affect native plant species' richness (Marty 2005). Marty's (2005) study indicates that wet season grazing resulted in a decrease of native forb species at vernal pool edge habitat, but year-round grazing actually improved species' richness (Factor A listing threats). (USFWS, 2011)

Stressor: Non-native plants and small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Lomatium cookii is also threatened by encroachment of nonnative plants and small population size (Factor E listing threats). Nonnative plants that can outcompete L. cookii include annual grasses and herbs. Nonnative grasses, namely Hordeum marinum ssp. gussoneanum (Mediterranean barley), Lolium spp. (perennial and annual rye), and Taeniantherum caput-medusae (medusahead), form a dense thatch layer that inhibits plant growth (USFWS 2010). (USFWS, 2011)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)

Exposure:
Response:
Consequence:
Narrative: Depending on whether intentions were deliberate or inadvertent, Factor D, the lack of legal protection for all federally or state listed plants on privately owned property could be partially responsible for much habitat loss in recent years due to development in areas that were incorrectly assumed to be outside of jurisdictional wetlands (USFWS 2006). (USFWS, 2011)

Recovery

Reclassification Criteria:
Reclassification from Endangered to Threatened status may be considered for Lomatium cookii when the following criteria are met: (USFWS, 2010)

a. At least 32 of 36 documented/extant Lomatium cookii occurrences (approximately 90 percent) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

b. At least 90 percent of suitable habitat acreage within each Priority 1 core area (one core area in the Rogue Valley and seven core areas in the Illinois Valley) has been protected from development. At least 85 percent of suitable habitat acreage within Priority 2 core areas (three core areas in the Rogue Valley and six core areas in the Illinois Valley) has been protected from development. (See Tables IV-1, IV-2, and IV-4 of the Recovery Plan). All suitable vernal pool and wet meadow habitat must include soils and hydrology that support Lomatium cookii. This habitat includes both occupied and suitable habitat. Suitable habitat that is not currently known to be occupied must be protected to provide for corridors and dispersal habitat, restoration dynamics, provide for reintroduction/introduction sites, and to protect currently undiscovered populations. (USFWS, 2010)

c. Management plans for each protected core area are developed and implemented as soon as feasible for Lomatium cookii protection and conservation. The management plans should address vegetation control, including thatch buildup and noxious weeds; monitoring of threats and population levels in detail sufficient to quantitatively assess population trends; maintaining hydrological functions; and outreach to neighboring landowners. Management plans should take an ecosystem approach to management by ensuring the long-term maintenance of wetland and adjacent upland plant associates. (USFWS, 2010)

d. Additional Lomatium cookii occurrences identified through future site assessments, GIS and other analyses, and status surveys that are determined essential to recovery are protected. (USFWS, 2010)

e. Achievement of self-sustaining Lomatium cookii populations will be determined through species monitoring and status surveys in each protected occurrence. Population trends must be shown to be stable, increasing or showing only minor declines from high population levels for 10 years prior to consideration for reclassification. (USFWS, 2010)

f. Seed collection is accomplished at each core area as insurance against the risk of stochastic extirpations and to ensure that genetic variation can be restored if extirpations occur. Seed banking may also be necessary in order to complete the reintroductions or introductions required to meet recovery criteria (see Table IV-4 of the Recovery Plan). (USFWS, 2010)

g. Reintroductions and introductions must be carried out as described in Table IV-4 of the Recovery Plan. Introductions may replace extirpated occurrences that cannot be restored to the same site as the original occurrence. (USFWS, 2010)

Delisting Criteria:
Delisting may be considered for Lomatium cookii when all downlisting criteria plus the following criteria are met: (USFWS, 2010)

a. Status surveys, status reviews, and population monitoring show the populations are self-sustaining. Population trends must be shown to be stable, increasing or exhibiting only slight declines from high population levels during a 10-year period prior to consideration following downlisting (e.g., evidence of reproduction and recruitment) and have been determined to be stable, increasing or showing only minor declines from high population levels, and implementation of management plans is effectively managing or eliminating threats. (USFWS, 2010)

b. At least 34 of 36 Lomatium cookii occurrences (approximately 95 percent of documented/extant occurrences) have been protected from development. If extant occurrences become extirpated, protection of reintroduced or introduced occurrences may be substituted. Introduced or newly discovered populations outside of currently known core areas may be substituted if deemed equivalent in their contribution to recovery. (USFWS, 2010)

c. At least 95 percent of suitable vernal pool habitat acreage within each Priority 1 core area and 90 percent of suitable vernal pool habitat acreage within Priority 2 core areas has been protected from development. All suitable vernal pool and wet meadow habitat must include soils and hydrology that support Lomatium cookii . Reintroductions and introductions are accomplished, as necessary and applicable, to replace populations where status surveys indicate the species has been extirpated (Table IV-4). (USFWS, 2010)

d. A post-delisting monitoring plan has been developed for Lomatium cookii. (USFWS, 2010)

Recovery Actions:

- 1. Protect vernal pool and wet meadow habitat from loss, fragmentation, degradation, and incompatible uses. Protection of vernal pool and wet meadow habitat is the broader objective of this recovery plan, because listed species addressed in the plan are now found in mostly fragmented habitat remnants. The first step is to identify and protect remaining relatively higher quality habitat. Although we have identified core areas of suitable habitat for listed species largely based on aerial photo interpretation, Geographic Information Systems soil data layers, topographic maps, historic species occurrence data, and species population mapping, there are uncertainties that can only be resolved by conducting ground level surveys. Complementary actions (1.1 and 1.2) may be necessary steps prior to actual habitat protection actions and are presented sequentially in order as Priority 2 actions. Priority 1 actions will focus habitat protection within identified Priority 1 and 2 recovery

core areas, while lower priority actions may include actions outside of core areas. In general, actions which address the most critical threats (loss, fragmentation, or degradation of habitat) are the highest priority actions. (USFWS, 2010)

- 2. Manage, monitor, and restore vernal pool and wet meadow habitat. Management plans are encouraged to be developed to conserve the listed species occurring at each site. Elements of plans may include: restriction of off-road vehicle use by fencing access roads into preserves using proper signage to restrict vehicle access and avoid inadvertent habitat destruction; habitat restoration and noxious weed prevention programs; use of mowing, burning, or managed grazing to reduce density of native and nonnative vegetation; monitoring effects of management actions for effectiveness, employing adaptive modification; continued monitoring of known Lomatium cookiipopulations on extant sites; surveys for new sites in appropriate habitat; or population introductions into unoccupied habitat. Management plans should identify responsibilities of the management agency or organization to protect species. (USFWS, 2010)
- 3. Conduct rangewide population status surveys. A status survey is a process comprising literature review, examination of herbarium or museum specimens, and a series of surveys conducted throughout a species' range. Historical localities of a species are identified, potential locations where the species may occur are predicted based on distributional and ecological data, and historical and potential locations are surveyed for presence of a species. Ground surveys may be a follow-up to determine if species still occur at site. (USFWS, 2010)
- 4. Conduct research essential to the conservation of these species. In addition to or in conjunction with current monitoring efforts, provide opportunities for further research with schools, State and local governments, or private endeavors. Study pollination vectors between and among populations. Research role of mammals, insects, birds, and wind as cyst and seed dispersal vectors. Evaluate techniques to reduce impacts from encroachment of native woody plant succession. Conduct research on prescribed burning, mowing, and native planting on introduced annual grasses. Refine research on appropriate grazing practices. Research genetic and morphologic traits among individuals and populations. Investigate restoration and recovery methods of historical vernal pool ecosystems that were degraded due to biosolid fill, and log debris fill. Determine incidence of herbivory or predation on Lomatium cookiipopulations. Develop offsite and onsite cultivation and propagation techniques for Limnanthes pumila ssp. grandiflora. Research associated soil crusts as indicators for vernal pool health and function. (USFWS, 2010)
- 5. Enhance public awareness and participation in recovery of the species. Seek to involve stakeholders in the recovery implementation process. Stakeholders are those parties that may be affected by proposed recovery actions, and may include, but are not limited to, Federal and State agencies, Tribal governments, county and city governments, nongovernmental organizations, and private landowners. Through schools, local community meetings, recovery team meetings, county, city, and State fairs, or other venues, we seek to establish contacts with private landowners to provide information about the species. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans. Prior to delisting, a 5-year post-delisting monitoring plan should be developed and in effect. Monitoring and research results should be used to guide the long-term conservation of the species. These tasks are considered a lower priority until more significant and urgent conservation actions can be achieved. Complete post-delisting monitoring plan for Limnanthes pumila ssp. grandiflora. (USFWS, 2010)

- Recommendations for Future Actions: • Develop conservation easements or conservation programs for existing occurrences of Lomatium cookii on private lands. • Make visits to historical Lomatium cookii occurrences in the Illinois and Rogue Valleys to determine whether the plants are still present or have become extirpated. • Augment Lomatium cookii on protected habitat in appropriate locations in the Illinois and Rogue Valley areas. • Conduct best management practices studies for Lomatium cookii. (USFWS, 2019)

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SPECIES ACCOUNT: *Lupinus aridorum* (Scrub lupine)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/7/1987; Southeast Region (R4) (USFWS, 2015)

Physical Description

Woody, perennial herb, with sprawling stems up to 1 m long. The leaves are obovate-elliptic, 4 to 7 cm long and 2 to 4 cm wide. The base and end of the leaf are rounded with a sharp point at the leaf's end. The petioles are 2.0 to 4.5 cm long and the stipules are very small or absent. A silvery pubescence covers the leaves and stems. The flowers are a pale flesh-colored pink and are 4 to 5 cm long. The upper petal (standard) has a black center surrounded by a maroon area. Flowers are arranged in racemes with stalks 4 to 13 cm long. Each raceme has 5 to 14 flowers, but up to 25 on occasion. Fruits are long, woody, and elliptical with a pointed end. It is differentiated from L. villosus, the only other pink flowering lupine, in that L. aridorum is not prostrate, has hairs on the leaves and stem, and is the only upright pink-flowering lupine in Florida. (USFWS, 1999).

Taxonomy

Until being named L. aridorum in 1982, this taxon was identified as L. diffusus and L. westianus (52 FR 11172). Isley (1986, 1990) evaluated the systematics of L. aridorum in his floristic treatment of the pea family (Fabaceae) in the Southeast and concluded that L. aridorum belongs to the same species as L. westianus of the Gulf Coast of northwest Florida, which differs mainly in flower color (blue). Isley's taxonomic status for the central Florida plant is L. westianus var. aridorum (McFarlin ex Beckner) Isley. However, the former classification L. aridorum was used to list the species (52 FR 11172), and will be used here to maintain consistency. (USFWS, 1999; USFWS, 2016)

Historical Range

Historical range is two areas of central Florida: western Orange and extreme northwestern Osceola counties on the southern Mount Dora Ridge and in north-central Polk County on the Winter Haven Ridge (USFWS, 2007).

Current Range

Currently found on two interior ridges in central Florida: Winter Haven Ridge in Polk County and Mount Dora Ridge in Orange and Osceola Counties. (USFWS, 2016)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Average 2-4 years, up to 6-7 years (USFWS, 2022)

Breeding Season

Adult: Flowers in late March-May (USFWS, 1999)

Reproduction Narrative

Adult: The scrub lupine has been found in bloom between March and May. The seed pods mature by June, and the seeds fall off the plant and take root nearby or remain in a long-lived seedbank. Recent information indicates the plant may bloom from one to three times throughout its life, though few seeds are produced the first year. Pollinators of this species are unknown (USFWS, 1999). Many perish after the first year, but most survive 2 to 3 years with 1 to 3 reproductive cycles. Plants have been recorded to flower at 6 to 7 years. (USFWS, 2022).

Habitat Type

Adult: Terrestrial (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Sandy openings in sand pine-rosemary-oak scrub (USFWS, 1999)

Dependencies on Specific Environmental Elements

Adult: Soils are very dry and have very little organic accumulation, and quite acidic with a pH from 4.0 to 4.5 (USFWS, 1999).

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Habitat is sandy openings in sand pine-rosemary-oak scrub. Soils are very dry and have very little organic accumulation, and quite acidic with a pH from 4.0 to 4.5. The scrub lupine will not grow near rosemary (Ceratiola ericoides) because of rosemary's allelopathic effects. Most of the sites where L. aridorum is now found are moderately to severely disturbed by soil scraping, road construction, land clearing, or off-road vehicles (USFWS, 1999; NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal is not well described (USFWS, 1999).

Population Information and Trends

Population Trends:

Declining (USFWS, 2007)

Species Trends:

3 - 4 populations extirpated since 2003 (USFWS, 2007)

Number of Populations:

8 (USFWS, 2022)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

There has been a documented decline in the spatial distribution and historic range of scrub lupine. As of 2003, the historical records of 40 populations had declined to 11 extant lupine populations occupying about 23 acres. Three or four of these populations have been extirpated since 2003, leaving six to seven scrub lupine populations (USFWS, 2007). There are a total of 8 known sites having at least 1 plant in existence surveyed for this review in 2022. Four locations occur on each ridge within the 2 counties (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction, modification, and degradation on private lands remain the primary threat range-wide to the species. Populations occurring on private lands remain subject to adverse human activity, predominately development. Additionally, lack of management — especially fire suppression — on private lands degrades the habitat over time resulting in less suitability to maintain population viability. These human activities are no longer threats to populations on public conservation lands because of protection afforded and restricted use; however, budget constraints and prioritizing available resources may preclude proper, necessary management activities on conservation lands at times. Only three natural populations occur on public lands with the majority of the populations in private ownership. Little opportunity exists for future protection or management opportunities on these lands because of the urban matrix where they occur. (USFWS, 2016)

Stressor: Disease or predation (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Several species of fungus have been observed on L. aridorum plant tissues: charcoal root rot (Macrophomina phaseolina), black leaf spot (Diplocarpon rosae), and recently an unknown black fungus. Little is known about the unidentified black fungus that appears to be confined to the seed coat on L. aridorum. The seed pod looks totally normal but upon opening it the fungus is apparently just on the seeds. Examinations of seed development (Stout 2016) in 2014 at the Lake McLeod NWR documented seeds from 11 of 15 plants (73%) were lost due to this fungal growth. Ten of 20 plants (50%) examined in 2015 had seed loss from fungal sources. No evidence of fungal infested seeds was detected in 2016 (30 plants in sample). Bacteria-induced wilt continues to be observed in L. aridorum populations. It is speculated that the bacteria blocks the conducting xylem tissue to the leaf. The sudden death of plants undergoing wilt may occur anytime during the year. Medium to large plants may be more subject to wilt than smaller recruits. Less than 5% of a population may die from this agent in a typical year. The moth, Uresiphita reversalis, has been a source of mortality to the lupine populations (L. aridorum, L. diffusus) studied during the last 5 years (Stout 2016). Stout (2016) documented roughly 200 L. diffuses individuals devastated by the larvae in one population with no evidence of any insects predating on the moth larvae. (USFWS, 2016)

Recovery

Reclassification Criteria:
Not defined. (USFWS, 1999).

Recovery Priority Number: 2C

Delisting Criteria:
1. Protect sites in Polk and Highlands counties, and establish a disturbance regime to create bare, sunny openings (USFWS, 2007).

2. Conduct demographic monitoring for the foreseeable future. Manage and rehabilitate publicly-owned habitats in Orange County (USFWS, 2007).

3. Manage and rehabilitate publicly-owned habitats in Orange County (USFWS, 2007).

Recovery Actions:

- Determine current distribution of L. aridorum. This species has an extremely restricted range. In South Florida, it is found only in northern Polk County off the Lake Wales Ridge. This species is found in a fast growing urbanizing area and essentially all of its habitat has been converted from the natural state. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of L. aridorum. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of L. aridorum. S4.1. Develop monitoring protocol to assess population trends for L. aridorum. Develop a quantitative description of the population structure of L. aridorum. (USFWS, 1999)
- Provide public information about L. aridorum. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private land owners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where L. aridorum is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. The public should be informed that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of L. aridorum and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- Update and revise the recovery plan to improve and clarify the objective measurable criteria and better address the five factors. (USFWS, 2016).

- Collaboration with conservation land managers to increase habitat suitability of occupied habitat. Actively engage landowners to protect and manage occupied habitat. (USFWS, 2016)
- Continued research on biology and ecology: genetics; seed germination (soilmicrobial interactions); out planting techniques to reduce mortality; fungus and bacteria stressors. (USFWS, 2016)
- Conduct research on different habitat management techniques and their effects in regards to maintaining or improving the residual seed bank for populations. (USFWS, 2016)
- Increase existing monitoring efforts. (USFWS, 2016)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence. • Actively engage landowners to protect, manage, and monitor occupied habitat. • Continued research on biology and ecology: genetics, seed germination (soil-microbial interactions), fungus and bacteria stressors. • Conduct studies of soil seed banks across the range on different habitat and seasonality for the restoration of degraded ecosystems and understanding the type of seed bank: transient, persistent, or transient: short-term and long-term persistent (USFWS, 2022).

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SPECIES ACCOUNT: *Lupinus nipomensis* (Nipomo Mesa lupine)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/20/2000; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb (NatureServe, 2015). The low-spreading individuals can reach 8 inches (20 centimeters) in height (Riggins 1993). Leaves are pinnately compound into five to seven leaflets. Up to 10 pinkish-purple flowers are borne on the ends of the inflorescences (flowering stems). Leaves and stems are succulent, and provide prolonged moisture for seed development (USFWS, 2009).

Taxonomy

Recognized as distinct in Kartesz's 1999 Synthesis (had been questionable synonymized into Lupinus concinnus ssp. concinnus in the 1994 Checklist). Recognized as distinct by Jepson, CNDDB, and the 1999 Federal Register (NatureServe, 2015). A member of the pea family (Fabaceae) (USFWS, 2009).

Historical Range

Historically and currently, the species is known only from the southwestern corner of San Luis Obispo County, California, scattered over an area of approximately 2 miles wide and 2 miles long (3.2 by 3.2 kilometers (km)) (USFWS, 2009).

Current Range

It is currently extant at Nipomo Mesa, San Luis Obispo County, California (NatureServe, 2015). Colonies are scattered across a 2-mile (3.2-km) stretch of backdune habitat west of Highway 1 and between Black Lake Canyon to the north and Oso Flaco Lake to the south (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2009)

Lifespan

Adult: One year (USFWS, 2009)

Breeding Season

Adult: March - May (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Insect pollinators, based on closely related species (USFWS, 2009)

Reproduction Narrative

Adult: This is an annual species. Potentially, seed production could reach on the order of 1,000 seeds; however, based on 2 years of sampling, observed seed production per plant ranged from 1 to over 200, with most plants producing less than 30 fruits (Walters and Walters 1988). Flowers are self-compatible if manipulated; however, they may require insect visitation for full complements of seeds (Center for Plant Conservation (CPC) 2009). While pollination ecology has not been specifically studied for L. nipomensis, other lupine taxa are known to be pollinated by butterflies and a variety of bee taxa, especially from the genera Bombus, Osmia, Synhalonia, and Anthidium (Moldenke 1976) (USFWS, 2009). It blooms from March to May (NatureServe, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Coastal dune scrub (USFWS, 2009)

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 2009)

Geographic or Habitat Restraints or Barriers

Adult: Occurs < 50 m elevation (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (inferred from USFWS, 2009)

Habitat Narrative

Adult: Inhabits stabilized coastal sand dunes at < 50 m elevation. (NatureServe, 2015). It is restricted to sandy soils associated with the Callender Dune Sheet (Cooper 1967). Habitat for Lupinus nipomensis is comprised of stabilized back dunes supporting a central coastal dune scrub community. Lupinus nipomensis needs open habitat to persist. Sandy soils along the coast typically undergo a certain amount of natural disturbance from coastal winds and from the activity of wildlife (USFWS, 2009).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

1 population; 10 occurrences (USFWS, 2020)

Population Size:

Variable; 139 - 771 (USFWS, 2020)

Population Narrative:

Lupinus nipomensis (Nipomo lupine) is a small annual plant in the pea family (Fabaceae). Historically and currently, the species is known only from the southwestern corner of San Luis Obispo County, California, scattered over an area of approximately 2 miles wide and 2 miles long (3.2 by 3.2 kilometers (km)) (Figure 1). It is restricted to sandy soils associated with the Callender Dune Sheet (Cooper 1967). For purposes of this review, we are considering the entire extent of the species to comprise one population; however, the California Natural Diversity Database (CNDDB) has divided the population into approximately 10 occurrences for tracking purposes. Over the last 4 years, the total number of individuals has fluctuated between approximately 139 and 771, depending on winter and spring climatic conditions (Land Conservancy of San Luis Obispo County (Conservancy) 2009). Over time, the species' habitat has been fragmented by State Highway 1 and oil refinery facilities, and bounded on the eastern side by development and agriculture. The small size of the populations and their proximity to a variety of human activities makes it vulnerable to stochastic extinction. (USFWS, 2020)

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: A Notice of Preparation to expand refinery capabilities at the Conoco-Phillips plant has been received (County of San Luis Obispo 2008). The Service has also recently received a notice regarding a proposal to construct a telecommunications facility less than 0.25 mile (0.4 km) away from EO #7 (C. Mehlberg, Service, in litt. 2009). The project proponent notes that the site was previously developed with agricultural fields; whether above-ground plants or a seed bank of L. nipomensis remains is unknown. In addition, it appears that several housing developments have been constructed within a mile of L. nipomensis habitat over the past 5 years (Google Earth 2009). The presence of a larger human population in the adjacent area is likely to introduce additional direct and indirect effects (such as trampling from recreational use, spread of invasive horticultural species used in landscaping, and loss of pollinator habitat) on the species as time goes on. Little opportunity for population expansion is available adjacent to the existing populations because habitat has already been converted to other uses, including roads, facilities, agriculture, and housing (USFWS, 2009).

Stressor: Pocket gophers (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: While pocket gophers are known to harvest seeds of many species in general (Martin et al. 1951), it is more likely that they consume the roots, stems, and leaves of L. nipomensis, and that seeds die prior to full maturation. However, seed that are able to complete maturation despite being excised from the plant may find suitable germination sites in the vacated gopher mounds the following winter season (Walters and Walters 1988). In addition, the listing rule stated that the presence of veldt grass increases the food source for pocket gophers and thus potentially increases their numbers and their potential harm to L. nipomensis (Walters and Walters 1988). Survey results for the 3 years from 2007 through 2009 indicate that from 28 to 31

percent of L. nipomensis individuals are consumed by pocket gophers on Conoco-Phillips property (Conservancy in litt. 2009); therefore, pocket gophers continue to be a threat to the species (USFWS, 2009).

Stressor: Nonnative plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In general, invasion of this habitat by nonnative species (particularly veldt grass (see Bossard et al. 2000)) is a threat to populations of native species because individuals cannot compete well for light, water, and resources (D'Antonio and Vitousek 1992). Veldt grass was described as "rampant" in the area at least 25 years ago (McLeod and Walters 1987); its presence can cause a shift from scrub habitat to grassland habitat (Bossard et al. 2000, California Invasive Plant Council 2009). Since 2000, the Conservancy has been actively removing veldt grass from Lupinus nipomensis habitat. While these efforts may have slowed the conversion to a monoculture of veldt grass, it is likely that the habitat will have to be managed in perpetuity to maintain the open patches that is required by L. nipomensis (USFWS, 2009).

Stressor: Stochastic events (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The existence of less than 10 occurrences and the small number of individuals in the occurrences place Lupinus nipomensis at risk of extinction from stochastic events. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Groom et al. 2006; Primack 2006). In particular, although the plants are apparently self-compatible and capable of self-fertilization, the small size of the population makes it difficult for this species to persist while sustaining the impacts of habitat alteration that favors nonnative plant species and the potential loss of pollinator habitat (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of increasing diversity shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects (USFWS, 2009).

Recovery

Reclassification Criteria:

Nipomo lupine may be considered for downlisting when the following criteria are met: 1. At least three resilient occurrences display stable or increasing population trends averaged over 10 consecutive years; 2. Each of the three resilient occurrences is protected from habitat loss, including development activities; 3. Each of the three resilient occurrences is being managed in a way that will support continued existence of Nipomo lupine and its coastal dune scrub habitat, including management of non-native, invasive species; 4. Management is effective as shown by monitoring for 10 consecutive years; and 5. An ex situ permanent conservation seedbank is established in a Center for Plant Conservation-affiliated botanic garden that reflects the breadth of the species' genetic diversity. (USFWS, 2021)

Delisting Criteria:

Once the downlisting criteria have been met, Nipomo lupine may be considered for delisting when the following criteria are met: 1. At least five resilient occurrences, are successfully established within the GuadalupeNipomo Dunes Complex, and display stable or increasing population trends averaged over 10 consecutive years; 2. Each of the five resilient occurrences is protected from habitat loss, including development activities; 3. Each of the five resilient occurrences is being managed in a way that will support continued existence of Nipomo lupine and its coastal dune scrub habitat, including management of non-native, invasive species; and 4. Management is effective as shown by monitoring for 10 consecutive years. (USFWS, 2021)

Recovery Actions:

- The recovery actions for Nipomo lupine are provided below. 1. Protect all currently unprotected habitat where the species occurs. The coastal dune scrub habitat associated with Nipomo lupine has a limited distribution and is considered a sensitive vegetation type. USFWS will work with potential partners to establish conservation easements, fee title agreements, or other appropriately protective measures on private lands that support the species and its habitat for conservation. 2. Conduct outplanting activities at suitable sites to establish new occurrences throughout the Guadalupe-Nipomo Dunes region. Potential outplanting locations include: • Kathleen's Canyon Overlook – located along Black Lake Canyon, on the corner of Callender Road and State Route 1 in rural Arroyo Grande. The Land Conservancy of San Luis Obispo (LCSLO) recently purchased this 55-acre site for conservation purposes. • Coreopsis Hill – located south of Oso Flaco Lake, southwest of the town of Nipomo, and less than one mile directly inland from the Pacific Ocean. The site is jointly owned by California Department of Parks and Recreation, Oceano Dunes State Vehicular Recreation Area and private landowners that support environmental stewardship and long-term preservation of the property. However, a conservation easement for the site has not yet been established with the private entity. The site is approximately 60 acres. • USFWS Guadalupe-Nipomo Dunes National Wildlife Refuge (Refuge) – a 2,553- acre site located northwest of the town of Guadalupe and west of State Route 1. The property is part of a national system that is managed specifically for conservation purposes. • Guadalupe Oil Field – a remediation site for diluent contaminants that is owned and managed by Chevron Corporation in cooperation with several other agencies and partners. The property is located on the north side of the Santa Maria River and immediately south of the Refuge. It is 2,700 acres in size. • Dune Lakes Limited – a privately owned duck-hunting club located north of Black Lake and south of the town of Oceano. LCSLO holds a conservation easement on approximately 970 acres of this 1,255-acre property. • Oceano Dunes Natural Preserve – this property is part of the Oceano Dunes State Vehicular Recreation Area and is owned and managed by California Department of Parks and Recreation. The preserve area is

approximately 500 acres and is located southwest of the town of Oceano. • Trilogy Dunes Open Space – this site is located southeast of the Phillips 66 Refinery and is designated as an open space preserve to offset impacts from two associated residential developments under the California Environmental Quality Act. The property is approximately 175 acres. 3. Manage habitat that supports the species to reduce or eliminate threats to the population (particularly non-native, invasive weeds) and to foster natural regeneration and recruitment of Nipomo lupine. 4. Collect seed and deposit accessions into the permanent conservation seedbank established for the species at the Santa Barbara Botanic Garden that includes additional backup sent to the U.S. Department of Agriculture's National Laboratory for Genetic Resource Preservation seed vault, located in Fort Collins, Colorado. 5. Conduct annual census monitoring and experimental research projects across the occurrences to fill data gaps and document the progress of recovery implementation. 6. Determine those factors necessary for seed survival, optimal germination, and effective seedling establishment and use this information to ensure future recovery efforts. In particular, consider the role of disturbance, predation, and pollination on the species viability. 7. Conduct genetics and demographic research to better inform future recovery activities and criteria. Examples of potential projects include: • Investigate the effects of outplanting on the species genetic variability and compare variability of extant occurrences to that of propagated lines. • Determine the number of reproducing individuals required for population resiliency in any given occurrence. • Quantify seedbank longevity. 8. Develop opportunities for education and outreach within local and regional communities, and throughout San Luis Obispo County. (USFWS, 2021)

- Complete a Recovery Outline and Species Action Plan for Lupinus nipomensis as a first step in preparing a recovery plan for the species (USFWS, 2009).
- Work with Conoco-Phillips and California Department of Transportation to ensure that management of their lands and rights-of-way is consistent with the long-term persistence of Lupinus nipomensis at those sites. In addition, work with the County of San Luis Obispo to ensure that consideration is given to L. nipomensis during projects review and implementation (USFWS, 2009).
- In partnership with Santa Barbara Botanic Garden, continue with research on seed characteristics, particularly to determine the extent of the soil seed bank present, and whether there is a difference in seed viability between those produced from self-fertilization and those produced by cross-pollination to determine if lack of pollinators is a concern (USFWS, 2009).
- In partnership with Santa Barbara Botanic Garden and the Conservancy, experiment with establishment of new populations in other coastal dune scrub habitat in coastal San Luis Obispo County (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Complete a Recovery Outline and Species Action Plan for Lupinus nipomensis as a first step in preparing a recovery plan for the species. 2. Work with Conoco-Phillips and California Department of Transportation to ensure that management of their lands and rights-of-way is consistent with the long-term persistence of Lupinus nipomensis at those sites. In addition, work with the County of San Luis Obispo to ensure that consideration is given to L. nipomensis during projects review and implementation. 3. In partnership with Santa Barbara Botanic Garden, continue with research on seed characteristics, particularly to determine the extent of the soil seed bank present, and whether there is a difference in seed viability between those produced from selffertilization and those produced by cross-pollination to determine if lack of

pollinators is a concern. 4. In partnership with Santa Barbara Botanic Garden and the Conservancy, experiment with establishment of new populations in other coastal dune scrub habitat in coastal San Luis Obispo County. (USFWS, 2020)

- Trilogy Dunes Open Space – this site is located southeast of the Phillips 66 Refinery and is designated as an open space preserve to offset impacts from two associated residential developments under the California Environmental Quality Act. The property is approximately 175 acres. (USFWS, 2021)

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SPECIES ACCOUNT: *Lupinus sulphureus ssp. kincaidii* (Kincaid's Lupine)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/24/2000; Pacific Region (R1)

Physical Description

Lupinus sulphureus ssp. kincaidii, a dicot herbaceous perennial, was first described in 1921 by A.A. Heller as Lupinus oreganus from a collection made in Eugene, Oregon (Wilson et al. 2003). In the intervening decades, Phillips (1955) described the plant as a subspecies, L. sulphureus ssp. kincaidii. Hitchcock (1961) retained the position noted by Phillips (1955), but preferred the combination as a varietal rank, L. sulphureus var. kincaidii, although this is not accepted under the rules of botanical nomenclature (Wilson et al. 2003). Additional taxonomic work may be needed for this subspecies, and it is possible that the subspecies should be considered a distinct species, L. oreganus (Wilson et al. 2003). (USFWS, 2010) This taxonomic change for Kincaid's lupine, from the subspecies Lupinus suiphureus ssp. kincaidii to the full species Lupinus oreganus, has now been recognized by the Oregon Department of Agriculture (Oregon Department of Agriculture, 2019) and by botanical authorities such as the Oregon Flora Project's Vascular Plant Checklist (laster et al. 2019) and the Flora of Oregon (S. Meyers pers. comm. 2019). Other authorities, such as the Natural Resources Conservation Service's USDA PLANTS database (USDA PLANTS 2019), the Integrated Taxonomic Tnformation System (ITIS.GOV 2019), the Flora of the Pacific Northwest (Hitchcock and Cronquist 2018), and Washington Department of Natural Resources (Washington Natural Heritage Program 2019, p. 19) now recognize Kincaid's lupine as a variety, Lupinus oreganus var. kincaidii C.P. Sm. (the other variety being L. oreganus var. oreganus, formerly L. biddlei). Whether a full species or an infraspecies, all authorities now agree that at a minimum, Kincaid' s lupine should be recognized under the specific epithet "oreganus" instead of "suiphureus." (USFWS, 2019)

Taxonomy

Lupinus sulphureus ssp. kincaidii was first described in 1921 by A.A. Heller as Lupinus oreganus from a collection made in Eugene, Oregon (Wilson et al. 2003). In the intervening decades, Phillips (1955) described the plant as a subspecies, L. sulphureus ssp. kincaidii. Hitchcock (1961) retained the position noted by Phillips (1955), but preferred the combination as a varietal rank, L. sulphureus var. kincaidii, although this is not accepted under the rules of botanical nomenclature (Wilson et al. 2003). Additional taxonomic work may be needed for this subspecies, and it is possible that the subspecies should be considered a distinct species, L. oreganus (Wilson et al. 2003). (USFWS, 2010) This taxonomic change for Kincaid's lupine, from the subspecies Lupinus suiphureus ssp. kincaidii to the full species Lupinus oreganus, has now been recognized by the Oregon Department of Agriculture (Oregon Department of Agriculture, 2019) and by botanical authorities such as the Oregon Flora Project's Vascular Plant Checklist (laster et al. 2019) and the Flora of Oregon (S. Meyers pers. comm. 2019). Other authorities, such as the Natural Resources Conservation Service's USDA PLANTS database (USDA PLANTS 2019), the Integrated Taxonomic Tnformation System (ITIS.GOV 2019), the Flora of the Pacific Northwest (Hitchcock and Cronquist 2018), and Washington Department of Natural Resources (Washington Natural Heritage Program 2019, p. 19) now recognize Kincaid's lupine as a variety, Lupinus oreganus var. kincaidii C.P. Sm. (the other variety being L. oreganus var. oreganus, formerly L. biddlei). Whether a full species or an infraspecies, all authorities now agree that at a minimum, Kincaid' s lupine should be recognized under the specific epithet "oreganus" instead

of “suiphureus.” (USFWS, 2017)

Historical Range

"Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid’s lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat" (USFWS, 2010 p. II-20).

Current Range

Douglas County, Oregon to Lewis County, Washington, and into southern British Columbia. Considered extirpated in British Columbia. In Oregon, in the Willamette and Umpqua Valleys. Kincaid's lupine is restricted to upland prairie habitat "Before Euro-Americans settled the Willamette Valley, prairies were one of the dominant habitat types, accounting for perhaps 30 percent of the valley floor (Altman et al. 2001). Prairies were created and maintained by natural and human-caused disturbances; the native Kalapuya peoples burned the prairies frequently to maintain high quality hunting and gathering grounds (Boyd 1986). As settlers arrived, native habitats were converted to agricultural landscapes, annual burning ceased, and native upland prairies and wet prairies now cover much less than one percent of their former area (Habeck 1961, Johannessen et al. 1971, Towle 1982), making them among the rarest of North American ecosystems (Oregon Natural Heritage Program 1983, Noss et al. 1995)." (USFWS 2010 p. I-5). "The majority of the habitat for Lupinus sulphureus ssp. kincaidii is on private lands, thus partnering with private landowners by working with nongovernmental organizations (e.g., land trusts), local governments such as soil and water conservation districts, and the Service’s Partners for Fish and Wildlife program is essential to achieve recovery." (USFWS 2019 p.7)

Critical Habitat Designated

Yes; 11/30/2000.

Legal Description

On October 31, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective November 30, 2006) for Lupinus sulphureus ssp. kincaidii (Kincaid's lupine) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 13 critical habitat units (CHUs) in Oregon and Washington (71 FR 63862-63977).

Critical Habitat Designation

The critical habitat designation for Lupinus sulphureus ssp. kincaidii includes 13 CHUs in Benton, Lane, Polk, and Yamhill Counties, Oregon, and Lewis County, Washington. This species critical habitat encompasses approximately 585 acres (ac) (237 hectares (ha)). Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule (71 FR 63862-63977; USFWS, 2006).

Unit KL–1 consists of approximately 4 ac (1.6 ha) of private land in Lewis County, Washington.

Unit KL–2A and 2B encompass approximately 6.25 ac (2.5 ha) and 14.1 ac (5.7 ha) respectively, of private land in northern Yamhill County. KL–2A supports Lupinus sulphureus ssp. kincaidii patches along both the east and west sides of Oak Creek Road. KL– 2B is located approximately

0.68 miles (1.1 km) south of KL–2A along both the east and west sides of Oak Creek Road, near the junction with Fairdale Road.

Unit KL–3 consists of approximately 51 ac (20.6 ha) of private lands within Yamhill County.

Unit 4 of Lupinus sulphureus ssp. kincaidii (Unit KL–4A and 4B) Unit KL–4A and 4B consists of approximately 68.6 ac (27.8 ha) of private lands in Yamhill County and is located west of Muddy Valley Road and south of Eagle Point Road.

Unit 5 of Lupinus sulphureus ssp. kincaidii (Unit KL–5) Unit KL–5 encompasses approximately 1.7 ac (0.7 ha) of ODOT land in southern Yamhill County and is located south of State Highway 18, east of Ballston Road, and approximately 0.6 mi (1 km) south of the Yamhill River.

Unit KL–6 encompasses approximately 3.6 ac (1.5 ha) of primarily ODOT land in northern Polk County. The Lupinus sulphureus ssp. kincaidii population occurs in two patches scattered along the northeast and southwest sides of Highway 22, near the intersection with Mill Creek Road.

Unit KL–7 consists of approximately 12.3 ac (5 ha) of private lands in central Polk County. This unit is located near the junction of Highway 223 and Oakdale Avenue, and largely falls within the City of Dallas urban-growth boundary.

Unit KL–8 consists of approximately 11.5 ac (4.6 ha) of private and State lands in Benton County. This unit occurs in McDonald Forest located off Oak Creek Road and supports one of the highest quality remaining prairies.

Unit KL–9 encompasses approximately 171.6 ac (69.4 ha) of private lands within Benton County. This unit is located in Wren, Oregon, between Kings Valley Highway, Cardwell Hill Road, and Blakesly Creek Road, approximately 2 mi (3.2 km) southwest of Unit KL–8.

Unit KL–10 consists of approximately 17.9 ac (7.2 ha) of private lands within Benton County and is located north of Philomath, with the habitat occurring primarily to the south of West Hills Road and to the west of 19th Street.

Unit KL–11 encompasses approximately 64.6 ac (26.2 ha) of prairie habitat distributed across Federal and private lands in Lane County. This unit is located in West Eugene, near the Fern Ridge Reservoir, just south of Clearlake Road, and on both the east and west sides of Fir Butte Road. The area included in Units KL–11A, 11B, 11C, 11D, and 11E.

Unit KL–12 encompasses approximately 141.2 ac (57.1 ha) of prairie habitat distributed across Federal and private lands in Lane County. This unit is in west Eugene and located north of Bailey Hill Road and west of Bertelsen Road. This unit primarily occurs on lands owned by TNC and the BLM, with 4 percent occurring on private lands. The area included in KL– 12A, 12B, 12C, 12D, and 12E, collectively represents habitat with the features essential to the conservation of a functioning Lupinus sulphureus ssp. kincaidii metapopulation.

Unit KL–13 encompasses approximately 16.2 ac (6.6 ha) of private land in Lane County, and is located north of Powell Road and west of Coyote Creek.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lupinus sulphureus ssp. kincaidii critical habitat consists of two components (71 FR 63862-63977):

(i) Early seral upland prairie, or oak savanna habitat with a mosaic of lowgrowing grasses and forbs, and spaces to establish seedlings or new vegetative growth; an absence of dense canopy vegetation; and undisturbed subsoils.

(ii) The presence of insect outcrossing pollinators, such as Bombus mixtus and B. californicus, with unrestricted movement between existing lupine patches.

Special Management Considerations or Protections

Lupinus sulphureus ssp. kincaidii populations respond positively to habitat restoration. Mowing, burning, and mechanical removal of weeds, when done appropriately, have all been shown to benefit Fender's blue populations. At sites managed by The Nature Conservancy (TNC), the Fender's blue butterfly and L. sulphureus ssp. kincaidii populations increased following removal of noxious non-native plants such as Rubus discolor (Himalayan blackberry) and Cytisus scoparius (Scotch broom) (Fitzpatrick 2005, pp. 6, 7, 10, 11, 20). At Baskett Slough National Wildlife Refuge in western Oregon, Wilson and Clark (1997, p. 10, 11) studied the effects of controlled fire and mowing on the Fender's blue butterfly and its native upland prairie. Although fire killed all larvae in treated patches, nearby unburned (untreated) patches provided a source of female Fender's blue butterflies that were able to recolonize the entire burned (treated) area. Wilson and Clark (1997, pp. 10, 23) also found that in the year following mowing and burning treatments, Fender's blue butterfly eggs were 10 to 14 times more abundant in treated plots than in undisturbed control plots. Woody plants were reduced by 45 percent with burning and by 66 percent with mowing. At the Corps' Fern Ridge Reservoir, the Fender's blue population has increased dramatically since fall mowing of L. sulphureus ssp. kincaidii patches has been implemented. The abundance of Fender's blue butterfly eggs and L. sulphureus ssp. kincaidii has increased as blackberry bushes have been controlled in several test plots located on BLM lands in Eugene, Oregon (Kaye and Cramer 2003, p. 10). In general, Fender's blue butterfly egg abundance increased substantially at sites treated to control non-native weeds (Schultz et al. 2003, p. 69). (USFWS, 2006)

Lupinus sulphureus ssp. kincaidii is at risk of inbreeding depression and site extirpation across their respective ranges because populations are small and isolated from one another. This species will benefit from reestablishing prairie plant patches in proximity to core populations. (USFWS, 2006)

Many remaining populations of Lupinus sulphureus ssp. kincaidii populations occur in road rights of ways and are adversely affected by maintenance activities such as mowing or spraying of herbicides at the wrong time of year. A few L. sulphureus ssp. kincaidii populations along roads persist, likely because the routine maintenance provides open, full-sun conditions characteristic of L. sulphureus ssp. kincaidii habitat.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2010) "Pollination is largely accomplished by small native bumblebees (Bombus mixtus and B. californicus), solitary bees (Osmia lignaria, Anthophora furcata, Habropoda sp., Andrena spp., Dialictus sp.) and occasionally, European honey bees (Apis mellifera) (Wilson et al.2003). Insect pollination appears to be critical for successful seed production (Wilson et al.2003). Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual clones can be several centuries old (Wilson et al.2003), and become quite large with age, producing many flowering stems." (USFWS 2010 p. II-22)

Dependency on Other Individuals or Species

Adult: "Pollination is largely accomplished by small native bumblebees (Bombus mixtus and B. californicus), solitary bees (Osmia lignaria, Anthophora furcata, Habropoda sp., Andrena spp., Dialictus sp.), and occasionally European honey bees (Apis mellifera) (Wilson et al. 2003). Insect pollination appears to be critical for successful seed production (Wilson et al. 2003)." (USFWS 2010 p. II-22) Kincaid's lupine is the larval host for the Endangered Fender's blue butterfly. (USFWS 2010)

Breeding Season

Adult: Flowering begins in April and extends through June (USFWS 2010). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al.2003) (USFWS, 2010).

Reproduction Narrative

Adult: Flowering begins in April and extends through June (USFWS 2010). As the summer dry season arrives, Kincaid's lupine becomes dormant, and is completely senescent by mid-August (Wilson et al.2003). Pollination is largely accomplished by small native bumblebees (Bombus mixtus and B. californicus), solitary bees (Osmia lignaria, Anthophora furcata, Habropoda sp., Andrena spp., Dialictus sp.) and occasionally, European honey bees (Apis mellifera) (Wilson et al.2003). Insect pollination appears to be critical for successful seed production (Wilson et al.2003). Kincaid's lupine reproduces by seed and vegetative spread. It is able to spread extensively through underground growth. Individual clones can be several centuries old (Wilson et al.2003), and become quite large with age, producing many flowering stems. As part of a genetic evaluation, collections taken from small populations of Kincaid's lupine at the Baskett Slough National Wildlife Refuge were found to be genetically identical, indicating that the population consists of one or a few large clones (Liston et al.1995). Reproduction by seed is common in large populations where inbreeding depression is minimized and ample numbers of seeds are produced. In small populations, seed production is reduced and this appears to be due, at least in part, to inbreeding depression (Severns 2003). Kincaid's lupine is vulnerable to seed, fruit and flower predation by insects, which may limit the production of seeds. Seed predation by bruchid beetles and weevils and larvae of other insects has been documented, and may result in substantially reduced production of viable seed (Kaye and Kuykendall 1993, Kuykendall and Kaye 1993). Floral and fruit herbivory by larvae of the silvery blue butterfly (Glaucopsyche lygdamus columbia) has also been reported (Kuykendall and Kaye 1993). The vegetative structures of Kincaid's lupine support a variety of insect herbivores, including root borers, sap suckers and defoliators (Wilson et al.2003). Kincaid's lupine is the primary larval host plant of the endangered Fender's blue butterfly (Wilson et al.2003). Female Fender's blue

butterflies lay their eggs on the underside of Kincaid's lupine leaves in May and June; the larvae hatch several weeks later and feed on the plant for a short time before entering an extended diapause, which lasts until the following spring (Schultz et al.2003). Kincaid's lupine, like other members of the genus Lupinus, is unpalatable to vertebrate grazers (USFWS, 2016).

Habitat Type

Adult: Upland prairie (USFWS, 2010)

Environmental Specificity

Adult: Moderate (Inferred from USFWS, 2016)

Habitat Narrative

Adult: "In the Willamette Valley and southwestern Washington, Kincaid's lupine is found on upland prairie remnants where the species occurs in small populations at widely scattered sites. A number of populations are found in road rights-of-way, between the road shoulder and adjacent fence line, where they have survived because of a lack of agricultural disturbance. Some of the populations in Washington occur in pastures and appear to benefit from light grazing by livestock, which reduces the cover of competing shrubs and grasses (Joe Arnett, Washington Department of Natural Resources, in litt 2008). Common native species typically associated with Kincaid's lupine include: Festuca idahoensis ssp. roemeri, Danthonia californica, Calochortus tolmiei, Eriophyllum lanatum, and Fragaria virginiana. The species appears to prefer heavier, generally well-drained soils and has been found on 48 soil types, typically Ultic Haploxerolls, Ultic Argixerolls, and Xeric Palehumults (Wilson et al.2003). In Douglas County, Oregon, Kincaid's lupine appears to tolerate more shaded conditions, where it occurs at sites with canopy cover of 50 to 80% (Barnes 2004). In contrast to the open prairie habitats of the more northerly populations, in Douglas County, tree and shrub species dominate the sites, including Pseudotsuga menziesii (Douglas-fir), Quercus kelloggii (California black oak), Arbutus menziesii (Pacific madrone), Pinus ponderosa (ponderosa pine), Calocedrus decurrens (incense cedar), Arctostaphylos columbiana (hairy manzanita) and Toxicodendron diversilobum. In contrast to historical ecosystem composition, invasive non-native species are a significant component of Kincaid's lupine habitat today (USFWS 2010). Common invasives include: Arrhenatherum elatius, Brachypodium sylvaticum, Dactylis glomerata, Festuca arundinacea, Rubus armeniacus and Cytisus scoparius (Wilson et al.2003). In the absence of fire, some native species, such as Toxicodendron diversilobum and Pteridium aquilinum, invade prairies and compete with Lupinus sulphureus ssp. kincaidii" (USFWS, 2010).

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2019)

Resiliency:

Moderate

Representation:

Moderate

Redundancy:

Moderate

Number of Populations:

21 - 80 (NatureServe, 2015) "The rangewide survey for Lupinus sulphureus ssp. kincaidii did not census every known occurrence of the species, but concentrated on those populations with the potential to contribute to the recovery goals for the species. Sites were selected for survey based on a priority system considering population size, connectivity with other populations, landownership, co-occurrence with Fender's blue butterfly, and date of most recent monitoring efforts. Small, isolated populations, especially those on private lands, were not prioritized for surveys. If sites had been monitored within the last 5 years, these sites were not resurveyed, but instead the most recent data were utilized in the report. As a result, the rangewide survey and monitoring report provides data from 84 populations of L. sulphureus ssp. kincaidii across its range (Ottombrino-Haworth et al. 2017, pp. 16, 23, 72–582). These 84 populations are distributed across six recovery zones for L. sulphureus spp. kincaidii as follows: 27 in Salem West, 26 in Corvallis West, 14 in Eugene West, 8 in Douglas County, 5 in SW Washington, and 4 in Eugene East. There are no known extant populations in the Corvallis East and Salem East recovery zones." (USFWS, 2019)

Population Size:

"Overall foliar cover has increased from an estimated range of 14,070 to 19,118 square meters (m2) (1.4 to 1.9 hectares (ha); 3.5 to 4.7 acres (ac)) at the time of listing to approximately 22,785 m2 (2.3 ha; 5.6 ac) today (Table 1). A few recovery zones have seen increases in foliar cover of L. sulphureus ssp. kincaidii since the 2010 5-year review, and in some cases those increases are quite large; these increases are primarily in the Corvallis West and Salem West recovery zones, where recovery efforts, including augmentation and outplanting of L. sulphureus ssp. kincaidii, have been concentrated in recent years. These zones have benefitted from the availability of seed specific to these areas (the lack of genetically appropriate seed sources is a continuing problem in many of the recovery zones), as well as the incidental advantage gained by L. sulphureus spp. kincaidii from being cultivated as the host plant for the endangered Fender's blue butterfly (Icaricia icarioides fenderi), which also occurs in those recovery zones. In contrast the foliar cover of L. sulphureus ssp. kincaidii has declined in the Douglas County and Southwest Washington recovery zones, and has remained roughly the same in Eugene West. However, as this most recent survey was the first rangewide effort using a standardized approach, at this point in time it is difficult to make any truly definitive assessments regarding population trend (Ottombrino-Haworth et al. 2017, p. 45). " (USFWS 2019 p. 4)

Population Narrative:

Kincaid's lupine is found in dry upland prairies from Lewis County, Washington, in the north, south to the foothills of Douglas County, Oregon; however, most of the known and historical populations are found in the Willamette Valley (USFWS 2010). Historically, the species was documented from Vancouver Island, British Columbia, Canada (Dunn and Gillet 1966), but has not been located in that region since the 1920s (Kaye 2000). Before Euro-American settlement of the region, Kincaid's lupine was likely well distributed throughout the prairies of western Oregon and southwestern Washington; today, habitat fragmentation has resulted in existing populations that are widely separated by expanses of unsuitable habitat. Range-wide, Kincaid's lupine is known at about 164 sites, comprising about 608 acres of total coverage

(USFWS 2010). In Oregon, the ONHIC (2014) reported Kincaid's lupine over 100 sites. From these locations, at least 43 populations are considered potential populations that could contribute to recovery (USFWS, OFWO, 2014, unpublished data); and 25 of those populations have protection in place for Kincaid's lupine. Until the summer of 2004, Kincaid's lupine was known from just two extant populations in Washington, in the Boistfort Valley in Lewis County, more than 160 km (100 miles) from the nearest population in the Willamette Valley (USFWS 2010). Arnett (2014) reported a total of 5 populations across 9 sites of Kincaid's lupine in 2014. At two sites, Kincaid's lupine covered more than 1,000 m2 (1,196 square yards)each (Boistfort and Cowlitz Prairie); only one plant was observed at Drew's Prairie in 2013. Only one location (Lozier Preserve within the Cowlitz Prairie population) has protection for Kincaid's lupine; all other locations are privately owned with no formal protections. Monitoring the size of Kincaid's lupine populations is challenging because its pattern of vegetative growth renders it difficult to distinguish individuals (Wilson et al.2003). Instead of counting plants, most monitoring for this species relies on counting the number of leaves per unit area, partly because there is a strong correlation between Fender's blue butterfly egg numbers and lupine leaf density (Schultz 1998, Kaye and Thorpe 2006). Leaf counts are time consuming, however, and recent evaluations have shown that lupine cover estimates are highly correlated with leaf counts, much faster to perform, and useful for detecting population trends (Kaye and Benfield 2005) (USFWS, 2016).

Threats and Stressors

Stressor: Plant succession (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: A serious long-term threat to all Willamette Valley prairie species is the change in community structure due to plant succession. The vast majority of Willamette Valley prairies would likely be forested if left undisturbed. The natural transition of prairie to forest in the absence of disturbance such as fire will lead to the eventual loss of these prairie sites unless they are actively managed (Johannessen et al.1971; Kuykendall and Kaye 1993) (USFWS, 2016).

Stressor: Urbanization (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urbanization is listed as a threat to this species. Land development and alteration in the prairies of western Oregon and southwestern Washington have been so extensive that the remaining populations are essentially relegated to small, isolated patches of habitat. Habitat loss is likely to continue as private lands are developed; at least 49 of 54 sites occupied by Lupinus sulphureus ssp. kincaidii in 2000 at the time of listing were on private lands and are at risk of being lost unless conservation actions are implemented (USFWS 2000) (USFWS, 2016).

Stressor: Agriculture (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agriculture is listed as a threat to this species (USFWS, 2016).

Stressor: Silviculture (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Silviculture practices are listed as threats to this species (USFWS, 2016).

Stressor: Roadside maintenance (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Roadside maintenance is listed as a threat to this species (USFWS, 2016).

Stressor: Habitat fragmentation (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat/loss of genetic variability
Narrative: Habitat fragmentation and isolation of small populations may be causing inbreeding depression in Lupinus sulphureus ssp. kincaidii. The subspecies was likely wide-spread historically, frequently outcrossing throughout much of its range, until habitat destruction and fragmentation severely isolated the remaining populations (Liston et al.1995). There is some evidence of inbreeding depression, which may result in lower seed set (Severns 2003). Hybridization between Lupinus sulphureus ssp. kincaidii and Lupinus arbustus has been detected at Baskett Slough National Wildlife Refuge (Liston et al.1995)

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 6C

Delisting Criteria:
Delisting will be considered when all of the following conditions have been met: (USFWS, 2010)

1. Distribution and abundance. The distribution of populations should reflect the extent of the species' historical geographic distribution to the extent practicable. See Table IV-5 in the Recovery Plan for distribution and abundance goals for this species. (USFWS, 2010)

2. Population trend and evidence of reproduction. The number of individuals in the population (or area of foliar cover for Lupinus sulphureus ssp. kincaidii or Sidalcea nelsoniana) shall have been stable or increasing over a period of at least 15 years. Stable does not mean that the population size is static over time; over a period of 15 years, the number of individuals in the population may exhibit natural year-to-year variability, but the trend must not be declining. Populations must show evidence of reproduction by seed set or presence of seedlings. (USFWS, 2010)

3. Habitat quality and management. Sites supporting populations of listed plants considered in Criterion 1 above must meet these criteria: (a) Prairie quality. Sites supporting populations of

the listed plant species must be managed for high quality prairie habitat. High quality prairie habitat consists of a diversity of native, non-woody plant species, low frequency of aggressive non-native plant species and encroaching woody species, and essential habitat elements (e.g., nest sites and food plants) for native pollinators. See Appendix D of the Recovery Plan for suggested criteria for evaluating prairie quality and diversity. (b) Security of habitat. For each listed species, a substantial portion of the habitat for the populations should either be owned or managed by a government agency or private conservation organization that identifies maintenance of the species and the prairie ecosystem upon which it depends as the primary management objective for the site, or the site must be protected by a permanent or long-term conservation easement or covenant that commits present and future landowners to the conservation of the species. (c) Management, monitoring, and control of threats. Each population must be managed appropriately to ensure the maintenance or restoration of quality prairie habitat for each species and to control threats to the species. Use of herbicides, mowing, burning or livestock grazing in management should be implemented with appropriate methods and timing to avoid impacts to listed plant species. Management should be coordinated with adjacent landowners to minimize effects of pesticide drift, changes in hydrology, timber harvest, or road/utility maintenance. Species that may hybridize with Sidalcea nelsoniana or Lupinus sulphureus ssp. kincaidii should be managed as appropriate to avoid contact with these taxa. Other potential threats relating to scientific research, overcollection, vandalism, recreational impacts, or natural herbivory/parasitism should be successfully managed so as not to significantly impair recovery of the species. (USFWS, 2010)

4. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must represent the species' geographic distribution and genetic diversity through collections across the full range of the species. Collections from large populations are particularly important as reservoirs of genetic variability within the species. (USFWS, 2010)

5. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species, provide a basis for determining whether the species should be again placed under the protection of the Endangered Species Act, and provide a means of assessing the continuing effectiveness of management actions. (USFWS, 2010)

Recovery Actions:

- Details of the Recovery Actions are available in the 2010 Recovery Plan. Presented below is the introductory paragraph only. (USFWS, 2010)
- 1. Preserve, restore, and manage populations and habitat for the listed prairie species covered by this plan. The listed prairie species of western Oregon and southwestern Washington addressed by this plan are now found only in small, highly fragmented upland and wet prairie habitat remnants. The first step in the recovery of these species is to identify and protect the remaining populations with the greatest potential for restoration. The next step is to augment and, if necessary, reintroduce populations to restore connectivity between those that are currently isolated from one another to restore gene flow and create a population structure that provides for resiliency in a dynamic natural environment. Recovery for all of these species will depend upon the successful establishment of a network of protected populations in managed, suitable prairie habitats distributed across their

historical range. As a large portion of the remnant prairie habitats within the range of these species is in private ownership, recovery will to a large extent depend upon the successful development of partnerships with private landowners and support of their efforts to protect, restore and manage native prairie habitats in the region. (USFWS, 2010)

- 2. Coordinate recovery actions to benefit other listed species and nonlisted prairie species of conservation concern. The extensive loss of both wet and upland prairie habitats throughout the geographic region addressed by this draft recovery plan has resulted in the concurrent declines of many of the native plants and animals associated with these ecosystems. In this plan we have attempted to focus not only on the recovery of the listed prairie species, but to extend these recovery efforts to the ecosystems upon which they depend. The recommended actions for restoring and reconnecting prairie habitats in western Oregon and southwestern Washington are intended to extend benefits beyond the threatened or endangered species addressed in the plan to all of the native prairie species in these regions, including nonlisted prairie species that are recognized as in decline. Proactive efforts to restore prairie systems should contribute to the arrest or reversal of these declines, thereby preventing the need to list these species in the future. Particularly on sites where listed species co-occur with nonlisted species of conservation concern, landowners or managers should be made aware so as to tailor management actions to avoid inadvertent negative impacts on any such species. Coordination with other agencies, private landowners, or other interested parties will help ensure that the recovery actions outlined in this plan benefit the habitat and populations of other native prairie species. (USFWS, 2010)
- 3. Promote protection of listed species and prairie restoration on private lands. More than 90 percent of the land in the Willamette Valley is in private ownership. The restoration of prairie systems and their native plant and animal communities can therefore only be successful with the participation of private landowners. Without active management, populations of both listed and nonlisted species endemic to prairie habitats are almost certain to experience further declines. Working with private landowners and providing incentives to participate in the recovery effort for these species are critical elements of the recovery strategy. (USFWS, 2010)
- 4. Cultivate partnerships with both public and private agencies and organizations to promote the conservation of prairie ecosystems and listed prairie species. A diverse group of agencies and organizations are involved in recovery activities for the native prairies in western Oregon and southwestern Washington, including, but not limited to, the U.S. Fish and Wildlife Service, the Willamette Valley National Wildlife Refuge Complex, the U.S. Bureau of Land Management, U.S. Army Corps of Engineers, Confederated Tribes of Grand Ronde, Oregon Department of Transportation, City of Eugene, The Nature Conservancy, Oregon State University, Institute for Applied Ecology, Greenbelt Land Trust, McKenzie River Land Trust, Oregon Oak Communities Working Group, Washington Native Plant Society, Oregon Native Plant Society, Heritage Seedlings, and Berry Botanic Garden. Information regarding the recovery efforts for the prairie species should be shared with city and county planning, parks, and natural resource departments throughout the region covered by this recovery plan. City and county governments are the primary agencies that determine future land uses, and their participation is important for the recovery and restoration of the prairies and their associated listed species. Some local agencies are already making significant contributions toward prairie restoration; the West Eugene Wetlands are an excellent example of a significant conservation accomplishment achieved through a partnership of federal and local governments and private landowners/organizations. Plans,

data, and information pertinent to the recovery of the prairie species must be synthesized and shared effectively between all agencies, groups, and individuals to leverage collective conservation efforts and achieve recovery. (USFWS, 2010)

- 5. Revise and update recovery plan as needed. Based on the results of the recommended research and monitoring efforts and the evaluation of the relative success or failure of different management techniques, the recovery plan should be revised periodically as needed to reflect this increased knowledge and improve the efficacy of future recovery actions. The scientific validity of the recovery criteria should also be reviewed and refined, if necessary, as more accurate species-specific data become available to assist with refining recovery criteria. (USFWS, 2010)
- 6. Develop post-delisting monitoring plans for each listed species prior to delisting. To ensure the continuing recovery of the listed species and adequacy of management actions to maintain the species at viable levels into the foreseeable future, a post-delisting monitoring plan must be developed and ready for implementation prior to delisting of any threatened or endangered species. Such a monitoring plan must be designed to be continued for a minimum of 5 years following the delisting action. (USFWS, 2010)
- Recommendation for Future Action from 2017 5-Year Review: Site naming conventions remain inconsistent and do not reflect “populations” as functional units. We recommend that a standard procedure for aggregating sites into populations be developed so that the Service and our partners can describe the number of populations in a more meaningful way. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: We recommend that the taxonomy of this species be reviewed as multiple names are currently being used for the same species. Naming conventions and genetics issues surrounding Kincaid’s lupine remain unresolved. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Management is imperative for prairie species to survive. Removal of woody species, control of invasive weeds and, in some cases, reintroduction of the once common native prairie matrix species may be necessary to maintain suitable habitat for Kincaid’s lupine. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: Recovery of Kincaid’s lupine will require voluntary conservation by private landowners. The majority of this species’ habitat is privately owned and, due to the regulatory limitations, the Service is not able to prevent privately owned populations from being destroyed. Working with private landowners, conservation organizations, and local governments to conserve and protect Kincaid’s lupine is essential to achieving recovery. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: We recommend that the issue of hybridization be addressed through genetic analysis or crossing studies of Kincaid’s lupine. Current publications are limited to one known instance of hybridization between Kincaid’s lupine and spur lupine at Baskett Slough National Wildlife Refuge (Liston et al. 1 995). In order to determine the role of hybridization and the risk it poses to this species, additional genetic information is needed for Kincaid’s lupine populations throughout its range. (USFWS, 2017)
- Recommendation for Future Action from 2017 5-Year Review: The gaps in data evident in this analysis also indicate the need for accurate and up-to-date population (foliar cover) estimates for a number of sites. We recommend a complete survey effort to assess the status of all presumed extant populations of Kincaid’s lupine throughout its range. (USFWS, 2017)

- All of the General Plant Conservation Measures (Section 3.13.1) apply for Kincaid's lupine. Additional species-specific measures include: • Broadcast application of grass-specific herbicides may be used in on up to half of an area occupied by Kincaid's lupine between February 15 and April 15. If using a weed wiper to apply a grass-specific herbicide for a particular listed plant during the growing season, the herbicide will be applied to the upper grass stems of targeted non-native plants, thus avoiding the shorter listed plant species. • All other broadcast applications will only occur after August 15 when Kincaid's lupine is dormant. This plant is the primary host plant for Fender's blue butterflies (another listed species); see additional PDC, restrictions, and conservation measures that apply for Fender's blue butterfly (USFWS, 2016).

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SPECIES ACCOUNT: *Lupinus tidestromii* (Clover lupine)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A creeping, perennial herb, 1-3 dm tall, rhizomatous. Roots bright yellow. Narrow leaves with 3-5 leaflets, arranged in a fan shape. Stems and leaves with short hairs. Inflorescence stems are 4-8 cm long, and whorls of flowers are blue to lavender. Fruits are pods containing 5-8 seeds with blackish spots (Fish and Wildlife Service 1997). (NatureServe, 2015)

Taxonomy

Lupinus tidestromii (Tidestrom's lupine) was described by Edward Greene in 1895 from an 1893 collection made by Ivar Tidestrom on the Monterey Peninsula. In 1938, Alice Eastwood described a similar lupine from Point Reyes (L. layneae). Philip Munz (1958) later recognized the Point Reyes plants as a variety of L. tidestrornii, and called them L. tidestrornii var. layneae to separate them from the Monterey Peninsula plants. The recent treatment by Rhonda Riggins and Teresa Sholars suggested that L. tidestromii exists as a single, variable species (Riggins and Sholars 1993) (USFWS, 1998).

Historical Range

Historically, Tidestrom's lupine was found extensively along the California coast (Service 2009, p. 17). At the time of listing, there were three geographically separate areas containing the species along the California coastal dunes: the southernmost populations were found at various sites on the northern tip of the Monterey Peninsula, the central populations were found in PORE, and a northern population was found at Goat Rock Beach on the Sonoma Coast State Beach (SCSB). There were also another two possible populations within the northern area in Sonoma County, one at Dillon Beach and the other at Bodega Head (Service 2009, pp. 5–6). According to the final listing rule, plants collected from Bodega Head in 1925 may have been misidentified as Tidestrom's lupine because of the limited dune habitat in the general area and the vegetative condition of the specimen (Service 1992, p. 27850). The Bodega Head population was most likely extirpated before listing and surveys have not found any evidence of the plants (D. Smith, Marin Chapter, California Native Plant Society, in litt. 2008, as cited in Service 2009). The population at Dillon Beach in Marin County has also likely since been extirpated, but follow-up surveys are needed to confirm At the time of our 2009 5-year review, populations existed at the same three sites described at the time of listing (Service 2009, p. 5). The current species distribution of Tidestrom's lupine remains limited to these three geographic locations (USFWS, 2023).

Current Range

This species is found in clustered colonies at 3 sites along the California coastal dunes: the southern most populations are found at various sites from Carmel Beach to Asilomar State Beach (ASB) on the northern tip of the Monterey Peninsula, the central populations are found in their highest numbers and concentration on Point Reyes National Seashore around Abbott's lagoon, and the northern most populations are found at Goat Rock Beach on the Sonoma Coast State Beach (SCSB). (USFWS, 2009)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering occurs from May through June (USFWS, 1998).

Key Resources Needed for Breeding

Adult: Bees/Insect/Wind (USFWS, 2023)

Reproduction Narrative

Adult: The life history of Lupinus tidestromii is largely unknown or the information is unpublished. Flowering occurs from May through June. L. tidestrornii is probably pollinated by bees (Moldenke 1976). Within populations, plants exhibit highly congested distributions. Most lupine seeds for all 5 coastal species can be found littered at the plant base. This and large seed size is consistent with localized limited dispersal, and limited long-distance dispersal by abiotic factors. Seeds of Lupinus are generally long lived and probably forms a persistent dormant seed bank. For seeds to germinate under natural conditions, the seed coat probably must be degraded (although not necessarily scarified, as by "sandblasting" by windblown sand). Lupinus tidestromii grows in stable to slightly mobile dunes, far from "sandblasting" habitats, so very slow microbial decomposition of seed coats of long-lived seeds is the more likely route to germination. This is not a species of accreting foredunes, and it has very low burial tolerance compared with larger dune plants of the pea family (e.g., Lupinus chamissonis and Lathyrus littoralis, which grow in highly mobile dunes). As a result, Lupinus tidestromii is confined to the vast stable deflation plains next to southern Abbotts Lagoon (USFWS, 1998). The life history of Tidestrom's lupine is that of a short-lived perennial with a long-lived seed bank. Flowering occurs from May through June, and while this species has previously been classified as bee-pollinated, recent evidence supports other methods of pollination. During regular surveys of Tidestrom's lupine populations at Point Reyes National Seashore (PORE), no bees or flying insects were observed near a Tidestrom's lupine plant (Park Service 2022, p. 63). Ants have been observed on individuals in the PORE populations, but their role, if any, in pollination is unclear (Park Service 2022, p. 63). It is likely that the species is at least partly wind pollinated. Tidestrom's lupine has also been documented to be highly capable of autonomous selfing, which has led to concerns of low genetic diversity, especially for small populations (Coppoletta 2005, pp. 18–19). Within populations, plants exhibit highly clumped distribution. Seeds are large and usually found littered around the plant base. Seeds are generally long lived and form a persistent dormant seed bank. They require some type of seed coat degradation, such as scarification in blowing sand, in order to germinate. Additionally, researchers at Washington University have documented mature Tidestrom's lupine individuals that go through nonreproductive phases where no flowers or seeds are produced (USFWS, 2023).

Habitat Type

Adult: Coastal dunes (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs on partially stabilized coastal dunes up to about 8 m high in the mild maritime climate of the central California coast and grows in coastal dune communities in association with Menzies' wallflower, sand gilia, beach sagewort, sand verbena, and mock heather (Fish and Wildlife Service 1997) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the limited number of known locations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are generally long lived and probably form a persistent dormant seed bank. Very slow microbial decomposition or long term erosion of the seed coat from sand scarification is the likely route for germination. This species has a very low burial tolerance and does not survive in accreting foredune formations. In addition, Dr. Knight believes that historically, large storms moved extensive areas of sand and brought deeply buried seeds to the surface where they could germinate (USFWS, 2009).

Population Information and Trends

Number of Populations:

12 (USFWS, 2023)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

The nineteen extant populations consist of 433 individuals (Fish and Wildlife Service 1997). Known from nineteen extant populations (Fish and Wildlife Service 1997). (NatureServe, 2015) While there were no abundance estimates available at the time of listing, our 1998 Recovery Plan documented 19 extant occurrences containing a total of 433 individuals of Tidestrom's lupine within the three disjunct geographic areas mentioned above (Service 1998, p. 49). At the time of our 2009 5-year review, there were 16 known extant occurrences: nine within PORE, six in the Monterey peninsula (four on private land, one on City of Pacific Grove/U.S. Coast Guard property, and one on California State Park property), and one in Sonoma County at SCSB (Service 2009, Appendix A). Between 2001 and 2005, PORE implemented a formal sampling scheme for Tidestrom's lupine populations within their jurisdiction (Park Service 2022, p. 33).

Surveys for most populations have continued through 2021 (Park Service 2022, p. 33). Census estimates in our 2009 5-year review varied and were not provided for all occurrences; however, general trend information was provided for most. At the time of our 2009 5-year review, the populations at PORE were considered stable or declining, the population at SCSB was increasing, and the southernmost populations that had been surveyed were considered stable (Service 2009, p. 21). Since our 2009 5-year review, two populations in the Monterey Peninsula (Diversity Database # 5 and 11) that were historically present were not found during a 2021 survey (Parr 2021, pp. 6- 7). Two populations at PORE (Diversity Database # 16 and 24) have had significant habitat degradation and were not found during surveys in 2001 and 2014 respectively (Park Service 2022, pp. 38, 45-46). Follow-up surveys are needed to confirm the presence or absence of individuals at these occurrences. Currently, there are 12 known extant occurrences of Tidestrom's lupine (Table 1). The largest population occurs over 50 acres of open dune habitat southwest of Abbott's Lagoon in PORE (Diversity Database # 13) and in 2021 was estimated to contain over 150,000 individuals (Park Service 2022, p. 46). The population at Goat Rock Beach in Sonoma County (Diversity Database # 17) has not been surveyed since 2011; however, the population numbers are believed to be stable at around 1,000 individuals (USFWS, 2023)

Threats and Stressors

Stressor: Commercial and residential development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Commercial and residential development along coastal communities continues to be the primary threat to habitat loss while trampling from hikers and livestock, and dune stabilization from invasive species are also contributing threats. These threats are considered to be current and foreseeable and this factor is still valid (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Disease is currently not considered a threat to the species; however, predation from small mammals is considered to be a new current and foreseeable threat factor in this analysis. It is recommended that this threat be addressed in the recovery delisting criteria number 3 (Habitat and populations will be free of invasive weeds) as invasive weeds provide shelter for the mammals who prey on the seeds of L. tidestromii (USFWS, 2009).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1992. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2009).

Stressor: Hybridization (USFWS, 2009)
Exposure:
Response:
Consequence: Extirpation
Narrative: Hybridization from L. chamissonis in the Monterey Peninsula is considered to be a new, current and foreseeable threat factor in this analysis. This new threat was not considered in the original listing for Lupinus tidestromii and should be considered a new recovery criterion for the Monterey Peninsula populations (USFWS, 2009).

Stressor: Invasive species (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive species continue to be a very significant threat with habitat loss and hybridization. The threat of invasive species is currently being addressed and managed on protected sites; however, unsecured private lands have no protection against such threats (USFWS, 2009)

Stressor: Trampling (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: Trampling by both humans and livestock is considered a threat to this species (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Impacts to the species under predicted future climate change are unclear. Current forecasts of warming are expected to raise mean temperatures and sea levels along of coast of western North America (IPCC 2007). While it appears reasonable to assume that the species may be affected, we have no knowledge of more detailed climate change information or literature specifically for this species. We lack sufficient information to predict with certainty the extent of effect that climate change along the California coast will have on the species. We do not know when or how the changes may occur, the potential changes to the ecosystem, or the level of threat posed by seasonal changes, rising mean temperatures and rising sea levels on the habitat (USFWS, 2009).

Recovery

Reclassification Criteria:
Secure habitat for the species at current known occurrences (USFWS, 2009).

Management measures at the secured habitat locations (USFWS, 2009).

Monitoring of recovery for the secured habitat locations (USFWS, 2009).

Additional restored habitat (USFWS, 2009)

Recovery Priority Number: 5

Delisting Criteria:
15 years of monitoring (USFWS, 2009).

Reintroduced populations within historic range through natural means (USFWS, 2009).

Habitat and populations will be free of invasive weeds (USFWS, 2009).

Average of 10,000 individuals and progress toward the eradication of beach grass and iceplant at PORE (USFWS, 2009).

Private land occurrences protected, endowments secured and managed for recovery (USFWS, 2009).

Historic populations at Dillon Beach are restored and occupied (USFWS, 2009).

Recovery Actions:

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. Habitat at PORE, ASB and SCSB has been secured for the species; however, these current protections are not permanent. Point Reyes National Seashore has designated the majority of areas that contain Lupinus tidestromii and other federally listed plants as “wilderness” providing protection under the National Parks Service regulations regarding wilderness. This encompasses approximately 33,000 acres and contains greater than 50 percent of the individuals as of the 2008 census (PORE LUTI report 2008). This percentage varies yearly depending on stochastic population fluctuations. Asilomar State Beach has designated 25 acres of dune habitat that contain L. tidestromii and other listed species as a Natural Dune Preserve under the California State Parks regulations and is protected by such definition. From a census conducted in 2000 the preserve contains approximately 40 percent of the genetically pure (unhybridized) individuals on ASB (Madison, pers. comm. 2009). A new comprehensive census for L. tidestromii is being conducted in 2009 and will include a determination of pure and hybrid populations. Although the “wilderness” and “Dune Preserve” designations provide a higher level of protection for the listed plant and its habitat, these protections can be changed or altered through a policy change or redesignation. Sonoma Coast State Beach currently has no extra protections for the areas that contain the listed plant other than those provided by the California State Parks regulations regarding protected species on State Parks lands. Pebble Beach and Spanish Bay golf courses have protected habitat with a mitigation agreement from the private land owner. The City of Carmel has designated the North Dune an Environmental Sensitive Habitat Area (ESHA). This designation does not provide any physical protections for the plant; however, it does provide limited protection against development unless this designation is removed or changed. Several private land occurrences on the Monterey Peninsula still remain unprotected. This private land protection on the Monterey Peninsula was a criterion in the Recovery Plan; however, this criterion for private land occurrences may not be feasible at this time with the threat of hybridization in the

Monterey Peninsula populations. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed; however, they are not complete. Monitoring efforts at PORE, SCSB and ASB are currently in their 8th year and are planned through 2015. Monitoring on public and private land occurrences are being performed through public city efforts; however no plan has been enacted or planned through a future date. Monitoring has also been done sporadically by California Native Plant Society (CNPS) for the Monterey Peninsula populations on private land when access has been granted. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is currently being addressed. Management measures are not permanent and could be altered or withdrawn depending on the status of the protections afforded the species. Management for recovery of the species has been implemented for the secured habitat sites at PORE, SCSB and ASB. Point Reyes National Seashore is under management through National Parks Service and SCSB and ASB are under management through California State Parks. Management plans have been written for all three locations through their respective agency with regards to recovery of the species and include reduction of effects from recreation use of the parks, invasive plants removal, and dune restoration efforts. Pebble Beach and Spanish Bay golf courses in Monterey County also have management plans for the continued conservation and protection of the plant on their respective properties. The City of Carmel North Dune is not considered a secured habitat, but the city has adopted several shoreline management plans and is currently in the process of creating a long term management plan for the North Dune population. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: The criterion is still valid and is being addressed; however, no new occurrences beyond the extent of the populations described from the time of listing and in this review have been identified. The populations at PORE and SCSB have increased in individual numbers since the time of listing, but naturally reintroduced populations on the Monterey Peninsula are generally hybrids and currently being removed. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, this criterion has been met and has been addressed. Monitoring for recovery has been implemented at the PORE, SCSB, and ASB secured habitat sites. Research efforts by Dr. Knight and her colleagues include extensive monitoring at PORE. Monitoring for SCSB is being conducted currently by State ecologist Brendan O'Neil. Point Reyes National Seashore monitoring includes individual population counts, observing for invasive plants, small mammal predation, habitat and plant (L. tidestromii) condition. Sonoma Coast State Beach populations are being monitored for rough population counts, effects from human recreational use, habitat and plant (L. tidestromii) condition. Asilomar State Beach is being monitored for rough population counts, effects from human recreational use, and

hybridization effects. Pebble Beach and Spanish Bay golf courses have private monitoring in accordance with the mitigation agreement which includes monitoring for rough population stands. The City of Carmel North Dune is not considered a secured habitat; however, the population has been monitored and the City's ESHA designation has general monitoring incorporated in the program. This monitoring effort is superficial; it is not guaranteed and is not specific for the listed plant. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. At the time of listing there was no substantial dune restoration or invasive weed removal efforts. Currently, extensive dune restoration efforts are ongoing at PORE. Sonoma Coast State Beach and ASB are conducting minor dune restoration efforts and continual invasive weed removal. Although these efforts have been enacted, invasive weeds have not been completely removed at any of these locations and will most likely be a continual threat Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Reclassification criteria: Is the criterion valid and have they been addressed: Yes, additional restored habitat is being created at the PORE and SCSB sites to extend the range of Lupinus tidestromii at those sites. Dune restoration efforts are being conducted on several sites along the California coast; however no restoration efforts specifically for L. tidestromii are being conducted. The seed life for L. tidestromii is considerably long, so these other dune restoration efforts may provide new occurrences for L. tidestromii provided there is a viable seed bank. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009). Delisting Criteria: Is the criterion valid and have they been addressed: Yes, the criterion is still valid and is being addressed. Efforts are currently being conducted and progress towards both criterions has shown positive trends toward meeting recovery. The largest population, located near Abbott's Lagoon is estimated to have over 100,000 individuals, and this number has persisted since 2001. The dunes near Abbott's Lagoon have received a great deal of restoration attention from 2002-2006 (Ammophila arenaria removal). The second largest population, located on the dunes west of the Mendoza Ranch, was estimated at 32,528 individuals in 2003 whereas a 2007 census by Dr. Knight et al. estimated 11,668 individuals. The third largest population at PORE, located on the dunes near the Davis residence declined from 982 individuals in 2003 to 159 individuals in 2007, likely due to encroachment of iceplant. Removal of beach grass and iceplant surrounding this population was conducted in July 2008 through the mechanical removal of the beach grass (digging 3m into the ground and overturning this invasive grass) and hand removal of the iceplant. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Delisting Criteria: Is the criterion valid and have they been addressed: Yes, securing private lands for recovery is still a valid criterion; however, with the current information regarding the hybridization and until the threat of hybridization can be addressed this criterion may become obsolete for the Monterey Peninsula populations unless genetically pure individuals can be reintroduced. No private land occurrences other than Pebble Beach and Spanish Bay

golf courses are currently or under process for endowment or managed for recovery at the time of this review. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).

- Is the criterion valid and have they been addressed: Yes, the criterion is still valid; however, currently no efforts are being made at Dillon Beach for the reintroduction of Lupinus tidestromii. This criterion would be considered vital to the expansion of the species. Dillon Beach provides highly suitable habitat, but is under threat of development and high human usage. More controlled conservation measures would need to be enacted before reintroduction could take place naturally or through manned efforts. Listing factors addressed: (Factor A) Present or Threatened Destruction, Modification, or Delisting Criteria: Curtailment of Habitat or Range, (Factor D) Inadequacy of Existing Regulatory Mechanisms, (Factor E) Other Natural or Manmade Factors Affecting Its Continued Existence (USFWS, 2009).
- Continue Dune restoration and eradication of invasive plants at PORE and SCSB (USFWS, 2009).
- Continue monitoring at PORE, SCSB and ASB. Establish structured monitoring plan for Monterey Peninsula populations on private lands (USFWS, 2009).
- Secure further conservation easements and/or acquire lands for protection of Monterey Peninsula populations (USFWS, 2009).
- Continue research of hybridization and seed predation threats (USFWS, 2009).
- Conduct accurate census of the Monterey private land occurrences (USFWS, 2009).
- Examine and implement dune restoration efforts for repopulation at Dillon Beach (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Tidestrom's lupine. Some of these recommendations have already been discussed in previous recovery documents (Service 1998; Service 2009) and remain valid. A list of recommended future actions for each population is included in Appendix C. 1. Habitat management and restoration. Habitat loss and degradation as a result of development and invasive plant species continue to be the primary threat to Tidestrom's lupine. To aid in the recovery of this species, additional restored habitat should be created through the removal of invasive plant species. Two secured locations, Goat Rock Beach and PORE, have particularly high potential for the creation of additional restored habitat for Tidestrom's lupine. PORE has conducted several large-scale dune restoration projects that involved the removal of European beachgrass, iceplant, and other invasive plant species (Appendix B; Park Service 2022 pp. 8–15). Continued removal of invasives within past restoration areas should help to keep Tidestrom's lupine established in those areas and reduce deer mice seed predation pressure (Dangremond et al. 2010, pp. 2265– 2266; Pardini et al. 2018 p. 1193). Future restoration projects that involve the creation of newly suitable habitat and reintroductions into this habitat could increase connectivity and genetic health. The Tidestrom's lupine population at Goat Rock Beach (Diversity Database #17) responded favorably to past restoration efforts and may be a good fit for future management actions. After a restoration project at Goat Rock Beach in 2002 that involved the removal of invasive plant species, the Tidestrom's lupine population at this location increased from approximately 400 individuals to over 1,000 individuals as a result of a natural expansion into

the newly bare sand dunes (O'Neil pers. comm. 2021). State Parks removes weeds within this population annually to prevent the invasion of non-native species and because of these efforts the Goat Rock Beach population has remained stable for almost ten years (O'Neil pers. comm. 2021). Habitat restoration in other parts of SCSB, in conjunction with reintroductions into the newly created suitable habitat, would increase the distribution and redundancy of this species as currently the single population at Goat Rock Beach is the only population north of PORE. If possible, non-natives should be mechanically removed from an area or sprayed with herbicide and then mowed or scraped to accelerate decomposition. Herbicide treatments alone can result in standing dead biomass that lasts for years before decomposing, impeding colonization of native species during that time (Parsons pers. comm. 2021). Additionally, as the Monterey Peninsula populations have been shown to be genetically distinct from those at PORE, occurrences on private lands should be protected and occurrences on public lands should be managed through the continued removal of invasives. 2. Fencing of dune habitat and/or use of boardwalks where Tidestrom's lupine occur. For populations where trampling by humans and/or off-leash dogs is of concern, fencing should be installed to demarcate sensitive dune habitat. Signs identifying environmental sensitive areas may also help keep visitors from entering the dune habitat. In highly trafficked areas in the Monterey Peninsula, cable guideline fencing has proven ineffective in preventing people and off-leash dogs from entering the dune habitat and trampling Tidestrom's lupine (Dorrell-Canepa pers. comm. 2021). Instead, the installation of wood fencing is recommended to separate and protect sensitive dune habitat in places like North Dunes in Carmel-by-the-Sea (Diversity Database # 8) where there is considerable foot traffic. Another option would be establishing boardwalks such as those at ASB (Diversity Database #4), which have appeared to be effective in keeping the public from trampling Tidestrom's lupine (Gray pers. comm. 2021). 3. Reintroductions. Reintroductions into secured habitat should be conducted to increase the redundancy of Tidestrom's lupine. Currently there is only a single population in Sonoma County at Goat Rock Beach, thus putting the northern region at risk of extirpation from a catastrophic event or impacts from climate change. Reintroductions into suitable habitat within Sonoma Coast State Beach is recommended. Additionally, reintroductions into suitable habitat within the Monterey Peninsula could help increase population numbers and expand population ranges to increase resiliency. For example, ASB had relatively low population numbers during the most recent survey in 2021 and could benefit from reintroductions in unoccupied areas with suitable habitat. Reintroductions should also be performed in conjunction with habitat restoration if natural recolonization fails to occur. 4. Caging individual Tidestrom's lupine plants. In areas with significant deer predation, caging of individual plants during flowering and fruiting season is recommended. Asilomar State Beach has had success with chicken-wire cages installed once the plants start flowering in the winter and early spring and removed in the summer once the plants go to seed (ASB 2017, pp. 1–2). Inverted gopher baskets have also been used at North Dunes in Carmel-by-the-Sea to protect newly transplanted seedlings from herbivory (Dorrell-Canepa 2020, p. 8). In populations with known herbivory by grazers, cages should be installed prior to the reproductive season on as many Tidestrom's lupine individuals as possible to increase the chances of recruitment. 5. Controlling for hybridization with Chamisso bush lupine. Hybridization of Tidestrom's lupine with Chamisso bush lupine is a primary threat to the Monterey peninsula populations. When Chamisso bush lupine is found at ASB and North Dunes in Carmelby-the-Sea the plants are removed. Hybrids, which can be identified by their size and growth patterns, are also removed (ASB 2018, pp. 2–3; Dorrell-Canepa 2020, Appendix E). Removal of true Chamisso bush lupine and known hybrids should continue to occur. 6. Research. Additional research on Tidestrom's lupine ecology and threats would help land managers understand which factors are affecting population viability. Specifically, research into genetic diversity between and among populations may help explain why some populations at PORE have continued to decline despite active

management and if seed translocations would be beneficial for declining populations. An investigation into how the species is pollinated would also help identify what factors may be affecting recruitment. Research into the dominant mating strategy of this species (outcrossing vs. selfing) would be helpful in identifying the level of inbreeding occurring. Additionally, research into potential fitness effects from rust fungus and ant predation will be necessary to determine if those threats warrant future attention. 7. Monitoring. Annual monitoring of all populations is recommended to track population trends and determine how populations respond to management efforts. As this species is a short-lived perennial, population fluctuations are expected, and regular population monitoring will help managers identify overall population trends. At a minimum, monitoring should consist of annual population counts or estimates, depending on the size of the population. More detailed information concerning whether an individual is a seedling, non-reproductive plant, or reproductive plant would allow more precise population tracking and is recommended when possible. Additional observations on plant health, signs of predation, disease, and hybridization should be documented when possible (USFWS, 2023).

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SPECIES ACCOUNT: *Lyonia truncata var. proctorii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/27/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

A perennial evergreen shrub which may reach up to 2 meters in height. The leaves are alternate, elliptic to ovate, coriaceous, and from 0.9 to 4.5 centimeters long and 0.4 to 2.3 centimeters wide. The leaf margins may be toothed and the lower surface is sparsely to moderately lepidote and moderately to densely pubescent. The inflorescences are fasciculate with from 2 to 15 flowers. Pedicels are from 2 to 5 millimeters in length and sparsely pubescent. Flowers are small (0.7 to 1.5 millimeters in length), white, and urn-shaped. The fruit is a dry capsule, 3 to 4.5 millimeters in length and 2.5 to 4 millimeters in width, sparsely pubescent, and contains seeds approximately 2.5 millimeters in length (USFWS, 1994).

Taxonomy

In the family Ericaceae, one of 3 varieties (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Endemic to Puerto Rico and are known to occur only in the summit area of Cerro Mariquita in the Sierra Bermeja, municipality of Cabo Rojo. Elevations range from 270 to 300 meters (USFWS, 1994). In 2013, two new localities of L. truncata var. proctorii were reported during surveys at La Tinaja Tract by Morales-Pérez (2013). These localities (lower slopes) were estimated with a total of 280 individuals; about 80 percent of those individuals were recorded within the LCNWR land (La Tinaja), and 20 percent were documented southwest of the property in an adjacent private land known as Lozada Farm (Morales-Pérez 2013). Morales- Pérez (2013) reported a third locality of the species in the upper slope at Cerro Mariquita where the species was originally reported. In 2016, Service biologists visited the northwest section of the Finca Lozada and observed around 49 individuals of L. truncata var. proctorii (C. Pacheco, Service, unpublished data, 2016). Overall, the population is characterized as old population structure (composed of only mature plants) with no evidence of natural recruitment in the wild (O. Monsegur-Rivera, Service, 2018, pers. comm.). (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering in October, April, and May (USFWS, 1995)

Reproduction Narrative

Adult: Species is insect pollinated, with flowering observed in October, April, and May (USFWS, 1994). Little additional information is available about reproductive biology (inferred from USFWS, 2010)

Habitat Type

Adult: Terrestrial (USFWS, 1994)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical dry forest life zone (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: 270 to 300 meters; extremely steep slopes (USFWS, 1994)

Habitat Narrative

Adult: Habitat is described as subtropical dry forest life zone (USFWS, 2010). Found at 270 to 300 meters elevation, on extremely steep slopes. Soils have been described as Guayama cherty clay loam, 20 to 60 percent slopes, a soil series which covers most of the steep slopes of the Sierra Bermeja. This soil is from 14 to 30 centimeters deep to weathered siliceous rock and is acid in nature (USFWS, 1994).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Little information is available about dispersal mechanisms (inferred from USFWS, 2010)

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Stable (USFWS, 2010)

Population Growth Rate:

Slow (inferred from USFWS, 2010)

Number of Populations:

1 (USFWS, 2010)

Population Size:

63 (USFWS 2010)

Population Narrative:

The Service considered the species status as stable. In 1991, Proctor conducted a population survey on the species, estimating 63 individuals in two subpopulations located on the eastern and northwest cliffs of Cerro Mariquita. Breckon and Kolterman (1994) concluded that this population size may be underestimated by 50% due to difficulties to access the population (extremely steep slopes). On January 21, 2008, Service biologists conducted a preliminary survey

on the species finding only 13 individuals on the eastern cliffs of Cerro Mariquita. On February 19, 2009, Service biologist visited the northwest subpopulation estimating the population at around 12 individuals. Because the areas where the species is located are very difficult to access and localities reported by Proctor (1991) and Breckon and Kolterman (1994) are unclear, comprehensive surveys with secure rappelling equipment should be conducted to establish the overall status of the species. However, during the last three years changes in land use and habitat conditions have not been documented at the Cerro Mariquita area (USFWS, 2010).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Grazing induced habitat modification, dispersal of invasive grass species, predation of seedlings and saplings, and land clearing pose a serious threat (USFWS, 2010). When - Lyonia truncata var proctorii - was listed in 1993, the Service identified habitat destruction and modification as one of the factors affecting the continued existence of the species. At that time, these three species were found in Sierra Bermeja, a privately owned site subjected to agricultural, rural and tourist development. In addition, the final rule for pelos del diablo also identified proposed copper and gold mining as a threat to the species in Cerro Las Mesas. In 1996, DOI acquired La Tinaja Farm (LTF) in the Sierra Bermeja mountain range. The Service incorporated this land to the Cartagena Lagoon National Wildlife Refuge, protecting 50% of the known populations of Lyonia truncata var proctorii, approximately 80% of the known individuals of Vernonia proctorii, and its suitable habitat, and about 50% of the populations of A. chaseae and pelos del diablo. However, the remaining individuals of these species in Sierra Bermeja are located in the adjacent Cerro Mariquita area, which remains under private ownership. Although the Cerro Mariquita area was classified by the Puerto Rico Planning Board as a District of Conservation Resource 1 (CR1) (the most restrictive for development, precluding tourist and residential development and mining activities), this classification allows agricultural (e.g. cattle grazing) and rural developments (one house in 25 acres of land). In 2006 and 2007, private landowners cut new roads to gain access through their properties to the peak of Cerro Mariquita affecting indeterminate amount of habitat for these species (Pacheco, USFWS 2009, field observations). (USFWS, 2019).

Stressor: Other natural or man-made factors (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The species is currently threatened by competition from exotic grasses, human-induced fires, and landslides (USFWS, 2010).

Stressor: Limited distribution (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Lyonia truncata var proctorii is only found in a limited area on the edge of a precipice of the upper Jurassic chert in Cerro Mariquita. Any seismic event in this area and heavy rain that

result in a landslide may affect a significant portion of the population. In September 2009, the Service observed three landslides at the Cerro Mariquita due to the heavy rain. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. The known populations on privately owned land in Sierra Bermeja are placed under protective status (USFWS, 2010)

2. New populations (the number of which should be determined following the appropriate studies) capable of self-perpetuation have been established within protected areas, such as the Cabo Rojo National Wildlife Refuge (USFWS, 2010)

Delisting Criteria:
Not available.

Recovery Actions:
- Prevent further habitat loss and population decline (USFWS, 1994)
- Gather information on the distribution and abundance in southwestern Puerto Rico (USFWS, 1994).
- Conduct research to define habitat requirements, reproductive biology/ecology, and propagation techniques (USFWS, 1994)
- Establish new populations (USFWS, 1994)
- Better define, and possibly modify, recovery goals as additional information on the biology, ecology, propagation, and management is accumulated (USFWS, 1994).
- Protection of currently known natural populations occurring on privately owned lands by establishing long-term conservation mechanisms such as Habitat Conservation Plans (HCP), conservation easements and conservation agreements with the landowners. (USFWS, 2019).
- Develop conservation and management plans with landowners that includes education on species description and needs and fire management. (USFWS, 2019)
- Establishment of new populations on protected lands within the Sierra Bermeja or other suitable habitats in southwestern Puerto Rico. (USFWS, 2019).
- Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species (USFWS, 2010).
- Conduct comprehensive surveys at Sierra Bermeja to determine relative abundance and distribution (USFWS, 2010).
- Promote Conservation agreements with private landowners to protect and enhance existing populations (USFWS, 2010).
- Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses (USFWS, 2010).
- Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season (USFWS, 2010).
- Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge (USFWS, 2010).

- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild (USFWS, 2010).
- Determine the number of self-sustainable populations needed to delist the species (USFWS, 2010).
- Additional surveys should be conducted in Puerto Rico (USFWS, 2010).
- Continue protecting existing populations and their habitat (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species. Conduct comprehensive surveys of these four species at Sierra Bermeja to determine relative abundance and distribution. Conduct surveys at Cerro Las Mesas to determine if pelos del diablo is still present at this area. Conduct surveys at Punta Melones and Peñones de Melones to determine the status of A. chaseae at these areas. Promote Conservation agreements with private landowners to protect and enhance existing populations. Initiate propagation programs for these species to enhance existing populations in the Sierra Bermeja mountain range and establish new populations of A. chaseae and pelos del diablo in protected areas in southwestern Puerto Rico. Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses. Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season. Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge. Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild. Determine the number of self-sustainable populations needed to delist the species. Additional surveys should be conducted for the four species in Puerto Rico. Continue protecting existing populations and their habitat. Work closely with International Affairs to obtain information from pelos del diablo on the Island of Cuba. (USFWS, 2019a)

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SPECIES ACCOUNT: *Lysimachia asperulaefolia* (Rough-leaved loosestrife)

Species Taxonomic and Listing Information

Listing Status: Endangered; 7/13/1987; Southeast Region (R4)

Physical Description

A perennial rhizomatous herb, with erect stems 30 to 60 centimeters (cm) tall. Leaves are sessile in whorls of 3 to 4, are broadest at the base (0.8 to 2 cm wide), and have three prominent veins. The upper surface is deep yellow-green or blue-green and lustrous; the leaf margins are entire and slightly revolute (Figure 1). The yellow bisexual flowers are borne in a loose, cylindrical, terminal raceme, 3 to 10 cm long. The corolla is 1.5 cm across. There are usually five petals that have ragged margins near the apex and that have dots or streaks. The anthers are yellow-orange, and the style tapers to the simple stigma. The fruit is a capsule. Stipitate glands are usually present on most parts of the plant. Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October. Although the plants are dormant in the winter, they are easy to find in the fall because of the distinctive leaf pattern and the reddish color of the leaves. (USFWS, 1995)

Taxonomy

Lysimachia asperulaefolia was described by Jean Louis Marie Poiret in 1814. Since listing as endangered in 1987, there have been no changes to the nomenclature of the species, however some references now spell the specific epithet as “asperulifolia” an orthographic variant of “asperulaefolia.” In addition, in the listing documents and the Recovery Plan, the common name is referred to as Rough-leaved Loosestrife; however, some references use the common name Rough-leaf Loosestrife. Ironically, the leaves are actually smooth in texture. The genus Lysimachia is now considered to be part of the Myrsinaceae family and not the Primulaceae family (Weakley 2012). (USFWS, 2014)

Historical Range

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. (USFWS, 1995)

Current Range

Southern coastal plain and sandhills of North Carolina and the sandhills of South Carolina. Twelve counties in North Carolina; one county in South Carolina. (USFWS, 2014)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering is from late May to early June (USFWS, 1995).

Reproduction Narrative

Adult: The first spring shoots of L. asperulaefolia appear in late March or early April. Flowering begins in late May and extends through mid to late June. L. asperulaefolia is an obligate out-crossing species, pollinated by solitary bees: most of the pollinators are in the genus Dialictus. Pollinators were found to be scarce and inefficient, perhaps contributing to low natural fruit and seed set. Fruit and seed set were much higher when flowers were artificially pollinated (Frantz 1984). Another possible explanation for low fruit and seed set is that populations are highly clonal, with several shoots arising from one rhizome. Since self-fertilization does not occur, pollinator activity among ramets would not result in seed set. Fruits are visible within 3 weeks of fertilization, but capsules do not dehisce until October. An average of 3.2 capsules are produced by flowering stems, with an average of less than two seeds per capsule. In one germination trial, 85 percent of the seeds germinated (Frantz 1984). While fruit and seed set are low, this is not unusual for a perennial species that apparently has a life strategy based largely on rhizomatous growth and therefore does not depend upon sexual reproduction and seedlings for short-term survival (USFWS, 1995). Flowering is from late May to early June. Seeds are formed by August, but capsules do not dehisce until October (USFWS, 1995).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Rough-leaf loosestrife occurs most often in ecotones between longleaf pine uplands and pond pine pocosins in moist, sandy or peaty soils with low vegetation that allows for abundant sunlight to the herb layer (USFWS 1993). Fire is primarily responsible for maintaining low vegetation in these ecotones which have been documented to occur between the following habitat types: longleaf pine savanna and pocosin; longleaf pine flatwood and pocosin; longleaf pine savanna and mixed herb; longleaf pine-pond pine and evergreen shrub; longleaf pine/wiregrass savanna and Carolina bay pocosin; Streamhead Pocosin and Pine/Scrub Oak Sandhill; and Sandhill Seep and Pine/Scrub Oak Sandhill (NCNHP 1993). This species often spreads from the ecotone into the open edges of the bordering habitats, for example into longleaf pine savannas and low shrub communities of Carolina bays. Other habitats and community types in which it has been found include: Low Pocosin, High Pocosin, Wet Pine Flatwoods, Pine Savanna, Streamhead Pocosin, and Sandhill Seep (Schafale and Weakley 1990), as well as creek flood basins, pond and lake margins, boggy seeps and meadows, boggy pools in shrub pocosins, and disturbed areas such as roadside depressions, powerline rights-of-way, firebreaks, and trails. In the NC Sandhills, Lysimachia asperulifolia prefers to be in lower parts of the ecotone, well within the shrub zone, even when such ecotones are well-burned. On Fort Bragg, a sizeable occurrence was found in a shrub ecotone/pocosin that had burned within four

months of its discovery; most shrubs there had been 2 meters or more tall prior to burning. Low Pocosins occur in areas with deep peat overlaying wet sands and in Carolina bays. They are nutrient-poor, seasonally saturated, and dominated by a dense shrub layer, kept small by low nutrients and severe fires. L. asperulifolia occupies openings in the dense shrub layer (USFWS 1993). Rough-leaf loosestrife is also found in the ecotones between Wet Pine Flatwoods or Pine Savannas and High Pocosins where the water table is near the surface during winter and early spring. If burned, these ecotones remain open with characteristic grasses, herbs, and low shrubs (USFWS 1993) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends

Population Trends:

See narrative.

Number of Populations:

53; 52 in NC and 1 in SC (USFWS, 2021)

Population Narrative:

When the recovery plan was prepared in 1995, Lysimachia asperulaefolia was known from the southeastern coastal plain of NC and the sandhills of NC and SC. Since the 2014 5-Year Review, 12 new sub-populations (sub-EOs) were discovered in NC. Currently, state natural heritage programs recognize 53 extant populations or principal EOs (52 in NC and one in SC). Since the 2014 5-Year Review, natural heritage program records indicate that the ranks of three populations have improved while six populations declined, indicating that those populations have fewer stems than previously observed, or possibly even disappeared. (USFWS, 2021)

Threats and Stressors

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Residential and commercial development are listed as threats to this species (USFWS, 2014).

Stressor: Road construction (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Road construction is listed as a threat to this species (USFWS, 2014).

Stressor: Silviculture (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Silviculture (pine plantations) are listed as a threat to this species (USFWS, 2014).

Stressor: Wetland draining/filling (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Wetland draining and/or filling are listed as threats to this species (USFWS, 2014).

Stressor: Herbicide use (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Herbicide use, especially on road shoulders and powerline rights of way has potential to quickly cause negative impacts to this rhizomatous perennial (USFWS, 2014).

Stressor: Herbivory (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Herbivory (likely by deer) is listed as a threat to this species (USFWS, 2014).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of federal listing, this species was also listed as state endangered by the State of North Carolina under the Plant Protection and Conservation Act of 1979 (North Carolina Code Article 19B, § 106-202.12; NC Act). The NC Act provides limited protection from unauthorized collection and trade of plants listed under that statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities (Robinson and Finnegan 2014). The NC Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat, but that agency has not yet created any nature preserves for this species (USFWS, 2014).

Stressor: Fire suppression (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire suppression was also identified as a serious threat. The lack of fire in the habitat where this species occurs allows woody species to grow and compete for sunlight, eventually shading out this low growing species. The exclusion of fire also affects nutrient cycling and insect populations (USFWS, 2014).

Stressor: Small population size (USFWS, 2014)

Exposure:
Response:
Consequence: Loss of populations
Narrative: Populations that are small in size and number of individual plants are vulnerable to stochastic events (USFWS, 2014).

Recovery

Reclassification Criteria:
1. Management plans have been prepared and are being implemented for all publicly owned population centers and those owned by The Nature Conservancy (USFWS, 1995)

2. Populations at these centers have been monitored for at least 5 years and are determined to be stable. (USFWS, 1995)

Delisting Criteria:
1. When the reclassification criteria are met and a binding management agreement for each population center is in place (USFWS, 1998)

Recovery Actions:

- 1. Protect significant sites and adjacent habitat. - Map all sites and mark sites in the field (except where there is ready public access and where signs would increase the threat of collecting): include in the marked area the adjacent habitat and buffer. - Map and search appropriate habitat for new sites within each population center. - Prepare a management plan for each population center. (USFWS, 1995)
- 2. Conduct research to more fully understand habitat conditions, fire frequency effects, seedling recruitment, genetic diversity among and within sites and population centers , population dynamics, and reestablishment techniques. (USFWS, 1995)
- 3. Enforce laws protecting the species and its habitat. Provisions of the Endangered Species Act of 1973, as amended, will be enforced. North Carolina regulations prohibit taking a protected species from private property without the landowner's written permission and a State permit. However. at this time the collection of L. asperulaefolia plants ~ not the major threat to the species' continued survival. In meeting their responsibilities under the Endangered Species Act, the military services involved have developed guidance directing certain actions with respect to listed species occurring on their bases. Implementation of these policies and directives should continue. (USFWS, 1995)
- 4. Reintroduce the species into historic habitat. In cooperation with the North Carolina Botanical Garden and the Center for Plant Conservation, plants should be propagated and a program of reintroduction should be initiated. Historic sites, such as the proposed Minnesott Ridge-Prescott Ridge Natural Area in Pamlico County, would be ideal sites for this program. Plants introduced into such an area should derive from the same population center, when possible, or from a nearby population source, unless genetic analyses indicate that inbreeding is a problem within populations. The genetic analysis will assist in determining appropriate reintroduction source material. (USFWS, 1995)
- 5. Negotiate binding management agreements. In order to ensure the survival of this species and proceed with delisting. permanent binding management agreements should be negotiated between the Service and landowners. The North Carolina Plant Conservation Program or North Carolina Natural Heritage Program should assist the Service in monitoring

these agreements. (USFWS, 1995)

- 6. Conduct public information and education activities. News releases concerning the status and significance of the species and recovery efforts should be prepared and distributed to newspapers on the coastal plain and in the sandhills area. Cooperation with military bases should be sought: this would be a positive public relations opportunity for them. State agencies managing lands where L. asperulaefolia occurs should prepare/distribute brochures and offer educational hikes to sites where this would be appropriate. (USFWS, 1995)
- 7. Annually review the recovery efforts. The Service, North Carolina Plant Conservation Program. North Carolina Natural Heritage Program, and South Carolina Heritage Trust should meet annually with the managers of L. asperulaefolia sites to assess progress toward the recovery goals, review new information, assign any new sites to a new or existing population center, evaluate and coordinate programs planned for the coming year, and, if necessary, redirect monitoring or management actions. (USFWS, 1995)
- Revisit known populations that have not been visited in the past three years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the NCNHP database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; report the results of these site visits to the appropriate Heritage Program (USFWS, 2014).
- Search for additional populations in appropriate habitat (USFWS, 2014).
- Prioritize known sites for protection and identify recovery populations (USFWS, 2014).
- Protect additional populations (USFWS, 2014).
- Identify those populations that would contribute the most toward recovery (self-sustaining, protected, etc.) as recovery populations (USFWS, 2014).
- Determine which sites have management plans and how they are being implemented (USFWS, 2014).
- Develop and implement management plans for all remaining protected populations (USFWS, 2014).
- Determine the management techniques for sustaining populations, such as fire frequency and seasonality (USFWS, 2014).
- Update monitoring protocols and remind land managers about their commitment to monitoring this species on their property, continue to analyze monitoring data using PVA or other accepted methods (USFWS, 2014).
- Complete a population genetic analysis as suggested by Edwards (2007) (USFWS, 2014).
- Organize a meeting of land managers, researchers and other interested parties to discuss the long-term recovery of this species (USFWS, 2014).
- Work with NC Botanical Garden to conserve germplasm and further develop propagation and transplantation protocols (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed in the 2014 5-Year Review remain important to the conservation and recovery of Lysimachia asperulaefolia and efforts to accomplish those actions should continue. Since the 2014 5-Year Review, progress has been made on several of the past recommendations for future actions. • Surveys have resulted in the discovery of 12 new occurrences or sub-populations that are part of two parent populations of Lysimachia asperulaefolia. (No new isolated populations have been found.) • A management plan for Lysimachia asperulaefolia and Echinacea laevigata populations at Fort Jackson Army Base in SC was

completed in 2015. • Management plans for Holly Shelter Game Land and Sandhills Game Land are available online. The plan for Holly Shelter would benefit from more information about Lysimachia asperulaefolia. The Service is planning to work with the NC Wildlife Resources Commission and NCNHP to incorporate more specific information about rare plant management in future versions of these plans. • The NCPCP received a Recovery Challenge Grant which will fund preparation of a management plan for their Boiling Springs Lakes / Hog Branch Ponds Preserves. • The Service has contacted land managers at Bladen Lakes State Forest and offered to help prepare a management plan for their populations of Lysimachia asperulaefolia. The Service has encouraged land managers to develop and implement management plans by providing a template management plan. • Jessica Roach at UNCW is currently conducting research on the genetic structure of this species. • Elsa Youngsteadt and Clyde Sorenson at NCSU are conducting research on the pollination ecology of Lysimachia asperulaefolia populations at Ft. Bragg Army Base in NC. • The NC Botanical Garden completed out-plantings at Fort Bragg Army Base from 2012 to 2014. • The Service updated and simplified monitoring protocols for land managers that participated in the 2000-2012 long-term monitoring project summarized in Robinson and Buchanan (2014). The Service recommends initiating or continuing the following efforts that will contribute to the recovery of the species: • Revisit known populations that have not been visited in the past five years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the heritage program database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; and report the results of these site visits to the appropriate heritage program. • Search for additional populations in appropriate habitat. • Prioritize a list of populations that will contribute the most toward recovery (selfsustaining, protected, etc.) as recovery populations. • Work with land managers at Bladen Lakes State Forest, Boiling Springs Lakes, Holly Shelter Game Lands and Sandhills Game Lands to improve Lysimachia asperulaefolia populations. • Remind land managers about commitments to manage and monitor for this species. • Organize a meeting of land managers, researchers, and other interested parties to discuss the recovery of this species. • Work with the NC Botanical Garden to conserve germplasm and further develop propagation and best practices for transplanting and augmenting populations. • Develop a plan to augment populations to increase genetic variation and seed production. (USFWS, 2021)

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SPECIES ACCOUNT: *Macbridea alba* (White birds-in-a-nest)

Species Taxonomic and Listing Information

Listing Status: Threatened; 6/8/1992; Southeast Region (R4)

Physical Description

This perennial herb usually has one stem (often clothed with long, multicellular hairs) which may be branched. The leaves are oblanceolate or spatulate, mostly in 6-8 pairs. White flowers are borne from May through July in compressed thyrses (dense flower cluster in which the main axis is racemose and the branches are cymose). The small clusters of white buds and flowers look like eggs and little bird heads in a nest. Each flower is bisexual, has a green calyx and a white two lipped-corolla about 2.5-3 cm long; the pistil and filaments are white, and the anthers purple basally. Each flower can produce four nutlets (small fruit similar to a nut), which are about 2-2.5 mm long, narrowly obovate in outline, and light brown (Godfrey and Wooten 1981, Godt et al. 2004). (USFWS, 2009)

Taxonomy

The genus Macbridea, which belongs to the mint f~mily (Lamiaceae or Labiatae), consists of only two species (Kral 1983, Godfrey and Wooten 1981). Macbridea alba Chapman was first collected about 1860 by A. W. Chapman and a friend named Gausman (Roger Sanders, then a graduate student at University of Texas, currently at Bot. Res. Inst. of Texas, in litt. 1977), and it was named by Chapman (1860). (USFWS, 1994).

Historical Range

See current range/distribution.

Current Range

Endemic to the Florida panhandle and is still restricted to the same four counties: Bay, Gulf, Franklin, and Liberty. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and vegetative (USFWS, 2009)

Reproduction Narrative

Adult: Dr. Walker surmised that Macbridea may require regular recruitment from seed and is a poor competitor with other plants, requiring bare ground to germinate and grow (USFWS, 1994). Macbridea alba is a hermaphroditic species capable of both sexual and vegetative (via rhizomes) reproduction (Godt et al. 2004). This species is capable of both 9 outcrossing and selfing. However, selfed seeds exhibit inbreeding depression (Godt et al. 2004). Pitts-Singer et al. (2002) studied the pollinator-plant relationship at two sites located on the ANF. Twenty

inflorescences were observed for 34 hours over five days. The authors observed 70 visits of nine insect and spider species. Since only bumble bees (Bombus spp.) were large enough to make contact with the reproductive structures of the flowers, the authors concluded that bumble bees are the potential pollinators of M. alba. Thus, bumble bees are probably critical to the long-term persistence of M. alba because they provide a mechanism for ensuring seed set, and facilitate gene flow between plants and plant populations (Negrón-Ortiz, pers. interpretation) (USFWS, 2009).

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits grassy vegetation on poorly drained, infertile sandy peat soils of the Florida Gulf coastal lowlands near the mouth of the Apalachicola River. Also in seepage bogs and savannas and, sparingly, on drier sites with longleaf pine and runner oaks. (Based on Ward 1979.) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The authors observed in the field that seeds germinated while in the infructescences (the fruiting stage of the inflorescence), suggesting that the matured ovules lack dormancy, in addition to the possibility of viviparous seedlings. About 87% of dry-stored seeds were viable (or germinable) for six months after dispersal, but viability of dry-stored and of buried seeds was insignificant after one year. They concluded that a persistent seed bank is not present, based on the lack of emergence of seedlings from soil that was field collected prior to seed dispersal. This lack of seed dormancy and seed bank means that if the established individuals are eliminated, a population cannot re-establish itself (USFWS, 2009).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

1000 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

Plant tolerates some disturbance due to forestry operations although actual effects and population numbers unknown. Substantial areas within the small range of this plant have were converted to short rotation pine plantations during the 20th century. Decline of 30-50% Many occurrences have shown fluctuating numbers from year to year (EO data in the NatureServe central database as of April 2012). 33 occurrences verified since 1989, but some of these are sub-occurrences which are clustered into larger occurrences (EO data in the NatureServe central database as of April 2012) (NatureServe, 2015). Moderate redundancy, resiliency and representation are inferred based on the number of known populations and individuals as well as the relatively large geographic distribution of the species.

Threats and Stressors

Stressor: Logging (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The timber industry in North Florida became well established in the 1850s (FNAI 2005). It started in Franklin County in the 1870s and continued to be a prominent industry until the mid-1990s (Howell and Hartsell 1995). The St. Joe Paper Company had close to a million acres in timber in the eastern region of the panhandle. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999; therefore, this industry is no longer considered a primary threat (USFWS, 2009).

Stressor: Urban development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urban development continues to threaten white birds-in-a-nest. The St. Joe Company owns extensive areas of land in Northwest Florida, and focuses on commercial and residential development along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (http://www.1000friendsofflorida.org/PUBS/2060/01-Northwest-Florida). According to the study, much of the new development will be focused along roadways. Many M. alba's locations are found along US 98 and other state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, road widening and new roads continue to pose a threat to the species from habitat loss (USFWS, 2009).

Stressor: Fire suppression (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Suppression of fire during the dormant season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Thus, fire

suppression continues to be a threat to M. alba. Lack of fire, and subsequent growth of shrubs (particularly encroachment of Cyrilla racemiflora L., commonly known as swamp titi) and saplings in the understory, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008). Declining fire frequency reduces M. alba abundance in areas where it was previously observed in great quantities (FNAI 2008). In recently burned areas, however, plant emergence is prolific within two years of the fire event (F. Winters, 2008, pers. comm.). The ANF utilizes a 3-5 yr interval burn rotation. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., 4-5 yr intervals, are needed to maintain optimal M. alba populations (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individual plants/Loss of habitat
Narrative: Section 7(b)(4) and 7(b)(2) of the Act generally do not apply to listed plants species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on nonfederal areas in violation of state law or regulations or in the course of any violation of a state criminal trespass law. Several populations of M. alba occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. Neither section of the Act provides protection for plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of state-listed plants from their property. Macbridea alba is protected under Florida State Law, chapter 85-426, which includes preventions of taking, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (http://www.virtualherbarium.org/EPAC). Bay County code of ordinance (chapter 19-Environmental Standards), under sections 1907 and 1909, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (http://www.municode.com/Resources/gateway.asp?pid=14281&sid=9). Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, reconstruction, or maintenance projects) affecting protected species, then the Service can request a consultation with the Florida Department of Transportation under the Act (M. Mittiga, 2009, pers. comm.). In the Apalachicola National Forest SR 65 ROW, it should conform to specifications and coordination between Talquin Eletric, FDOT and the Service. Currently, these protections are inadequate; see section IV, action 1 (USFWS, 2009).

Recovery

Reclassification Criteria:
Not relevant. (USFWS, 1994)

Delisting Criteria:
1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

Recovery Actions:
- Protect population in Apalachicola National Forest and on other public lands: At present, we have about 21 protected locations with an estimated 3,967 to 7,262 plants. (USFWS, 2009)
- Manage rights-of-way: This is an ongoing action. Macbridea alba is found scattered under the Apalachicola National Forest Utility ROW of SR 65. Protective measures have been established with Talquin Electric during annual maintenance and the upcoming pole replacement. Management for other M. alba elements of occurrences found in ROW outside SR 65 has not been initiated (USFWS, 2009).
- Protect and manage these plants outside Apalachicola National Forest: 3.1. Secure protection, Develop and implement management and monitoring plans for protected sites. (USFWS, 2009)
- Systematics and other studies: Genetic structure of M. alba, and Comparison of M. alba and M. carolinensis. (USFWS, 2009)
- Garden propagation and reintroduction. his recovery action has not been initiated. According to Schulze et al. (2002) study, an ex-situ collection of seeds is not recommended due to the lack of dormancy, and poor viability of dry-stored seeds. Although conserving this species in-situ is the best option, an ex-situ collection of established seedlings and adults is recommended (USFWS, 2009).
- 1. Manage ROW (Rights-of-Way). Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and USFWS; a management plan should be developed and implemented (USFWS, 2009).
- 2. Establish an ex-situ collection of seedlings and adults (USFWS, 2009).
- 3. Conduct population biology studies at ANF a. Compare the demographic performance of M. alba in pinelands and road habitats i) Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in roadside populations of SR 65 and pinelands. ii) Perform germination experiments (USFWS, 2009).
- 4. Revisit and conduct inventories (e.g., the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring) on all the historical locations (USFWS, 2009).
- 5. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants (USFWS, 2009).
- 6. Implement monitoring for selected populations in Bay, Gulf, Franklin, and Liberty counties. Note: Bay (Lathrop Bayou) and Gulf (SJBP) have a monitoring program. A similar monitoring protocol should be followed, thus results can be comparable across sites. Monitoring should examine density and abundance of individuals. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since M. alba occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large, protected and managed populations. Plants should be monitored

several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. The results would help determining the smallest size at which a population can exist without facing extinction, i.e., the minimum viable population size (USFWS, 2009).

- 7. The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Estimate the levels of clonality and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices, i.e., establish a representative percentage of the total genetic variation of M. alba. Sampling should occur across the range; testing clonality could involve sampling the established monitoring plots at ANF and SJSBP. a. By understanding clonality, the Service will be able to determine what is an individual and evaluate abundance. Specifically, we will be able to 1) relate flowering stems (both vegetative and flowering) to number of individuals in a given area, and 2) infer the effect of fire on flowering stems/individuals. b. The identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations. 2. Establish an ex-situ collection of seeds, seedlings, and adults. There is an ongoing conversation among FDACS, ABG, FWS, and Univ. Illinois Urbana-Champaign to establish an ex-situ collection at the ABG. 3. Clarify limits of desiccation and cold tolerance for ex-situ seed storage recommendations. 4. Understand in-situ seed germination and seedling survival vs. the role of viviparous seed germination and offspring survival, and the implications of both reproductive strategy for M. alba. 5. Monitoring. Implement monitoring for selected populations outside of ANF: Bay, Gulf, and Franklin counties. It is recommended to set up more subplots and monitor abundance and survival of both flowering and nonflowering individuals over time, whether seedling recruitment is occurring, and the effect of mechanical site preparation and hurricane disturbances. 6. Censuses. Censuses are most critical for populations outside ANF and for EOs found without plants. Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range. A consistent and repeatable method should be employed. 7. Manage ROWs. Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and the Service and document commitment to these conservation practices in land management plans or agreements. (USFWS, 2020)

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SPECIES ACCOUNT: *Maesa walkeri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub or small tree (USFWS, 2015).

Taxonomy

A member of the primrose family (Primulaceae) (USFWS, 2015).

Historical Range

Historically, M. walkeri was known from at least 13 occurrences on Guam and 9 occurrences on Rota (Bishop Museum 2014—Online Herbarium Database) (USFWS, 2015).

Current Range

It occurs on Guam and Rota (Mariana Islands). The cumulative data indicate that Maesa walkeri was once relatively abundant on Guam and Rota, and has since declined substantially on Guam (USFWS, 2015). Distribution: Guam, Rota (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: Long (USFWS, 2023)

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the forest ecosystem (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
50% decline in range (USFWS, 2015)

Species Trends:
Increasing (USFWS, 2015)

Number of Populations:
5 (USFWS, 2023)

Population Size:
786 (USFWS, 2023)

Population Narrative:
It has declined across at least 50 percent of its range (i.e., on Guam). Currently, M. walkeri is known from 5 occurrences in the forest ecosystem on Guam and Rota, totaling at least 686 individuals. This is a significant increase over numbers of individuals that were known at the time of the proposed rule (estimated at fewer than 60). On Guam, there are two individuals (M and E Pacific, Inc. 1998, pp. 31, 79; Grimm 2013, in litt.); and on Rota, there are at least 684 individuals spread out across the Sabana, with a healthy population structure consisting of seedlings, juveniles, and adults (Harrington et al. 2012, in litt.; Gawel 2013, in litt.; Liske-Clark et al. 2015, in litt.) (USFWS, 2015). There are approximately five populations of Maesa walkeri totaling at least 786 individuals on Guam and Rota. The overall population on Rota may be considerably larger than the number of individuals counted, ranging between 684 to several thousand individuals. The populations on Guam are smaller, only 52 individuals in one population, 43 in a second population, and only 7 known from a third. Recruitment has been reported on Rota and there is evidence of recruitment on Guam. (USFWS, 2020). Number of Known Populations:5 . Number of Individuals in the Wild in the Marianas: 786 (USFWS, 2023).

Threats and Stressors

Stressor: Development, military training, and urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In their 2015 Final SEIS (http:// guambuildupeis.us/) (see ‘‘Historical and Ongoing Human Impacts,’’ above), the U.S. Department of Navy states that approximately 5,000 Marines will be relocated from Okinawa to Guam, accompanied by approximately 1,300 dependents, with a concurrent introduction of support staff and development of infrastructure, and increased use of resources such as water (Berger et al. 2005, p. 347; JGPO– NavFac, Pacific 2015, p. ES–3). The current preferred alternative sites on Guam for cantonment and live-fire training include the Naval Computer and Telecommunications Station Finegayan and Northwest Field on Andersen AFB, where this species occurs. Further, the Navy is planning jungle training at the Naval Munitions Site (NMS) on Guam, which will require the establishment of foot trails within the southern portion of the NMS due to repeat use during maneuvering training. This species occurs on the Naval Magazine. In November 2007, the people of Rota voted to legalize casino gambling to increase tourism, and two development projects have been proposed. Development around

and within forested areas on Rota will also directly impact the forest habitat and individuals of this species (USFWS, 2015).

Stressor: Ungulates (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In the Hawaiian Islands, pigs have been described as the most pervasive and disruptive nonnative influence on the unique native forests, and are widely recognized as one of the greatest current threats to Hawaii's forest ecosystems (Aplet et al. 1991, p. 56; Anderson and Stone 1993, p. 195). The negative impacts from pig rooting and wallowing described above negatively affects this species and its habitat. Several herds of Asiatic water buffalo or carabao roam southern Guam and the Naval Magazine area, and cause damage to the forest ecosystem that supports this species. Philippine deer have caused extensive damage resulting in changes in the forest structure, including erosion, grazing to the point of clearing the entire herbaceous understory, consumption of seeds and seedlings preventing regeneration of native plants and the spread of invasive plant species, and other physical damage (e.g., trunk rubbing) (Schreiner 1997, pp. 179–180; Wiles et al.1999, pp. 193–215; Berger et al. 2005, pp. 36, 45–46, 100; CNMI–SWARS 2010, p. 24; JGPO–NavFac, Pacific 2010b, p. 3–33; SWCA 2011, pp. 35, 42; Harrington et al. 2012, in litt.) (USFWS, 2015).

Stressor: Fire (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Fire is a human-exacerbated threat to native species and native ecosystems throughout the Mariana Islands, particularly on the island of Guam. Fire can destroy dormant seeds of native species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to those favorable to alien plants (USFWS, 2015).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 8

Delisting Criteria:
Not available - this species does not have a recovery plan.

Minimum Number of Stable Populations: 10. Reproducing Individuals / Population: 200 (USFWS, 2023)

Recovery Actions:

- Not available - this species does not have a recovery plan.

- In 2012, the Guam Plant Extinction Prevention Program (GPEPP) was formed to address conservation concerns for a select group of native Mariana Islands plant species, including Maesa walkeri. GPEPP is a partnership between the University of Guam (UOG), multiple Federal agencies (USFWS, DOD, and USDA), Hawaii State DLNR, and the Hawaii Plant Extinction Prevention Program (Hawaii PEPP). The goal of GPEPP is to prevent the extinction of native Mariana Islands plant species that have fewer than 200 individuals remaining in the wild on the island of Guam (GPEPP 2014, in litt.). The program's main objectives are to monitor, collect, survey, manage, and reintroduce native plant species in the Mariana Islands. They plan to work with conservation partners to protect wild populations and preserve genetic material (GPEPP 2014, in litt.) (USFWS, 2015).
- A conservation project on Rota, administered through the Water and Environmental Research Institute of the Western Pacific at the University of Guam, is aimed to analyze the island's hydrology, with the ultimate goal of protection of the Sabana Watershed and Talakhaya Springs (Keel et al. 2007, pp. 5, 22–23). Erosion control, revegetation, and water source preservation conducted as part of this project may provide protection to this species (USFWS, 2015).
- Threat and Recovery Potential: Full species with a moderate degree of threat and a high recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine population status and current distribution—Determine the distribution and number of all individuals on each island. Identify priority sites for species conservation. Assess the status and threats to each population to inform prioritization of conservation effort. • Conduct research to clarify life history information and threats to the populations and their habitat—Conduct research to determine the best way to control the brown treesnake, rodents, and invasive invertebrates. Assess development and land designation and zoning threats to conservation of habitat needed for recovery. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control ecosystem-altering nonnative invasive plant species and those that compete with M. walkeri at all populations. Implement measures such as fire danger assessments, fire suppression responses, fuel treatments, regulations, and public outreach to prevent fire from burning native limestone forest. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction. • Reintroduction and translocation—Augment populations and increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of predation and typhoons, and climate change. • Develop regulations and policy essential to recover the species and their habitats— Encourage the development of legislation to ensure protection of the listed species under Commonwealth or Territorial law. Develop and support the implementation of biosecurity plans to prevent the influx of new pests and invasive species into the Territory and inter-island movement of pests and invasive species. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and inventories – • The USFWS recommends all sites containing suitable habitat be surveyed for Maesa walkeri prior to implementation of projects entailing vegetation or soil disturbance. • Joint Region Marianas (JRM) surveyed for ESA-listed species, including M. walkeri, at the Naval Munitions Site (NMS) and Naval Base Guam Telecommunication Site, Tarague Triangle, MSA Igloos, THAAD, and other projects to document

locations and estimate population densities in sites that are proposed for ungulate exclusion and forest restoration (JRM 2019 and 2020). • Captive propagation for genetic storage and reintroduction • The Guam Plant Extinction Prevention Program (GPEPP) currently has 11 individuals of Maesa walkeri representing a single tree from Mount LamLam secured in their nursery; reproduction has not been observed in the nursery. Experimental plantings have been conducted at three locations. A total of 6 plants were outplanted at Inarajan, and currently two individuals remain alive (GPEPP 2018). • Habitat protection – • A major biosecurity focus within the Mariana Islands is preventing the spread of the brown treesnake to the CNMI from Guam. Federal agencies support local capacity both in Guam and the CNMI. Efforts include inspection of all arriving cargo from Guam to the CNMI by brown treesnake detection dogs as well as specialized snake trapping around all major ports of entry. The Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of InteriorOffice of Insular Affairs (U.S. Geological Survey, USFWS), are using aerial applications of acetaminophen to suppress the snake in forested areas in AAFB (Dorr, et al. 2016, in litt.; Phillips 2014, in litt; BTSTWG 2015, entire). In addition, repeated and sustained applications could drastically reduce brown treesnake abundance on a landscape scale (Siers, et al. 2018, in litt.). • An island-wide Habitat Conservation Plan for Guam, that would provide a collaborative and comprehensive approach to endangered species conservation on non-federal lands, is beginning to be developed (USFWS 2020). • The Rota Special Resource Study is being conducted by the National Park Service to consider partnerships to foster cooperative planning and management to protect limestone forest and other important resources within approximately 4,400 acres on Rota (NPS 2020, p. 14). • A 2020 Memorandum of Understanding between JRM and the USFWS outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative (REPI) to address conservation of upland vegetation communities (DON and USFWS 2020). (USFWS, 2020)

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SPECIES ACCOUNT: *Malacothamnus fasciculatus var. nesioticus* (Santa Cruz Island bush-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small shrub, up to 2 m in height. Produces pink flowers, up to 3.75 cm broad, scattered along the ends of the branches. Blooms in June and July. (NatureServe, 2015)

Taxonomy

The 2nd edition of The Jepson Manual (Baldwin et al. 2012) accepts distinct varieties of Malacothamnus fasciculatus, including var. nesioticus, however, it states "Vars. maybe be untenable, needs study." M. fasciculatus var. nesioticus is included (along with several other names) in the synonymy of M. fasciculatus in Hickman (1993) and in Kartesz (1999). However, genetic studies have shown that var. nesioticus may be distinct variety (Swenson et al. in prep, as cited in USFWS 1995). In the summary and table of the July 31, 1997 notice in the Federal Register (in which the USFWS determines this taxon as endangered) this taxon is listed as M. fasciculatus SSP. nesioticus, although no publication of the name with this rank appears to exist. In the text of the notice it is called Malacothamnus fasciculatus VAR. nesioticus (NatureServe, 2015)

Current Range

Currently known from only four small populations on Santa Cruz Island. (USFWS, 2012)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Scrub (Natureserve, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: One population is in a coastal scrub community, the other is in the dry interior. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Not Available.

Number of Populations:

6 Natural pops 12 outplanted(USFWS, 2021)

Population Size:

236 (USFWS, 2021)

Threats and Stressors

Stressor: Small population size and limited distribution (USFWS, 2007)
Exposure:
Response:
Consequence: Extinction
Narrative: Malacothamnus fasciculatus var. nesioticus is threatened by the risk of stochastic extinction due to small population size and limited distribution, which was a threat at the time of listing and continues to be a threat. The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 1998); Groom et al. 2006). In particular, small population size makes it difficult for this species to persist while sustaining the impacts of soil loss, shrub canopy loss, and competition with annual plants

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The disruption of native habitats and displacement of native species by alien plants, particularly sweet fennel (Foeniculum vulgare) and nonnative grasses, was considered a major threat at the time of listing (62 FR 40954). Fennel is particularly invasive because its leaves and stems contain chemicals that inhibit the growth of native plants (Schoenherr et al. 1999). Ironically, nonnative grazers seemed to control the spread of fennel by keeping a check on its abundance. Consequently, once the sheep had been removed, a program to manually remove sweet fennel was initiated for fear that it would take over vast areas of the island (Schoenherr et al 1999) (USFWS, 2007).

Recovery

Reclassification Criteria:
Establish five viable populations on Santa Cruz Island (addresses Listing Factors A, C, and E.) Only four populations are known at this time. Although surveys in historical and other suitable habitat have been conducted, other populations have not been found. In addition, no reintroduced populations have been established. Therefore, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2007).

Maintain populations as stable or increasing with evidence of natural recruitment for a period of 15 years that includes the normal precipitation cycle (addresses Listing Factors A, C, and E).

Because the species has not been listed for a minimum of 15 years, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2007).

Seed stored in CPC (Center for Plant Conservation) cooperating facilities. (USFWS, 2021)

Seed germination and propagation techniques understood. (USFWS, 2021)

Successful outplanting techniques developed. (USFWS, 2021)

Life history research conducted (USFWS, 2021)

Weed management plan developed and implemented. (USFWS, 2021)

If declining, determine cause and reverse trend (USFWS, 2021)

Delisting Criteria:
Discover or establish five additional populations (addresses Listing Factors A, C, and E). This criterion has not been met (USFWS, 2007).

No decline after downlisting for 10 years (addresses Listing Factors A, C, and E). This criterion has not been met. Although we believe the intent of this criterion is appropriate, we think it should be refined in the future to focus more on long-term trends, rather than a short-term, absolute decline, once additional information about the life history of the species and its response to recovery actions are better understood (USFWS, 2007).

All potential habitat surveyed. (USFWS, 2021)

Recovery Actions:

- Seek additional funding beyond 2007 to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery prescriptions (USFWS, 2007).
- Expand the fennel eradication program as soon as feral pigs have been eliminated from Santa Cruz Island (USFWS, 2007).
- Implement exotic vegetation removal, such as nonnative grasses, from Santa Cruz Island (USFWS, 2007).
- Refine the generalized downlisting criteria to take into consideration new information regarding the limited number of genotypes that currently exist. Attaining the recovery objective of securing several populations containing a minimum of 2,000 plants each is unrealistic for this species (USFWS, 2007).
- Refine delisting criteria to emphasize long-term population trends rather than short-term gains or declines (USFWS, 2007).
- Investigate the community-level factors that influence population abundance, distribution, and demographic trends (e.g., slope steepness and aspect, vegetation type, etc.) (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: • Search for additional natural populations • Increase monitoring frequency and consistency of natural populations • Increase natural population seed banking, and fund seed bank maintenance in perpetuity • Determine why seedling recruitment is low/non-existent • Augment existing populations when possible (USFWS, 2021)

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SPECIES ACCOUNT: *Malacothrix indecora* (Santa Cruz Island malacothrix)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with broadly lobed, fleshy leaves. Produces hemispheric heads, 2-6 mm wide, of yellowish-green flowers. The heads are surrounded by long bracts. Blooms April-September. (NatureServe, 2015)

Taxonomy

Malacothrix indecora was first described by Edward Lee Greene (1886), based on specimens collected from "islets close to the northern shore of Santa Cruz Island." In 1957, Williams published a combination of the species as Malacothrix foliosa var. indecora (Ferris 1960) and subsequently Munz (1974) later synonymized the taxon with Malacothrix foliosa. However, Ferris (1960) and others (Smith 1976, Davis 1980) continued to recognize the taxon as Malacothrix indecora and this nomenclature has been retained in the most recent treatments of the genus (Davis 1993, Jepson 2010, Flora of North America (FNA) 2010a). There have been no changes in the taxonomic classification or nomenclature since the time of listing (USFWS, 2010).

Historical Range

See current range/distribution.

Current Range

Known from three of the northern Channel Islands (Santa Cruz Island, San Miguel Island, and Prince Island) in Santa Barbara County, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known about the life history ofSanta Cruz Island malacothrix. This annual species is poorly to moderately selfcompatible (Davis 1998) (USFWS, 2000).

Habitat Type

Adult: Coastal bluffs and flats (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The species generally occurs on coastal bluffs and slopes, often on midden sites, at elevations of less than 20 meters (65 feet). The species occurs on Santa Cruz Island, Santa Rosa Island, and San Miguel Island, Santa Barbara County, California. The islands are part of Channel Islands National Park (CINP). Most of Santa Cruz Island (76%) is private property of The Nature Conservancy, CINP owns the rest of Santa Cruz Island and all of Santa Rosa Island, and San Miguel Island is owned by the Navy but is administered by CINP. Both CINP and TNC lands are managed for natural resource conservation (USFWS, 2022).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found

Population Information and Trends

Population Trends:

Not available

Number of Populations:

3 extant (USFWS, 2022)

Population Narrative:

The status of both Malacothrix indecora and M. squalida has not changed substantially since the time of listing in 1997. Currently, there are eight known populations of M. indecora, which occur on four of the northern Channel Islands: Anacapa, San Miguel, Santa Rosa, and Santa Cruz. These populations have exhibited some decline in the number of individuals over the last 15 years and we are lacking recent or comprehensive survey data for all of the populations, which makes it difficult to draw any conclusions about the current abundance trend for this species. There are three locations of M. indecora that were recently discovered in the spring of 2010 on East Anacapa Island where large patches of iceplant were removed in 2009. These new discoveries appear to indicate that this species might be expanding its range, since it was not historically known from Anacapa Island. There are two known extant populations of M. squalida, which occur on two of the northern Channel Islands: Santa Cruz and Anacapa. These populations have exhibited some decline and overall fluctuation in numbers of individuals over the last 15 years, but the number of individuals of this species is already very low and we do not have any recent or comprehensive survey data, which makes it difficult to draw any conclusions about the current abundance trend for this species (USFWS, 2011). Distribution: The distribution of Santa Cruz Island malacothrix has not changed since the last 5- year review (Service 2010). There are at three extant and one historical occurrences on Santa Cruz Island, one extant occurrence on Santa Rosa Island, and two presumed extant occurrences on San Miguel Island (Table 2). The San Miguel Island occurrences have not been visited in more than 20 years; whether they remain extant is unknown. Santa Cruz Island malacothrix, contrary to information in the last 5-

year review, is not known to occur on Anacapa Island (USFWS, 2022)

Threats and Stressors

Stressor: Fire and Invasive Species (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: we still believe that non-native plant species and catastrophic fires pose a risk to both the Malacothrix species. With the removal of non-native herbivores, we have also seen an increase in vegetation biomass, thus increasing the chance of larger and more frequent fires. Particularly, the vegetative biomass of non-native species has increased, due to the removal of non-native herbivores and continued exposure, thus increasing the amount of competition for resources for both Malacothrix species. There has been some speculation that climate change may further complicate these two issues; however we lack adequate information to draw any conclusions about the specific changes that may occur on the northern Channel Islands as a result of climate change (please see discussion under Climate Change below) (USFWS, 2010).

Stressor: Hybridization (USFWS, 2010)
Exposure:
Response:
Consequence: Extirpation
Narrative: Malacothrix indecora and M. squalida hybridize both with one another and with several other Malacothrix species (McEachern, in litt. 2010). In particular, there is one documented occurrence of M. indecora and M. squalida hybrids in a north-draining canyon at Potato Harbor on Santa Cruz Island (McEachern, in litt. 2010). There are two other Malacothrix species that occur on the same islands as M. indecora, but M. indecora is the only other Malacothrix species that co-occurs with M. squalida (Junak et al. 1995). Hybridization was not addressed in the listing rule or the recovery plan and we lack any specific data which would allow us to draw any conclusions about how hybridization may affect either of these species at this time (USFWS, 2010).

Stressor: Stochastic Extinction (USFWS, 2010)
Exposure:
Response:
Consequence: Extirpation
Narrative: At the time of listing, we noted that due to the limited geographic range, and limited number of individuals and populations of both Malacothrix indecora and M. squalida, these species were at risk of stochastic extinction resulting from loss of genetic diversity, through chance events affecting survival and reproduction, and through naturally occurring catastrophic events, such as fire, drought, disease, or storms (Service 1997). We believe that the existence of only two and eight relatively isolated populations of M. squalida and M. indecora, respectively, place these species at risk of extinction from stochastic events. Because both species have a relatively limited geographic range and exist as only a few populations, the genetic viability and resilience of both M. indecora and M. squalida to human-caused or natural disasters may be greatly reduced (Menges 1991, Ellstrand and Elam 1993). Studies on Santa Cruz Island have shown that unexpected, complex interactions sometimes result in substantial declines within endemic species populations that were assumed to be stable (Roemer et al. 2001). The

conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (Shaffer 1981, Groom et al. 2006, Primack 2006). In particular, although the plants are apparently self-compatible, the small size of the populations make it difficult for these species to persist while sustaining the impacts of soil damage (compaction and erosion) and habitat alteration that favors non-native species (USFWS, 2010).

Stressor: Climate Change (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Because all of the populations for both Malacothrix species occur on coastal bluffs in close proximity to the ocean, these species are subject to a wide range of climatic conditions, such as occasional salt spray (Wilken 1996), which may directly affect the soils and plants at low elevation exposed coastal flats. Sea level rise and the continued erosion of the ocean-front cliffs on the exposed bluffs of the northern Channel Islands from high surf and storm events, in addition to climate variability, both from year to year and due to large-scale climate change, pose a threat to the relatively small and exposed Malacothrix populations (USFWS, 2010).

Recovery

Reclassification Criteria:
1. Maintain existing stable populations on San Miguel, Santa Cruz, and Santa Rosa Islands for a period of 15 years that includes the normal precipitation cycle (USFWS, 2022).

2. Seed stored in CPC cooperating facilities (USFWS, 2022).

3. Seed germination and propagation techniques understood (USFWS, 2022).

4. Successful outplanting techniques developed (USFWS, 2022)

5. Life history research conducted (USFWS, 2022)

6. Weed management plan developed and implemented (USFWS, 2022).

7. If declining, determine cause and reverse trend (USFWS, 2022)

Delisting Criteria:
1. No decline after downlisting for 10 years (USFWS, 2022).

2. All potential habitat surveyed (USFWS, 2022).

Recovery Actions:
- Reclassification criteria: This criterion is relevant; however, it should be updated to include a more measurable and threats-based component. Additionally, it may become increasingly difficult to evaluate the population over 15 years that includes the normal precipitation cycle due to the fact that the normal precipitation cycle is already changing and is predicted to continue to fluctuate considerably under the effects of climate change (IPCC 2007). This

criterion does not include a clear definition of what constitutes a stable population for this species; therefore, it should be updated to include a more concrete definition of this term. David Keith presents a widely accepted method of evaluation of at-risk plant species that is based on The World Conservation Union (IUCN) Red List Criteria of 1994, consisting of a set a decision rules based on quantitative thresholds of population size, distributional range, rates of decline, and extinction risk (Keith 1997). We recommend that the recovery criteria for Malacothrix indecora be updated to include a more well-defined method, such as the one presented by Keith (1997), for assessing when this species can be considered stable and recovered. Despite the three new occurrences of Malacothrix indecora that were discovered this year, the most recent surveys of the M. indecora populations seem to show that overall, the number of individuals has decreased somewhat since listing (McEachern, in litt. 2010). Additionally, the precipitation cycles during the last 15 years have not been normal (Levine et al. 2009, Levine et al. 2010); therefore, this criterion has not been met (USFWS, 2010). Delisting criteria: This criterion is relevant; however it is rather vague. We recommend that this criterion be revised to take into consideration that there may be some fluctuation in the population sizes of these annual plant species; however, delisting may be considered when this species is considered recovered based on the quantitative methods of evaluation presented by Keith (1997) or some other comparable method. This criterion has not yet been met (USFWS, 2010).

- Develop and implement monitoring and adaptive management plans for all of the existing populations. Monitoring should occur at intervals of 1 to 2 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats. 1a. Work closely with agencies such as TNC, USGS, and NPS to continue monitoring efforts for the species and to develop a long-term adaptive management plan for special status species which occur on the northern Channel Islands (USFWS, 2010).
- Develop and implement an integrated non-native plant control program for Santa Cruz, Anacapa, San Miguel, and Santa Rosa Islands, which complements and enhances existing efforts (USFWS, 2010).
- 3. Continue to research the species' life history requirements, especially with regard to the habitat conditions favorable to both species. 3a. Specifically, we recommend a follow-up study to evaluate the response of both Malacothrix species to the removal of the non-native mammals from Santa Cruz, Santa Rosa, and San Miguel Islands and whether recovery of the soil health and stability has occurred. Because non-native large herbivores still remain on Santa Rosa Island, some baseline data could be gathered now and compared with the results that are gathered several years after the eventual removal of the remainder of these animals (USFWS, 2010).
- Update the recovery criteria for both Malacothrix indecora and M. squalida to include a more measurable and threats-based evaluation method, based on the recommendations presented in the discussion of the recovery criteria for both species on pages 16 through 18 of this review (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Survey San Miguel Island occurrences to verify their continued persistence. 2. Establish regular monitoring for known natural populations of Santa Cruz Island malacothrix on Santa Cruz, Santa Rosa, and San Miguel Islands. 3. Enhance existing natural populations on Santa Cruz Island. 4. Establish new recovery populations on Santa Cruz Island. 5. Improve the completeness of coverage over years for Santa Cruz Island malacothrix in conservation seed banks, for both Santa Cruz and San Miguel Islands. 6. Survey additional potential habitat on

Santa Cruz and San Miguel Islands. 7. Restrict public access to the Lobo Canyon-Cow Canyon population during the Santa Cruz Island malacothrix growing season (USFWS, 2022).

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SPECIES ACCOUNT: *Malacothrix squalida* (Island malacothrix)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, up to 9 cm tall, with narrow, irregularly toothed or lobed leaves. Flowers are pale yellow, borne in hemispheric heads which are 4-10 mm wide. Blooms April-July. (NatureServe, 2015)

Historical Range

This species was historically reported as having four known occurrences on two of the northern Channel Islands: Santa Cruz and Anacapa. One of the historically reported populations on Santa Cruz Island has not been seen since 1886 (CNDDB 2010b, McEachern, in litt. 2010). Furthermore, based on our definition of a plant population (any occurrences within 0.25 mile of one another), two of the occurrences on Anacapa Island in the California Natural Diversity Database (CNDDB) are close enough in proximity to be considered a single population; therefore, we consider there to be two known extant populations of this species. (USFWS, 2010)

Current Range

There has been no significant change in the geographic range for Malacothrix squalida since listing in 1997; however, several of the known populations appear to have expanded in areal extent in the last few years. There are currently two known extant populations of Malacothrix squalida.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinating (USFWS, 2000)

Dependency on Other Individuals or Species

Adult: No such dependencies (inferred from USFWS, 2010)

Reproduction Narrative

Adult: The island malacothrix is self-pollinating; it is inferred to have no dependences on other individuals or species for reproduction (USFWS, 2010).

Habitat Type

Adult: Coastal bluffs and rocky areas of cismontane woodland (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chaparral; cismontane woodland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Soil derived from igneous and metamorphic rock along coastal dunes, bluffs, and exposed flats (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Elevation 15-200m (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Occurs on two islands: Santa Cruz Island and Anacapa (USFWS, 2010).

Environmental Specificity

Adult: Very Narrow (Inferred from USFWS, 2010)

Habitat Narrative

Adult: The species inhabits coastal bluffs and rocky areas of cicmontane woodland, and vegetation type is considered chaparral. The island malacothrix is observed at elevations of 15-200m, but the existing literature does not specify whether this is a geographic restraint (NatureServe, 2015). The species relies on soil derived from igneous and metamorphic rock along coastal dunes, bluffs, and exposed flats. It is distributed on two islands: Santa Cruz Island and Anacapa (USFWS, 2010).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: This species' motility/mobility, dispersal, or migration behavior and/or needs have not been determined (inferred from USFWS, 2010).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2010)

Number of Populations:

2 (USFWS, 2022)

Population Size:

Under 50 (USFWS, 2010)

Population Narrative:

It is not known whether island malacothrix populations are stable or in decline. The plant is considered to have to populations: one on Santa Cruz Island, and one on Anacapa. Population size was last noted to be under fifty individuals (USFWS, 2010). The 2010 5-year review (Service 2010) established that, at that time, there were two extant occurrences of island malacothrix, and one historical occurrence that had not been seen since 1886 (Table 2). This has not changed for the current 5-year review. The two presumed extant occurrences are on the ridge of Middle Anacapa Island and at Potato Harbor on Santa Cruz Island. However, plants have not been seen at the Middle Anacapa Island occurrence since 1998. The historical occurrence is at Prisoners

Harbor on Santa Cruz Island. Given that Prisoners Harbor is currently split by the border between TNC and CINP, the historical occurrence could have occurred on either one or both of the current landowners' property (USFWS, 2022).

Threats and Stressors

Stressor: Soil loss (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Habitat alteration (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Competition with non native plants (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Sheep grazing (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Sea bird nesting (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: This species is exposed to soil loss, habitat alteration, competition with non native plants, sheep grazing and feral pig rooting. Sea bird nesting may have some impacts to the populations on Middle Anacapa Island (Junak 2001). (NatureServe, 2015)

Stressor: Stochastic extinction due to limited distribution
Exposure:

Response:
Consequence:
Narrative: Stochastic extinction is named as a threat to extinction supplemental to those listed above (USFWS, 2010).

Stressor: Climate change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Expected climate change for the geographic region of the northern Channel Islands predicts both rising annual temperatures (Langridge 2018 pp. 13-15) and less frequent, more episodic rainfall (Langridge 2018 pp. 16-17). Changes in climate could threaten island malacothrix in two ways, as demonstrated by work with federally listed annual plants on Santa Rosa Island, including a close congener of island malacothrix, Malacothrix indecora. First, as vegetation and habitat shift with climate change, island malacothrix might not be able to disperse to suitable germination or recruitment habitat (Levine et al. 2008 p. 796). Second, the proper environmental cues could occur less frequently or not at all, decreasing germination of island malacothrix and causing declines in abundance and possible extirpations (Levine et al. 2008 pp. 800-805; Levine et al. 2011 pp. 2241-2246). In the California Channel Islands, climate change induced sea level rise is predicted to be about 0.25 m (0.8 ft) by 2050 (Sweet et al. 2022 p. 19) and 1.0 m (3.3 ft) by 2100 (Sweet et al. 2022 p. 23). The single location at which the island malacothrix has recently been seen, Potato Harbor on Santa Cruz Island, is on the immediate coast at an elevation of about 15 m (50 ft) and is on relatively soft substrate. This occurrence is threatened by storm surf erosion even without climate change, which increases the threat. The Middle Anacapa Island occurrence is at a higher elevation and is therefore less threatened by sea level rise (USFWS, 2022).

Stressor: Conflict between species (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: No collections of island malacothrix have been made from the Middle Anacapa Island occurrence since 1998, the year after the species was listed. Part of the reason is that plants are detectable only during a time of year that coincides with seabird roosting and nesting, and island access is currently not allowed when seabirds might be disturbed. This has been described as an example of a conflict between the needs of rare plants and protected fauna (Schneider and Carson 2020 p. 9). Island malacothrix is arguably the most endangered plant species at CINP, with only two occurrences, and only a maximum of about two dozen plants recorded at either of those occurrences at any time. To understand the status of this endangered plant, surveys for island malacothrix need to be conducted on Middle Anacapa Island at the appropriate time period in its life history (USFWS, 2022).

Recovery

Reclassification Criteria:
1. Discover or establish 10 populations on Anacapa and Santa Cruz Islands (USFWS, 2022)

2. Maintain stable populations for a period of 15 years that includes the normal precipitation cycle (USFWS, 2022)

3. Seed stored in CPC cooperating facilities (USFWS, 2022).

4. Seed germination and propagation techniques understood (USFWS, 2022).

5. Successful outplanting techniques developed (USFWS, 2022)

6. Life history research conducted (USFWS, 2022)

7. Weed management plan developed and implemented (USFWS, 2022)

8. If declining, determine cause and reverse trend (USFWS, 2022)

Recovery Priority Number: 2

Delisting Criteria:
There has been no decline of this species for 10 years after downlisting (USFWS, 2010)

2. All potential habitat surveyed (USFWS, 2022)

Recovery Actions:

- Develop and implement monitoring and adaptive management plans for all of the existing populations. Monitoring should occur at intervals of 1 to 2 years and include population abundance surveys, habitat condition assessment, and documentation of existing and potential threats (USFWS, 2010).
- Develop and implement an integrated non-native plant control program for Santa Cruz, Anacapa, San Miguel, and Santa Rosa Islands, which complements and enhances existing efforts (USFWS, 2010).
- Continue to research the species' life history requirements, especially with regard to the habitat conditions favorable to both species (USFWS, 2010).
- 4. Update the recovery criteria for both Malacothrix indecora and M. squalida to include a more measurable and threats-based evaluation method, based on the recommendations presented in the discussion of the recovery criteria for both species on pages 16 through 18 of the 2010 5-Year Review document (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Gain regular annual access to Middle Anacapa Island for meaningful surveys. 2. Continue searching for additional populations of island malacothrix on Anacapa and Santa Cruz Islands. 3. Establish regular monitoring for known natural populations of island malacothrix on both islands. 4. Conduct outplantings to establish new populations on both islands. 5. Improve the completeness of coverage of island malacothrix in conservation seed banks, with both natural populations over a wide range of years (USFWS, 2022).

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USFWS. 2022. Island Malacothrix (Malacothrix squalida) 5-Year Review: Evaluation and Summary. Ventura Fish and Wildlife Office. Ventura, California. 10 pp.

SPECIES ACCOUNT: *Manihot walkerae* (Walker's manioc)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/02/1991; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A perennial herb, highly branched or few-stemmed, sprawing or erect, up to 1.5 m tall. The stems are smooth, grayish-brown, 3.2 millimeters (0.13 inch) in diameter. The leaves are alternate, deeply incised, and palmately 5-lobed. Flowers are unisexual and occur in racemes with staminate flowers in the raceme opening later than pistillate ones. Staminate flowers are tubular, constricted in the middle; tepals are 1.2 centimeters (0.47 inch) long, light purplish streaked externally, and cleft one-fourth of the way down into 5 lobes; stamens are 6-10, filaments and anthers are cream-colored. Flowers from spring through autumn, probably following rains. Clusters of 2-3 fragrant, white flowers open in late afternoon and last only 1 day. There are separate male and female flowers on the same plant. (USFWS, 1993; NatureServe, 2015)

Taxonomy

Leon Croizat (1942) described Walker's manioc as a distinct species. Rogers and Appan (1973) place it within section Parvibracteatae of the genus Manihot. Its closest relative may be M. subspicata, another rare plant of south Texas and northeast Mexico found on caliche or rocky limestone substrates. Tom Patterson observed that the ranges of these two species overlap in the Loreto sand plain of Tamaulipas (Patterson 2008, pers. com.). (USFWS, 2009)

Historical Range

Walker's manioc is known only from the Lower Rio Grande Valley of Texas (Hidalgo and Starr counties) and northern Tamaulipas, Mexico. One historical location for Walker's manioc was Ringgold Barracks, an old fort located on the eastern outskirts of Rio Grande City, Starr County, Texas. (USFWS, 1993)

Current Range

Walker's manioc is known only from the Lower Rio Grande Valley of Texas (Hidalgo and Starr counties) and northern Tamaulipas, Mexico. (USFWS, 1993). As of 2019: Walker's manioc has been documented from as far north as Duval County in southern Texas (TXNDD 2018, p. 18) to the vicinity of Aldama (Service 2009, p. 11) in the most southern part of the state of Tamaulipas, Mexico; a distance of approximately 532 kilometers (km). (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 2009)

Breeding Season

Adult: Spring through fall (USFWS, 2009)

Reproduction Narrative

Adult: The species is self-fertile, and does not appear to require a rare or specialized pollinator (Best 2008). Flowers from spring through autumn, probably following rains. The fruit capsules contain up to three seeds, which are dispersed a distance of several meters by the spontaneous, violent dehiscence (rupturing) of the capsules upon drying, which impedes seed collection (Best 2008). Seeds may remain dormant for a year or more, but germination can be induced by exposure to heat and moisture (Simpson 1995), or gibberellic acid (a naturally occurring plant hormone) (Best 2008). Individual plants have produced up to 20 rounded tubers 2 to 3 inches (5 to 7.5 cm) in diameter, after about 3 years' growth (Best 2008). This demonstrates that the species perenniates in the wild through both seeds and tubers (Best 2008). (USFWS, 2009). Walker's manioc is capable of dormancy due to its underground tubers that remain viable even when unfavorable aboveground conditions (e.g., drought, extended period of high temperatures, freezes) result in leaves and stems dying back. The ability of the species to regenerate, or to spread to new sites, via pieces of tuber has positive implications for propagation and reintroduction recovery actions. Observations at Lower Rio Grande Valley National Wildlife Refuge (LRGV NWR) show that manioc plants can begin tuber production at less than one year of age (Best 2008 in Service 2009, p. 10) and that potted manioc plants can produce numerous, large tubers by 2.5 years. Field observations indicate that javelina (Pecari tajacu) dig up and consume tubers, but may also act as agents of dispersal by dropping tuber pieces as they move (Service 2009, p. 18). In Tamaulipas, Mexico, manioc grew from tuber pieces scattered about in a crop field (Best 2008 in Service 2009, p. 16). Tubers appear to help the species survive adverse environmental conditions as well as anthropogenic surface impacts including herbicides, mowing, and perhaps disking or plowing. Manioc has reemerged following herbicide application that killed the aboveground portions of the plants (Best 2008 and Patterson 2008 pers comm. in Service 2009, p. 10). (USFWS, 2019).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Widely-spaced or small clusters (USFWS, 2009)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 2009)

Habitat Narrative

Adult: The recorded habitat descriptions from collections of the species vary from native brush to grassland. Endemic to the Tamaulipan grassland-thornscrub community of the Lower Rio Grande Valley, where it occurs on sandy-loam soils underlain by caliche. Walker's manioc plants occupy only a small portion of the upland vegetation of the Goliad geological formation, in shallow, calcareous sandy soil overlying indurated caliche. The soil depth is often 12 in (30 cm) or less. Populations may consist of widely-spaced individual plants along bands of shallow soil,

or small clusters of a few dozen individuals. Johnston (1963), Best (1995, 2005), and Poole et al. (2007) have described plant species found in close association with Walker's manioc. These include short native grasses and herbaceous plants, and low shrubs and sub-shrubs. (USFWS, 2009; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2009)

Dispersal/Migration Narrative

Adult: The fruit capsules contain up to three seeds, which are dispersed a distance of several meters by the spontaneous, violent dehiscence (rupturing) of the capsules upon drying, which impedes seed collection (Best 2008). (USFWS, 2009)

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

3 (USFWS, 2009). Update: 11 (USFWS, 2019).

Population Size:

<1,000 individuals (NatureServe, 2015)

Population Narrative:

A regional endemic of southern Texas and northern Mexico, this species was thought to have been extirpated from the U.S. until a single surviving plant was discovered in 1990. Three sites on LRGV NWR, consisting of up to 90 individuals each, may be large enough to be considered viable populations. Five additional sites found in Texas have as many as 30 individuals. There is probably less than 1,000 individuals. (USFWS, 2009; NatureServe, 2015). With the exception of the Duval County population, all known Texas manioc populations occur in western Hidalgo County and southeastern-to-southcentral Starr County with the majority of these populations located within 2.4 km of the Rio Grande. Although the population data show a patchy, scattered distribution, much of the potential habitat between known populations has not been surveyed. The discovery of additional sites in 2009 illustrate the likelihood of finding more populations in unsurveyed suitable habitat on which the land cover has not been mined or otherwise built over. Three of the largest Texas populations occur on protected tracts of the LRGV NWR (TXNDD 2018, pp. 6, 8, and 10; Best 1996 in Service 2009), which implements monitoring and management actions intermittently. All other populations in Texas and Mexico, except for a small site on TXDOT ROW, are on privately-owned land. The TXDOT site in Hidalgo County is considered highly vulnerable because of its location along a road (D. Price 2007, pers. comm.). (USFWS, 2019).

Threats and Stressors

Stressor: Urban and residential development (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: Urban and residential development continues at a rapid pace throughout the border region of south Texas and northern Mexico. The human populations of Starr and Hidalgo Counties are projected to grow 67% and 88%, respectively, between 2000 and 2025 (Texas State Data Center 2008). Habitat loss is likely to continue both through development of sites as well as increased surface mining of caliche for construction of roads and parking lots. (USFWS, 2009)

Stressor: Energy development (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Intensive energy exploration continues throughout the entire range of Walker's manioc in south Texas and northeast Mexico. Under Texas and Mexican law, mineral rights owners take precedence over surface owners. Seismic exploration, pipelines, oil and gas wells, and access roads have proliferated on private lands as well as tracts of LRGV NWR, incrementally augmenting the loss of potential habitat of this and other listed plant and animal species. Habitats and populations at LRGV NWR are potentially vulnerable to impacts from oil and gas exploration, since USFWS does not own the mineral rights pertaining to most of the refuge's tracts. (USFWS, 2009). 2019 update: At the end of 2018, there were no wind turbines, oil and gas well pads, or roads directly impacting known manioc populations. However, the two south central Starr County manioc population sites were within 4.0 km and 4.8 km from existing turbines at large wind farms to the east and north, respectively. A 56–100-turbine wind farm is proposed for construction to the northwest of these populations. In Starr and Hidalgo counties, there are five existing wind farms (USGS 2019, unpaginated) with some of the 380 turbines atop manioc-appropriate soils. Wind energy development does not have a federal nexus and is not required to carry out surveys for listed species, therefore placement of turbine pads and internal roads could impact undiscovered populations, but the level of impacts is unknown. (USFWS, 2019).

Stressor: Habitat loss (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The primary threats to Walker's manioc are habitat loss and competition from invasive grasses. Although the caliche outcrops where the species occurs are not conducive to production of row crops, extensive surface mining of caliche supplies much of the base material for highways, unpaved roads, well-drilling pads, and parking lots throughout the region. Surface mining of caliche is therefore a major threat to species, such as Walker's manioc, that are endemic to exposed caliche outcrops. (USFWS, 2009)

Stressor: Invasive plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Many species of Old World grasses have been introduced in the Tamaulipan region of south Texas and northeast Mexico for cattle forage and erosion control, including several that

are now highly invasive (Best, in press). The “common variety” of buffelgrass (Pennisetum ciliare) was derived from a single apomictic individual from northern Kenya (Holt 1985). Common buffelgrass was introduced in south Texas beginning in 1946 and is now abundant from Texas and Tamaulipas to Arizona and Sonora. Buffelgrass is well adapted to the welldrained calcareous soils where Walker’s manioc occurs. This forage grass is typically established by root-plowing sites with powerful tracked vehicles, then broadcasting the seed in the disturbed soil. A large amount of potentially suitable habitat for Walker’s manioc has been converted to root-plowed buffelgrass pasture. Buffelgrass often increases following soil disturbance, allowing it to spread rapidly along road, powerline, and pipeline rights-of-way. It is present at most Walker’s manioc sites, frequently dominating the herbaceous vegetation and suppressing most native species including Walker’s manioc. In the Loreto sand plain another introduced grass, pitted bluestem (Bothriochloa pertusa), may also compete with Walker’s manioc (Best 2005). (USFWS, 2009)

Stressor: Genetic swamping (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: A closely related plant, cassava (Manihot esculenta), is an important staple crop throughout the tropics. Walker’s manioc may serve as a source of genetic material for the development of improved cassava cultivars (U.S. Fish and Wildlife Service 1990b, 1993a). The storage life of edible cassava roots is significantly diminished by post-harvest physiological deterioration (PPD). Researchers created an inter-specific hybrid between cassava and propagated specimens of a Mexican collection of M. walkerae which is the only known source of resistance to PPD (Centro Internacional de Agricultura Tropical 2005; Cuambe 2007). This research has not directly affected wild populations, since the source material came from cultivated plants. However, if the inter-specific hybrid or cultivars derived from it are able to back-cross with wild plants, this could threaten wild populations through genetic swamping. (USFWS, 2009)

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: In September 2003, Tom Patterson reported an incidence of digging in the exact locations of Walker’s manioc plants on three tracts of LRGV NWR (Patterson 2003, pers. com.). These plants had been precisely mapped with GPS, and had been identified with numbered aluminum tags. A refuge law enforcement officer (who is a skilled tracker) and the plant ecologist investigated these sites. They determined that the digging had not been done by humans and identified numerous tracks of javelina (collared peckary) at these sites. Javelina feed heavily on plant seeds and tubers (Leopold 1972). The refuge staff observed that some partially-eaten tuber fragments had sprouted new roots and shoots (Best 2008). Feral hogs are abundant in the region, and may also constitute a serious threat to Walker’s manioc populations (Patterson 2008, pers. com.). Patterson also observed rabbits consuming the stems and leaves of Walker’s manioc (Patterson 1996, pers. com.). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:

Consequence:
Narrative: According to the Intergovernmental Panel on Climate Change (IPCC) (2007) "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level." Average Northern Hemisphere temperatures during the second half of the 20th century were very likely higher than during any other 50-year period in the last 500 years and likely the highest in at least the past 1300 years (IPCC 2007). It is very likely that over the past 50 years cold days, cold nights and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). It is likely that heat waves have become more frequent over most land areas, and the frequency of heavy precipitation events has increased over most areas (IPCC 2007, p. 1). Some climate change models also predict increased precipitation along the Gulf Coast, largely due to increased tropical storm activity and severity (Twilley et. al. 2001). Since the species now occurs in some of the most xeric of regional habitats, increasing rainfall could reduce its competitive advantage in those marginal sites. Regardless of how changes in temperature and rainfall amounts and patterns may affect the autecology of Walker's manioc, the altered synecology may be far more significant. For example, higher winter temperatures and increased precipitation could augment competition from buffelgrass or other introduced invasive grasses. Conversely, the same changes could expand the range or increase the pathogenicity of Pyricularia grisea, a rust fungus that attacks buffelgrass, thereby reducing its invasiveness. The possible effects of climate change on the synecology of Walker's manioc habitat are infinitely complex. Therefore, the Service will continue to monitor the species and its habitat, and will adapt our recovery and management strategies when necessary to address the changing conditions. (USFWS, 2009)

Stressor: Quarrying/Mining (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Google Earth imagery dated January 2017 shows numerous pits or caliche quarries in the area between the most eastern manioc population in southern Texas and Rio Grande City, Texas. Mining is evident on this imagery to both the north and south of Highway 83 with ongoing activity at a number of the sites as evidenced by on-site vehicles. Expansion of a number of these pits can be confirmed by comparing imagery across years. All of the manioc sites in Hidalgo and Starr counties, including some on refuge tracts, are in relatively close proximity to either active quarries or what appear to be old pits that are now full of water, illustrating that the species occurs within a zone of active caliche or gravel quarrying. On private land, known populations are not currently protected by agreements and any undiscovered populations that may exist remain threatened by caliche mining. (USFWS, 2019).

Stressor: U.S./Mexico Border development (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Walker's manioc's proximity to the Rio Grande and to HWY 83 increases the vulnerability of the species to development which tends to occur along the river and HWY 83. Proximity to the Rio Grande also means more vulnerability to new roads, new border barriers, increased traffic, and other activities related to increased law enforcement and border security. (USFWS, 2019).

Recovery

Reclassification Criteria:
Maintain or establish 15 self-sustaining populations of Walker's manioc in the United States. Establish management plans (public lands) or management agreements (private lands) to insure the protection of these populations. (USFWS, 1993)

2019 Downlisting Criterion amendment: Within the Hidalgo-Starr Counties, Texas Recovery Unit, establish or maintain 15 distinct, self-sustaining populations of Walker's manioc. Each population should consist of at least 1,000 reproductive individuals. (USFWS, 2019).

Delisting Criteria:
1. Over a 30-year period, maintain at least 15 fully protected, self-sustaining populations containing at least 1,000 reproductive individuals in each, within the known U.S. range. (USFWS, 2019).

Protection and management agreements need to be perpetual to provide a permanent level of protection. (USFWS, 2019).

Recovery Actions:
- Protect the habitat of the existing populations on private lands in the United States and Mexico. (USFWS, 1993)
- Gather biological information necessary for management and develop a monitoring program for populations. (USFWS, 1993)
- Search for new populations in the United States and Mexico. (USFWS, 1993)
- Establish a botanical garden population. (USFWS, 1993)
- Initiate a reintroduction program into suitable habitat on the Lower Rio Grande Valley National Wildlife Refuge, Texas Parks and Wildlife Department lands and other lands made available for use. (USFWS, 1993)
- In 2019, one Recovery Unit was identified: Recovery Unit 1 – Hidalgo-Starr Counties, Texas. (USFWS, 2019).
- Criterion 1 calls for establishment or maintenance of at least 15 self-sustaining populations of 100 or more individuals. This criterion should be revised using updated methods to describe what constitutes a viable population, and the number and geographic distribution of populations necessary for recovery. (USFWS, 2009)
- Criterion 2 requires establishment of "agreements for the protection and management of all populations on private lands..." However, USFWS has no authority to require private landowners to protect endangered plants. Furthermore, because the USFWS cannot survey private lands without the owner's permission, it is not possible to quantify the number of populations requiring protection. The criterion, as currently written, tends to promulgate misinterpretation of the authority of the Endangered Species Act, and might discourage landowners from cooperating with USFWS in the conservation of this species. Finally, successful recovery may be possible without protecting all known sites. This criterion should be revised to establish quantifiable, attainable objectives. (USFWS, 2009)
- The plan should have a recovery criterion that addresses seed banking, establishment of refugium populations and reintroduction efforts, all of which serve as safeguards against the

unavoidable loss of populations to development, competition from invasive species, or catastrophic events. (USFWS, 2009)

- Periodic monitoring and surveys of known sites in Texas and Tamaulipas. In particular, a quantitative survey should be conducted at the three sites on LRGV NWR to detect population trends at those sites. (USFWS, 2009)
- Additional surveys of potential habitat in Texas and Tamaulipas, focusing on sites with Goliad-formation caliche outcrops that have not previously been surveyed. (USFWS, 2009)
- Seed collection for propagation and seed banking, establishment of seed increase plots, and pilot reintroduction projects. (USFWS, 2009)
- In-situ investigation of reproductive biology and population dynamics. (USFWS, 2009)
- Investigation of the genetic structure of known populations throughout the species range. (USFWS, 2009)
- Establish cooperative efforts to promote the conservation of Goliad formation caliche outcrops. (USFWS, 2009)
- Promote cooperative efforts with Mexican agencies, scientists, and non-profit conservation organizations to conserve populations in Mexico. (USFWS, 2009)
- Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands. (USFWS, 2009)
- Determine whether inter-specific hybrids of M. esculenta and M. walkerae, or cultivars derived from those hybrids, are able to create fertile progeny with wild M. walkerae. (USFWS, 2009)

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SPECIES ACCOUNT: *Marshallia mohrii* (Mohr's Barbara's buttons)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/7/1988; Southeast Region (R4)

Physical Description

Erect perennial herb, 3 to 7 decimeters (1 to 2.3 feet) tall. The leaves are alternate, 8 to 20 centimeters (cm) (3.2 to 7.8 inches) long, firm-textured, three-nerved, and lanceolate-ovate in shape. Leaves are often clustered near the base and gradually reduce in size upwards. The flowers are typically produced in several heads in a branched arrangement. The heads are approximately 2.5 cm (1 inch) broad and consist of disk flowers (tubular in shape) which are pale pink or white in color. The fruit is an achene (USFWS, 1991).

Taxonomy

In the sunflower family (Asteraceae) (USFWS, 1991). The taxon is currently recognized as valid by the Integrated Taxonomic Information System (ITIS) (ITIS 2015), as well as national and regional floras (e.g., Flora of North America [Watson 2006] and Flora of the Southern and Mid-Atlantic States [Weakley 2015]). While the taxonomic status of this species is not affected, some authors use the alternate common name Coosa Barbara's-buttons (e.g., Noss 2012, Spaulding 2013, Weakley 2015) rather than Mohr's Barbara's buttons used by the Service and others (e.g., Chafin 2007, ITIS 2015, NatureServe 2015). (USFWS, 2016)

Historical Range

Historical records exist for Walker County, Georgia, and Walker and Cullman Counties, Alabama, in addition to the current range (USFWS, 1991).

Current Range

Currently known from Bibb, Cherokee, and Etowah Counties, Alabama, and Floyd County, Georgia (USFWS, 1991)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Insect (EPA, 2016)

Breeding Season

Adult: Flowering in mid-June; fruiting in July to August (EPA, 2016)

Key Resources Needed for Breeding

Adult: Insects for pollination (EPA, 2016)

Reproduction Narrative

Adult: Mohr's Barbara's button flowers mid-May to June (Patrick et al. 1995). Flowers are pollinated by beetles, butterflies, and other small insects and must be cross-pollinated to set viable fruit (USFWS, 2019).

Habitat Type

Adult: Wetland, Terrestrial (NatureServe, 2015b)

Habitat Vegetation or Surface Water Classification

Adult: Barrens, forest edges, meadows, grasslands (NatureServe, 2015b)

Dependencies on Specific Environmental Elements

Adult: sandy clays, which are alkaline, high in organic matter, and seasonally wet (USFWS, 1991)

Environmental Specificity

Adult: Narrow (NatureServe, 2015b)

Habitat Narrative

Adult: The habitat is moist prairie-like openings in woodlands, along shale-bedded streams, and meadows. The soils are sandy clays, which are alkaline, high in organic matter, and seasonally wet. Most currently known populations occur on soils of the Conasauga-Firestone Association. Plants occur in full sun or partial shade in a grass-sedge community (USFWS, 1991; NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds are probably dispersed by birds and other small mammals (USFWS, 2019).

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

19 extant (USFWS, 2022)

Population Size:

Up to 6,740 individuals estimated (USFWS, 2016)

Population Narrative:

Schotz (2014) estimated the total range-wide population to be up to 6,740 individuals. Additional recent survey data from some of these sites and other sites not visited by Schotz in Alabama (e.g., AANG 2015, TVA 2015) suggests that this estimate is low; however, 2015 surveys by Malcolm Hodges (pers. comm. 2015) did not relocate plants at three small sites in Georgia where Schotz had previously found them. Together, this recent survey data suggests that the range-wide Mohr's Barbara's buttons population size may approach 10,000 plants (Schotz 2014, AANG 2015, M. Hodges pers. comm. 2015, TVA 2015). Individual sites may range from fewer than 20 plants to well over 1,000 (Schotz 2014, AANG 2015, TVA 2015); although, most (27

[79%]) of the 34 extant sites surveyed by Schotz support 200 or fewer plants. Furthermore, two-thirds of the plants encountered during Schotz's surveys were found at only seven sites. Additionally, Schotz noted that at a given site, plants may be clustered in areas of approximately 50 square feet or can be scattered across several acres, which is similar to observations made by others (i.e., AANG 2015, TVA 2015). (USFWS, 2016). 19 known extant populations (USFWS, 2022)

Threats and Stressors

Stressor: Destruction and Degradation of Habitat (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Clearing, conversion, and agricultural activities remain persistent threats to various Mohr's Barbara's buttons' occurrences (Schotz 2014). Nearly one-third (11 of 34) of extant sites Schotz (2014) surveyed have been converted to pine plantations and/or had been impacted by recent timber harvests. In addition, logging is thought to have extirpated Etowah County, Alabama's only known population (Schotz 2014, D. Spaulding pers. comm. 2015), while conversion to row crop agricultural field has likely extirpated one population in Cherokee County, Alabama (Schotz 2014). Suitable habitat for Mohr's Barbara's buttons remains vulnerable to loss. As described above, most Coosa Valley prairies are thought to have been lost since the early 1800s with the only known remnants of this habitat currently located in Floyd County, Georgia (Duncan 2013). Similarly, Bibb County, Alabama's Ketona dolomite glades are unique and exceedingly rare habitats and are vulnerable to damage by recreational uses and adjacent logging activities. Schotz (2014) noted damage to two glades by recreational traffic (e.g., ATV use) and logging damage or vulnerability of two others. Construction of a borrow pit is thought to have reduced available habitat for one site in Floyd County, Georgia (Schotz 2014). Furthermore, development and associated habitat destruction are projected to continue for decades to come throughout the southeastern United States (Stein et al. 2010), which could further encroach upon and limit habitat suitable for Mohr's Barbara's buttons. (USFWS, 2016)

Stressor: Inadequate/Incompatible Habitat Management (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: An important threat to Mohr's Barbara's buttons' continued survival is incompatible and inadequate land management. While the species is apparently able to survive certain types of forestry practices (e.g., limited timber harvesting that opens up the canopy), its apparent inability to tolerate heavy shading likely increases it susceptibility to practices that promote vegetation succession and encroachment of invasive species (e.g., fire suppression). Fire may be an important mechanism for maintaining the open character of some of Mohr's Barbara's buttons habitats. Inadequate fire regimes threaten some occurrences by allowing competing vegetation—particularly hardwoods—to grow unchecked, thereby encroaching upon available habitat for Mohr's Barbara's buttons and reducing availability of resources (e.g., light) that the species requires to survive and thrive (Patrick et al. 1995, Schotz 2014). Fire exclusion was noted as a primary threat to 24% of sites surveyed by Schotz (2014), whereas succession was considered a threat to 29%. Highway and utility rights-of-way are currently home to various Mohr's Barbara's buttons sites. The known extent of three extant populations are restricted to a

TVA utility right-of-way (in Jefferson County, Alabama), whereas portions of at least six other populations occur in either utility or road rights-of-way (Allison 1993, Schotz 2014, M. Hodges pers. comm. 2015). As such, these sites are heavily dependent upon compatible management regimes to maintain healthy populations (e.g., Schotz 2014, AANG 2015, TVA 2015). Mohr's Barbara's buttons is particularly vulnerable to herbicides and incompatible mowing regimes within its habitats; however, appropriate mowing regimes may also serve as valuable conservation tools in these areas (Schotz 2014). Schotz (2014) noted that nearly one-third of all sites surveyed were vulnerable to incompatible management regimes within rights-of-way throughout the species' range. Furthermore, at least one site along a road right-of-way in Cherokee County, Alabama is thought to have been extirpated by incompatible management (Schotz 2014). Additional emphasis on reintroducing fire or fire surrogates (e.g., mowing) is needed to promote healthy populations and maintain open conditions that this species requires. (USFWS, 2016)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Mohr's Barbara's buttons is a State threatened plant in Georgia (Patrick et al. 1995) and, therefore, receives State protection from non-permitted collection and sale; however, State law does not provide protection against habitat destruction in Georgia. Collection of this species on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973, O.C.G.A. 12-6-170. No such provisions are afforded to plants found on privately owned lands in the State. The species does not receive any specific legal protections from State laws or regulations in Alabama. (USFWS, 2016)

Stressor: Invasive Species (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: During the most recent range-wide survey, Schotz (2014) noted that invasive species are a potential threat to some Mohr's Barbara's buttons populations. Indeed, Schotz (2014) observed encroachment of exotic invasive plants species at 14 Mohr's Barbara's buttons sites. These species—predominantly Chinese privet (Ligustrum sinense)—left unchecked have the potential to degrade habitat quality and out-compete Mohr's Barbara's buttons for resources (e.g., moisture, nutrients, light, and recruitment sites). Currently, threats posed from invasive plants at most sites appears to be minimal (Schotz 2014); however, habitat management (e.g., fire, mechanical or hand thinning, etc.) may be required to control invasive species where they threaten Mohr's Barbara's buttons. (USFWS, 2016). Wild Hogs Rooting by wild hogs (Sus scrofa), which are non-native invasive species, was noted in the vicinity of some Mohr's Barbara's buttons occurrences in Bibb County, Alabama, but was not observed directly impacting Mohr's Barbara's buttons (M.S. Wiggers, pers. obs., August 2017). Although no direct impacts to Mohr's Barbara's buttons by wild hogs have yet been observed, wild hogs may represent an emerging threat to some populations. As has been summarized elsewhere, wild hogs can cause myriad deleterious effects—ranging from direct destruction of plants to degradation of habitat—on the communities in which they are found (cf. Massei and Genov 2004, Barrios-Garcia and Ballari 2012). Continued monitoring is needed to further assess the potential impacts and threats posed by wild hogs (USFWS, 2022).

Stressor: Small Population Size (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Most extant populations of Mohr's Barbara's buttons are comprised of a number of small, fragmented occurrences. While population sizes (i.e., number of plants obtained from counts or estimates) are not available for all sites/populations of Mohr's Barbara's buttons, the most recent range-wide status assessment by Schotz (2014) found that most sites had small local population sizes and that most of the range-wide population was contained in only a few sites with comparatively large local populations. Indeed, Schotz found that 53% (18 of 34) of extant sites had local populations of ≤100 individuals and 79% (27 of 34) of these sites had ≤200 individuals. Together, sites with ≤200 individuals accounted for about one-third of the total population evaluated by Schotz. By contrast, only three sites evaluated were found to have 500 or more plants, which accounted for nearly half of the entire population evaluated range-wide. Small population sizes increase the vulnerability of individual sites to environmental and anthropogenic perturbations and chance events. In addition, small population sizes increase the risks posed by inbreeding and genetic drift, which may limit the species' adaptive capacity and ability to cope with future stressors (Ellstrand and Elam 1993). (USFWS, 2016)

Stressor: Climate Change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Specific impacts of climate change on populations of Mohr's Barbara's buttons are poorly understood; however, a variety of impacts are possible. Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). Davenport (2007) suggested that Mohr's Barbara's buttons may be negatively impacted by climate change within Alabama as available habitat becomes constricted. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007, Hawkins et al. 2008), which may thereby reduce sexual reproduction of Mohr's Barbara's buttons. While disease is not currently known to threaten Mohr's Barbara's buttons, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004, Garrett et al. 2006, Hawkins et al. 2008). Given the variety and complexity of climate change's potential effects (cf. Hawkins et al. 2008, Walther 2010), more research is needed to assess its potential long-term impacts on Mohr's Barbara's buttons populations and habitats. (USFWS, 2016)

Recovery

Reclassification Criteria:
Not applicable.

Recovery Priority Number: 14

Delisting Criteria:
1. There are 15 viable populations and all are protected from present and foreseeable human-related and natural threats (USFWS, 1991)

2. At least three populations each should be located within the two physiographic regions represented by its historic range (Cumberland Plateau, Ridge and Valley) (USFWS, 1991).

3. At least three of the 15 populations should be located within Alabama and three in Georgia. Viability of populations will be assessed through monitoring for a period not less than 15 years (USFWS, 1991).

Recovery Actions:
- Protect existing populations from any present or foreseeable threats, and search for additional populations (USFWS, 1991)
- Determine population size. Conduct demographic studies and gather life history information (USFWS, 1991).
- Determine habitat characteristics. An understanding of this species ecology is an important component to determining what factors limit its distribution (USFWS, 1991).
- Determine parameters of a viable population. The long-term survival of the species will be ensured only if a sufficient number of viable populations are protected. (USFWS, 1991).
- Determine and implement appropriate management. Management of habitat, as well as protection, appears to be essential for ensuring that vigorous populations are maintained (USFWS, 1991).
- Conduct monitoring studies. A general monitoring program should be devised and implemented on sites in order to track population trends and evaluate the effectiveness of recovery efforts (USFWS, 1991).
- Preserve genetic material. Protection of the gene pool should be accomplished through seed bank storage and by maintaining material in cultivation (USFWS, 1991).
- Recommendations for Future Actions from 2016 5-Year Review: •Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. •Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. •Investigate metapopulation structure and dynamics of the species. •Conduct studies into the species' life history, biology, and ecology. •Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. •Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management). (USFWS, 2016)
- Personnel of the Alabama Highway Department (Department) are aware of the plants on or near the ROWs they maintain and of the importance of protecting them. An informal agreement exists between the U.S. Fish and Wildlife Service (Service) and the Department for protection of the plants on their ROWs (USFWS, 1991).
- One population on private land in Cherokee County is protected through a long-term Cooperative Agreement (USFWS, 1991).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES The following actions are recommended to support and promote recovery of Mohr's Barbara's buttons. Use of a numbered list for these recommendations is for convenient reference and does not necessarily imply prioritization of any action over others. 1. Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed. 2. Investigate efficacy of habitat management techniques (e.g., fire). Update and improve monitoring and habitat management methods. 3. Conduct studies to determine the number and distribution of populations required to maintain the species' genetic diversity. 4. Investigate metapopulation structure and dynamics of the species. 5. Conduct studies into the species' life history, biology, and ecology. 6. Update the species' recovery plan to reflect current knowledge (e.g., distribution, habitats) and needs (e.g., data/knowledge deficiencies, management) (USFWS, 2022).

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SPECIES ACCOUNT: *Melanthera (=Lipochaeta) kamolensis* (Nehe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/15/1992; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Lipochaeta kamolensis is a low perennial herb in the aster family (Asteraceae). The occasionally somewhat woody stems are low-lying or free-climbing, 30 cm to 3 m (1-9.8 feet) long, rooting along their lower surfaces. Leaves are long and narrow or triangular, about 3-6 cm (1.2 2.4 in) long and 1-4 cm (0.4-1.6 in) wide, both surfaces hairy, especially along the veins. The leaves are lobed, sometimes deeply, along the middle vein in a feather-like arrangement (pinnately lobed), and are on leaf stalks (petioles) about 1 to nearly 2 cm (0.8 in) long. Flower heads occur singly or in pairs, each with 6 approximately 4-9 mm (0.2-0.4 in) petal-like ray florets surrounding about 15 small (3 mm [0.1 in]) disk florets. Each head is surrounded by lance shaped leaf-like parts (bracts); old bracts are tan in color. The fruits are small (approximately 1.5-2 x 2 mm (0.06-0.08 x 0.08 in]) and dry (achenes). (USFWS, 1997)

Taxonomy

The 2012 supplement to the Manual of the Flowering Plants of Hawaii (Wagner et al. 2012) accepts the change from the genus Lipochaeta to the currently accepted Melanthera, and recognizes Lipochaeta kamolensis as Melanthera kamolensis. The proposed change will recognize Lipochaeta kamolensis with the new name of Melanthera kamolensis. The range of the species has not changed with this taxonomic revision. Gardner (1979) stated that L. kamolensis is most closely related to L. subcordata (endemic to Kauai, Lanai, and Hawaii Island), and to a lesser degree to Lipochaeta venosa (endemic to Hawaii Island) and L. bryanii (endemic to Kahoolawe). The genus Lipochaeta comprises 20 species, restricted to the Hawaiian Islands. (USFWS, 1997; USFWS, 2014)

Historical Range

See Current Range (USFWS, 1997).

Current Range

Current range: over about 100 acre area in Kamole and Kepuni gulches of East Maui. (USFWS, 2014)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Lipochaeta kamolensis (Nehe) (aka Melanthera kamolensis) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Lipochaeta kamolensis includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Cenchrus agrimonioides, Flueggea neowawraea, Melicope adscendens, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Canavalia pubescens, Colubrina oppositifolia, Ctenitis squamigera, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Sesbania tomentosa, Solanum incompletum, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Canavalia pubescens, and Hibiscus brackenridgei, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant Canavalia pubescens, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of

these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Canavalia pubescens, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Lipochaeta kamolensis critical habitat consists of one component. Lowland dry (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The

125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some

occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Honeybees (USFWS, 1997)

Reproduction Narrative

Adult: Gardner (1979) noted flowering in December-February. Flowering was observed in April 1994 (A.C. Medeiros, L. Loope, and P.A. Thomas, personal observation 1994). Vegetative growth normally occurs only during the November-April/May wet season. During the dry season, the plants are desiccated and appear to be metabolically inactive. Though native bees (Nesoprosopis sp.) were observed nearby on flowers of other native species (e.g., Argemone glauca), only alien honeybees (Apis melifera) were observed visiting the flowers of Lipochaeta kamolensis. (USFWS, 1997)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Annual rainfall ranges from 24-30 inches with most rain coming in November through April (USFWS, 1997)

Habitat Narrative

Adult: Degener's type collection made in 1948 notes: "Very rare, among lantana and grass" (Medeiros el al. 1986). Medeiros el al. (1986) reported that the habitat "is highly impacted by cattle" and that "very little native vegetation remains"; at that time Lipochaeta kamolensis was found to persist "in small depressions and along cattle trails." Mean annual rainfall for the area is in the neighborhood of 600-750 mm (24-30 in). Rainfall is variable from year to year and highly seasonal, with most rain coming in November-April (Giambelluca el al. 1986). (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2023)

Population Size:

1 wild (USFWS, 2023)

Population Narrative:

In 2012, there were approximately 30 to 40 individuals of Lipochaeta kamolensis on East Maui (USFWS 2012; A. Medeiros, U.S. Geological Survey, pers. comm. 2010). Overall, Lipochaeta kamolensis has increased from approximately 25 wild individuals reported in the last 5-year review to approximately 30 to 40 wild individuals (USFWS 2012; A. Medeiros, pers. comm. 2010). (USFWS, 2014). The latest review of the species by IUCN in 2015 reported one subpopulation of four individuals (Chau et al. 2015); however, by 2018, only one wild plant remained (Oppenheimer, 2018, in litt.) (USFWS, 2018). Currently, there is one pure wild individual of Melanthera kamolensis and two groups of mixed wild/hybrid plants totaling fewer than 100 individuals on Haleakalā. There are three subpopulations of translocated plants within an exclosure at Kanaio. At least four founders are currently represented in seed collections and propagation. Translocation is ongoing, with more than 60 individuals reintroduced; however, only 10 currently survive. Recruitment has been observed at one translocated subpopulation (USFWS, 2023).

Threats and Stressors

Stressor: Drought (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Drought may exacerbate the effects of ungulates and has direct adverse impacts on M. kamolensis (PEPP 2013). (USFWS, 2014)

Stressor: Landslides and flooding (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Landslides and flooding destruction or degradation of habitat – This species is threatened by landslides and erosion (PEPP 2012). (USFWS, 2014)

Stressor: Ungulate trampling, grazing, and browsing (USFWS, 1997)

Exposure:
Response:
Consequence:
Narrative: Habitat destruction and predation by feral goats and domestic cattle threaten Lipochaeta kamolensis (Medeiros et al. 1986; R.W. Hobdy, personal communication 1994). Ironically, however, heavy grazing of habitat surrounding L. kamolensis serves a partially positive role in removing much of the biomass of alien vegetation, which would potentially fuel wildland fires. (USFWS, 1997)

Stressor: Alien plant species (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: The remaining habitat of Lipochaeta kamolensis has been much altered by alien plant species. Three species have spread widely within the last decade on leeward East Maui, and though present in the habitat of Lipochaeta kamolensis in limited cover, have the potential to dominate the site. These species include a leguminous vine, Glycine wightii, and two invasive grasses, Melinis minutiflora (molasses grass), and Panicum maximum (Guinea grass). (USFWS, 1997)

Stressor: Wildland fire (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Fire is a major threat to the persistence of Lipochaeta kamolensis; a single fire could extirpate either of the only known populations (R.W. Hobdy, personal communication 1994). The fire threat would become much more severe with reduction of grazing/browsing and/or invasion of Penniselum selaceum (fountain grass). (USFWS, 1997)

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, citing the analysis by Fortini et al. (2013), but we did not include the species' vulnerability rank. The assessment by concluded that Melanthera kamolensis is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.95 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species is also one of the most vulnerable native Hawaiian plant species that has a projected future climate envelope. Therefore, additional management actions, such as locating suitable locations for recovery in both current and future climate envelopes, are needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Recovery Priority Number: 2

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:
- Develop landowner commitment to protect the two known populations of Lipochaeta kamolensis. (USFWS, 1997)
- Construct experimental exclosures within known populations to protect some but not all Lipochoeta kamolensis individuals.
- Monitor selected invasive weeds within and outside exclosures to determine long-term effects and manage weeds as needed. (USFWS, 1997)
- Develop a fire management action plan with Maui Division of Forestry and Wildlife (DOFAW) for protection of Lipochaeta kamolensis. (USFWS, 1997)
- Using seeds from known populations, establish outplantings of Lipochaeta kamolensis into protected sites. (USFWS, 1997)
- New Management Actions: • Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) surveys for and monitors populations of Melanthera kamolensis on east Maui (PEPP 2013, 2014, 2015, 2016, 2017b, 2018). • Captive propagation for genetic storage and reintroduction— o In 2017, PEPP reported that 10 founders were represented in collections from Luala‘ilua; and that three of 10 founders from a hybrid swarm (with M. rockii) in the same area had been collected for molecular analyses to study the hybrid swarm (PEPP 2017a). o The Lyon Arboretum Micropropagation Laboratory reported germination and propagation of Melanthera kamolensis from two collections, one in 2001 and another in 2012, though no propagules remain. The Lyon Arboretum Seed Laboratory reports almost 2,000 seeds in storage from 11 individuals collected between 2013 and 2016. There are also pooled collections from eight plants (382 seeds) from another location (Lyon Arboretum 2017). o The Olinda Rare Plant Facility (ORPF) reported 20 cuttings and nine potted plants collected from 10 individuals at an undocumented location and 14 cuttings and three potted plants from four individuals at Kepuni Gulch in 2013. In 2014, ORPF further

propagated cuttings into potted plants from five of the same individuals (15 plants) and six potted plants from two new individuals from Luala‘ilua. In 2015, 11 potted plants were sent out to Kahikinui (in situ). In 2017, almost 70 potted plants were produced, with at least six sent out in situ (Kanaio, Alena) (ORPF 2014, 2015, 2017). • Stochastic events—Build resiliency and redundancy—PEPP establishes and monitors outplanting sites and has reintroduced 28 individuals at two sites at Luala‘ilua and 35 individuals at three sites in Kanaio NAR (PEPP 2016, 2017b, 2018) (USFWS, 2018).

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species’ biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue monitoring the wild population of Melanthera kamolensis. • Ungulate monitoring and control—Construct and maintain exclusion fences to protect M. kamolensis from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations. • Fire monitoring and control—Develop and implement fire management plans for all wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species’ vulnerability to climate change. • Reintroduction and translocation—Continue to augment current populations and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Taxonomy research—Conduct research on the hybrid population to confirm hybrid status between M. kamolensis and M. rockii. • Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. Develop a strategy for preventing the extinction of this species if no suitable habitat is predicted in the future. • Alliance and partnership development—Initiate planning and work with landowners to contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. (USFWS, 2014)
- Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species’ vulnerability to climate change. (USFWS, 2014)
- Survey geographical and historical range for a current assessment of the species’ status. (USFWS, 2014)
- Fence remaining populations to protect them from the impacts of feral ungulates. (USFWS, 2014)
- Augment current natural populations to increase numbers of individuals. (USFWS, 2014)
- Develop and implement a fire management plan for all populations. (USFWS, 2014)
- Control invasive introduced plant species within enclosures. (USFWS, 2014)
- Continue monitoring wild populations. (USFWS, 2014)
- Conduct research on the taxonomy of the species to confirm if the population at Alena is a hybrid swarm between M. kamolensis and M. rockii. (USFWS, 2014)
- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2014)

- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2014)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2023. • Surveys and inventories—Continue to survey for additional populations of Melanthera kamolensis in areas of potentially suitable habitat and assess the current status of known populations. • Ungulate monitoring and control—Continue to construct and maintain exclosures, or strategic fencing as appropriate, to protect M. kamolensis from the negative impacts of feral ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with M. kamolensis, at all populations. • Fire prevention and control—Develop and implement fire management plans for all wild and translocated populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for recovery of the species. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for translocation. • Translocation and augmentation—Continue to translocate individuals into suitable habitat within historic range that is being managed for known threats to this species. • Genetic research—Conduct research on hybrid populations to confirm hybrid status between M. kamolensis and M. rockii. • Build resiliency, redundancy, and representation—Continue translocation of individuals into suitable habitat that is being managed for known threats to this species to reduce impacts of landslides, , and drought. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2023).

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SPECIES ACCOUNT: *Melicope balloui* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/05/1994; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Melicope balloui is a small tree or shrub in the rue family (Rutaceae). New growth is covered with yellowish-brown hairs and waxy scales, the hairs becoming grayish and they, along with the scales, more sparse with age. The generally oval-shaped leathery leaves (5-10 x 3-7 cm [2-3.9x 1.2-2.8 in]) occur in pairs on 10-26 mm (0.4-1.0 in) leaf stalks (petioles) opposite each other on the stems. The leaves have about 9-14 pairs of veins branching from the main vein connected by another vein near the periphery of the leaf. The leaves are slightly hairy, the underside becoming less hairy except around the main vein. Female flowers are yellowish green, tiny (petals approximately 4 mm (0.2 in) long) and are densely covered with small hairs. They growin flat clusters of five to nine, each on individual 5 mm (0.2 in) stalks (pedicels), on 3-16 mm (0.1-0.6 in) stalks (peduncles) from the point of leaf attachment. Details of male flowers are unknown. Petals and some other floral parts (sepals) usually persist as the fruit matures; the fruits are about 26 mm (1.02 in) wide, each 12-13 mm (0.47-0.51 in) part containing one or two 7 mm (0.3 in) seeds. (USFWS, 1997)

Taxonomy

Melicope balloui is opposite-leaved, distinguishing it from species in Section Pelea, locally Melicope clusiifolia and Melicope haleakalae. When sterile, Melicope balloui is not easy to distinguish from other opposite-leaved members of the genus. Individuals of Melicope balloui bearing fruit can be distinguished from the more common and widespread M. volcanica and M. molokiensis by the distinctive silky-haired fruiting exocarp (capsule exterior) and sparsely haired endocarp (capsule interior). Melicope balloui is an East Maui endemic (found nowhere else). A recent review (Hartley and Stone 1989) synonymized the near exclusively Hawaiian genus Pelea with Melicope, resulting in Melicope balloui (Rock) Hartley and Stone. Wagner et al. (1990) state that the correct name of this species may actually be Melicope mannii, pending a determination when a type specimen is designated for that taxon. Part of the description of Pelea mannii is based on Mann & Brigham 376 (“AC, BISH” per Wagner et al. 1990), which is actually Melicope balloui. (USFWS, 1997)

Historical Range

See Current Range (USFWS, 1997)

Current Range

Current range includes East Maui. (USFWS, 1997)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Melicope balloui (Alani) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR

17790-18110).

Critical Habitat Designation

The critical habitat designation for Melicope balloui includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Wet—Unit 1 (and) Palmeria dolei—Unit 2—Lowland Wet (and) Pseudonestor xanthophrys—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants Bidens campylotheca ssp. waihoiensis, Clermontia samuelii, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. kunthiana, C. maritae, C. mceldowneyi, Huperzia mannii, Melicope balloui, and M. ovalis. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants Clermontia oblongifolia ssp. mauiensis, C. peleana, Mucuna sloanei var. persericea, Phyllostegia haliakalae, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 1 (and) Palmeria dolei—Unit 10—Montane Wet (and) Pseudonestor xanthophrys—Unit 10— Montane Wet This area consists of 1,313 ac (531 ha) of State land and 798 ac (323 ha) of privately owned land, at Haiku Uka on the northern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Cyanea duvalliorum, C. maritae, C. mceldowneyi, Huperzia mannii, Melicope balloui, and Phyllostegia pilosa, and by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 1 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, C. samuelii, Cyanea copelandii ssp. haleakalaensis, C. glabra, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, Cyrtandra ferripilosa, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Melicope ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) Palmeria dolei—Unit 11—Montane Wet (and) Pseudonestor xanthophrys—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Bidens campylotheca ssp. pentamera, Clermontia samuelii, Cyanea copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. mceldowneyi, Geranium hanaense, G. multiflorum, and Wikstroemia villosa, and by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, Cyanea glabra, C. maritae, Cyrtandra ferripilosa, Diplazium molokaiense, Huperzia mannii, Melicope balloui, M. ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, and Schiedea jacobii, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) Palmeria dolei—Unit 12—Montane Wet (and) Pseudonestor xanthophrys—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, Cyanea copelandii ssp. haleakalaensis, C. hamatiflora ssp. hamatiflora, C. maritae, and Melicope ovalis, and by the forest bird, kiwikiu (Pseudonestor xanthophrys). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Clermontia oblongifolia ssp. mauiensis, C. samuelii, Cyanea duvalliorum, C. glabra, C. horrida, C. kunthiana, C. mceldowneyi, Cyrtandra ferripilosa, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Huperzia mannii, Melicope balloui, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, or by the forest bird, the akohekohe (Palmeria dolei), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) Palmeria dolei—Unit 13—Montane Wet (and) Pseudonestor xanthophrys—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Clermontia samuelii, Cyanea copelandii ssp. haleakalaensis, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. maritae, Cyrtandra ferripilosa, and Huperzia mannii. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, Cyanea duvalliorum, C. glabra, C. mceldowneyi, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Melicope balloui, M. ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) Palmeria dolei—Unit 14—Montane Wet (and) Pseudonestor xanthophrys—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant Bidens campylotheca ssp. pentamera. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, C. samuelii, Cyanea copelandii ssp. haleakalaensis, C. duvalliorum, C. glabra, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. maritae, C. mceldowneyi, Cyrtandra ferripilosa, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Huperzia mannii, Melicope balloui, M. ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Melicope balloui critical habitat consists of two

components. Lowland wet (east Maui) and Montane wet (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of

these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations from 1,280 to 1,520 meters (4,200-4,990 feet) (USFWS, 1997)

Environmental Specificity

Adult: Low, with few key requirements (USFWS, 1997)

Habitat Narrative

Adult: This species is "known only from wet forest, about 1,280-1,520 meters (4,200-4,990 feet), slopes of Haleakala, Maui, between Olinda and Ukelele (Wagner et al. 1990)" and from similar wet forest in Kipahulu Valley. Associated native species include Acacia koa, Cibotium chamissoi, Cibotium glaucum, Diplazium sandwichianum, Melicope clusiifolia, Metrosideros polymorpha, and Sadleria pallida. Associated alien species include Cyathea cooperi, Paspalum conjugatum, Psidiumcalleianum, and Rubus rosifolius. (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1-2 (USFWS, 2011)

Population Size:

possibly extinct (USFWS, 2023)

Population Narrative:

It was observed in 1997 in Opana Gulch in Waikamoi, north of Puu o Kakae at 1,311 meters (4,300 feet) elevation (Wood 2009). About 50 individuals were seen in 1999 in Kipahulu Valley, along Palikea Stream, Delta Camp Region, at 914 meters (3,000 feet) elevation (Wood 2009). In 2009, it was seen again in the same general area, but at a higher elevation of 1,082 meters (3,550 feet) (Wood 2009). In total, about 50 individuals are estimated to currently exist. (USFWS, 2011). Currently, there is one potential individual of Melicope balloui in Waikamoi Preserve, and possibly as many as 50 individuals in Kīpahulu on east Maui, depending upon verification of taxonomy (Robertson 2016, in litt.) (USFS, 2018). Currently, there are no known individuals of Melicope balloui on Haleakalā. No genetic analyses have been conducted on collected materials. There are no new collections or propagules. Further genetic research and surveys are needed (USFWS, 2023).

Threats and Stressors

Stressor: Feral pigs (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Feral pigs are currently being controlled in Haleakala National Park. Constant vigilance is required to keep fences repaired and to remove pigs that get in through breaks in the fence. (USFWS, 1997)

Stressor: Invasive plants (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: If uncontrolled, Paspalum conjugalum (Hilo grass), Clidemia hirta (Kosters' curse), Psidium cattleianum (strawberry guava), Hedychium gardnerianum (kahili ginger), and Cyathea cooperi (Australian tree fern) all potentially represent serious threats to the long-term survival of Melicope balloui. Other invasive introduced plant species include Ageratina adenophora (sticky snakeroot), Andropogon virginicus (broom sedge), Clidemia hirta (Koster's curse), Paspalum conjugatum (Hilo grass), P. urvillei (vasey grass), Rubus argutus (blackberry), and Rubus rosifolius (thimbleberry) (Wood 2009). (USFWS, 1997; USFWS, 2011)

Stressor: Insect predation (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: The endemic microlepidopteran Prays cf. fulvocanella Walsingham (Yponomeutidae) is known to feed on the buds, flowers and seeds of Melicope and Platydesma. (USFWS, 1997)

Stressor: Predation by rats, moths, unknown insects, and the black twig borer (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Rats (Rattus spp.) are noted as a threat to this species because are known to eat plants in the genus Melicope (Wood 2009). Unidentified Lepidoptera moths eat the flowers of this species preventing seed production. Similarly, an unknown insect have been noted to bore into the seed capsules of this species limiting seed production. Black twig borer (Xylosandrus compactus) is a threat to the species. (USFWS, 2011)

Stressor: Avian dispersal (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Oppenheimer believes the avian dispersal agent has become depleted and is potentially extinct, therefore constricting the dispersal area of this species (H. Oppenheimer, pers. comm. 2010). (USFWS, 2011)

Stressor: Small population size (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: In addition to all of the other threats, species like Melicope balloui that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 1997). (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that Melicope balloui is vulnerable to the impacts of climate change, with a vulnerability score of 0.418 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered. (USFWS, 1997)

Recovery Priority Number: 5

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. (USFWS, 1997)

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1997)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1997)

Recovery Actions:

- Maintain relatively pig-free condition of Kipahulu Valley of Haleakala National Park. (USFWS, 1997)
- Continue alien plant control in Kipahulu Valley of Haleakala National Park, with emphasis on Clidemia hirla, Cyathea cooperi, Hedychium gardnerianum, and Psidium cattleianum. (USFWS, 1997)
- Produce an accurate assessment of population numbers and distribution; establish simple baseline monitoring of known individuals. (USFWS, 1997)
- Search for Melicope balloui on northwest Haleakala. (USFWS, 1997)
- Conduct/encourage research on limiting factors. (USFWS, 1997)
- New Management Actions: • Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) comanages one possible individual of Melicope balloui on east Maui (PEPP 2017) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2018. • Population viability and monitoring—Continue monitoring the wild individuals of Melicope balloui. Continue to survey the geographical and historical range of the species for additional populations. • Population biology and taxonomic research—Conduct taxonomic and genetic studies to determine if the currently known individuals are appropriately identified. • Ungulate monitoring and control—Construct and maintain exclusion fences to protect M. balloui from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all individuals. • Invertebrate predation or herbivory—Research and implement effective control methods for the black twig borer and for Lepidoptera moths. • Rodent predation or herbivory—Implement effective control methods for rodents around all individuals. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation—Augment current population and reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for its recovery. • Alliance and partnership development—Initiate planning and work with the Division of Forestry and Wildlife and other land managers to contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).
- Survey areas where Melicope balloui has been reported to establish current status of the species. (USFWS, 2011)
- Conduct taxonomic and genetic study to determine if the currently known individuals are appropriately identified as this species. (USFWS, 2011)
- Monitor known populations and collect any available seeds. (USFWS, 2011)

- Maintain the fences around existing populations to provide protection from the negative impacts of feral ungulates. (USFWS, 2011)
- Continue to control invasive introduced species around known populations. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control unidentified Lepidoptera moths. (USFWS, 2011)
- Develop and implement methods to control black twig borer. (USFWS, 2011)
- Propagate to augment the existing populations. (USFWS, 2011)
- Establish additional populations within protected suitable habitat. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2023. • Surveys and inventories—Continue to survey for additional individuals of Melicope balloui in areas of potentially suitable habitat and assess the current status of known populations. • Ungulate monitoring and control—If the species is found, construct and maintain exclosures to protect M. balloui from the negative impacts of feral ungulates. • Invasive nonnative plant monitoring and control—If the species is found, control established ecosystem-altering nonnative invasive plant species, and those that compete with M. balloui, at all populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use this information to determine future landscape needed for recovery of the species. • Invertebrate monitoring and control—If the species is found, research and implement effective control methods for the black twig borer and Leptidoptera moths, if necessary. • Captive propagation for genetic storage and reintroduction— o If the species is found, begin collection and propagation efforts for maintenance of genetic stock and for translocation. o If the species is found, evaluate genetic resources currently in storage to determine the need to place additional material into long-term storage due to this species' vulnerability to climate change. • Translocation and augmentation—If the species is found, augment current populations and translocate individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology and taxonomic research—Conduct genetic studies to determine if individuals closely fitting the description are M. balloui, are the variable M. volcanica, or are another unique species. • Build resiliency, redundancy, and representation—If the species is found, manage for known threats to reduce impacts of predation and herbivory and low numbers. • Alliance and partnership development—If the species is found, work with partners and other land managers in planning and implementation of ecosystemlevel restoration and management to benefit this taxon (USFWS, 2023).

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SPECIES ACCOUNT: *Melicope lydgatei* (Alani)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/28/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Melicope lydgatei is a long-lived perennial in the Rutaceae (citrus family). This species is a small shrub that has leaves arranged oppositely or in groups of three. The leaves are crowded and opposite, elliptic-oblanceolate, elliptic, or elliptic-ovate, 4 to 10 cm (1.6 to 3.9 in) long, and 2.5 to 6 cm (1.0 to 2.4 in) wide. The 3 to 20 mm (0.1 to 0.8 in) stemmed flowers form axillary cymes of one to five flowers. The flowers are green or red, with petals 10 mm (3.9 in) long and 5 mm (2 in) wide. The berries are white and ovoid shaped, 1 to 2.6 cm (0.4 to 1.0 in) long, and seeds are about 0.5 mm (0.02 in) long. The species' leaf arrangement, the amount of fusion of the fruit sections, and the hairless exocarp (outermost layer of the fruit wall) and endocarp (innermost layer) distinguish it from other species in the genus (Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Melicope lydgatei was formerly known throughout the Koolau Mountains of Oahu from Hauula to Kahana, Kipapa Gulch to Waimano, and Kalihi Valley to Wailupe Valley. Currently, two known occurrences containing between 39 and 40 individuals are known in the wild. One occurrence occurs in the Manana area and contains one or two individual plants. The other occurrence with 38 plants is along Opaeula/lower Peahinaia trail. No seedlings have been observed at these occurrences but juveniles are present (HINHP Database 2001; U.S. Army 2003a; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Melicope lydgatei (Alani) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Melicope lydgatei (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 27,051 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Melicope lydgatei includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Melicope lydgatei includes 15 critical habitat units, covering two ecosystem types, which encompass approximately 27,051 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland

Mesic—Units 4, 5, 6, 7; Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16.

Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao

and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Melicope lydgatei critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Melicope lydgatei occurs within the Lowland mesic and Lowland wet ecosystems in the Koolau Mountain caldera complex :

Oahu—Lowland Mesic—Units 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Melicope lydgatei to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: This species has been observed in flower in May and in fruit from June to July. Little else is known about its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors (HINHP Database 2001; Service 1998a; U.S. Army 2003a).

Habitat Type

Adult: mesic and wet forests

Habitat Narrative

Adult: Melicope lydgatei typically grows in association with Acacia koa, Bobea elatior, Dicranopteris linearis, Metrosideros polymorpha, Psychotria sp., or Syzygium sandwicensis on ridges in mesic and wet forests at elevations between 349 and 671 m (1,145 and 2,201 ft).

Dispersal/Migration

Population Information and Trends

Number of Populations:

1 (USFWS, 2019)

Population Size:

12 (USFWS, 2019)

Adaptability:

Fragility unknown. (NatureServe, 2015)

Population Narrative:

Fragility unknown. Currently, 3-4 plants known. 2 current (between 1982 and 1997) and 13 historical occurrences. (NatureServe, 2015). Currently there are 12 wild mature individuals of Melicope lydgatei in one population in the Koʻolau mountains. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that M. lydgatei is extremely vulnerable to the effects of climate change. Fencing and ungulate control protects a portion of one population. Collection have been made from many individuals, but genetic storage collections are minimal. Five individuals were outplanted and four currently survive. (USFWS, 2019)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The primary threats to Melicope lydgatei include loss of habitat and degradation of the remaining habitat by non-native plants, insects, and animals. Feral pigs impact this species by consuming fruits and other plant parts and by rooting soil, which degrades the habitat. The black twig borer burrows into the branches and introduces a pathogenic fungus, pruning the host severely and often killing branches or whole plants. Plants typically suffer slight to severe defoliation that leads to reduced vigor due to the infestation of this non-native insect (59 FR 14482). The occurrences located on military land are threatened by fire caused by military activities. The small number of individuals and occurrences with the related limited gene pool and depressed reproductive vigor make this species extremely vulnerable to inbreeding depression and destruction due to the occurrence of a catastrophic event (59 FR 14482).

Recovery

Recovery Actions:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of Melicope lydgatei. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for M. lydgatei identifies important conservation actions. Where it is topographically feasible, exclosure fences should be constructed around the all known occurrences of M. lydgatei to reduce impacts from feral pigs. Pigs should be controlled or removed from these areas and the broader landscape to alleviate impacts on native ecosystems. Control and removal of non-native plants should be carried out in the vicinity of all known occurrences. A number of parasitoids have been introduced to control the black twip borer, though none of them have become established. Further research on biological control of this beetle should be supported. Note that any biocontrol agents should be tested against native Hawaiian scolytids prior to their introduction into the State (Service 1998a). Ongoing Conservation Actions: The Lyon Arboretum has successfully propagated this species (Service 1998a). The Service is currently not aware of any other conservation actions for this species.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and inventories—Continue to conduct thorough surveys of suitable habitat where Melicope lydgatei currently and historically occurred for a thorough assessment of the species. • Ungulate monitoring and control—Continue to construct and monitor fencing to provide protection from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species, and those that compete with Melicope lydgatei at all populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Invertebrate predation and herbivory—Develop and implement methods to control the black twig borer. • Captive propagation—Continue to collect material for genetic storage and for propagation and reintroduction. • Research—Research seed dormancy and propagation methods for germination success. • Reintroduction—Continue to reintroduce and establish new populations and augment existing populations in protected habitat within historical range. • Population viability monitoring—Study Melicope lydgatei in regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, and specific environmental requirements, limiting factors, and threats. • Alliance and partnership development—Continue to work with the Division of Forestry and Wildlife, PEPP, the ANRP, and land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)
- New Management Actions: • Fencing for ungulates—The Army's Natural Resources Program-Oʻahu continues to monitor and maintain ungulate fencing at the ʻŌpaeʻula management unit (Peʻahināiʻa) that protects at least nine individuals of Melicope lydgatei (U.S. Army 2018). • Nonnative plant control—Nonnative plant control is conducted at the ʻŌpaeʻula management unit with the goal of maintaining nonnative plant cover at less than 50 percent (Army Natural Resources Program (ANRP) 2018). • Captive propagation for genetic storage and reintroduction— o There is no directed management of this species by the ANRP; however, they report propagation of two plants

representing two individuals from the population at ʻŌpaeʻula (U.S. Army 2018). o The Plant Extinction Protection Program (PEPP) reports making collections (airlayers, cuttings, seeds) from 22 individuals (PEPP 2017). o ANRP has four plants from three founders, one from each of three subpopulations (ANRP 2018). • Reintroduction—PEPP outplanted five individuals of Melicope lydgatei at Poamoho; currently four survive (PEPP 2016, 2017, 2019). (USFWS, 2019)

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USFWS. 2019. 5-YEAR REVIEW Short Form Summary Species Reviewed: Melicope lydgatei (alani). 9 pp.

SPECIES ACCOUNT: *Mentzelia leucophylla* (Ash Meadows blazingstar)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A biennial herb, up to 5 dm high. The leaves are densely covered with soft white hairs. Bright yellow flowers bloom from late May into September. Flowers open only for brief periods in late afternoon. (NatureServe, 2015)

Taxonomy

Possibly a variant of M. oreophila per Jim Morefield, NVHP. (NatureServe, 2015)

Current Range

Western slope and bajadas of mountain range in Ash Meadows, south Nye County, Nevada. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Mentzelia leucophylla (Ash Meadows blazingstar) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Nevada (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Mentzelia leucophylla includes one CHU in Nye County, Nevada (50 FR 20777-20794).

Nevada, Nye County, Ash Meadows.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Mentzelia leucophylla critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include sandy or saline clay soils along canyon washes and near springs and seeps.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 1990)

Breeding Season

Adult: Flowering continues from June to September (USFWS, 1990)

Other Reproductive Information

Adult: Flowering is exhibited by bright yellow flowers arranged in open, broad infloresences (USFWS, 1990)

Reproduction Narrative

Adult: The Ash Meadows Blazingstar is inferred to reproduce sexually. Its flowering season occurs from June to September. Flowers are bright yellow, arranged in open and broad infloresences (USFWS, 1990).

Habitat Type

Adult: Desert wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Springs and seeps that are fed by an extensive groundwater system; light-colored, fine-grained soils with a high salt content (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Local distribution of small populations (USFWS 1990)

Environmental Specificity

Adult: Very Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS 1990)

Habitat Narrative

Adult: This species inhabits desert wetland, near springs and along canyon washes maintained by springs and seeps that are fed by an extensive groundwater system. Found in light-colored, fine-grained soils with a high salt content, often growing with 2 other narrowly endemic plants: the Ash Meadows milk-vetch (Astragalus phoenix) and the Ash Meadows sunray (Enceliopsis nudicaulis var. corrugata) (NatureServe, 2015). The species is distributed locally in small populations. Tolerance ranges are inferred to be low (USFWS, 1990).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Little or no information exists on seed dispersal, seed germination, or seedling establishment in the wild. Additional dispersal/migration information is also lacking (inferred from USFWS, 1990).

Population Information and Trends

Number of Populations:

2 Max scale, 12 minimum scale (USFWS, 2020)

Population Size:

1,513 (USFWS, 2020)

Population Narrative:

There is little information about population level and species level trends. In 1997 there were 8 known populations, but the current population number estimate has been reduced to 1-5 populations (NatureServe, 2015).

Threats and Stressors

Stressor: Habitat disruption (USFWS 1990)
Exposure:
Response:
Consequence:
Narrative: Approximately 65 miles of gravel and unimproved roads now exist within the essential habitat, directly affecting this species (USFWS, 1990)

Stressor: Agricultural use (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Agricultural use presents a general threat to this species (NatureServe, 2015)

Stressor: Trampling by horses, cattle, and sheep (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Destruction by horses presents a general threat to this species (NatureServe, 2015)

Stressor: Proposed MX missile system (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: The proposed MX missile system is considered to be a possible threat to this species (NatureServe, 2015)

Recovery

Reclassification Criteria:
None listed

Not available
Not available
Not available
Not available
Not available
Not available

Delisting Criteria:

1. All non-native animals and plant species must be eradicated from essential habitat. These non-native species currently include sailfin mollies, mosquitofish, largemouth bass, black bullheads, bullfrogs, crayfish, turban snails, wild horses, salt cedar and Russian olive (USFWS, 1990).

2. Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates, and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 1990).

3. Reestablish water to historic springbrook channels, which are free of barriers that eliminate genetic exchange between populations by preventing movement of native fishes throughout their historic range (USFWS, 1990).

4. The essential habitat must be secure from detrimental human disturbance including mining, OHVs, and the introduction of non-native species (USFWS, 1990).

5. Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 1990).

6. Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitats (USFWS, 1990).

7. All of the listed plant species and the candidate plant species are present in all the sites that they have historically occupied as identified in Appendix A Table XV of the Recovery Plan. Within each critical habitat unit, the listed plant has a frequency value equal to or greater that the frequency value determined by Task 644 needed as an indicator of a self-sustaining plant population (USFWS, 1990).

Recovery Actions:

- Secure habitat and water sources for the Ash Meadows ecosystem (USFWS, 1990)
- Conduct research on the biology of the species (USFWS, 1990)
- Conduct management activities within essential habitat (USFWS, 1990
- Reestablish populations/monitor new & existing populations (USFWS, 1990)
- Determine/verify recovery objectives (USFWS, 1990)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Over the next five years, the Service should focus on: • Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). • Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009

(Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); • Support Ash Meadows blazingstar research at the Ash Meadows NWR to monitor the population as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and • Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time.(USFWS, 2020)

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SPECIES ACCOUNT: *Mezoneuron (=Caesalpinia) kavaiense* (Uhi uhi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/08/1986; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Caesalpinia kavalensis is a medium-sized tree up to 10 meters (35 feet) tall with rough, dark bark and a spreading crown. The leaves are twice compound, made up of 1 to 5 pinnae with 4 to 8 pairs of leaflets. Each leaflet is about 4 cm (1.5 in) in length. The flowers are borne in terminal racemes and are pink to red in color. The pink seed pods are short (9 to 13 cm or 3.5 to 5.1 in) and broad (4.5 to 6 cm or 1.8 to 2.4 in) and winged on one side. These pink pods, the bright flowers and bright green lacy foliage combine to make this an attractive tree (Rock 1913 and Wagner et al. 1990). (USFWS, 1994)

Taxonomy

Mezoneuron kavaiensis is a synonym, referring to the totality of the taxon Caesalpinia kavaiensis. The change of the name back to Caesalpinia kavajensis does not indicate any ambiguity of identification of this Hawaiian species, as it is distinctly different from other Caesalpinia in Hawaii. The name change follows the opinion of Hattink (1974) that all members of the genus Mezoneuron properly belong within Caesalpinia. The most widely used common name for Caesalpinia kavajensis is the Hawaiian, uhiuhi. On Maui it is also known as kea. Wagner et al. (1990) and Lamoureux (1982) also list kalamona as a native name, but Rock (1913) says that this is the common name for an introduced Cassia species, not Caesalpinia kavajensis. (USFWS, 1994)

Historical Range

Caesalpinia kavaiensis occurs or has occurred on dry leeward portions of five of the main Hawaiian Islands which includes Hawaii, Maui, Oahu, Kauai, and Lanai. (USFWS, 1994)

Current Range

Endemic to Hawaiian Islands. Its current range includes Kauai, Waianae Mountains of Oahu, and Hawaii. (NatureServe, 2015). Island Distribution: Found on Kauai, Hawaii and Oahu. Extirpated on Molokai and Maui. (USFWS, 2021c)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Some isolated trees produce viable seed, showing that the species is capable of self-pollination, e.g. the single living wild tree on Kauai. Some wild trees and some cultivated trees regularly produce a good quantity of viable seeds. Seeds germinate in nature and can be germinated in nurseries. However, some isolated trees that flower apparently do not produce viable seed. The tree growing in the Botany Department Courtyard, University of Hawaii at

Manoa, has been found to produce normal pollen, but has never set seed. It is not known what kinds of barriers to self-pollination, if any, may be responsible for this failure (Lamoureux 1982). (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Occurs between 14 and 18 degrees Celsius (USFWS, 1996)

Habitat Narrative

Adult: Caesalpinia kavaiensis occurs in dry and moist forests and shrublands on gulch slopes and, on Hawaii, on old lava flows. Historically, Caesalpinia kavaiensis has occurred between about 60 meters (200 ft) and approximately 900 meters (3000 ft) elevation. The general slope is 5 to 10 degrees. The substrate is mostly rough a'a lava covered by a thin and discontinuous layer of organic soil (Sato et al. 1973, Lamoureux 1981). The steep slope and rugged volcanic features of the landscape impede passage on the ground. The rainfall in this area is about 75 to 100 cm (30 to 40 in) a year, with no pronounced wet and dry seasons (Blumenstock and Price 1961). Air temperature also fluctuates little during the year, with mean monthly temperatures varying between 14 and 18 degrees Celsius (Lamoureux 1982). The moderate rainfall and high insolation in combination with the shallow, excessively drained, soil provides a dry habitat where moisture is probably frequently limiting. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The broad, winged pod suggests that the seeds are dispersed by a combination of gravity and wind. Seeds may also be dispersed by ingestion by birds (Lamoureux 1982) or introduced mammals. (USFWS, 1994)

Population Information and Trends

Population Trends:

Short-term trends indicate slight increases (USFWS, 2015)

Population Growth Rate:

Slight increase (USFWS, 2015)

Number of Populations:

11 (USFWS, 2015). ~9 (USFWS, 2021c)

Population Size:

99 wild, 535 reintroduced (USFWS, 2015). ~100 (USFWS, 2021c)

Population Narrative:

There are approximately 11 occurrences containing 99 wild individuals (77 mature and 22 immature) and 535 reintroduced individuals (6 mature and 529 immature) of Mezoneuron kavaiense on Kauai, Oahu, Lanai, and Hawaii. Overall, the numbers of individuals have increased from the approximately 70 to 80 individuals reported in the previous 5-year review to approximately 99 mature wild individuals in 2015. The numbers of reintroduced individuals have also increased from the approximately 149 individuals reported in the previous 5-year review to approximately 535 individuals in 2015. (USFWS, 2015). Currently, there are 35 wild plants on the island of Hawai‘i, and one wild mature plant plus two immature plants on O‘ahu, all other known wild plants are not locatable (O‘ahu, Kaua‘i) or are extirpated (Lāna‘i, Maui). Seed collections from wild, reintroduced plants, and from living collections are ongoing, with propagation and some reintroductions on Kaua‘i, O‘ahu, and Hawai‘i. Approximately 50 founders from Hawai‘i are currently represented in collections and about 6 founders from O‘ahu are represented, and representation from one wild plant on Kaua‘i is complete. Four populations on Hawai‘i are in exclosures, and at least one population each from O‘ahu and Kaua‘i are in exclosures. Nonnative plant control is reported at two locations on Hawai‘i and one location each on O‘ahu and Kaua‘i. Public outreach is conducted on the island of Hawai‘i. (USFWS, 2021b)

Threats and Stressors

Stressor: Grazing and browsing by ungulates (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Rock (1913), Degener (1946) and others recognized that the rapid disappearance from North Kona of Caesalpinia kavaiensis and Kokia drynarioides was mostly due to forest destruction and community disintegration as a result of cattle ranching in the dry forest. Nearly all of the habitat on the island of Hawaii is or has until recently been managed for commercial cattle production. Seedlings and saplings of both species are highly palatable to cattle. Feral goats and sheep also live in this habitat. On Oahu, Maui and Kauai, feral goats have unrestricted access to the Caesalpinia kavaiensis habitat (Lamoureux 1982) and the Lanai individual may also be subject to browsing by Axis deer (Axis axis) and Mouflon sheep (Ovis musimon). It is unlikely that either species can recover while subjected to such grazing. (USFWS, 1994)

Stressor: Fountain grass invasion and enhanced fire danger (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Today the most devastating factor within the dry forest habitat of these two species on the island of Hawaii is the invasion by fountain grass that has occurred during this century, resulting in its complete domination of the groundcover in the dry forest habitat of North Kona. Fountain grass has two major negative impacts on the community: the promotion of fire and usurpation of native plant habitat. Fountain grass is a fire-adapted bunch grass that enhances fuel-loading and promotes fire (Tunison in press). Unlike most other alien grasses, fountain grass can invade barren lava flows that were not formerly subject to wildfire. Major fires burned through Puuwaawaa Ranch in 1986 and 1988. Trees of both species, as well as other native dry forest species, were completely eliminated from the burned areas in these fires. Wildfire also burned a major portion of the boundary kipuka section of the Kokia drynarioides critical habitat

in May, 1993, killing an estimated 80% of the Kokia drynarioides and Caesalpinia kavaiensis found there (L. Mehrhoff, personal communication 1993). The establishment of a closed layer of fountain grass completely alters the structure of the vegetation at these formerly bare-lava sites. The competitive interactions of fountain grass with native tree seedlings have not been scientifically studied, but it is believed that the fountain grass has an adverse effect on seedlings of Caesalpinia kavalensis and Kokia drynarioides as well as other native woody plants in these communities (Lamoureux 1981, 1982). Upon the removal of fountain grass from protected exclosures on Bishop Estate land, numerous Kokia drynarloides seedlings have been observed next to a fallen adult tree (Steve Bergfeld, Division of Forestry and Wildlife, personal communication 1991), and five Caesalpinia kavaiensis seedlings survive where fountain grass was removed from under an adult tree inside a DOFAW exclosure. (USFWS, 1994)

Stressor: Other alien plants (USFWS, 1994; USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Many other alien plants are naturalized in the North Kona habitat. Two that are widespread and disruptive are lantana (Lantana camara) and silk oak (Grevillea robusta). Two cultivated plants that have become established locally on the cinder cone of Puuwaawaa itself are the custard apple (Annona cherimola) and Pittosporum viridiflorum (Takeuchi 1990). Takeuchi cautions that if fountain grass is controlled in the future, these or other alien plants may increase in cover and become serious pests. The subpopulation at Puupane, Oahu, is being shaded and crowded by Australian red cedar (Toona ciliata) (J. Obata, personal communication 1992) and both the Makaleha and Puupane populations are surrounded by stands of Christmasberry and Strawberry guava (Psidium cattleianum). The Makaleha population is also bordered on one side by Lantana camera. The reintroduced population on Lanai is threatened by Ageratina adenophora (Maui pamakani), Ageratina riparia (Hamakua pamakani), Buddleja asiatica (dog tail), Cinnamomum burmannii (Padang cassia), Leptospermum scoparium (New Zealand tea tree), Morella faya (fire tree), and Rubus rosifolius (Plant Extinction Prevention Program [PEPP] 2013, 2015a, b). (USFWS, 1994; USFWS, 2015)

Stressor: Land ownership/land use classification (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The critical habitat of Kokia drynarioides and the surrounding areas of Kaupulehu and Puuwaawaa ahupuaa that contain several Caesalpinia kavaiensis trees do not have protective state or county zoning. All or nearly all of the land has a State Land Use Classification (LUC) of Agriculture, and much of it is actively managed for commercial ranching. This lack of protective zoning is somewhat alleviated by the Hawaii endangered species law which gives jurisdiction to the Department of Forestry and Wildlife (DOFAW) to manage endangered plant populations. (USFWS, 1994)

Stressor: Insect damage (USFWS, 1994)
Exposure:
Response:
Consequence:

Narrative: The alien black coffee twig borer (Xylosandrus compactus) attacks and may kill Caesalpinia kavaiensis seedlings (Lamoureux 1982). Xvlosandrus attacks on outplanted seedlings in North Kona have been observed but no deaths have been attributed to them (S. Bergfeld personal communication 1991). Damage from Xylosandrus may be far more serious on Oahu. Based on observations over a 20 year period, J. Obata (personal communication 1992) attributes the marked decline of this previously "widespread" species on Oahu to a combination of the twig borer and drought. DOFAW staff report (C. Corn, personal communication 1993) that ants farming aphids are one of the biggest threat to the survival of outplanted C. kavaiensis seedlings in North Kona. No insect predators of Kokia drynarioides are reported (Lamoureux 1981), but Xylosandrus is known to kill other species, apparently through the introduction of a fungus (L. Wong, personal communication 1993), and may be a threat to Kokia drynarioides. (USFWS, 1994)

Stressor: Seed predation (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Predation of seeds of both species by introduced rats, mice and unspecified game birds and invertebrates is well known. Rats eat the seeds of both species while they are still on the tree (Lamoureux 1981, 1982). The large, hard, bean-like seeds of Caesalpinia kavaiensis have been found in rat burrows (Lamoureux 1982) as have the seed coats of Kokia drynarioides (Derral Herbst, U.S. Fish and Wildlife Service, personal communication 1992). The importance of seed predation has not been scientifically assessed. (USFWS, 1994)

Stressor: Genetic problems (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Since the numbers of individuals of both of these two species are very low, it is possible that each species' viability may be reduced due to problems with in-breeding and the depleted gene pool. At this time, it appears that both species produce viable seeds that grow normally when protected. If Kokia drynarioides are grown in botanical gardens near other Kokia species from other islands, it is possible that cross-pollination leading to hybridization may take place. Such mixing of the gene pools should be avoided by keeping careful records of provenance. It is unlikely that Caesalpinia kavaiensis will inadvertently hybridize with any available species. (USFWS, 1994)

Stressor: Destruction by volcanic eruption (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The North Kona populations of these two species occur in a relatively restricted area on the side of a dormant volcano that last erupted about 1800 AD. A future eruption could threaten these wild populations. (USFWS, 1994)

Stressor: Illegal harvests of Caesalpinia kavaiensis (USFWS, 1994)
Exposure:
Response:
Consequence:

Narrative: The dark, dense wood of Caesalpinia kavaiensis is prized by a few knowledgeable craftsmen (Lamoureux 1982). The few remaining wild trees are considered at some risk to illegal harvesting (Herbst 1986). (USFWS, 1994)

Stressor: Drought (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The North Kona area has experienced drought conditions for several years, and if these two species reproduce only in widely spaced times of favorable climactic conditions, the prolonged drought could be a factor in their recent decline. It is also possible that the drought conditions have exacerbated the insect infestation problems because dry vegetation is more susceptible to such invasion (C. Corn, personal communication 1993). (USFWS, 1994)

Stressor: Instability of substrate (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Because of past habitat destruction, current Caesalpinia kavalensis populations on Oahu are now limited to steep, inaccessible terrain which is subject to frequent rock slides which damage the trees. Feral goats in these areas add to the landslide problem by dislodging rock and soil, and by browsing on stabilizing ground cover (C. Corn, personal communication 1993). (USFWS, 1994)

Stressor: Landslides and flooding (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Landslides and flooding loss or degradation of habitat – Erosion is a threat to this species on Oahu (PEPP 2010), Kauai (PEPP 2013), and Lanai (PEPP 2015b). (USFWS, 2015)

Stressor: Slug herbivory (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: On Lanai, herbivory by slugs were reported as a threat (PEPP 2015b). (USFWS, 2015)

Stressor: Invertebrate predation or herbivory (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The white fly (unknown species) and cottony cushion scale (Icerya purchasi) are a threat to this species in North Kona and may lead to the death of young plants if not controlled (J. Wagner, Future Forests Nursery, pers. comm. 2015). (USFWS, 2015)

Recovery

Reclassification Criteria:

1. There are a minimum of 100 naturally reproducing individuals in each of 3 secure populations of each species in North Kona. (USFWS, 1994)

2. When there are three Caesalpinia kavaiensis populations, each with a minimum of 100 naturally reproducing individuals, on each of Oahu, Lanai, Kauai and Maui. (USFWS, 1994)

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Current habitat of Caesalpinia kavaiensis and Kokia drynarioides should be protected through cooperative agreements with landowners, and threats to current populations should be controlled. (USFWS, 1994)
- Implementing the management plan will require further research to identify and characterize the environmental threats that are preventing natural regeneration of these two species and to develop management techniques. It is suggested that all dry forest endangered species research be coordinated and contracted through a single office in order to maximize information sharing among researchers and to avoid duplication of efforts. (USFWS, 1994)
- The increase in numbers of these two species should be enhanced by special care and treatment of seeds and seedlings within the management sites. When possible, the present practice of outplanting nursery-raised seedlings should be de-emphasized for two reasons: 1) increasing numbers by outplanting will not reduce the environmental factors that are responsible for endangerment; and 2) nursery-raised stock may carry insects or pathogens into the natural population. Recruitment from seeds collected on the site or from nearby trees should be promoted by management techniques developed through research. Techniques might include barriers to discourage seed predation, drip irrigation systems, placement of seeds in select microhabitats, and shelters or other features to reduce evapotranspiration. Augmentation through transplant of nursery raised stock may be necessary in areas where only a few or no mature individuals remain. (USFWS, 1994)
- Establish new populations. In order to reach the delisting goals of 3 populations of each species on Hawaii island and 3 populations of Caesalpinia kavaiensis on Oahu, Lanai, Kauai and Maui, new populations of Caesalpinia kavaiensis will have to be established on Lanai, Kauai and Maui within the historical range of the species. (USFWS, 1994)
- An important role for research is to verify the scientific validity of the stated recovery objectives in this plan. (USFWS, 1994)
- Survey geographical and historical range for a current assessment of the species' status. (USFWS, 2015)
- Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. (USFWS, 2015)
- Maintain existing exclosures and monitor for potential incursions. (USFWS, 2015)
- Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. (USFWS, 2015)
- Continue monitoring wild and reintroduced individuals. (USFWS, 2015)
- Develop and implement a fire management plan for all existing exclosures. (USFWS, 2015)

- Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. (USFWS, 2015)
- Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021. • Surveys and inventories—Continue surveys of geographical and historical range for a current assessment of the species' status. • Ungulate control—Maintain existing exclosures and monitor for incursions. • Invasive nonnative plant monitoring and control—Eradicate invasive introduced plants within exclosures and maintain exclosures to be free of invasive nonnative plants. • Predator and herbivore monitoring and control—Implement effective measures to control rats and slugs and determine and implement effective control methods for nonnative insects. • Fire prevention and control—Implement existing fire management plan for O'ahu and develop and implement fire management plans for occurrences on Kaua'i and Hawai'i. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into managed suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change. • Reintroduction and translocation— o Continue reintroductions and augmentations into suitable habitat in areas that are managed for known threats. o Increase numbers of populations and individuals within suitable habitat to reduce impacts from drought, landslides and erosion. o Assess suitability of available habitat on Lāna'i and Maui for possible reintroductions. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to impacts of climate change, including drought. • Population biology research—Study M. kavaiense to determine viable population size and structure, and reasons for low natural recruitment. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2021b)

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SPECIES ACCOUNT: *Mimulus michiganensis* (Michigan monkey-flower)

Species Taxonomic and Listing Information

Listing Status: Endangered; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

The Michigan monkey-flower is a member of the Scrophulariaceae (snapdragon) family and is an aquatic to semi-aquatic glabrous perennial herb with lax stems averaging 36 cm (14 in) in length. It roots at its lower stem nodes to produce clones of up to several hundred stems. The broadly ovate to roundish, opposite leaves are inconspicuously to coarsely sharp-toothed and evenly distributed along the stem. Bright yellow, snapdragon-like, tubular flowers, ranging from 16 to 27 mm (0.6 to 1.1 in) in length, are produced from the upper leaf axil and are borne on slender pedicels that may be longer than the leaves. The flowers have two upper lips and three-lobed lower lips, with the lower lip and tube irregularly spotted.

Taxonomy

Direct final rule (revised the scientific name from Mimulus glabratus var. michiganensis to Mimulus michiganensis) effective December 13, 2010. (USFWS, 2018).

Current Range

There are 19 element occurrences, including two historical occurrences (MNFI 2012) of MMF, ranging from Benzie and Leelanau counties to Mackinac County (Figure 3 and Appendix A). However, the majority of occurrences are clustered within the Mackinac Straits region. The newest colony was discovered in 2008 (MNFI 2012). Overall, the entire population is stable, although MMF colonies at a few sites are in decline (MNFI 2012). However, this information was obtained from records in which most have not been updated in more than 10 years (MNFI 2012). A systematic survey would provide a more accurate description of MMF abundance and population trends.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: bloom from approximately mid-June to mid-August, extending occasionally into October.

Reproduction Narrative

Adult: Michigan monkey-flowers bloom from approximately mid-June to mid-August, extending occasionally into October. The fruit, which is seldom produced, consists of an oblong, pointed capsule around 8–10 mm (0.3–0.4 in) long, containing numerous oval seeds with longitudinal striations. Michigan monkey-flower essentially has no pollen viability and is nearly totally dependent on vegetative propagation via rhizomes (Bliss 1983, Bliss 1986). The Maple River population is the only population that has viable pollen and is capable of self-pollination (Posto and Prather 2000, Posto 2001). The taxon as a whole is also highly unlikely to produce seed

asexually (Posto and Prather 2000). Because MMF depends primarily on vegetative propagation for reproduction, dispersal is greatly limited and likely occurs only locally through the fragmentation of clonal colonies.

Habitat Type

Adult: Alkaline spring seepages and streams

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Michigan monkey-flower is a very rare Michigan endemic that is restricted to cold, alkaline spring seepages and streams, usually in association with northern white cedar (Thuja occidentalis) swamps found along current or post-glacial Great Lakes shorelines. It frequently occurs in cedar swamps formed in drainages found at the base of relatively steep, moraine slopes and bluffs. Colonies of MMF have been found in muck-covered sand in cold, flowing water that ranged in temperature from 8.7° to 16.6°C (47.6° - 61.9°F), and with a pH of 7.66 to 8.21. However, research (Posto 2001) has shown that MMF seeds germinate best in light at approximately 23°C, suggesting that seed germination is probably highest along the water margins in the sun, rather than under water. Optimal habitat conditions for this plant are comprised of a combination of moderate to high light availability, cool substrate, and high nutrient availability within a narrow pH range, demonstrating its relatively specialized habitat requirements.

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2018).

Number of Populations:

18 (USFWS, 2023)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

There are 19 element occurrences, including two historical occurrences (MNFI 2012) of MMF, ranging from Benzie and Leelanau counties to Mackinac County (Figure 3 and Appendix A). However, the majority of occurrences are clustered within the Mackinac Straits region. The newest colony was discovered in 2008 (MNFI 2012). Overall, the entire population is stable, although MMF colonies at a few sites are in decline (MNFI 2012). However, this information was obtained from records in which most have not been updated in more than 10 years (MNFI 2012). A systematic survey would provide a more accurate description of MMF abundance and population trends. Occurrences of Michigan monkey-flower are often localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small

streams and spring-fed seeps within northern white cedar swamps (Penskar and Higman 2001). Large to moderately-sized populations include occurrences on Glen Lake, Burt Lake, and portions of the Mackinac County shoreline within the Manitou Payment Highbanks formation in the Brevort to Epoufette region (Penskar and Higman 2001). Relatively little population monitoring has been conducted for MMF, and thus the demography of its populations cannot be characterized. However, observations of colonies of the taxon through summer and winter seasons indicate that in fall colonies die back and become more or less dormant in streams and springs where water flow and temperature stay relatively constant, with colonies re-initiating growth in spring. Occurrences of Michigan monkey-flower are often localized, sometimes consisting of small but dense patches restricted to small seeps, springs, and depressions, whereas others are comprised of numerous patches of plants widely dispersed along small streams and spring-fed seeps within northern white cedar swamps (Penskar and Higman 2001). Large to moderately-sized populations include occurrences on Glen Lake, Burt Lake, and portions of the Mackinac County shoreline within the Manitou Payment Highbanks formation in the Brevort to Epoufette region (Penskar and Higman 2001). Range and distribution: Currently Michigan monkey-flower has 18 extant element occurrences. Recent surveys have indicated that at two areas, populations had extended beyond the area previously thought to be occupied and therefore, some adjacent element occurrences have been combined. The previous status review (2018) for Michigan monkey-flower listed 23 element occurrences. The species still occurs in the same six Michigan counties – Benzie, Leelanau, Charlevoix, Emmet, Cheboygan, and Mackinac (USFWS, 2023).

Threats and Stressors

Stressor: Invasive Plants
Exposure:
Response:
Consequence:
Narrative: The greatest threat to MMF is direct destruction and modification of its habitat. Michigan monkey-flower's habitat has been developed for recreational and residential purposes, which has led to severe impacts to and, in some cases, extirpation of historical populations. Hydrological disruptions also constitute a serious threat, as water diversion, warming of water sources, and other groundwater alterations lead to less than optimal habitat conditions. Consequently, this species may be inadvertently impacted by offsite activities. Populations of MMF are particularly vulnerable to extirpation due to low numbers and limited capability for sexual reproduction. Additionally, periodic high water levels of the Great Lakes and strong winter storms impact MMF habitat that occurs near the Great Lakes shoreline by redirecting seepage streams and opening the overstory by felling cedars. However, opening of the overstory may also benefit MMF by allowing for colonization. Invasive species, such as coltsfoot (Tussilago farfara) and reed canary grass (Phalaris arundinacea), represent an additional threat. Coltsfoot (Figure 2) is a very aggressive invasive plant growing within several MMF patches in the Glen Lake area (Jody Marquis, Mama Bear Restorations, Inc., pers. comm. 2010). It spreads rapidly via vegetative reproduction by rhizomes and windborne distribution of dandelion-like seed heads. The Glen Lake area provides habitat to several high-ranking MMF colonies and without intervention and control of coltsfoot, localized extirpations are likely. Reed canary grass, although not a current threat to MMF colonies, is present in the vicinity. Control of reed canary grass when it is not yet considered a threat, is most successful at this stage, and minimizes its chances of negatively impacting MMF in the Glen Lake area. (USFWS, 2016). Additional invasive plant threats posed by

marsh thistle (Cirsium palustre) and Canada thistle (Cirsium arvense). (USFWS, 2018).

Stressor: Climate change
Exposure:
Response:
Consequence:
Narrative: Our analyses under the Endangered Species Act include consideration of ongoing and projected changes in climate. The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007). Various types of changes in climate can have direct or indirect effects on species. These effects may be positive, neutral, or negative and they may change over time, depending on the species and other relevant considerations, such as the effects of interactions of climate with other variables (e.g., habitat fragmentation) (IPCC 2007). In our analyses, we use our expert judgment to weigh relevant information, including uncertainty, in our consideration of various aspects of climate change. Climate change models predict the climate of the Great Lakes region will grow warmer and drier over the next century, with precipitation increasing in winter and decreasing in summer (AMEC 2006; Anton Reznicek, University of Michigan, pers. comm. 2004; Kling et al. 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10–20 percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling et al. 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling et al. 2003). Earlier models had indicated that increased precipitation, higher air temperatures, and reduced ice cover would increase evaporation in the Great Lakes, resulting in lake level drops of 1.5 feet to as much as 8 feet (Sousounis and Glick 2000, AMEC 2006, Kling et al. 2003). However, more recent models show a more variable response in lake levels. A majority of the model simulations run by Angel and Kunkel (2010) resulted in reductions in lake levels, yet also showed a high degree of uncertainty in possible future lake levels, depending on future emissions. Furthermore, Hayhoe et al. (2010) suggested that the competing effects of shifting precipitation and warmer temperatures will result in little change in Great Lakes levels until the end of the century, when net decreases in lake levels are expected under higher emission scenarios. A warmer climate will also likely cause an increase in water temperatures that may facilitate the invasion of warm water-adapted species or exotic species (MacIsaac et al. 2002; AMEC 2006). Increased water temperatures will also result in decreased ice cover and, when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000, AMEC 2006). Additionally, AMEC (2006) predicts that increased precipitation will increase the flow rates of some rivers and streams, resulting in increased scouring, deposition of sediment, nutrients and pesticides, bank erosion, channel widening, and siltation of gravel beds and estuaries. Thus, climate change could significantly alter the natural stream morphology and likely make the habitat unsuitable for this Michigan endemic.

Stressor: Predation (USFWS, 2018).

Exposure:
Response:
Consequence:
Narrative: The NPS at Sleeping Bear Dunes National Lakeshore (Jennifer Chaffin, NPS pers. commun. 2011) observed evidence of deer browse in the past and, more recently, evidence of insect browse on Michigan monkey-flower plants in the vicinity of their Orr Restoration Site. The average insect browse in 2011 was three percent for the whole Michigan monkey-flower population within the restoration site while deer browse prior to 2011 was observed to be as much as 25 percent (Chaffin, pers. commun. 2011). (USFWS, 2018).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Recovery Actions:

- The Michigan Monkey-flower Recovery Plan was approved on September 17, 1997 (USFWS 1997). The objective of the recovery plan is to secure long-term protection for all occurrences of MMF, thereby allowing reclassification, and ultimately, removal from the Federal List of Endangered and Threatened Wildlife and Plants. Michigan monkey-flower may be considered for reclassification from endangered to threatened status when protection is secured for all eight occurrences ranked “A - excellent” or “B - good” and delisted when all occurrences are sufficiently protected. The recovery goals listed in the recovery plan are: (1) long-term protection for all known existing occurrences, with primary emphasis on the preservation of essential habitat; (2) field surveys for new occurrences and to determine the specific status of recently discovered and historical sites; (3) biosystematics research to determine the most appropriate taxonomic classification, and; (4) demographic, physiological, breeding system, and genetic studies to understand population biology, specific habitat requirements, floral biology, and genetic variability, and long-term post-delisting viability monitoring.
- New in 2018 - 1: Develop a plan for conducting regular surveys, assessments, and monitoring at all known extant and historical Michigan monkey-flower locations. Continue exploration for new occurrences in the Lower Peninsula and eastern Upper Peninsula, and provide detail mapping of all occurrences. Document habitat and status conditions and population trends during these assessments. Recovery plan action numbers: 2-21, 2-22, 2-23, 2-45 Penskar (2012) was not able to access the Manitou Payment Highbanks occurrence due to a lack of permission from the landowner, and the historical Mullet Lake-West Shore occurrence was not accessed due to insufficient time and resources. Both of these sites should be considered priorities for future surveys. (USFWS, 2018).
- 2018 - 2: Research is needed to understand the genetic diversity within and between patches or populations. Recovery plan action number: 2-44 (USFWS, 2018).
- 2018 - 3: Research is needed to understand the genetic diversity within and between patches or populations. Recovery plan action number: 2-44 (USFWS, 2018).
- 2018 - 4: Work with public and private landowners, site managers, and other stakeholders to protect the species and its stream/seep habitat upstream, if possible. Acquire land containing occupied or suitable Michigan monkey-flower habitat. Recovery plan action numbers: 2-13, 2-15. (USFWS, 2018).

- 2018 - 5: Provide education and outreach to stakeholders and the public. Recovery plan action number: 1-121 (USFWS, 2018).
- 2018 - 6: Monitor approach of non-native species and control as appropriate. Recovery plan action number: N/A (USFWS, 2018).
- 2018 - 7: Evaluate if the fundamental recovery objective in terms of the number of previously known and newly discovered occurrences requiring long-term protection warrants revision. (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for future actions • Develop a plan for conducting regular surveys, assessments, and monitoring at all known extant and historical Michigan monkey-flower locations. It is especially important to prioritize populations that have not been surveyed in the last decade. An updated population status is crucial for these areas. Continue exploration for new occurrences in the Lower Peninsula and eastern Upper Peninsula and provide detail mapping of all occurrences. Document habitat and status conditions and population trends during these assessments. Recovery plan action numbers: 2-21, 2-22, 2-23, 4-45 • Monitor non-native and aggressive native species and control as appropriate. • Genetic research to understand the diversity among and between populations. Recovery plan action number: 2-44 • Acquire land containing occupied or suitable Michigan monkey-flower habitat. Create outreach materials for public and private landowners, site managers, and general stakeholders to inform and protect the species and its habitat. Recovery plan action numbers: 1-121, 1-122, 1-123, 1-15 (USFWS, 2023).

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SPECIES ACCOUNT: *Mirabilis macfarlanei* (MacFarlane's four-o'clock)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/29/1979; Pacific Region (R1)

Physical Description

A herbaceous perennial with a deep-seated, thickened root. This species typically blooms from May through June. The bright pink flowers are conspicuous, up to 25 millimeters (1 inch) long by 25 millimeters (1 inch) wide. The flowers occur in inflorescences, which consist of a group of three to seven flowers subtended by a five-lobed involucre (saucer-shaped bract). The flowers are funnel-shaped with awidely expanding limb. Leaves are opposite, somewhat succulent, and broadly lanceolate to ovate. (USFWS, 2000)

Taxonomy

Mirabilis macfarlanei is a member of the four-o'clock family (Nyctaginaceae). It was first described in 1936 (Constance and Rollins 1936) from specimens collected along the Snake River Canyon. Mirabilis macfarlanei is morphologically similar to Mirabilis greenei, found in the Klamath region of California and Oregon. In contrast to M greenei, M macfarlanei has broader leaves and shorter, nearly round bracts (Constance and Rollins 1936). At least two other species of Mirabilis occur in the Pacific Northwest (M linearis and M bigelovii var. retrorsa), but these species do not overlap in distribution with M macfarlanei (Hitchcock and Cronquist 1973). (USFWS, 2000)

Historical Range

M. macfarlanei was known from only three populations along the Snake River Canyon in Oregon (Hell's Canyon National Recreation Area) and the Salmon River Canyon in Idaho. (USFWS, 2000)

Current Range

Portions of the Snake, Salmon, and Imnaha river canyons in Wallowa County in northeastern Oregon, and adjacent Idaho County in Idaho. (USFWS, 2000)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (USFWS, 2016); Sexual (USFWS, 2000)

Lifespan

Adult: > 20 years (based on observations of individual plants) (USFWS, 2000)

Breeding Season

Adult: Seeds are typically dispersed in June and July, and seed germination probably occurs in early spring.(USFWS, 2000)

Other Reproductive Information

Adult: Specific conditions required for germination and seedling survival are unknown (USFWS, 2000)

Reproduction Narrative

Adult: Mirabilis macfarlanei reproduces by seed, as demonstrated by the presence of seedlings with cotyledons and the documented survival of some of these seedlings in population monitoring studies (Kaye 1992). Vegetative reproduction by off-shoots beneath the soil surface also occurs. M. macfarlanei is primarily an outcrosser, but is able to produce a small proportion of one-seeded fruits through autogamy (self-pollination). Inflorescences bagged to exclude pollinators produced fewer fruits than open-pollinated inflorescences. Seed dispersal has not been studied, but apparently seeds fall to the ground and are transported by gravity and rain (Kaye 1992). Seed viability is low.; Mirabilis macfarlanei is a taprooted perennial that reproduces by seed, but also colonizes via long spreading rhizomes. Individual plants tend to produce a few to several hundred stems in clusters ranging up to about nine square meters in size (Callihan 1988). The species has been able to persist in areas historically grazed by livestock since the 1870's, and presently in poor ecological condition. Preliminary data suggests grazing may have a negative effect on plant height, but additional research is needed (Kaye 1995). The most serious consequences of livestock grazing are likely indirect, most notably habitat degradation. At one site in Idaho, the number of M. macfarlanei plants appears to be stable several years after a range fire. An increase in Bromus tectorum, however, suggests that habitat degradation is an ongoing problem. The underground stems of M. macfarlanei would survive most natural fires, especially since they would likely occur later in the summer, when the plant is dormant. Genetic studies (Barnes 1994; 1995; Wolf et al. 1994) have shown that measures of genetic diversity in M. macfarlanei were lower than for plants with a similar life history. The greatest level of gene flow occurred between populations that were 0.5 km apart. Levels of gene flow decreased as distances between populations increased.; ASEXUAL; Perfect; Predominantly outcrossing (NatureServe, 2015).

Habitat Type

Adult: River canyon slopes (USFWS, 2016)

Environmental Specificity

Adult: Narrow (USFWS, 2016)

Habitat Narrative

Adult: Gentle to very steep, open river canyon slopes. Aspects vary, but are usually southeast to west. Soils are often sandy and underlain by talus. Mirabilis macfarlanei occurs in river canyon habitats characterized by regionally warm and dry conditions. Precipitation occurs mostly as rain during the winter and spring. Sites are dry and open, or with scattered shrubs. Plants can be found on all aspects, but most often on southeast to western exposures. Slopes are often steep, but range to nearly flat. Plants can occur along any slope position. Soils vary from sandy to rocky. Talus rock often underlies the soil substrate and several sites are relatively unstable and prone to erosion. The associated vegetation is usually in early to mid-seral condition, and the grasslands are typically grazing modified versions of Agropyron spicatum communities. In a habitat analysis study conducted at a site in Oregon, the vegetation associated with a population of M. macfarlanei appeared to be influenced by aspect, soil development and topographic

position, at least on a local scale (Kaye 1992). Nearby sites without M. macfarlanei had a higher number of weedy annual species, and more gentle slopes with deeper, more stable soils (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds apparently fall near the parent plant and are transported by gravity and rain water. It is possible that M macfarlanei seeds may be dispersed by birds or mammals, but seed dispersal has not been studied for this species. No information exists on whether M macfarlanei maintains a soil seed bank (USFWS, 2000)

Population Information and Trends

Population Trends:

Stable (USFWS, 2016)

Number of Populations:

13 (USFWS, 2022)

Population Narrative:

Mirabilis macfarlanei occurs within the geographic area identified in the 2000 Recovery Plan: the Salmon, Snake, and Imnaha river canyons in Idaho and Oregon. The species occurs in 13 Element Occurrences (EOs), 9 in Idaho and 4 in Oregon. Land ownership is comprised of BLM, Forest Service, and private lands. Of the 13 EOs, 5 are located on BLM land, 1 is located on both BLM and private land, 4 are located on Forest Service land, 1 is located on both Forest Service and private land, and 2 are located solely on private land. Both the BLM and the Forest Service continue to conduct surveys for Mirabilis macfarlanei. The Forest Service conducted surveys in the Hells Canyon National Recreation Area, Wallowa-Whitman National Forest annually from 2007 through 2014. Approximately 4,700 acres of suitable habitat were surveyed over the 8 year period, with an average of nearly 600 acres per year. The BLM surveyed an average of approximately 1,000 acres of suitable habitat on BLM lands annually from 2010 through 2015. Despite these survey efforts, no new M. macfarlanei populations have been discovered since the last 5-year review in 2009. The BLM has established a new population of Mirabilis macfarlanei at the Lower Otto Creek Conservation area located on BLM land. The BLM worked cooperatively with a local private landowner to transplant approximately 25 rhizomes from private property to the Lower Otto Creek Conservation area in April 2015 (in accord with the FWS Section 7 Biological Opinion (dated July 22, 2011) prepared for the Shroyer Trail and Lower Otto Creek Conservation Area project). This population has not yet been counted as a new EO. Future monitoring will document the success of this transplanting. Monitoring data show an overall stable population trend for Mirabilis macfarlanei. In 2000, one of the action items identified in the M. macfarlanei Recovery Plan was to monitor population trends (U.S. Fish and Wildlife Service 2000). In 2007, the Service funded a project to synthesize and analyze monitoring data collected by the BLM between 1981 and 2004, and the Wallowa-Whitman NF from 2001 to 2006, and to provide a general review of the respective monitoring programs (Mancuso and Shepherd 2008). Among its results, analysis found no significant change in M. macfarlanei ramet abundance over the years at most monitored occurrences. Mirabilis macfarlanei forms colonies from an extensive lateral root system that can extend up to 10 meters (33 feet; Yates 2007).

Clonal shoots emanating from the same root system are referred to as ramets. Collectively, these genetically identical ramets comprise a genet (or the individual plant). While this review acknowledged the impressive monitoring datasets, which included over 20 years of data collection, it also included a set of recommendations to improve the efficiency and value of the BLM and Forest Service monitoring efforts. One of these recommendations was the development and implementation of a rangewide monitoring strategy (U.S. Fish and Wildlife Service 2007; U.S. Fish and Wildlife Service 2009). In response, a collaborative effort to develop and implement a new, standardized, rangewide monitoring program for M. macfarlanei was initiated in 2010. Development of the new monitoring program was guided by management objectives identified by the Service, the BLM, and the Forest Service. The overall purpose of the new monitoring plan is to provide more comprehensive documentation and a better understanding of the rangewide conservation status of M. macfarlanei. The monitoring program is designed to collect quantitative information on M. macfarlanei and its habitat. A full description of the monitoring protocol is provided in Mancuso 2011. Ten Mirabilis macfarlanei transects were sampled in 2010 to test the proposed new monitoring protocols. Transect locations represented eight suboccurrences within six M. macfarlanei EOs. Monitoring results comparing 2010 results to pre-2010 datasets indicated that overall, M. macfarlanei percent frequency values for 2010 were similar to pre-2010 mean values and analysis found no significant difference ($p<0.05$) in 2010 frequency compared to pre-2010 mean values for any of the monitoring plots sampled in 2010 (Mancuso 2011, p. 13). These data support the 2008 findings by Mancuso and Shepard (2008) that suggest the Mirabilis macfarlanei “population size” is stable rangewide (Mancuso 2011, p. 13). Monitoring data has not been reanalyzed since 2005 because the new monitoring protocol has not yet been established at all Mirabilis macfarlanei EOs. In addition, monitoring sites that have been established are monitored on a rotation. Annual monitoring is not conducted due to concerns regarding excessive researcher disturbance that can result from trampling of the fragile soils on steep slopes where these plants occur (USFWS, 2016). The species occurs in 13 officially recognized Element Occurrences (EOs), 9 in Idaho and 4 in Oregon, with just a few thousand individual plants occurring among them [Idaho Fish and Wildlife Information System (IFWIS) database; the Oregon Biodiversity Information Center (ORBIC) database; and additional reports from Idaho (Hill et al. 2020)]. An EO is the distinct geographic location where a species occurs. Plants are typically tracked as EO records by State or province Natural Heritage Programs or Conservation Data Centers and are determined by grouping together occurrences into a single population (or “Element Occurrence”) if they occur within 1.6 kilometers (1 mile) of one another. While Idaho uses the 1.6 km separation distance it should be noted that Oregon uses a 500-meter separation distance. The 13 officially recognized EOs includes one established population, Lucile Caves (EO ID 7), which was established by the BLM in 1988. In addition to the 13 officially recognized EOs, an additional EO, Lower Otto, was established in 2015 by the BLM, bringing the total number of MacFarlane’s four-o’clock populations to 14. Because this population was recently established, it has not been included in the IFWIS database and therefore does not have an EO number yet. These established populations will be discussed in more detail below under Population Augmentation and Establishment. See Table 1 for a list of all EOs and associated land ownership (USFWS, 2022).

Threats and Stressors

Stressor: Grazing by livestock and wildlife
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Although it is uncertain whether most or all M macfarlanei populations have been grazed by domestic livestock in the past, livestock grazing still occurs at some sites. Livestock impact this species directly by trampling or consuming plants, and can result in reduced reproduction (i.e., seed set) for M macfarlanei plants. Native and introduced ungulate species, including Rocky Mountain bighorn sheep (Ovis canadensis), Rocky Mountain elk (Cervus elaphus), and mountain goats (Oreamnos americanus), are found in the vicinity of M macfarlanei habitat in Hell's Canyon National Recreation Area and the Salmon River Canyon. Although evidence of herbivory by rabbits and deer has been observed, native wildlife species do not appear to significantly threaten this species. However, the potential introduction of additional Rocky Mountain bighorn sheep or mountain goats by State or Federal agencies could threaten M macfarlanei habitat. Mountain goats and other ungulate species can impact rare plant habitat by trampling or consuming plants and by exposing mineral soil. (USFWS, 2000)

Stressor: Invasive nonnative plant species
Exposure:
Response:
Consequence:
Narrative: Exotic (non-native) plant species pose a serious threat to M macfarlanei and other native plants since they compete with native species for space, light, water, and nutrients. Two of the most serious exotic species are Brornus tectorum (cheatgrass) and Centaurea soistitiatis (yellow star-thistle). Centaurea sotstitialis infestations have increased significantly in the Snake River Canyon over the past decade. Efforts to control Centaurea sotstitialis have been initiated at a few sites containing M macfarlanei(USFWS, 2000). This threat was listed as a primary threat in the 2015 5-year review (USFWS, 2015).

Stressor: Wildfire or Fire History
Exposure:
Response:
Consequence:
Narrative: Specific effects of historic and current fire regimes on M macfarlanei are unknown. Fire suppression activities and rehabilitation efforts, including seeding with normative species, are a potential threat to this species. It is possible that M macfarlanei habitat has bumed less frequently in the past 100 years due to fire suppression. Sites where fire has been excluded are vulnerable to accelerated succession, e.g., the invasion of shrubs or trees into grassland or meadow communities. However, the invasion of cheatgrass alters natural community dynamics by producing greater fine fuel levels, which may result in frequent, large-scale range fires. In areas where cheatgrass has invaded sagebrush-grass communities, altered fire dynamics have converted formerly productive, perennial communities to annual-dominated communities with increased fire management problems. Wildfires that occur during summer and fall months when M macfarlanei plants are dormant may have minimal direct effects on this species since the underground rhizomes will be largely insulated from fire. However, fires may result in adverse changes in the ecological condition of sites and lead to the subsequent invasion of exotic species. Burning may also result in concentrations of ungulates grazing within the burned areas, which might cause increased trampling of M macfarlanei plants. The primary concern from wildfires appears to be during the active growing period (typically April through June) when the aboveground plants would be susceptible to fire kill or injury (USFWS, 2000). This threat was

stated to be a primary threat in the 2015 5-year review (USFWS, 2015).

Stressor: Herbicide and pesticide spraying
Exposure:
Response:
Consequence:
Narrative: Spraying vegetation in areas where M macfarlanei occurs could potentially have an adverse effect on this species if weed control activities are not carefully implemented and monitored. (USFWS, 2000)

Stressor: Landslides and flood damage
Exposure:
Response:
Consequence:
Narrative: Activities associated with flood damage repair, including maintaining roads, trails, and facilities damaged by landslides or flooding, should be considered as a potential threat to M macfarlanei habitat. (USFWS, 2000)

Stressor: Insect damage and disease
Exposure:
Response:
Consequence:
Narrative: Some M. macfarlanei plants have been damaged by insects, including lepidopterans and spittle bugs. A type of fungal disease was also previously noted from M macfarlanei plants. Because of connections between ramets, diseases may spread rapidly through clonal plant populations. Although damage from insects and disease do not currently appear to be significant in M macfarlanei populations, these threats should be monitored. (USFWS, 2000)

Stressor: Tramplling, off-road vehicle use, road maintenance/construction
Exposure:
Response:
Consequence:
Narrative: Off-road vehicles: Several M macfarlanei colonies are found within 0.5 kilometer (1/4 mile) of existing roads or highways in Idaho and Oregon. In addition, many M macfarlanei colonies are on steep slopes that are particularly vulnerable to erosion. Uncontrolled off-road vehicle use is a potential threat to this species on both public and private lands. -- Road and trail construction and maintenance: Some M macfarlanei populations in Idaho and Oregon are located near existing roads and trails, and could be adversely impacted by road or trail maintenance activities. The construction of new roads or trails is also a threat to this species. (USFWS, 2000)

Stressor: Collection
Exposure:
Response:
Consequence:
Narrative: Mirabitis macfarlanei is an attractive plant that could be sought by amateur or professional botanists for scientific or horticultural purposes. Because some colonies are readily accessible, collection of M macfarlanei should be considered a potential threat to this species.

(USFWS, 2000)

Stressor: Mining
Exposure:
Response:
Consequence:
Narrative: Although no populations are currently known to be impacted by mining, one M macfarlanei population is located near an existing gravel mining operation along the Salmon River in Idaho County, Idaho. In addition, road construction is often associated with mining activity. The Hell's Canyon National Recreation Area is closed to any new mining claims. However, expansion of existing mining operations and development of future mining operations(e.g., borrow pits) should be considered a potential threat to M macfarlanei. (USFWS, 2000)

Stressor: Competition for pollinators
Exposure:
Response:
Consequence:
Narrative: Preliminary observations have shown that successful pollination of M macfarlanei may be hindered by competition from adjacent plant species. For example, researchers have noted the presence of mixed pollen loads on solitary bees, which are considered to be potential pollinators of M macfarlanei. No data currently exists on the natural history (e.g., biotic and abiotic requirements) of the primary pollinators of M macfarlanei. It is unknown whether pollinator populations are adequate for the successful reproduction of M macfarlanei at all sites, although one study found that seed set in M macfarlanei does not appear to be pollen limited. (USFWS, 2000)

Stressor: Inbreeding depression.
Exposure:
Response:
Consequence:
Narrative: Some observers have noted that seedling recruitment isapparently rare in populations of M macfarlanei. This could be influenced by extrinsic factors such as competition, inadequate pollination, nutrient levels, or annual precipitation. Inbreeding depression could result in poorseed viability, reduced germination success, orpoor seedling survivorship. If new individuals are not successfully added to the population, the population viability of M macfarlanei may decrease over time. (USFWS, 2000)

Recovery

Reclassification Criteria:
Recovery Priority Number: 11

Delisting Criteria:
A minimum of 11 populations are secure from threats and naturally reproducing with stable or increasing population trends for at least 15 consecutive years. (USFWS, 2015)

Population sizes are above the minimum necessary to maintain the viability of the species. (USFWS, 2015)

Populations of this species occur throughout its current range in each of three geographic areas (i.e., Imnaha, Snake, and Salmon River areas). (USFWS, 2015)

Management practices reduce and control threats. On Federal land, habitat management plans are in place and monitoring is used to ensure implementation and effectiveness of conservation management practices. On non-Federal lands, M. macfarlanei populations are managed and conserved. (USFWS, 2015)

A post-delisting monitoring program for the species is developed and implemented. This program will be developed through coordination with the BLM, Forest Service, FWS, and other interested parties. (USFWS, 2015)

Recovery Actions:

- Task 1: Protect essential habitat and control threats: Protect essential (occupied and potentially suitable) habitat and implement actions that may be necessary to eliminate or control threats. Manage habitat to maintain or enhance viable populations of M macfarlanei. Habitat should be managed to allow for the maintenance of natural ecosystem functions and processes and contribute to the long-term preservation of this species. Because M macfarlanei populations are genetically distinct), all populations should be protected in order to maintain the genetic variability of this species. (USFWS, 2000)
- Task 2: Monitor population trends and habitat conditions: Achieving recovery will require monitoring of both M. macfarlanei individuals and habitat throughout its range in Idaho and Oregon. Monitoring will provide information on threats to M macfarlanei habitat, and will also provide feedback on the effectiveness of management and conservation activities. (USFWS, 2000)
- Task 3: Conduct research essential to the conservation of the species: Additional research on the reproductive biology and life history of M. macfarlanei needs to be conducted to ascertain whether these recovery objectives are valid. Information on life history, population characteristics, and habitat requirements should be obtained to allow specification of management and population goals. Partnerships with other State, Federal, or private agencies and individuals should be developed where possible in order to meet these objectives. The Fish and Wildlife Service will work with appropriate agencies to ensure that adequate funding can be obtained to conduct essential research on M. macfarlanei . (USFWS, 2000)
- Task 4: Conduct surveys in potential habitat areas. Manage and protect any newly discovered M. macfarlanei populations.: Intensive field work should be conducted to locate additional populations of this species in each of the three geographic areas in which it is currently known (i.e., along the Imnaha, Salmon, and Snake River corridors in Idaho and Oregon). The habitat of any newly discovered populations should be protected and managed as necessary and appropriate following the protocol given in Task 1.
- Task 5: Establish propagule banks, including a long-term seed storage facility for M. macfarlanei. Seeds of M. macfarlanei should be collected according to currently accepted protocol, and stored at a long-term seed storage facility such as the Berry Botanic Garden (Portland, Oregon). Seeds from many M. rnacfarlanei sites are currently being stored at the Berry Botanic Garden. Additional seeds will be collected to capture as much of the species'

genetic variability as possible. Berry Botanic Garden staff will also be conducting germination and propagation studies for M. macfarlanei. The Fish and Wildlife Service will assist with securing permits for activities as appropriate. (USFWS, 2000)

- Task 6. If warranted. establish and maintain new populations. If M. macfarlanei is extirpated from formerly occupied areas, or if population viability analyses suggest that additional populations are needed for full recovery, new populations of M. macfarlanei may be established as necessary and appropriate. (USFWS, 2000)
- Task 7. Validate and revise recovery objectives, as needed. The recovery plan should be modified to incorporate any new information as it becomes available. In particular, the results of any population viability analyses conducted for M macfarlanei will be considered in future recovery plan revisions. The recovery plan should be reviewed every 5 years. and updated if necessary. (USFWS, 2000)
- Continue working as an interagency technical team to collaborate on recovery actions for this species. (USFWS, 2015)
- Continue control efforts of invasive nonnative plant species and noxious weeds. The Service suggests developing site-specific management plans and monitoring schedules for individual EOs. (USFWS, 2015)
- Develop and implement studies to assess general life history and ecological needs, including studies addressing soil chemistry and moisture regimes. (USFWS, 2015)
- Continue to pursue opportunities to work with landowners towards conservation of this species on private lands. (USFWS, 2015)
- Continue the rangewide monitoring program and conduct and a 10-year analysis of the data set. (USFWS, 2015)
- Continue survey efforts to locate potential new populations. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: • Conduct an SSA for Macfarlane's four-o-clock, with an emphasis on incorporating more current climate change modeling. • Using the information gathered in the SSA determine if a revised Recovery Plan is warranted. • Continue working as an interagency technical team to collaborate on recovery actions for this species. • Complete site-specific HMPs. • Continue the plant propagation program (through both nursery and micropropagation), identification of appropriate areas for population establishment, and associated outplanting efforts at new and existing populations. • Continue control of invasive nonnative plant species and noxious weeds, and conduct research to inform effectiveness of these treatments. • Continue to work with partners to mitigate impacts from livestock grazing. • Develop and implement studies to determine if sexual reproduction is occurring. • Utilize the recommendations in the 2020 rangewide monitoring report to revise the monitoring protocol and continue the rangewide monitoring program. • Continue survey efforts to locate new populations using the newly developed Habitat Suitability Model (USFWS, 2022).

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SPECIES ACCOUNT: *Mitracarpus maxwelliae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/9/1994.

Physical Description

A low, densely-branching, mound like shrub which may reach approximately 20 centimeters in height. The somewhat woody branches are striate and sharply 4-angled. The leaves are opposite, sessile, linear or linear-lanceolate, densely scabrous, and from 1 to 3 centimeters long and 2 to 5 millimeters wide. The flower heads are terminal, dense, sub-globose, and from .8 to 1.3 centimeters in diameter. The corolla is white, narrowly funnelform, minutely glandular-papillose, and 5 to 6 millimeters long. The capsule is about 1.5 millimeters in diameter, opening by a transverse circular split at about the middle. The seeds are ellipsoid, brownish-black, and 1.2 millimeters long and .8 millimeter wide (Proctor 1991a). (USFWS, 1998). Can be misidentified or confused in the field as Spermacoce glabra (USFWS, 2018).

Historical Range

See current range/distribution.

Current Range

Known from only one locality in the Guanica Commonwealth Forest, Guanica, Puerto Rico (USFWS, 1998). As of 2018: Species has been Monte de la Brea in GCF and has expanded to Monte Las Pardas. (USFWS, 2018). Both locations are at La Montalva Ward in the municipality of Guanica. The population at Monte de la Brea is within the boundaries of the Guanica Commonwealth Forest (GCF), whereas the population at Monte Las Pardas occurs in a public land slated for development. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little information is available on the reproductive biology of either Mitracarpus maxwelliae or M. polycladus. The Center for Plant Conservation (1992) indicates that little seed set of M. polycladus occurred in cultivation. Studies of the reproductive biology of these species are currently underway (USFWS, 1998).

Habitat Type

Adult: Scrub or Dwarf Coastal Forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 1998)

Site Fidelity

Adult: High (Inferred from USFWS, 1998)

Habitat Narrative

Adult: Both Mitracarpus maxwelliae and M. polycladus are found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest. Here the species grow in crevices and soil pockets of coastal rocks. The vegetation in the area is dwarfed in stature due to the salt spray and lack of soil and consists of species such as Bucida buceras, Bursera simaruba, Exostema caribaeum, Coccoloba microstachya, Plumeria alba, and Pilosocereus royenii (USFWS, 1998). High site fidelity and ecological integrity of the community as well as low tolerance ranges are inferred based on the specific habitat requirements of the species as well as the low number of known populations and individuals.

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2011)

Number of Populations:

Four (USFWS, 2011)

Population Size:

17,637 (FR Vol. 88, No. 210)

Additional Population-level Information:

By 2011, M. maxwelliae was only known from Monte de la Brea in the GCF, the type locality for the species (where the species was originally described) (Service 2011). New information on the species confirms that the species also occurs in Monte Las Pardas, a Commonwealth land located at 1.63 kilometers (km) (1.01 miles) northeast from Monte de la Brea. In February 2015, Omar Monsegur, a Service biologist, found M. maxwelliae in four sites at Monte Las Pardas while he was searching for endangered plant species in this area (O. Monsegur, Service, unpublished data, 2015). Later in 2016, J. Chabert and E. Ventosa (both Environmental Consultants for ebp Design Group Consulting Engineers, P.S.C.) found the species in three additional sites at Monte Las Pardas (Charbert and Ventosa, 2017). They estimated that the species occupies an area of approximate 0.818 acre (ac) (0.331 hectare (ha)) in each location. On October 16, 2017, Carlos Pacheco, Service recovery lead biologist for this species, visited the M. maxwelliae populations in Monte Las Pardas to validate these new records. He confirmed that the species occurs in seven locations scattered throughout the Monte Las Pardas area (Figure 1; C. Pacheco, Service biologist, unpublished data, 2018). (USFWS, 2018).

Population Narrative:

Mitracarpus maxwelliae is only known from one area (Monte de la Brea) in the Guánica Commonwealth Forest and population estimates have remained stable (between 1443 to 1882 adult plants) since 1991. However, the area occupied by the species has decreased by about 50

percent in ten years. This information needs to be verified in the field with newer surveys and site visits. Mitracarpus polycladus is currently known from Puerto Rico and the islands of Saba and Anegada in the British Virgin Islands. Based on the new information we have gathered during this review, the species has expanded its current distribution. At the time of listing, we were not aware of the two localities reported in the Anegada Island and only one locality was reported in the Guánica Forest. No population estimates were available for the species. Currently, the species is known from approximately 1,400 adult individuals in seven localities in Puerto Rico; six localities in the Guánica Commonwealth Forest and another in a private property adjacent to the forest. Based on the new information, we believe that the current status of M. polycladus is increasing or improving (USFWS, 2011). Low resiliency, redundancy and representation are inferred based on the number of known populations and individuals. The plant Mitracarpus maxwelliae, (Family Rubiaceae), is a mound-like shrub considered endemic to the Municipality of Guánica since the species has not been found anywhere else in Puerto Rico or any other island in the Caribbean Region. Information gathered on M. maxwelliae, and discussed in previous reviews, indicates that the number of populations and the overall number of individuals within its natural range have increased since the species was listed in 1994 (Service 2011 and 2018). By 2011, M. maxwelliae was only known from Monte de la Brea in the Guánica Commonwealth Forest, which is where the species was originally described (Service 2011). In 2018, the species was confirmed to occur in Monte Las Pardas, a Commonwealth land located at 1.63 kilometers (km) (1.01 miles (mi)) northeast of Monte de la Brea (Figure 1; Service 2018). Throughout this new range, the species has a very limited spatial distribution and has a clumped pattern, suggesting that the aggregated distribution is a result of low seed dispersal (Buitrago-Soto 2002, Service 2018). In both populations, the M. maxwelliae individuals are found along unpaved roads, trails and growing on dry exposed gravel. Since the 2018 5-year review, no new information about the M. maxwelliae abundance has been available. In 2011, the abundance of M. maxwelliae in Monte de la Brea was estimated at around 1800 individuals (Service 2011). Later in 2018, Service biologists conducted a rapid assessment on the status of M. maxwelliae populations at Monte de la Brea, reporting 1,869 adult plants (459 adults with flowers and 1,410 adults without flowers) and 1,431 seedlings within an area of .20 ac (0.08 ha) (Table 1; Service 2018). Although the entire population was not surveyed, they also observed that M. maxwelliae seemed to be relatively abundant in the areas not surveyed. In 2017, J. Chabert and E. Ventosa (2017), conducted an inventory on M. maxwelliae in Monte Las Pardas, estimating the species population in over 300 adult plants within 2.45 ac (0.99 ha), 3 populations with over 100 adult plants each (Service 2018). Since 2018, the populations of M. maxwelliae in Monte de la Brea and in Monte Las Pardas have not been monitored. (USFWS, 2023).

Threats and Stressors

Stressor: Roadway maintenance (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: M. maxwelliae occurs at both sides of the only roadway access to Manglillo Grande beach and Punta Brea area. These areas are used by local residents and tourists throughout the year. Although, this unpaved roadway is within the GCF and is managed for conservation, any mechanized maintenance, improvement, widening or increase in traffic on this roadway would affect severely the habitat suitability for the species and would result in loss of significant portion

of the known populations. Because the highest concentration of M. maxwelliae plants are found on the access road to areas frequently utilized by visitors and subjected to maintenance, this factor should be considered as a moderate threat. However, since this locality is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Competition with native and exotic grasses (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The rapid growth of native and exotic grass on areas where these species occur can represent an increase in fuel that may further the impact of fire (USFWS, 2011).

Stressor: Human induced fire (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Because M. maxwelliae and M. polycladus are known to occur in a limited area subjected to human uses and susceptible to human-induced fire, this factor should be considered as a moderate threat. However, since the species is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Tourist development (USFWS, 2018; USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: A tourist development is planned at Montes Las Pardas. (USFWS, 2018; USFWS, 2019).

Stressor: Climate change, severe drought (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Severe droughts and sea level rise resulting from climate change is believed to impact these species as M. maxwelliae and M. polycladus are found growing on sandy and rocky soil near sea level. Also, germination and seedling survival depends on the length of the rainy season as highest mortality of seedlings has been observed during the driest period (Buitrago-Soto 2002). (USFWS, 2019).

Recovery

Reclassification Criteria:
Recovery Priority Number: 17

Delisting Criteria:
1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest (USFWS, 2011).

2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other coastal areas in the Guánica Commonwealth Forest (USFWS, 2011).

Amended delisting criterion 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and Factor E). (USFWS, 2019).

Amended delisting criterion 2: Existing natural populations of M maxwelliae (2 populations), M polycladus (6 populations) and E. woodburyan (6 populations) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Amended delisting criterion 3. Within the historic range, establish at least three (3) new populations of M maxwelliae and M. polycladus, and E. woodburyana on lands protected by a conservation mechanism that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- The first criterion has been met partially. A Cooperative Agreement between the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) is in place since 1983 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico. In addition, the Guánica Commonwealth Forest is managed by the DNER for conservation of fish and wildlife resources, including federally-listed species (DNER, 1976). The DNER also implements a fire-prevention and management program during dry season to protect fish and wildlife resources. However, the existing Guánica Commonwealth Forest management plan does not mention the specific management activities or the number of individuals needed to ensure the species recovery (USFWS, 2011).
- It is difficult to determine if the second criterion has been met because the number of new populations established was not specified. Service biologists conducted surveys on M. polycladus in 2007, 2009 and 2010, finding five additional localities in the Guánica Commonwealth Forest. Approximately, 2925 individuals (doubled from previously known individuals) were observed in five localities within the forest. In October 2008 (FY 2009), Service biologist Carlos Pacheco found a new population with 12 individuals at the Ballenas property. Additionally, the species is found in two localities in the Lesser Antilles (Saba Island and Anegada Island). New information of the species reflects that the species is more widely-distributed than previously thought. M. maxweliae is still restricted to only one known population in the Guánica Commonwealth Forest (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the GCF and establish new populations in protected areas in southern Puerto Rico. (USFWS, 2018).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild. (USFWS, 2018).
- Determine the number of self-sustainable population needed to delist each species. (USFWS, 2018).
- Work closely with the PRDNER and landowners to ensure the protection of the species and its habitat in private lands. (USFWS, 2018).

- Continue implementing fire prevention practices in the GCF during dry season. (USFWS, 2018).
- Develop and implement a comprehensive exotic/invasive grass control in areas where the species occurs to avoid competition. (USFWS, 2018).
- Added in 2019: Genetic material from all populations is preserved through long-term seed storage and/or propagation efforts. This recovery action should be added as new Task in the recovery plan (USFWS, 2019).
- Revise the recovery plan to include new information on the biology of the species and the development of measurable criteria for delisting the species. (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the Guánica Commonwealth Forest and establish new populations in protected areas in southwestern Puerto Rico (USFWS, 2011).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild (USFWS, 2011).
- Determine the number of self-sustainable populations needed to delist each species (USFWS, 2011).
- Additional surveys should be conducted for both species in Puerto Rico (USFWS, 2011).
- Conduct additional studies on the biology and ecology of the M. maxwelliae and M. polycladus (USFWS, 2011).
- Work closely with the Guánica Commonwealth Forest to address current threats within the forest (USFWS, 2011).
- Continue protecting existing populations and their habitat (USFWS, 2011).
- Identify possible threats of M. polycladus in private properties adjacent to the Guanica Forest (USFWS, 2011).
- Work closely with International Affairs to obtain information from M. polycladus on the Virgin Islands (USFWS, 2011).

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U.S. Fish and Wildlife Service. 2011. Mitracarpus maxwelliae / (no common name) Mitracarpus polycladus / (no common name) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service Southeast Region Caribbean Ecological Services Field Office, Boquerón, Puerto Rico.

SPECIES ACCOUNT: *Mitracarpus polycladus* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/9/1994. Reclassified to Threatened November 1, 2023 (FR Vol. 88, No. 210).

Physical Description

A suffrutescent perennial. It is branched near the base, and the erect or spreading stems may reach up to 45 centimeters in height. The branches are 4-angled and glabrous. Leaves are opposite, linear to linear-lanceolate, 2 to 4.5 centimeters long, .3 to .5 centimeters wide, glabrous and often with an inrolled margin and decurrent base. The inflorescence is terminal and capitate, 8 to 13 millimeters in diameter, many flowered and subtended by 3 bracht-like leaves. The corolla is white, about 5 millimeters long, with ovate leaves. The seed capsule is 1.5 millimeter in diameter, (USFWS, 1998). Can be misidentified or confused in the field as Spermacoce glabra (USFWS, 2018).

Historical Range

See current range/distribution.

Current Range

Known from only one location in Puerto Rico, in the Guanica Commonwealth Forest in the municipality of Guayanilla, Puerto Rico, where it grows in crevices and soil pockets of coastal rocks in arid areas (Figure 1). Exact numbers of individuals have been difficult to estimate due to extreme drought conditions in recent years. It is also known from the island of Saba in the Lesser Antilles (Proctor 199 ib). (USFWS, 1998). The species is now found in the Guanica, Yauco and Guayanilla municipalities of Puerto Rico, as well as the Guanica Commonwealth Forest (GCF) and San Francisco Wind Farm. (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little information is available on the reproductive biology of either Mitracarpus maxwelliae or M. polycladus. The Center for Plant Conservation (1992) indicates that little seed set of M. polycladus occurred in cultivation. Studies of the reproductive biology of these species are currently underway (USFWS, 1998).

Habitat Type

Adult: Scrub or Dwarf Coastal Forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 1998)

Site Fidelity

Adult: High (Inferred from USFWS, 1998)

Habitat Narrative

Adult: Both Mitracarpus maxwelliae and M. polycladus are found in the vegetation type which has been described as coastal scrub forest over exposed limestone rock or coastal dwarf forest. Here the species grow in crevices and soil pockets of coastal rocks. The vegetation in the area is dwarfed in stature due to the salt spray and lack of soil and consists of species such as Bucida buceras, Bursera simaruba, Exostema caribaeum, Coccoloba microstachya, Plumeria alba, and Pilosocereus royenii (USFWS, 1998). High site fidelity and ecological integrity of the community as well as low tolerance ranges are inferred based on the specific habitat requirements of the species as well as the low number of known populations and individuals.

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2011)

Number of Populations:

Four (USFWS, 20110)

Population Size:

Approximately 17,624 adult (FR Vol. 88, No. 210)

Population Narrative:

At the time of listing, M. polycladus was known from one locality at the Guánica Commonwealth Forest, but number of individuals was not estimated due to extreme drought conditions (Proctor 1991b). In 2007, Service biologist Carlos Pacheco found three additional localities and conducted a rapid assessment on the species estimating its abundance in 1,400 matures plants and 1,500 seedlings in four localities within the Guánica Commonwealth Forest (USFWS 2007, unpublished data). According to our field observations, we believe that the population trend of M. polycladus should be considered improving (Table 1) (USFWS, 2011). Low resiliency, redundancy and representation are inferred based on the number of known populations and individuals. By 2011, M. polycladus was known from the southern karst region of Puerto Rico, among the municipalities of Guánica, Yauco and Guayanilla. Within its range, the species was known from seven localities: six within the GCF, and one on a parcel of private land at Ballenas Sector in the Municipality of Yauco (Service 2011). New information on the M. polycladus reveals that the species occurs in three additional sites in the southern karst region of Puerto Rico (Figure 2). While Service biologists were searching for endangered plant species on the San Francisco Wind Farm in 2012, they found M. polycladus (Service 2013). Further searches for the species along the southern section of the GCF revealed that M. polycladus also occurs in the Hoya Onda area, in other sites along the state road PR 333, and is widely dispersed along the Mesetas area and in Monte Ventana (C. Pacheco, Service, unpublished data, 2018). (USFWS, 2018). Low resiliency,

redundancy and representation are inferred based on the number of known populations and individuals. Since the time of listing, the number of individuals and localities reported for M. polycladus have increased. Approximately 17,624 adult M. polycladus individuals are currently distributed in 10 natural localities in Puerto Rico occupying 0.44 ha (1.1 ac), with documented recruitment as evidenced by numerous seedlings in close proximity to adult plants, particularly after rain events. However, existing data indicate that seedlings' survival is uncertain due to natural thinning and environmental stochasticity (drought stress). However, effective recruitment has occurred, and seedlings and saplings were noted in seven of eight localities with abundance, seedling, and sapling counts in Puerto Rico during the 2018 assessment (FR Vol. 88, No. 210)

Threats and Stressors

Stressor: Roadway maintenance (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: M. polycladus occurs on exposed limestone rocks along the Mesetas trails and Brunos trails in the Guánica Commonwealth Forest. Currently, Mesetas trails and Brunos trails are managed by DNER as scenic trails and natural areas, avoiding any mechanized maintenance or widening of these trails. However, although these trails are off-limit for vehicle traffic, these trails are frequently used by hikers (locals and tourists) and mountain bikers throughout the year. Because the highest concentration of M. polycladus plants are found on trails frequently utilized by visitors but subjected to minimum maintenance, this factor should be considered as a low threat. Since the species is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Competition with native and exotic grasses (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The rapid growth of native and exotic grass on areas where these species occur can represent an increase in fuel that may further the impact of fire (USFWS, 2011).

Stressor: Human induced fire (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Because M. maxwelliae and M. polycladus are known to occur in a limited area subjected to human uses and susceptible to human-induced fire, this factor should be considered as a moderate threat. However, since the species is within a public forest managed for conservation the imminence of this threat should be considered non imminent (USFWS, 2011).

Stressor: Wind Farm Construction (USFWS, 2019).
Exposure:
Response:
Consequence:

Narrative: San Francisco Wind Farm poses threat from construction of wind turbines and associated facilities (USFWS, 2019).

Stressor: Climate change, severe drought (USFWS, 2019).
Exposure:
Response:
Consequence:
Narrative: Severe droughts and sea level rise resulting from climate change is believed to impact these species as M. maxwelliae and M. polycladus are found growing on sandy and rocky soil near sea level. Also, germination and seedling survival depends on the length of the rainy season as highest mortality of seedlings has been observed during the driest period (Buitrago-Soto 2002). (USFWS, 2019).

Recovery

Delisting Criteria:
1. A management plan that considers the protection and recovery of the species has been prepared and implemented for the Guánica Commonwealth Forest (USFWS, 2011).

2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas, such as other coastal areas in the Guánica Commonwealth Forest (USFWS, 2011).

Amended delisting criterion 1. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and Factor E). (USFWS, 2019).

Amended delisting criterion 2: Existing natural populations of M maxwelliae (2 populations), M polycladus (6 populations) and E. woodburyan (6 populations) show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor E). (USFWS, 2019).

Amended delisting criterion 3. Within the historic range, establish at least three (3) new populations of M maxwelliae and M. polycladus, and E. woodburyana on lands protected by a conservation mechanism that show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:
- The first criterion has been met partially. A Cooperative Agreement between the Service and the Puerto Rico Department of Natural and Environmental Resources (DNER) is in place since 1983 to establish and implement a vigorous endangered species program within the Commonwealth of Puerto Rico. In addition, the Guánica Commonwealth Forest is managed by the DNER for conservation of fish and wildlife resources, including federally-listed species (DNER, 1976). The DNER also implements a fire-prevention and management program during dry season to protect fish and wildlife resources. However, the existing Guánica Commonwealth Forest management plan does not mention the specific management activities or the number of individuals needed to ensure the species recovery (USFWS, 2011).

- It is difficult to determine if the second criterion has been met because the number of new populations established was not specified. Service biologists conducted surveys on M. polycladus in 2007, 2009 and 2010, finding five additional localities in the Guánica Commonwealth Forest. Approximately, 2925 individuals (doubled from previously known individuals) were observed in five localities within the forest. In October 2008 (FY 2009), Service biologist Carlos Pacheco found a new population with 12 individuals at the Ballenas property. Additionally, the species is found in two localities in the Lesser Antilles (Saba Island and Anegada Island). New information of the species reflects that the species is more widely-distributed than previously thought. M. maxweliae is still restricted to only one known population in the Guánica Commonwealth Forest (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the GCF and establish new populations in protected areas in southern Puerto Rico. (USFWS, 2018).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild. (USFWS, 2018).
- Determine the number of self-sustainable population needed to delist each species. (USFWS, 2018).
- Work closely with the PRDNER and landowners to ensure the protection of the species and its habitat in private lands. (USFWS, 2018).
- Continue implementing fire prevention practices in the GCF during dry season. (USFWS, 2018).
- Develop and implement a comprehensive exotic/invasive grass control in areas where the species occurs to avoid competition. (USFWS, 2018).
- Added in 2019: Genetic material from all populations is preserved through long-term seed storage and/or propagation efforts. This recovery action should be added as new Task in the recovery plan (USFWS, 2019).
- Revise the recovery plan to include new information on the biology of the species and the development of measurable criteria for delisting the species. (USFWS, 2011).
- Initiate propagation program for these species to enhance existing population in the Guánica Commonwealth Forest and establish new populations in protected areas in southwestern Puerto Rico (USFWS, 2011).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of both species in the wild (USFWS, 2011).
- Determine the number of self-sustainable populations needed to delist each species (USFWS, 2011).
- Additional surveys should be conducted for both species in Puerto Rico (USFWS, 2011).
- Conduct additional studies on the biology and ecology of the M. maxwelliae and M. polycladus (USFWS, 2011).
- Work closely with the Guánica Commonwealth Forest to address current threats within the forest (USFWS, 2011).
- Continue protecting existing populations and their habitat (USFWS, 2011).
- Identify possible threats of M. polycladus in private properties adjacent to the Guanica Forest (USFWS, 2011).
- Work closely with International Affairs to obtain information from M. polycladus on the Virgin Islands (USFWS, 2011).

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SPECIES ACCOUNT: *Monardella viminea* (Willowy monardella)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb or subshrub in the Lamiaceae (mint family) with a woody base and aromatic foliage. (USFWS, 2012)

Taxonomy

Monardella viminea was previously recognized and listed as Monardella linoides ssp. viminea. In 2003, Elvin and Sanders proposed a taxonomic split of this entity into two distinct species. Upon recognition of this taxonomic change and species split, the range of the listed entity was reduced, and the southernmost occurrences were reclassified as Monardella stoneana. For more details regarding the taxonomic classification of Monardella linoides ssp. viminea as a distinct species (M. viminea) and reclassifying a portion of Monardella linoides ssp. viminea as a separate species (M. stoneana), and the consequences of recognizing this split, please refer to the revised final listing and revised critical habitat rule published in the Federal Register on March 6, 2012 (USFWS 2012b, pp. 13394–13447) (USFWS, 2022).

Current Range

Occurs in coastal sage scrub and riparian scrub in sandy bottoms and on banks of ephemeral washes in canyons where surface water flows for usually less than 48 hours after a rain event (Scheid 1985, p. 3; Elvin and Sanders 2003, p. 430; Kelly and Burrascano 2006, p. 51). Monardella viminea is a geographically narrow endemic species restricted to three watersheds north of Kearny Mesa in San Diego County, California 2012 5-year Review for Monardella viminea 3 (Elvin and Sanders 2003, p. 431). Within these watersheds, M. viminea occurs on land owned by the Department of Defense at Marine Corps Air Station (MCAS) Miramar, the City of San Diego, the County of San Diego, and private parties. (USFWS, 2012)

Critical Habitat Designated

Yes; 3/6/2012.

Legal Description

On March 6, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Monardella viminea (Willowy monardella) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (77 FR 13394-13447).

Critical Habitat Designation

The critical habitat designation for Monardella viminea includes two CHUs in San Diego County, California. This species critical habitat encompasses approximately 122 acres (ac) (50 hectares (ha)) (77 FR 13394-13447).

Unit 1: Sycamore Canyon: Unit 1 consists of 118 ac (48 ha), and is located in Sycamore Canyon at the northeastern boundary of MCAS Miramar, north of Santee Lakes in San Diego County, California. These acres fall within the boundaries of the City of Santee, which has no approved

MSCP. This canyon is the only place where Monardella viminea is found in oak woodland habitat, and is one of the few areas in the range of M. viminea with mature riparian habitat (Rebman and Dossey 2006, p. 23). Sycamore Canyon is essential to the recovery of the species because it supports over 350 individual plants, or approximately 18 percent of the species' total population (City of San Diego 2010a, p. 257; Tierra Data 2011, p. 12), meaning this is an important unit that supports genotypes and diversity not found among the more impoverished occurrences. Additionally, this canyon is one of few that contains seedlings and juveniles (Tierra Data 2011, pp. 16–17), demonstrating that reproduction is occurring and the habitat in this unit is currently suitable to support all lifehistory phases of this declining species. The habitat in this unit provides redundancy and resiliency for M. viminea and, since there are areas of suitable habitat within the canyon where plants are not currently growing, the unit provides space for the growth and expansion of the species. This unit contains the physical or biological features essential to the conservation of M. viminea, including riparian channels with a natural hydrological regime, ephemeral drainages made up of rocky or sandy alluvium, sandy soil with sediment and cobble deposits, and surrounding vegetation that provides semi-open foliar cover. The PCE may require special management considerations or protection to address threats from nonnative plant species and erosion of the canyon (City of San Diego 2005, p. 68; 2006, p. 10; 2009, p. 2). Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to M. viminea habitat and potential management considerations.

Unit 2: West Sycamore Canyon: Unit 2 consists of 4 ac (2 ha) of land owned by water districts, and is located in West Sycamore Canyon adjacent to the eastern section of MCAS Miramar, in San Diego County, California. The northernmost point of the unit is just outside the boundary of MCAS Miramar. West Sycamore Canyon, in which Unit 2 is found, is essential to the recovery of Monardella viminea because it contains the largest number of M. viminea individuals of any canyon in the species' range and over 25 percent of the species' total population (Tierra Data 2011, p. 12), meaning this is an important unit that supports genotypes and diversity not found among the more impoverished occurrences. Additionally, this canyon is one of few that contains seedlings and juveniles (Tierra Data 2011, pp. 16–17), demonstrating that reproduction is occurring and the habitat in this unit is currently suitable to support all lifehistory phases of this declining species. The plants in this canyon were recently observed to be in good health with little to no pressure from herbivores, in contrast to many other areas such as San Clemente or Carroll Canyon, where individuals are declining or are in poor health (Tierra Data 2011, p. 25; Ince 2010, Table 3). The habitat in this unit provides redundancy and resiliency for M. viminea, and because there are areas of suitable habitat within the canyon where plants are not currently growing, the unit provides space for the growth and expansion of the species. Unit 2, which contains critical habitat for M. viminea in that portion of West Sycamore Canyon located outside of MCAS Miramar, includes the physical or biological features essential to the conservation of M. viminea, including riparian channels with a natural hydrological regime, ephemeral drainages made up of rocky or sandy alluvium, sandy soil with sediment and cobble deposits, and surrounding vegetation that provides semi-open foliar cover. The PCE in this unit may require special management considerations or protection to address threats associated with erosion from heavy rainfall events. Please see the Special Management Considerations or Protection section of this final rule for a discussion of the threats to M. viminea habitat and potential management considerations.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Monardella viminea critical habitat consists of four components (77 FR 13394-13447):

(i) With a natural hydrological regime, in which: (A) Water flows only after peak seasonal rainstorms; (B) High runoff events periodically scour riparian vegetation and redistribute alluvial material to create new stream channels, benches, and sandbars; and (C) Water flows for usually less than 48 hours after a rain event, without long-term standing water;

(ii) With surrounding vegetation that provides semi-open, foliar cover with: (A) Little or no herbaceous understory; (B) Little to no canopy cover; (C) Open ground cover, less than half of which is herbaceous vegetation cover; (D) Some shrub cover; and (E) An association of other plants, including Eriogonum fasciculatum (California buckwheat) and Baccharis sarothroides (broom baccharis);

(iii) That contain ephemeral drainages that: (B) Are made up of coarse, rocky, or sandy alluvium; and (C) Contain terraced floodplains, terraced secondary benches, stabilized sandbars, channel banks, or sandy washes; and

(iv) That have soil with high sand content, typically characterized by sediment and cobble deposits, and further characterized by a high content of coarse, sandy grains and low content of silt and clay.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the physical or biological features within the geographical area occupied by the species at the time of listing that are essential to the conservation of the species may require special management considerations or protection. The areas designated as critical habitat will require some level of management or protection to address the current and future threats to the physical or biological features. In all units, special management considerations or protection may be required to provide for the sustained function of the ephemeral washes on which Monardella viminea depends. The features essential to the conservation of Monardella viminea may require special management considerations or protection to reduce the following threats, among others: Cover by nonnative plant species that crowds, shades, or competes for resources; habitat alteration due to altered hydrology from urbanization and associated infrastructure; and any actions that alter the natural channel structure or course, particularly increased water flow that could erode soils inhabited by M. viminea or cover them with sediment deposits. Special management considerations or protection are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include, but are not limited to: Removal of nonnative vegetation by weeding, planting of native species along stream courses in canyons to help control erosion, use of silt fences to control erosion, restriction of development that alters natural hydrological characteristics of stream courses in canyons, and implementation of prescribed burns. Additionally, specialized dams and smaller barriers could be installed in canyons to help address floodwater runoff that results from upstream development (which can cause erosion and loss of clumps of Monardella viminea), although these dams must be of adequate size and strength to withstand increased storm flow caused by urbanization.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative (USFWS, 2008); Sexual (USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Bees and butterflies (USFWS, 2012)

Reproduction Narrative

Adult: The willowy monardella is a perennial species that reproduces at least in part vegetatively (USFWS, 2008). It also reproduces sexually. Monardella viminea is visited by numerous bees and butterflies, and is likely pollinated by a diverse array of insects. Specific species which pollinate M. viminea have not been identified (USFWS, 2012).

Habitat Type

Adult: Sandy washes and floodplains (USFWS, 2008)

Dependencies on Specific Environmental Elements

Adult: Perennial streams; ecosystem culture, function, and integrity; coarse, rocky, and sandy alluvium on terraced floodplains; semi-open canopies of coastal sage and riparian scrub with limited herbaceous understory (USFWS, 2008)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2008)

Habitat Narrative

Adult: The willowy monardella inhabits sandy washes and floodplains. The species is dependent on several environmental elements: perennial streams; ecosystem culture, function, and integrity; coarse, rocky, and sandy alluvium on terraced floodplains; semi-open canopies of coastal sage and riparian scrub with limited herbaceous understory (USFWS, 2008)

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2008)

Dispersal/Migration Narrative

Adult: The species is inferred to have low dispersal ability based on a limited historic range and its proximity and vulnerability to urban development (inferred from USFWS, 2008)

Population Information and Trends

Population Trends:

Declining (USFWS, 2008)

Number of Populations:

16 Extant EO's (USFWS, 2022)

Population Size:

Up to 6,000 total individuals, as many as six populations of fewer than 15 individuals (USFWS, 2008)

Population Narrative:

The willowy monardella is in decline at the population level. There are 8 extant occurrences (USFWS 2012) and at least 10 documented extirpated occurrences. The overall population is 6,000 individuals, but as many as six populations have fewer than 15 individuals. Species resiliency, representation, and redundancy are inferred to be low based on its vulnerability to stochastic events (USFWS, 2008). In summary, monitoring for Monardella viminea has occurred at 20 occurrences since 2012 (Table 1), providing new information about the species presence and abundance. We reassessed our previous occurrence status determinations and updated the status of four occurrences. Additionally, information was added for 3 EOs omitted from the previous 5-year review, 1 was merged with another EO, and 10 are new occurrences reported since 2012. Based on those updates, there are now 30 occurrences of M. viminea (Figure 1; Table 1) of which 16 are extant, 2 are presumed extant, 2 are possibly extirpated, and 10 are extirpated (USFWS, 2022).

Threats and Stressors

Stressor: Grazing/trampling; urban and residential development; recreational activities; altered hyrological regimes; road construction; soil removal; sand and gravel mining; trash dumping; erosion; wildfires; invasive plants (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: The species is threatened by several anthropogenic activities including grazing/trampling,urban and residential development, recreational activities, altered hydrological regimes, road construction, soil removal, sand and gravel mining, trash dumping, and erosion. Wildfires have also had an adverse effect on the species. Invasive plants such as bulrush and willow can take over otherwise suitable habitat for willowy monardella, a process likely exacerbated by fires (USFWS, 2008). Trampling of M. viminea occurs via human travel through the species' habitat. Nonnative plants threaten the species as they frequently out-compete native species for limited resources and grow more quickly, can smother seedling and mature M. viminea and prevent natural growth (Rebman and Dossey 2006, p. 12). Nonnative plants also have the potential to lower water tables and alter rates of sedimentation and erosion by altering soil chemistry, nutrient levels, and the physical structure of soil (USFWS, 2012).

Stressor: Urbanization and development (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Urbanization and development were recognized as threats to Monardella viminea in the listing rule and the 2012 revised final listing and critical habitat rule (USFWS 1998, p. 54946; 2012b, pp. 13398–13399). While most occurrences of M. viminea are found on land conserved or owned by MCAS Miramar, and the City or County of San Diego, development continues to be a threat at four occurrence (EOs 8, 12, 14, and 24) and was a contributing factor to extirpation at

seven occurrences historically (EOs 3, 4, 5, 6, 11, 25, and 39). Since the last 5-year review, EOs 5, 6, and 39, which were not discussed in the previous 5-year, are considered extirpated due to development (Table 1). Additionally, M. viminea occurrences remain indirectly threatened from surrounding urbanization due to higher levels of impervious surface areas that increase dry season runoff (AECOM 2022, p. 3). This increased runoff converts ephemeral drainages to a permanently wet state, promoting conversion to riparian habitat (USFWS, 2022)

Stressor: Altered Hydrology (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Altered hydrology was discussed as a significant threat to habitats that support Monardella viminea at listing and in the 2012 revised final listing and critical habitat rule (USFWS 1998, p. 54950; 2012b, p. 13399). Natural hydrological systems are required by M. Viminea to maintain and deposit material for secondary benches and streambeds on which the species grows (Sheid 1985, pp. 30–31, 34–35). Furthermore, a natural hydrological regime helps reduce competition from woody riparian species and nonnative grasses through scouring and erosion events; however, excessive scouring and erosion can reduce growth or damage M. viminea (Vernadero 2021, p. 53). Hydrological changes may occur within watersheds due to upstream urban development and precipitation changes that affect daily median and minimum discharges, dry season runoff, and flood magnitudes (White and Greer 2006, pp. 133–136). In the 2012 analysis, EOs 3, 4, and 11 were listed as extirpated due to altered hydrological patterns. Altered hydrology has continued to threaten Monardella viminea habitat throughout its range. Since the last review, altered hydrology has been identified as a threat during monitoring conducted by SDMMP on MSPA lands at EOs 1 (MOLIV_6LOCA004), 8 (MOLIV_4SYCA006), 21 (MOLIV_4WSCA003), and 29 (MOLIV_4SYCA001; MOLIV_4SYCA002) (CBI and AECOM 2021a, pp. 345–346). Loss or damage of M. viminea clumps was documented on MCAS Miramar following large scouring events during the 2015–2016 and 2016–2017 growing seasons (Vernadero 2021, pp. 53, 57). Additionally, some plants located in San Clemente Canyon (EO 35) were washed away after heavy rains in the past several years (Gordon 2022, pers. comm.). In summary, 10 occurrences are potentially impacted by the threat of altered hydrology (CDFW 2021) (USFWS, 2022).

Stressor: Nonnative Plant Species (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Nonnative plants were identified as a threat to Monardella viminea in the listing rule and in subsequent 5-year reviews (USFWS 1998, p. 54950; 2008, pp. 11–12; 2012b, p. 13404). This threat is ongoing, and nonnatives are listed as a threat at 11 out of 30 occurrences (CDFW 2021, pp. 1, 4–5, 9, 11–12, 15, 18, 22, 25, 37). Nonnative plants are present throughout all canyons on MCAS Miramar where M. viminea occurs. During the 2020 surveys, Vernadero (2021, pp. 32–34) observed nonnative plant cover in all but two monitoring plots. In some plots, nonnatives were the dominant plant species cover (Vernadero 2021, p. 32). In review comparing plot photographs captured in 2012 to photos captured in 2017 and 2020, surveyors noted the most distinguishable pattern was the increase in nonnative species (Vernadero 2021, p. 52). In monitoring completed off the MCAS Miramar base, SDMMP noted nonnatives as a medium (threat occurs in 10 to 50 percent of area within maximum extent) or high (threat occurs in 50 to

100 percent of area within maximum extent) level threat in 5 out 7 occurrences monitored in 2019 (CBI and AECOM 2021a, pp. 343–346) (USFWS, 2022).

Stressor: Climate Change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: The term "climate change" refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2013, p. 1450). Downscaled projections under several future climate scenarios are available for the range of Monardella viminea (USFWS, 2022).

Recovery

Reclassification Criteria:
None listed

Recovery Priority Number: 8

Recovery Actions:
- The Cities of San Diego and Santee have purchased private property as reserve land for Monardella viminea (USFWS, 2012)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to Monardella viminea and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Continue to monitor known M. viminea occurrences to update occurrence status, size, and threats. That information can be used to identify high-priority occurrences for management or areas for restoration. Work with landowners to implement management strategies as identified in the MSP Framework Rare Plant Management Plan (see CBI and AECOM 2021a, pp. 354–369). 2. Determine habitat characteristics that support M. viminea growth, survival, and reproduction. Identify areas of potential supportive habitat for reintroduction. 3. Enhance habitat where M. viminea occur, through nonnative plant control, flood control, and anti-erosion measures where necessary. Test available herbicides to learn their effect on M. viminea and determine whether it could be used to control nonnative grasses and forbs without negatively affecting M. viminea. 4. Identify suitable introduction/reintroduction sites to expand current distribution of M. viminea in areas where suitable habitat is present. Conduct habitat restoration to support pollinators, if necessary. 5. Research effects of drought and high temperatures on M. viminea recruitment and survivorship (USFWS, 2022).

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Revised Endangered Status, Revised Critical Habitat Designation, and Taxonomic Revision for Monardella linoides ssp. viminea

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SPECIES ACCOUNT: *Monolopia (=Lembertia) congdonii* (San Joaquin wooly-threads)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/19/2000; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

The common name "woolly-threads" is derived from the many long (up to 45 cm; 18 in), trailing stems covered with tangled hairs. However, San Joaquin woolly-threads plants also can be tiny (< 7 cm (3 in)) and erect with a single stem (Cypher 1994a). The tiny, yellow flower heads are clustered at the tips of the stems and branches. Each flower head is approximately 6 mm (0.25 in) long and contains two types of florets (the tiny flowers characteristic of the aster family); the four to seven outer florets differ in shape from the numerous inner florets. The two types of florets produce achenes (tiny, one-seeded fruits) that also differ in shape (Johnson 1993, Taylor 1989). (USFWS, 1998)

Taxonomy

n 1883. Gray named San Joaquin woolly-threads as Eatonella congdonii. The type specimen had been collected by Congdon near Deer Creek (Tulare County) in that same year. The current name, Leinbertia congdonii, was published by Greene in 1897, who determined that San Joaquin woolly-threads should be separated from snowy eatonella (Eatonella nivea). Subsequent taxonomists have upheld Greene's taxonomy (Johnson 1993, Taylor 1989). San Joaquin woolly-threads is the sole species in the genus Lembertia, which is in the aster family (Asteraceae). (USFWS, 1998)

Historical Range

The historical range of San Joaquin woolly-threads is based on 47 herbarium specimens and literature reports dating from 1883 to 1983; 30 of the occurrences were from the floor of the San Joaquin Valley, four were from the CuyamaValley. and the remainder were in the hills west of the San Joaquin Valley. These occurrences were concentrated in eight areas (in descending order of abundance): (1) the plains between Avenal and Mendota in Kings and Fresno Counties, (2) from Bakersfield to Shafter in Kern County, (3) the inner Coast Ranges of western Fresno and eastern San Benito Counties, (4) from north of Lokern to Lost Hills in Kern County, (5) the Carrizo and Elkhorn Plains in San Luis Obispo County, (6) the Cuyama Valley in Santa Barbara County, (7) east of Edison in Kern County, and (8) the type locality. However, 33 of the historical occurrences had been eliminated by 1989 (Taylor 1989). (USFWS, 1998)

Current Range

The Service states that Monolopia congdonii occur in Fresno, Kings, Kern, San Benito, San Luis Obispo, and Santa Barbara Counties. Nineteen populations of Monolopia congdonii were extant (55 FR 29361). Twelve populations remained in the San Joaquin Valley and adjoining foothills from the vicinity of Panoche Pass (San Benito County) southeasterly to Caliente Creek east of Bakersfield (Kern County). Another seven populations occurred to the southwest in the Cuyama Valley (San Luis Obispo and Santa Barbara Counties) and Carrizo Plain (San Luis Obispo County). Thirty-three of 52 historical populations had been lost (55 FR 29361), including a population from Tulare County (Taylor 1989). (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: February to April (USFWS, 2010)

Reproduction Narrative

Adult: San Joaquin woolly-threads is an annual herb, and its phenology varies with weather and site conditions. Monolopia congdonii typically flowers between late February and early April (B. Delgado pers. comm. from Service 1998). Each plant may have from 1 to more than 400 flower heads. Seed production depends on plant size and the number of flower heads but can range from 10 to 2,500 seeds per individual (Mazer and Hendrickson 1993; Cypher 1994; E. Cypher unpublished data from Service 1998). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Chenopod scrub, valley and foothill grassland; sand dunes (Skinner, 1997). (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers less than 10% shrub cover; found at elevations between 200 to 850 feet on the San Joaquin Valley and from 2,000 to 2,600 feet in San Luis Obispo and Santa Barbara counties (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Scattered (USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Monolopia congdonii occurs scattered in Nonnative Grassland, Valley Saltbush Scrub, Interior Coast Range Saltbush Scrub, and Upper Sonoran Subshrub Scrub communities (Service 1998). Plants that often occur with Monolopia congdonii include Bromus rubens (red brome), Erodium cicutarium (red-stemmed filaree), Schismus spp. (Arabian grass), Lasthenia spp. (goldfields), and Vulpia myuros (mouse tail fescue). Monolopia congdonii typically occupies microhabitats with less than 10 percent shrub cover, although herbaceous cover may be either sparse or dense, and cryptogamic crust (a layer of moss, lichen, and algae on the soil surface) may or may not be present. Monolopia congdonii occurs on neutral to sub-alkaline soils that were deposited in geologic times by flowing water. On the San Joaquin Valley floor, this species typically is found on sandy or sandy loam soils, particularly those of the Kimberlina series,

whereas on the Carrizo Plain, it occurs on silt rich soils. Monolopia congdonii frequently occurs on sand dunes and sandy ridges as well as along the high-water line of washes and on adjacent terraces. Occurrences have been reported at elevations ranging from approximately 200 to 850 feet on the San Joaquin Valley floor and surrounding hills, and from 2,000 to 2,600 feet in San Luis Obispo and Santa Barbara Counties (Service 1998). (USFWS, 2010)

Dispersal/Migration

Dependency on Other Individuals or Species for Dispersal

Adult: Possibly wind, water and animals (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Seed dispersal agents are unknown, but possible candidates include wind, water, and animals. Insect pollinators are not known to be required for seed-set in M. congdonii (Mazer and Hendrickson 1993); however, animals may be important to this plant species in other ways. (USFWS, 2010)

Population Information and Trends

Population Trends:

Declining (USFWS, 2020)

Number of Populations:

87 (USFWS, 2020)

Population Narrative:

Currently, there are 87 extant and presumed extant Diversity Database occurrences, and 24 extirpated and possibly extirpated occurrences. (USFWS, 2020)

Threats and Stressors

Stressor: Agricultural conversion and urbanization (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The loss and modification of habitat due to agricultural conversion and urban development remain the largest threats to Monolopia congdonii. As discussed in the final listing rule (55 FR 29361), 96 percent of the native habitats of the valley floor had been lost primarily to urbanization and agricultural land conversion by 1987. The Central Valley Project (CVP) is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the State's 58 counties. Agricultural conversions and related operations either directly or indirectly facilitated by the Central Valley Project include: conversion of native habitats to agricultural fields; conversion of land use to more water intensive purposes; disposal of agricultural drainwater; application of pesticides; and other mowing and harvesting operations. Agricultural conversion and related operations have contributed to the loss and degradation of several habitat types, including grasslands and alkali scrub associated with declines of multiple listed species (Service 1998). Currently, fewer than 150,000 acres on the San Joaquin Valley floor remain uncultivated; most of the remaining undeveloped land is located near, or in, the

foothills at the valley perimeter. Significant portions of these lands not cultivated for agriculture or urbanized have been developed for petroleum extraction, strip-mined for gypsum and clay, or occupied by roads, canals, airstrips, oil-storage facilities, pipelines, and evaporation and percolation basins. In addition, natural communities have been permanently altered by the introduction and proliferation of nonnative plants, which now dominate many remaining natural habitats (USFWS 1998). Residual natural communities are typically comprised of marginal and highly fragmented habitats. Habitat conditions are so marginal in many of these residual communities that the elimination of listed species is likely, if catastrophic events such as drought or floods were to occur (Service 1998). The California Department of Conservation (CDC) estimates that the conversion of farming or grazing land to residential or industrial uses between 2002 and 2004 in the San Joaquin Valley occurred at a rate of 26 acres per day (CDC 2007). The projected rate of development is anticipated to increase (American Farmland Trust 2007). As urbanization encroaches into valley floor agricultural areas, Monolopia congdonii habitats of the foothills are increasingly converted to perennial cropland. Other effects due to agriculture include soil salinization resulting from irrigation; a pattern that has been observed throughout history (Jacobsen and Adams 1958) where agriculture land use dominates arid regions. Soil salinization due to agriculture is common in California's San Joaquin Valley (Schoups et al. 2005; T. Maurer, Service, pers. comm. 2010) and may result in impairment to soil that would make restoration of habitat unlikely. In Fresno County, where Monolopia congdonii occurs, human population growth and urbanization have steadily increased. For the period between 1990 and 2000, population growth in Fresno County increased 16.5 percent (California Department of Finance 2007). (USFWS, 2010)

Stressor: Oil and gas extraction and conveyance (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Oil and gas extraction and conveyance continue to threaten Monolopia congdonii. Adverse effects of oil and gas development on M. congdonii include the loss of habitat, change in habitat quality, destruction of individuals or populations and their seedbank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. On the BLM lands where Monolopia congdonii occurs, oil and gas exploration is also a threat to the species' survival and recovery. (USFWS, 2010)

Stressor: Habitat threats from solar power developments (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Solar power development projects pose potential threats to and may impact large amounts of habitat. These projects can destroy, fragment, or impact Monolopia congdonii habitat by: altering landscape topography, vegetation, and drainage patterns; and reducing habitat quality through interception of solar energy normally reaching the ground surface, affecting ambient air temperatures through habitat shading, and altering soil moisture regimes (Smith 1984; Smith et al. 1987 as cited in J.R. Single, CDFG. in litt. 2010). Moreover, recently proposed solar projects tend to be large contiguous blocks of disturbance in undeveloped habitat lands, ranging from hundreds to several thousand acres. (USFWS, 2010)

Stressor: Off road vehicle use

Exposure:
Response:
Consequence:
Narrative: Off road vehicle use for recreational purposes is among the threats to Monolopia congdonii recorded in the CNNDB since 1990. The Kettleman Hills BLM population is reportedly under increasing threat from off road vehicle trespass (O'Dell in litt. 2007). Off road vehicle recreational use on Federal lands is often difficult to control due to limited staffing and area remoteness such as in the Kettleman Hills (O'Dell in litt. 2007). As of 2010, off road vehicle use continues to be a threat at Kettleman North Dome where BLM land is "checker-boarded" with Chevron oil fields. Chevron is making efforts to exclude off road vehicles by improving their fences and patrolling the area. There is also some existing threat of off road vehicle activity impact to the species and its habitat on Monocline Ridge, although this threat is lower than at the much more accessible Kettleman North Dome (O'Dell in litt. 2010). Off road vehicle use has been reported as a minor threat on the Carrizo Plain National Monument (BLM 2009). The threat of off road vehicle recreation use on private lands where Monolopia congdonii persists is unknown. (USFWS, 2010)

Stressor: Conservation measures (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The California Wildlife Conservation Board purchased 3,000 acres from TNC in December 1988 and 2,500 acres in 1989 to be managed by CDFG. Currently, the Carrizo Plain National Monument (formerly the Carrizo Plain Natural Area) contains over 200,000 acres of natural habitat. The Monument is jointly managed by the BLM, CDFG and The Nature Conservancy (TNC) (California Resources Agency 2008). Although, as discussed above, 130,000 acres within the Monument are open to potential oil and gas development. (USFWS, 2010)

Stressor: Grazing (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: In the final rule (55 FR 29361) we listed overgrazing (by domestic livestock) as a threat. Currently, we think that either the complete removal of grazing, uncontrolled grazing, or grazing that continues during the flowering time of Monolopia congdonii are threats to M. congdonii. Cattle grazing exclusion in one of BLM's populations in Jacalitos Canyon appears to have resulted in extirpation of that population, coincident with heavy accumulation of annual grass biomass (O'Dell in litt. 2010). The Bakersfield BLM office has noted the same effect of livestock exclusion resulting in plant number declines on part of population at Kettleman Middle Dome (O'Dell in litt. 2010). In contrast, cattle grazing on one of BLM's populations at Kettleman North Dome has maintained grass biomass low to the ground, which has greatly benefitted Monolopia, resulting in a population numbering in the thousands that is continuing to increase in size (O'Dell in litt. 2010). Grazing may be detrimental if it continues into the flowering period of M. congdonii (Cypher 1996). (USFWS, 2010)

Stressor: Herbivory (USFWS, 2010)
Exposure:
Response:

Consequence:
Narrative: Herbivory by giant kangaroo rats has been shown to reduce the reproductive capacity of individual Monolopia congdonii plants by up to 30 percent. The intensity of the damage to individual plants is correlated with distance from a burrow (Mazer and Hendrickson 1993). Monolopia congdonii growing on kangaroo rat precincts has been noted and attributed to the suggestion that the species is a poor competitor with introduced annual grasses (Taylor 1989). On the Carrizo Plain, greater M. congdonii plant size and flower head production has been associated with giant kangaroo rat activity (Mazer and Hendrickson 1993) as have been earlier seed germination and maturation (Cypher 1994). (USFWS, 2010)

Stressor: Competition from non-native grasses (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The southern San Joaquin Valley of California, as with much of western North America, has been invaded by nonnative plant species during the past 100 to 200 years. These include the following species: Bromus rubens (red brome), Vulpia myuros (mouse tail fescue), Schismus arabicus (Arabian grass), Hordeum murinum ssp. glaucum (known locally as foxtail and elsewhere as smooth barley), Bromus diandrus (ripgut brome), and Bromus hordeaceus (soft chess) (Biswell 1956; Heady 1977; Germano et al. 2001). These introduced grasses often germinate with the first October rains (J. Jones, Live Oak Associates, pers. comm. 2007) and become established before Monolopia congdonii seeds germinate. This allows nonnative plants to out-compete native plant species for water, nutrients, and sun light and places M. congdonii at a reproductive disadvantage. An overabundance of residual thatch from the previous year's nonnative grass production can have similar adverse effects by shading out or obstructing M. congdonii seedlings. Competition from nonnative grasses affects Monolopia congdonii on both private and public lands including the Carrizo Plain National Monument. (USFWS, 2010)

Stressor: Nitrogen deposition/landscape nitrification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Elevated atmospheric nitrogen (N) deposition is particularly harmful to N-limited ecosystems such as Monolopia congdonii habitat in the arid southern San Joaquin Valley where it leads to increases in nonnative annual grasses which outcompete the native flora (Fenn et al. 2003). Dry nitrogen deposition estimates for Bakersfield, Kern County near a CNDDB Monolopia congdonii occurrence, are 10 to 20 kilograms of N per hectare per year (22 to 44 pounds of N per 2.5 acres per year) (Blanchard et al. 1996). Nitrogen limited ecosystems of the western United States, such as the arid/semi-arid San Joaquin Valley, are adversely affected by N deposition as low as 3 to 8 kilograms of N per hectare per year (7 to 18 pounds of N per 2.5 acres per year) (Fenn et al. 2003). (USFWS, 2010)

Stressor: Trampling by livestock and soil compaction (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Trampling by livestock reduces survival of Monolopia congdonii in areas where livestock congregate, such as around water troughs. Trampling from livestock is a threat when it

reduces or eliminates the reproductive ability of the plant by, for example, damaging blossoms or seeds. Soil compaction resulting from domestic livestock may be less of an effect in habitat areas where soils have a low clay fraction than in soils with a high clay fraction. In some areas, such as the valley floor, M. congdonii is typically found on sandy or sandy loam soils (Service 1998). The Kimberlina soil series, which the plant is known to occupy, consists of very deep, well drained soils on flood plains and recent alluvial fans (Natural Resources Conservation Service 2003). In other types of soil, compaction is likely a threat to individual Monolopia congdonii. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The change in global climate presents a threat to Monolopia congdonii. Climate models predict for California an overall warming of 1.7 degrees to 5.8 degrees Celsius (3.0 degrees Fahrenheit to 10.4 degrees Fahrenheit) by 2100 (Cayan et al. 2006) but vary in their predictions for precipitation. VanRheenen et al. (2004), however, predicts a decrease in precipitation in the southern San Joaquin Valley. Any significant changes in temperature or precipitation could have drastic effects on M. congdonii populations. Climate change will likely result in changes in the vegetative communities of M. congdonii habitat and potentially increase nonnative species. However, there is insufficient data available at this time to predict the specific effects of climate change on M. congdonii. (USFWS, 2010)

Recovery

Reclassification Criteria:
1. 95 percent of occupied habitat on public land is secured and protected from incompatible uses. (USFWS, 2010)

2. A management plan is approved and implemented for recovery areas that include survival of the species as an objective. (USFWS, 2010)

3. Population monitoring in specified recovery areas shows stable or increasing numbers in all protected areas through one precipitation cycle. (USFWS, 2010)

Delisting Criteria:
1. 640 acres (260 hectares) or more of occupied habitat in the Lost Hills (Kern County) and one or more other sites on the San Joaquin Valley floor of 640 acres or more has been secured and protected from incompatible uses. (USFWS, 2010)

2) Population monitoring in specified recovery areas shows no decline after downlisting, if declining, determine cause and reverse trend. (USFWS, 2010)

3) Though not explicitly stated, the delisting criteria include meeting all of the downlisting criteria (Service 1998). (USFWS, 2010)

Recovery Actions:

- Develop and implement a regional cooperative program and participation plan. (USFWS, 1998)
- Protect and secure existing populations. (USFWS, 1998)
- Determine distributions and population statuses of featured species. (USFWS, 1998)
- Conduct important research and monitoring. (USFWS, 1998)
- Maintain and establish linkages in existing natural lands and between islands of habitat on the Valley floor and natural lands around the fringe of the Valley. (USFWS, 1998)
- Apply adaptive management to protected areas (Priority 3). (USFWS, 1998)
- If necessary, reintroduce selected featured species to appropriate habitat within their historic range. (USFWS, 1998)
- Periodically review the status of candidates and species of concern to determine if listing as endangered or threatened is necessary. (USFWS, 1998)
- Protect existing habitat in the San Joaquin Valley for Monolopia congdonii. (USFWS, 2010)
- Conduct surveys to determine trends in the range-wide status of the species and population abundance. (USFWS, 2010)
- Collect seeds from multiple populations adhering to the Center for Plant Conservation Guidelines (1991). Store seeds in facilities certified by the Center for Plant Conservation. (USFWS, 2010)
- When BLM revises the ACEC management plan, address invasive species, wildlife habitat improvements, and the protection/enhancement of special status species throughout the Panoche-Coalinga ACEC. Ensure that habitat can be protected in blocks of at least 160 acres and buffer zones of 500 feet or more are protected beyond the occurrence margins of Monolopia congdonii to reduce external influences and to allow for plant population expansion. (USFWS, 2010)
- Conduct research to determine the degree or intensity of threat from livestock grazing to the plant and its habitat. Include the variables of cattle stocking rate, relative weight or size of animals, numbers, and cattle sheltering or shade selection behavior. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following recommendations for future actions are from the 2010 5-year review (Service 2010), scientific literature, and as a result of discussions with species experts. 1. Protect existing habitat in the San Joaquin Valley for San Joaquin woolly-threads. 2. A comprehensive evaluation should be completed for all known occurrences (both extant and extirpated). The site-specific evaluation should include, at minimum, whether the species is present, the estimated population/occurrence size, and an in-depth analysis of threats at that location. 3. Implement and/or continue yearly surveys utilizing a standardized methodology to determine trends in the range-wide status of the species as well as population/occurrence abundance. 4. Continue studies that advance the understanding of the species' propagation requirements, knowledge of the physical and chemical elements of the soil required for successful re-establishment, the presence and role of mutualistic soil fungi, the species and role of pollinators, genetics, and seed dispersal mechanisms. 5. Conduct research to determine the degree or intensity of threat from livestock grazing to the plant and its habitat. Include the variables of cattle stocking rate, relative weight or size of animals, numbers, and cattle sheltering or shade selection behavior. 6. Analyze the potential for habitat degradation due to climate change and implement appropriate measures to ameliorate these threats. (USFWS, 2020)
- Habitat Conservation Plans are planning documents required as part of an application for an incidental take permit. They describe the anticipated effects of the proposed taking; how those

impacts will be minimized, or mitigated; and how the Habitat Conservation Plan is to be funded. Habitat Conservation Plans can apply to both listed and non-listed species, including those that are candidates or have been proposed for listing. Regional Habitat Conservation Plans develop large-scale conservation strategies within a specific region that are designed to conserve functional ecological systems and the covered species that depend on them. Such Habitat Conservation Plans aim to avoid a fragmented conservation landscape by working with local land use authorities and a designated implementing entity to conserve, enhance, and manage a preserve system. Project-level Habitat Conservation Plans are designed to fully offset the impacts associated with the permitted activity by contributing to a larger conservation design. Being included as a covered species under a Habitat Conservation Plan can result in habitat being set aside and managed for the species as mitigation for impacts associated with covered activities, such as planned urban development, within the Habitat Conservation Plan permit area. In addition to mitigation, avoidance, minimization, and other conservation measures (e.g. monitoring, seasonal work windows, habitat management, etc.) are implemented. Habitat Conservation Plans can also utilize banks, in-lieu fee programs, or other mechanisms to preserve habitat in perpetuity and contribute to a regional conservation strategy. The following are Habitat Conservation Plans that include this species and the year the permit for the Habitat Conservation Plan was issued: PG&E San Joaquin Valley Operations & Maintenance Habitat Conservation Plan 2007, Nuevo-Torch 1999, Kern Water Bank 1997, and Chevron Pipeline 1996. More information about Habitat Conservation Plans that include San Joaquin woolly-threads as a covered species can be found at: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=3746 (USFWS, 2020)

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SPECIES ACCOUNT: *Myrcia paganii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/18/1994; Southeast Region (R4) (USFWS, 2015)

Physical Description

An evergreen tree which may reach 9 meters and 13 centimeters in diameter. The bark is mottled and flaky, and the inner bark is orange-brown. Young twigs are flattened and have numerous soft brownish hairs. The leaves are opposite, simple, entire, coriaceous, aromatic, and glandular punctate below. The leaf blade is elliptic to elliptic-oblong, villous when young but glabrescent, 10 to 16 centimeters long, and 4 to 9 centimeters wide. The leaf base is acute, the apex obtuse, and the midvein is clearly impressed above. Petioles are 4 to 5 millimeters long. The flowers and fruit have not been described (USFWS, 1996). New in 2016: May reach 20 m in height (Little et al. 1974, Liogier 1994). (USFWS, 2016).

Taxonomy

In the Myrtaceae family (USFWS, 1996).

Historical Range

First collected south of the city of Arecibo, located in northern Puerto Rico. (USFWS, 1996)

Current Range

Currently known from 3 locations in the limestone hill region of the northwestern part of Puerto Rico (USFWS, 1996).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Little is known about the reproductive biology of Myrcia paganii. The plant has not been collected in flower or fruit and seedlings have not been observed (USFWS, 1996). Pollination occurs via insects (EPA, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 1996)

Habitat Vegetation or Surface Water Classification

Adult: Seasonal evergreen or semi-evergreen forest (USFWS, 1996)

Dependencies on Specific Environmental Elements

Adult: shallow, well-drained, alkaline soils (USFWS, 1996)

Habitat Narrative

Adult: Habitat is seasonal evergreen or semi-evergreen forest types of the subtropical moist forest life zone in the limestone region of north and northwestern Puerto Rico (Ewel and Whitmore 1973). This area receives from 175 to 200 centimeters of rainfall per year, with the dry season extending from January to March and the wet season from May through November (Vivaldi and Woodbury 1981). Species is found in soils that are shallow, well-drained, alkaline and interspersed between outcrops of hard limestone. The limestone outcrops may cover up to 75 percent of the surface (USFWS, 1996). Grows at elevations of of 150 to 250 m (492-820 ft) on steep hills and top of hills (USFWS 1997, Axelrod 2011, Trejo-Torres et al. 2011). The recent record of the species within the Toro Negro Commonwealth Forest (subtropical wet forest; Ewel and Whitmore 1973).... represents the first record of the species occurring on volcanic derived soils. (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information is available about the dispersal of Myrcia paganii. The plant has not been collected in flower or fruit and seedlings have not been observed (USFWS, 1996).

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

3 (USFWS, 1996)

Population Size:

8 individuals total (USFWS, 1996)

Population Narrative:

Little is known concerning the population structure of Myrcia paganii. Six individuals are known from a privately owned site, with one individual at each of two additional locations (USFWS, 1996). New in 2016: According to Trejo-Torres et al. (2011), in 2001 Pedro Acevedo (U.S. National Herbarium, Smithsonian National Museum of Natural History) and Danilo Chinea (UPRM) found a population of 10 individuals in the Biáfara sector in Arecibo. In 2005, during a flora and fauna study for the Senderos de Miraflores project in the Biáfara sector, Ruiz-Lebrón and Puente-Rolón also reported two populations of M. paganii comprised of 12-20 individuals (Departamento de la Vivienda de Puerto Rico 2009). In work conducted during 2002-2006, Trejo-Torres et al. (2011) found a total of 103 individuals of M. paganii. Ninety four of these individuals were found in four different areas within the northern karst region of Puerto Rico: Guajataca Commonwealth Forest (50 individuals, some were seedlings, number not specified), the private natural reserves of Mata de Plátano and El Tallonal (22 individuals), Biáfara sector, Arecibo (18 individuals; same population found by Acevedo and Chinea in 2001), and Piedra Gorda Ward, Plazuela sector in Camuy (4 individuals). Nine other individuals were found in 2006 by M. Caraballo (UPRRP) in the Toro Negro Commonwealth Forest (Trejo-Torres et al. 2011). In addition, J. Sustache (PRDNER, pers comm. 2015) provided information to the Service regarding the location of M. paganii in Quebradillas (1 sterile individual found at one of the proposed routes for highway PR-22), and El Tallonal (19 individuals, including adults and juveniles).

According to J. Sustache, he does not have the specific location of the individuals at El Tallonal, thus we are not certain these are the same individuals reported by Trejo-Torres et al. (2011). (USFWS, 2016).

Threats and Stressors

Stressor: Habitat modification or destruction (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Two populations of Myrcia paganii are found on privately owned land currently subject to intense pressure for agricultural, rural and tourist development. Adjacent land is being cleared for grazing by cattle and goats. One individual has been reported from the Guajataca Commonwealth Forest, where it may be affected by forest management practices (USFWS, 1994).

Stressor: Vandalism and collection (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: The number of individuals of C. thomasiana and M. paganii is so small that vandalism and collection could seriously affect the survival of these species (USFWS, 1994).

Stressor: Natural factors (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Because so few individuals are known to occur in a limited area, the risk of extinction is extremely high. Hurricane Hugo in 1989 dramatically affected the Monte Pirata area of Vieques, felling large trees and creating numerous canopy gaps (USFWS, 1994).

Stressor: Climate change (USFWS, 2016)
Exposure:
Response:
Consequence:
Narrative: Vulnerability to climate change impacts is a function of sensitivity and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Under this scenario, the populations of M. paganii may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting seed germination and/or the survival of seedlings. (USFWS, 2016).

Stressor: Genetic variation (USFWS, 2016).
Exposure:
Response:
Consequence:
Narrative: Given the very small numbers of individuals reported in wild populations of M. paganii, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift (Honnay and Jacquemyn 2007), which would limit the species'

ability to respond to a changing environment (Booy et al. 2000). Also, there may be genetic differences among populations. (USFWS, 2016).

Stressor: Phenology and Breeding system (USFWS, 2016).
Exposure:
Response:
Consequence:
Narrative: The reproductive biology of M. paganii is unknown, and we believe that the small and isolated populations may be affected by lack of natural recruitment. Many Myrtaceae flower sporadically and for very short periods of time. If the species is self-incompatible (not able to self-pollinate), its sexual reproduction would be severely limited. Thus, we consider the reproductive biology of the species and the small size of populations as threats to the species. (USFWS, 2016).

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
1. Populations on privately owned land are placed under protective status (USFWS, 1996).

2. New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established in protected areas such Commonwealth Forests of the limestone hill region (USFWS, 1996).

Recovery Actions:
- Protect the existing populations known from privately owned land (USFWS, 1996).
- Develop management plans for known populations (USFWS, 1996).
- Monitor known populations (USFWS, 1996).
- Enforce existing Commonwealth and Federal endangered species regulations (USFWS, 1996).
- Educate the public on conservation values and regulations (USFWS, 1996).
- Conduct research on the life history of the species and evaluate propagation techniques (USFWS, 1996).
- Conduct propagation and enhance existing populations or establish new ones on protected lands (USFWS, 1996).
- 2016 recommended actions (some overlap with prior actions) - 1: The recovery of M. paganii should focus on the protection of known populations and their habitat. (USFWS, 2016).
- 2016 - 2: Conduct studies to determine the current status of wild populations. Additional visits should be made after hurricanes or other major disturbances. (USFWS, 2016).
- 2016 - 3: Conduct studies on the species' phenology and reproductive biology, including its breeding system. (USFWS, 2016).
- 2016 - 4: Conduct studies to determine the genetic variation in order to develop a plan to preserve the species' germplasm. (USFWS, 2016).

- 2016 - 5: Currently known populations should be enhanced using seeds if available or vegetative propagation (e.g., air layering, tissue culture, etc.) if necessary. Ideally, the species' patterns of genetic variation should be known first. (USFWS, 2016).
- Not available.

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SPECIES ACCOUNT: *Myrsine linearifolia* (Kolea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A branched shrub, 2.5 to 8 meters (8.2to 26.2 feet) tall. The slightly fleshy, linear leaves are 5 to 9 centimeters (1.7 to 3 inches) long, 0.25 to 0.4 centimeter (0.09 to 0.14 inch) wide, often yellowish purple toward the base, and tend to be clustered toward the upper branches. The margins of the leaves are smooth and roll slightly toward the underside of the leaf. One to three apparently perfect (containing male and female parts) flowers, on stalks 1 to 4.2 millimeters (0.04 to 0.17 inch) long, occur in clusters among the leaves. The greenish petals are inversely lance-shaped, about 2.2 to 2.5 millimeters (0.09to 0.1 inch) long, and also have margins fringed with hairs. At maturity, the fruits are black elliptic-shaped drupes, about 6 millimeters (0.2inch) long. This species is distinguished from others of the genus by the shape, length, and width of the leaves, length of the petals, and number of flowers per cluster (USFWS, 1998).

Taxonomy

A member of the myrsine family (Myrsinaceae) (USFWS, 1998).

Historical Range

Historically, Myrsine linearifolia was known from 11 scattered locations on Kauai: Kaala (last seen in 1917), Olokele Valley (last seen in 1912), Kalualea (last seen in 1939), Kalalau Valley and Kahuamaa Flat, Limahuli-Hanakapiai Ridge, Koaie Stream, Pohakuao, the Namolokama summit plateau, Haupu (last seen in 1992), Lihue-Koloa Forest Reserve, along a ridge east-southeast of Puu Kolo to the summit (last seen in 1987), and Kokee State Park along Highway 550 near mile marker 19 (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a) (USFWS, 2010).

Current Range

Myrsine linearifolia grows in the Wahiawa Mountains, near Kapalaoa summit, south of a peak off the ridge between Hanapepe valley and Wahiawa drainage (USFWS, 2010). Island Distribution: Kauai (USFWS, 2021c)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Myrsine linearifolia on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

Critical habitat for Myrsine linearifolia is designated in six units totaling 4,491 acres in Kauai County, Hawaii. The units are Kauai 7—Myrsine linearifolia—a, Kauai 10—Myrsine linearifolia—b, and Kauai 11—Myrsine linearifolia—c, d, e, f.

Kauai 7—Myrsine linearifolia—a: This unit is critical habitat for Myrsine linearifolia and is 334 ha (825 ac) on private land. This unit contains Hokulei Peak, Haupu and Naluakeina Summits, and Queen Victoria's Profile. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial Myrsine linearifolia and is currently unoccupied. This unit is essential to the conservation of the taxon because it supports habitat that is important to the establishment of additional populations on Kauai in order to reach recovery goals. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order ro avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 10—Myrsine linearifolia—b: This unit is critical habitat for Myrsine linearifolia and is 167 ha (412 ac) on private and State land (LihueKoloa Forest Reserve). This unit contains Hulua, Kahili, and Kapalaoa Summits. This unit provides habitat for one population of 100 mature, reproducing individuals of the longlived perennial Myrsine linearifolia and is currently occupied with 47 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order ro avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Kauai 11—Myrsine linearifolia—c: This unit is critical habitat for Myrsine linearifolia and is 685 ha (1,692 ac) on State land (Alakai Wilderness Preserve), containing portions of Kipalau Valley. This unit provides habitat for three populations of 100 mature, reproducing individuals of the long-lived perennial Myrsine linearifolia and is currently occupied with 34 to 44 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as codominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order ro avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—Myrsine linearifolia—d: This unit is critical habitat for Myrsine linearifolia and is 286 ha (707 ac) on State (Halelea Forest Reserve, Hono o Na Pali NAR, and Na Pali Coast State Park) and private land. This unit contains Hono o Na Pali and Pali Eleele Summits, and Limahuli Falls. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial Myrsine linearifolia and is currently occupied with 23 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as codominant species. This unit is geographically separated from

the other five units designated as critical habitat for this island-endemic species, in order ro avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—Myrsine linearifolia—e: This unit is critical habitat for Myrsine linearifolia and is 345 ha (854 ac) on State land (Hono o Na Pali NAR, Kokee and Na Pali Coast State Parks). This unit contains Alealau, Pihea, and Puu o Kila Summits. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial Myrsine linearifolia and is currently occupied with 366 to 420 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order ro avoid all recovery populations from being destroyed by one naturally occurring catastrophe. Kauai 11—Myrsine linearifolia—f: This unit is critical habitat for Myrsine linearifolia and is 135 ha (334 ac) on State (Halelea Forest Reserve) and private land, containing Kaliko Summit. This unit provides habitat for one population of 100 mature, reproducing individuals of the long-lived perennial Myrsine linearifolia and is currently occupied with 20 to 30 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The habitat features contained in this unit that are essential for this species include, but are not limited to, diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as co-dominant species. This unit is geographically separated from the other five units designated as critical habitat for this island-endemic species, in order ro avoid all recovery populations from being destroyed by one naturally occurring catastrophe.

Primary Constituent Elements/Physical or Biological Features

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Diverse mesic or wet lowland or montane Metrosideros polymorpha forest with Cheirodendron spp. or Dicranopteris linearis as co-dominant species, and containing one or more of the following associated native plant species: Bobea brevipes, Cryptocarya mannii, Dubautia spp., Eurya sandwicensis, Freycinetia arborea, Hedyotis terminalis, Lysimachia glutinosa, Machaerina angustifolia, Melicope spp., Myrsine spp., Nothocestrum spp., Psychotria spp., Sadleria pallida, or Syzygium sandwicensis; and

(ii) Elevations between 129 and 1,345 m (424 and 4,411 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and

other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Lifespan

Adult: > 10 years (USFWS, 2010). Life Span: Long (USFWS, 2021c)

Reproduction Narrative

Adult: It is a long-lived perennial (USFWS, 2010).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist and wet forest (NatureServe, 2015); ohia-uluhe forest (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 1,920 - 4,200 ft. elevation (USFWS, 1998)

Habitat Narrative

Adult: Inhabits moist and wet forests on ridges and in gulches (NatureServe, 2015). It grows in Metrosideros polymorpha (ohia) - Dicranopteris linearis (uluhe) low wet forest with wind swept ridge and riparian vegetation (USFWS, 2010). Myrsine linearifolia typically grows in mesic to wet ohia forests that are sometimes co-dominant with olapa or uluhe from 585 to 1,280 meters (1,920 to 4,200 feet) elevation (USFWS 1996; 1998).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Stable (USFWS, 2022)

Species Trends:
Stable (USFWS, 2022)

Number of Populations:
~11 (USFWS, 2022)

Population Size:
100-750 (USFWS, 2022)

Population Narrative:
There are 164 - 197 wild individuals in 12 populations and 17 outplanted individuals. The numbers of populations and individuals have declined since the species was listed as threatened, but an accurate current status is not available (USFWS, 2010). Currently, Myrsine linearifolia is known from the upper cliffs of the Na Pali Coast to Koaiʻe in Waimea Canyon (Williams 2021, in litt.). In 2017, there were an estimated 11 populations with between 100-750 individuals (USFWS 2017). Currently, populations appear stable, with reproduction and regeneration observed during monitoring (S. Deans 2021, in litt.; A. Williams 2021, in litt.) (USFWS, 2022).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Threats which alter the habitat for Myrsine linearifolia include pigs (Sus scrofa), goats (Capra hircus), and mule deer (Odocoileus hemionus). Invasive introduced plant species which impact the habitat and compete with Myrsine linearifolia are Erigeron karvinskianus (daisy fleabane), Bryophyllum pinnatum (airplant), Axonopus fissifolius (narrow-leaved carpetgrass), Cyperus meyenianus (NCN), Holcus lanatus (common velvet grass), Melastoma septemnervium (NCN), Rhodomyrtus tomentosa (rose myrtle), Psidium cattleianum (strawberry guava), Pterolepis glomerata (NCN), Rubus argutus (blackberry), Rubus rosifolius (thimbleberry), and Stachytarpheta cayennensis (Brazilian tea) (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a, b; Perlman 2008; N. Tangalin, pers. comm. 2008; USFWS 1995) (USFWS, 2010).

Stressor: Herbivory (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Goats, rats (Rattus rattus), and mule deer are believed to eat Myrsine linearifolia (Hawaii Biodiversity and Mapping Program 2008; National Tropical Botanical Garden 2008a, b; Perlman 2008; N. Tangalin, pers. comm. 2008; USFWS 1995) (USFWS, 2010).

Stressor: Climate change loss or degradation of habitat

Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Myrsine linearifolia is vulnerable to the impacts of climate change, with a vulnerability score of 0.467 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Stressor: Fire destruction or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Fire can destroy dormant seeds as well as individual plants. Successive fires burn farther and farther into native habitat and alter microclimate conditions to further alter habitat conditions to favor nonnative plants. Nonnative plants convert native plant communities to nonnative dominated plant communities D'Antonio and Vitousek 1992; Tunison et al. 2002). Fire is reported as a threat to Myrsine linearifolia at Puu o Kila, Koaie, and Wahiawa drainage-Kahili (NTBG 2012d-f, 2013b-c, 2014c-d, 2016a-b) (USFWS, 2017).

Stressor: Hurricanes—Loss and degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Hurricanes were omitted in the last five year review. In November 1982, Hurricane Iwa struck the Hawaiian Islands, with wind gusts exceeding 100 miles per hour (mph) (161 kilometers per hour (kph)), causing extensive damage, especially on the islands of Niihau, Kauai, and Oahu (Businger 1998). In September 1992, Hurricane Iniki, a category 4 hurricane with maximum sustained wind speeds recorded at 140 mph (225 kph), passed directly over the island of Kauai. Many forest trees were destroyed (Perlman 1992), which opened the canopy and facilitated the invasion of nonnative plants (Kitayama and Mueller-Dombois 1995). A destructive hurricane holds the potential of driving a localized endemic species to extinction in a single event, and 70 percent of all listed plant species on Kauai are only found on Kauai. Hurricanes pose an ongoing and ever-present threat because they can happen at any time, although their occurrence is not predictable. Tropical cyclone frequency and intensity are projected to change as a result of climate change over the next 100 to 200 years (Vecchi and Soden 2007; Emanuel et al. 2008; Yu et al. 2010). In the central Pacific, modeling projects an increase of up to two additional tropical cyclones per year in the main Hawaiian Islands by 2100 (Murakami et al. 2013) (USFWS, 2017).

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Number of populations and individuals needed to meet Preventing Extinction Stage based on population and life history characteristics. Number of Populations: 3. Number of Individuals: 25 (USFWS, 2021c) Number of populations and individuals needed to meet Interim Stage based on population and life history characteristics. Number of Populations: 3. Number of Individuals: 100 (USFWS, 2021c) Number of populations and individuals needed for Downlisting based on population and life history characteristics. Number of Populations: 10. Number of Individuals: 200 (USFWS, 2021c)

Recovery Priority Number: 2

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on the Big Island (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population (for long-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Number of populations and individuals needed for delisting based on population and life history characteristics. Number of Populations: 10. Number of Individuals: 200 (USFWS, 2021c)

Recovery Actions:
- Protect current populations, control threats and monitor (USFWS, 1998).
- Expand current populations (USFWS, 1998).
- Conduct research essential to conservation of the species (USFWS, 1998).
- Establish new populations as needed to reach recovery objectives (USFWS, 1998).
- Validate and revise recovery criteria.
- Devise and implement a public education program.
- Maintenance of adequate genetic stock (USFWS, 1998).
- Development of management plans to control alien plant species (USFWS, 1998).
- New Management Actions: • Captive propagation for genetic storage and reintroduction—NTBG is currently germinating seeds and have plants in their nursery from Kalalau, Hono o Na Pali NAR and Upper Limahuli Preserve (NTBG 2017). This species has been difficult to determine if it is appropriate for long term seed storage and research is ongoing for other congeners (Keir and Weisenberger 2014, OANRP 2016; Lyon Arboretum 2017) (USFWS, 2017).

- Recommendations for Future Actions: Fire is reported as a new threat to Myrsine linearifolia at the Puu o Kila, Koaie, and Kahili (Wahiawa drainage) populations. No other significant new information regarding the species' biological status has been reported since the last 5-year review in 2010. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2017. • Surveys and inventories—Survey to determine the current status of the species and whether change in status from threatened to endangered is warranted. • Ungulate monitoring and control—Construct fenced exclosures to protect all populations against feral ungulates. Protect all occurrences against browsing and disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations. • Fire monitoring and control – Develop and implement fire prevention management plans. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Augment existing populations and create new populations in suitable protected habitat. • Predator and herbivore monitoring and control—Implement effective measures to control predation by ungulates and rats. • Population biology research—Study Myrsine linearifolia populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).
- Continue to collect seeds for adequate genetic storage (USFWS, 2010).
- Protect all populations against trampling, browsing and disturbances from feral ungulates (USFWS, 2010).
- Develop and implement methods of rat control for all populations (USFWS, 2010).
- Reintroduce to augment existing populations and create new populations in suitable protected habitat (USFWS, 2010).
- Work with Hawaii Division of Forestry and Wildlife and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2010).
- Survey to determine the current status of the species and whether change in status from threatened to endangered is warranted (USFWS, 2010).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are updated or reiterated for the 5-year review for 2022. • Surveys and inventories— o Survey to determine the current status of the species and whether change in status from threatened to endangered is warranted. o Determine sites that have the highest likelihood of maintaining reintroductions. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Myrsine linearifolia. • Site and habitat protection—Develop and implement effective control measures to reduce the impact of fire. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. • Predator and herbivore monitoring and control—Determine and implement effective methods to

control rodents. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Reintroduce individuals into suitable habitat that is being managed for known threats to this species to build resiliency and redundancy. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within and between populations and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2022).

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SPECIES ACCOUNT: *Navarretia fossalis* (Spreading navarretia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/13/1998; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Navarretia fossalis (spreading navarretia), a member of the Polemoniaceae (phlox family), is a low, mostly spreading or ascending annual plant, 4 to 6 in (10 to 15 cm) tall. The leaves are 0.4 to 2 in (1 to 5 cm) long and finely divided into slender spine-tipped lobes. The lower portions of stems are mostly hairless (glabrous). The flowers are arranged in flat-topped, compact, leafy heads. The white to lavender-white petals (corolla) are joined at their bases to form a tube, although the tips (lobes) are free. The fruit is an ovoid, two-chambered capsule. Each seed is covered by a layer that becomes sticky and viscous when the capsule is moistened. (USFWS, 2010)

Taxonomy

The range of N. fossalis overlaps with two other species in the genus Navarretia: N. intertexta (needle-leaved navarretia) and N. prostrata (prostrate navarretia). Navarretia fossalis is distinguished from the other two species by its linear corolla lobes, spreading or ascending habit, flat topped inflorescences, calyx size and shape (sepals collectively), and the position of the corolla relative to the calyx (Day 1993, p. 846). (USFWS, 2010)

Historical Range

See current range/distribution.

Current Range

The range of Navarretia fossalis extends from northwestern Los Angeles County to western Riverside County, and coastal San Diego County in California, to northwestern Baja California, Mexico (Figure 1). At the time of listing, 34 populations were considered extant in the United States, including populations contained in the listing rule and in the Recovery Plan. Nearly 60 percent of these populations were concentrated at three locations: Otay Mesa in southern San Diego County, alongside the San Jacinto River in western Riverside County, and near Hemet in western Riverside County (Bramlet 1993, pp. 10, 14; Bauder 1986a, pp. 4-11, 4-14). At listing, N. fossalis occupied less than 300 acres (120 hectares) of habitat in the United States (Service 1998b, p. 54978) (USFWS, 2023).

Critical Habitat Designated

Yes; 10/7/2010.

Legal Description

On October 7, 2010, the U.S. Fish and Wildlife Service (Service), designated final revised critical habitat for Navarretia fossalis (spreading navarretia) under the Endangered Species Act of 1973, as amended (75 FR 62192 - 62255). In total, approximately 6,720 acres (ac) (2,720 hectares (ha)) of habitat in Los Angeles, Riverside, and San Diego Counties, California, fall within the boundaries of the critical habitat designation. This final rule constitutes an overall increase of approximately 6,068 ac (2,456 ha) from the 2005 critical habitat designation for N. fossalis.

Critical Habitat Designation

The revised critical habitat designation for Navarretia fossalis includes six units totaling 6,720 acres in in Los Angeles, Riverside, and San Diego Counties, California. The units are Unit 1: Los Angeles Basin-Orange Management Area, Unit 2: San Diego: Northern Coastal Mesa Management Area, Unit 3: San Diego: Central Coastal Mesa Management Area, Unit 4: San Diego: Inland Management Area, Unit 5: San Diego: Southern Coastal Mesa Management Area, and Unit 6: Riverside Management Area.

Unit 1: Los Angeles Basin—Orange Management Area. Unit 1 is located in northwestern Los Angeles County and consists of two subunits totaling 176 ac (71 ha) of private land. Subunit 1A: Cruzan Mesa. Subunit 1A is located near the City of Santa Clarita in Los Angeles County. This subunit is on Cruzan Mesa, northwest of Forest Park and the Sierra Highway and southwest of Vasquez Canyon Road. Subunit 1A consists of 156 ac (63 ha) of private land and meets the selection criteria as satellite habitat. Cruzan Mesa is one of the only areas in Los Angeles County that supports mesatop vernal pools. As satellite habitat, this subunit supports a stable occurrence of Navarretia fossalis, provides potential connectivity with Subunit 1B, and likely supports a genetically distinct occurrence because of the separation of these two northern occurrences from other occurrences of N. fossalis. This subunit and Subunit 1B (described below) represent the most northern occurrences of this species. Subunit 1A contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as mowing or grading) that occur in the vernal pool basins. Subunit 1B: Plum Canyon. Subunit 1B is located near the City of Santa Clarita in Los Angeles County. This subunit is in Plum Canyon, west of Forest Park and the Sierra Highway and north of Plum Canyon Road. Subunit 1B consists of 20 ac (8 ha) of private land and meets the selection criteria as satellite habitat. As satellite habitat, this subunit supports a stable occurrence of Navarretia fossalis, provides potential connectivity with Subunit 1A, and likely supports a genetically distinct occurrence because of the separation of these two northern occurrences from other occurrences of N. fossalis. The Plum Canyon vernal pool habitat occurs on a flat area down-slope from the vernal pools on Cruzan Mesa. The vernal pools on Cruzan Mesa (Subunit 1A) and Plum Canyon represent the only habitat for N. fossalis in Los Angeles County and the most northern occurrences of this species. Subunit 1B contains the physical or biological features essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species within this subunit.

Unit 2: San Diego—Northern Coastal Mesa Management Area. Poinsettia Lane Commuter Station. Unit 2 is located in the City of Carlsbad in San Diego County and contains 6 ac (3 ha) of land owned by the North County Transit District and 3 ac (1 ha) of private land. This unit is loosely bounded by Avenida Encinas on the north, a housing development on the east, Poinsettia Lane on the south, and train tracks on the west. Unit 2 meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential

connectivity between occurrences on MCB Camp Pendleton and Subunits 4C1, 4C2, and 4D. The Poinsettia Lane vernal pool complex consists of a series of vernal pools that run parallel to a berm created by the train tracks. Unit 2 contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this unit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins.

Unit 3: San Diego—Central Coastal Mesa Management Area. Unit 3 is located in central coastal San Diego County and consists of three subunits totaling 103 ac (42 ha). This unit contains 102 ac (42 ha) owned by State and local governments, and approximately 1 ac (less than 1 ha) of private land. Subunit 3B: Carroll Canyon. Subunit 3B is located in the City of San Diego in San Diego County. This subunit is located to the southwest of the intersection of Parkdale Avenue and Osgood Way, and is loosely bounded by residential development on the north, open space to the east, and a quarry to the south and west. Subunit 3B consists of approximately 18 ac (7 ha) that includes 17 ac (7 ha) of land owned by State or local governments and 1 ac (less than 1 ha) of private land. Subunit 3B meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 3A and 3C. The Carroll Canyon vernal pool complex consists of a group of vernal pools on the edge of a mesa north of Carroll Canyon. Historically, there may have been more habitat for this species; however, the majority of vernal pool habitat in the vicinity of this subunit has been developed. Subunit 3B contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as trespass or illegal trash dumping) that occur in the vernal pool basins. Subunit 3C: Nobel Drive. Subunit 3C is located in the City of San Diego in San Diego County. This subunit is loosely bounded by the 805 interstate on the northeast, train tracks on the south, and Nobel Drive on the northwest. Subunit 3C consists of 37 ac (15 ha) of land owned by local government and meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 3B and 3D. The Nobel Drive vernal pool complex consists of a group of vernal pools on a mesa-top north of Rose Canyon. Subunit 3C contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 3D: Montgomery Field. Subunit 3D is located in the City of San Diego in San Diego County. This subunit is located at Montgomery Field (airport) to the northeast of the runway area. Subunit 3D consists of 48 ac (20 ha) of land owned by the City of San Diego and meets the selection criteria as satellite habitat. As satellite habitat, this subunit supports a stable occurrence of Navarretia fossalis and provides potential connectivity with the occurrence in Subunit 3C. The Montgomery Field vernal pool

complex consists of a large group of vernal pools east of the runway area at Montgomery Field, although only the northeastern portion of this vernal pool complex is being designated as critical habitat because the southeastern portion of this vernal pool complex has been hydrologically disconnected from other vernal pools by past development, is now isolated, and does not meet the definition of essential habitat. Navarretia fossalis has not been documented in the southeastern portion of this vernal pool complex. Subunit 3D contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species that occur in the vernal pool basins.

Unit 4: San Diego—Inland Management Area. Unit 4 is located within inland San Diego County and consists of four subunits totaling 206 ac (83 ha). This unit contains 18 ac (7 ha) owned by State and local governments, and 188 ac (76 ha) of private land. Subunits 4C1, 4C2, and 4D: San Marcos. Subunits 4C1, 4C2, and 4D are located in the City of San Marcos in San Diego County. These three subunits consist of three separate vernal pool complexes. The first (Subunit 4C1) is loosely bounded by La Mirada Drive on the northeast, Las Posas Road on the southeast, Linda Vista Drive on the southwest, and South Pacific Street on the northwest. The second (Subunit 4C2) is loosely bounded by Linda Vista Drive on the northeast, Las Posas Road on the east, West San Marcos Boulevard on the south, and South Pacific Street on the west. The third (Subunit 4D) is loosely bounded by South Bent Avenue on the northeast, commercial development on the southeast and southwest, and Linda Vista Drive on the northwest. Subunit 4C1 consists of 34 ac (14 ha) of private land, Subunit 4C2 consists of 15 ac (6 ha) of land owned by local government and 17 ac (7 ha) of private land, and Subunit 4D consists of 5 ac (2 ha) of private land. These three subunits meet the selection criteria as satellite habitat areas because they support stable occurrences of Navarretia fossalis and provide potential connectivity between occurrences in Unit 2 and Subunit 4E. The Service grouped these vernal pool complexes because of the clustered nature of these occurrences. These subunits have separate subunit numbers to be consistent with the numbering identified in the 2005 critical habitat designation. Subunits 4C1, 4C2, and 4D contain the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in these subunits may require special management considerations or protection to address threats from nonnative plant species and activities (such as commercial development, trespass, or OHV use) that occur in the vernal pool basins. Subunit 4E: Ramona. Subunit 4E is located in the unincorporated community of Ramona. This subunit is loosely bounded by the Ramona Airport and Ramona Airport Road on the north, Sawday Road on the east, Santa Maria Creek on the south, and a series of rock outcrops on the west. Subunit 4E consists of approximately 135 ac (55 ha) that includes 3 ac (1 ha) of land owned by State or local governments and 132 ac (53 ha) of private land. Subunit 4E meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity with occurrences in Subunits 4C1, 4C2, and 4D. The vernal pools in this subunit occur in gently sloping grassland habitat and are at the highest elevation where N. fossalis is known to occur. Subunit 4E contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1),

intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as agricultural activities or recreational use) that occur in the vernal pool basins.

Unit 5: San Diego—Southern Coastal Mesa Management Area. Unit 5 is located in southern San Diego County and consists of six subunits totaling 748 ac (303 ha). This unit contains 28 ac (11 ha) of federally owned land, 330 ac (134 ha) of land owned by State and local governments, and 390 ac (158 ha) of private land. Subunit 5A: Sweetwater Vernal Pools. Subunit 5A is located southwest of the Sweetwater Reservoir. This subunit is loosely bounded by the Sweetwater Reservoir on the north, steeply sloping topography on the east, State Route 125 on the south, and an unnamed drainage on the west. Subunit 5A consists of approximately 95 ac (38 ha) and includes 23 ac (9 ha) of Federal land that is part of the San Diego National Wildlife Refuge Complex, 1 ac (less than 1ha) of land owned by the State, and 71 ac (29 ha) of land owned by local government. This subunit meets our selection criteria as satellite habitat. This satellite habitat subunit supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 5B and 5F. Some of the area occupied by N. fossalis was lost during the construction of State Route 125. The soil from that area was salvaged and is being used to restore other vernal pools in this subunit. Subunit 5A contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5B: Otay River Valley. Subunit 5B is located in the City of Chula Vista and unincorporated San Diego County. This subunit is loosely bounded by Olympic Parkway on the north, a housing development on the east, and a landfill to the southwest. Subunit 5B consists of 24 ac (10 ha) of private land and meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5A and 5H. Subunit 5B contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5C: Otay Mesa. Subunit 5C is located on the eastern portion of Otay Mesa, directly northwest of and adjacent to the George F. Bailey Detention Facility at the terminus of Alta Road. Subunit 5C consists of 26 ac (11 ha) of State and local governmentowned land, and 16 ac (7 ha) of private land, and it meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5G and 5I. Subunit 5C contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical

and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5F: Proctor Valley. Subunit 5F is located between the unincorporated communities of Eastlake and Jamul in San Diego County. This subunit is located along Proctor Valley Road in Proctor Valley. Subunit 5F consists of approximately 88 ac (36 ha) and includes 51 ac (21 ha) of land owned by the City of San Diego and 37 ac (15 ha) of private land. Subunit 5F meets the selection criteria as satellite habitat because it supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5A and 5G. The vernal pools in this subunit occur in Proctor Valley on a flat area that is slightly elevated from the stream channel that runs through this valley. The vernal pools in this subunit to the west of Proctor Valley Road are severely impacted by OHV use, but the vernal pools to the east of Proctor Valley road remain relatively intact. Subunit 5F contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or OHV use) that occur in the vernal pool basins. Subunit 5G: Otay Lakes. Subunit 5G is located east of the City of Chula Vista in San Diego County. This subunit is loosely bounded by Lower Otay Reservoir to the north and west and by the slopes of Otay Mountain to the southeast. Subunit 5G consists of 140 ac (57 ha) of land owned by State or local governments and meets the selection criteria as satellite habitat because this location supports a stable occurrence of Navarretia fossalis and provides potential connectivity between occurrences of N. fossalis in Subunits 5F and 5I. The vernal pool complexes in this subunit are located on the flat areas to the south of Lower Otay Reservoir. Subunit 5G contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use) that occur in the vernal pool basins. Subunit 5H: Western Otay Mesa vernal pool complexes. Subunit 5H is located within the Otay Mesa Community planning area of the City of San Diego. Subunit 5H consists of approximately 139 ac (56 ha) that includes 41 ac (17 ha) of land owned by local governments and 98 ac (40 ha) of private land. Subunit 5H and Subunit 5I encompass the core habitat on Otay Mesa. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 5G and 5I. This subunit contains several mesa-top vernal pool complexes on western Otay Mesa (Bauder vernal pool complexes J 2N, J 2S, J 2W, J 4, J 13N, J 13S, J 14, J 33, J 34 as in Appendix D of City of San Diego, 2004). Subunit 5H contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or residential and commercial development) that occur in the vernal pool basins. Subunit 5I: Eastern Otay Mesa vernal pool

complexes. Subunit 5I is located in the City of San Diego. This subunit contains several mesa top vernal pool complexes on eastern Otay Mesa. Subunit 5I consists of 221 ac (89 ha) of private land. Subunit 5I and Subunit 5H encompass the core habitat on Otay Mesa. As core habitat, Subunit 5I contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 5B and 5H. This subunit contains several mesa-top vernal pool complexes on eastern Otay Mesa (Bauder vernal pool complexes J 22, J 29, J 30, J 31N, J 31S as in Appendix D of City of San Diego, 2004 and Service GIS). Subunit 5I contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as unauthorized recreational use or residential and commercial development) that occur in the vernal pool basins.

Unit 6: Riverside Management Area. Unit 6 is located in western Riverside County and consists of three subunits totaling 5,477 ac (2,217 ha). This unit contains 1,504 ac (609 ha) of land owned by the State of California's Department of Fish and Game and 3,973 ac (1,608 ha) of private land. Subunit 6A: San Jacinto River. Subunit 6A is generally located along the San Jacinto River near the cities of Hemet and Perris in Riverside County. This subunit is loosely bounded by Mystic Lake on the northeast and by the Perris Airport on the southwest. Subunit 6A consists of approximately 4,312 ac (1,745 ha), including 1,504 ac (609 ha) of land owned by State or local governments and 2,808 ac (1,136 ha) of private land. Subunit 6A encompasses core habitat along the San Jacinto River. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 6B and 6C. This subunit consists of seasonally flooded alkali vernal plains that occur along the San Jacinto River. Subunit 6A contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping or flood control) that occur in the vernal pool basins and associated watershed area. Subunit 6B: Salt Creek Seasonally Flooded Alkali Plain. Subunit 6B is located near the City of Hemet and west of the Hemet-Ryan Airport in Riverside County. This subunit is loosely bounded by Devonshire Avenue on the north, the boundary for the City of Hemet on the east, train tracks on the south, and lowlying hills on the west. Subunit 6B consists of 930 ac (376 ha) of private land that encompasses the core habitat along the Upper Salt Creek drainage west of the City of Hemet. As core habitat, this subunit contains a large area of habitat that supports sizable occurrences of Navarretia fossalis and provides potential connectivity between occurrences in Subunits 6A and 6C. This subunit consists of seasonally flooded alkali vernal plains not subject to U.S. Army Corps of Engineer jurisdiction. Subunit 6B contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to

address threats from nonnative plant species and activities (such as manure dumping, grazing, flood control, or discing for vegetation control) that occur in the vernal pool basins and associated watershed area. Subunit 6C: Wickerd and Scott Road Pools. Subunit 6C is located in the City of Menifee in Riverside County, California. This subunit is loosely bounded by low lying hills north of Garbani Road on the north, Briggs Road on the east, Scott Road on the south, and Menifee Road on the west. Subunit 6C consists of 235 ac (95 ha) of private land. This subunit meets the selection criteria as satellite habitat because this location supports a stable occurrence of Navarretia fossalis and provides potential connectivity among occurrences of N. fossalis in Subunits 6A, 6B, and with Subunit 6D that the Service is excluding under section 4(b)(2) of the Act (see Application Section 4(b)(2) of the Action section). This subunit consists of two large vernal pools. Subunit 6C contains the physical and biological features that are essential to the conservation of N. fossalis, including ephemeral wetland habitat (PCE 1), intermixed wetland and upland habitats that act as the local watershed (PCE 2), and the topography and soils that support ponding during winter and spring months (PCE 3). The physical and biological features essential to the conservation of the species in this subunit may require special management considerations or protection to address threats from nonnative plant species and activities (such as manure dumping, residential or agricultural development, discing for vegetation control, or maintenance of existing pipelines) that occur in the vernal pool basins and associated watershed area.

Primary Constituent Elements/Physical or Biological Features

Within these areas, the primary constituent elements (PCEs) for Navarretia fossalis consist of three components:

(i) PCE 1—Ephemeral wetland habitat. Vernal pools (up to 10 ac (4 ha)) and seasonally flooded alkali vernal plains that become inundated by winter rains and hold water or have saturated soils for 2 weeks to 6 months during a year with average rainfall (i.e., years where average rainfall amounts for a particular area are reached during the rainy season (between October and May)). This period of inundation is long enough to promote germination, flowering, and seed production for Navarretia fossalis and other native species typical of vernal pool and seasonally flooded alkali vernal plain habitat, but not so long that true wetland species inhabit the areas.

(ii) PCE 2—Intermixed wetland and upland habitats that act as the local watershed. Areas characterized by mounds, swales, and depressions within a matrix of upland habitat that result in intermittently flowing surface and subsurface water in swales, drainages, and pools described in PCE 1.

(iii) PCE 3—Soils that support ponding during winter and spring. Soils found in areas characterized in PCEs 1 and 2 that have a clay component or other property that creates an impermeable surface or subsurface layer. These soil types include, but are not limited to: Cieneba-Pismo-Caperton soils in Los Angeles County; Domino, Traver, Waukena, Chino, and Willows soils in Riverside County; and Huerhuero, Placentia, Olivenhain, Stockpen, and Redding soils in San Diego County.

Special Management Considerations or Protections

Critical habitat does not include manmade structures existing on the effective date of this rule and not containing one of more of the primary constituent elements, such as buildings, aqueducts, airports, and roads, and the land on which such structures are located.

Special management considerations or protection are required within critical habitat areas to address threats. Management activities that could ameliorate these threats include (but are not limited to) fencing Navarretia fossalis occurrences to prevent soil compaction and providing signage to discourage encroachment by hikers, cattle, sheep, and OHV activity; control of nonnative plants using methods shown to be effective; guiding the design of development projects to avoid impacts to N. fossalis habitat; enacting local ordinances to prohibit manure dumping; and restoring and maintaining natural hydrology and floodplain dynamics of watersheds associated with N. fossalis occurrences where feasible. These management activities will protect the PCEs for the species by reducing soil compaction to help maintain an impermeable surface (PCE 3) that supports ephemeral wetland habitat (PCE 1), which is needed to promote germination, flowering, and seed production for N. fossalis. Additionally, management of critical habitat lands will help maintain both the wetland and upland habitat that acts as the local watershed and provides intermittent flowing water on the surface and subsurface (PCEs 2 and 3).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2010)

Lifespan

Adult: 1 year (USFWS, 2010)

Breeding Season

Adult: May to June (USFWS, 2010)

Reproduction Narrative

Adult: Navarretia fossalis (spreading navarretia), a member of the Polemoniaceae (phlox family), is a low, mostly spreading or ascending annual plant. Plants usually flower in May and June because vernal pools must be devoid of standing water before plants begin to flower. Navarretia fossalis has a low pollen to ovule ratio, suggesting there is frequent self-pollination (Spenser et al. 1998, p. 81; D. Boose, Gonzaga University, pers. comm. 2008). Outcrossing, rather than self-pollination, could be advantageous for many vernal pool specialists because it provides a way to better adapt and evolve to the changing conditions of vernal pool habitat through the recombination of beneficial genes (Spenser et al. 1998, p. 81). (USFWS, 2010)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Grassland/herbaceous, playa/salt flat, vernal pools (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Dependent on the ephemeral inundation cycle found in vernal pool habitat and playa; temperature and moisture likely affect timing of germination; fruit absorbs water and expand to

break open the fruit after rain (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: Requires areas that are ephemerally wet in winter and spring but dry in summer and fall; vernal pools range in size from 10 to 164 feet wide (USFWS, 2010)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2010)

Habitat Narrative

Adult: Navarretia fossalis is typically found in vernal pool (seasonal depression wetlands) habitat, particularly in Los Angeles and San Diego Counties. In western Riverside County, however, N. fossalis is associated with seasonally flooded alkali vernal plain habitat that includes alkali playa (highly alkaline, poorly drained), alkali scrub, alkali vernal pool, and alkali annual grassland components. Vernal pools form in swales, shallow drainages, and depressions that are part of an undulating landscape where soil mounds are interspersed with basins, all above water-impervious soil layers. The hydrologic regime in western Riverside County, however, is unique. Navarretia fossalis here is associated with alkali soils series (Bramlet 1993, p. 1; USFWS 1994, p. 64812), which facilitate a hydrologic regime for this habitat involving sporadic flooding in combination with slow drainage on the alkaline soils. The listing rule states that Navarretia fossalis can also occur in ditches and other artificial depressions often associated with degraded vernal pool habitat (USFWS 1998b, p. 54978; Moran 1977, p. 155). Pools range in size from 10 to 164 feet (3 to 50 meters) across (Zedler 1987, p. 1). Navarretia fossalis abundance also varies from year to year depending on precipitation and the inundation/drying time of the vernal pool. Navarretia fossalis is dependent on the ephemeral inundation cycle found in vernal pool habitat and playas, but may also occur in man-made depressions and ditches that have the same hydrological dynamics. For many vernal pool plant species, temperature and moisture affect the timing of plant germination (Myers 1975, p. 67). Although not proven, it is likely that N. fossalis uses these same cues for germination. Most Navarretia species have indehiscent fruit, or fruit with fibers that absorb water and expand to break open the fruit after a substantial rain (Spenser et al. 1998, p. 82). The timing of germination is important so that the plant germinates under favorable conditions in the spring rather than the summer, autumn, or winter. Navarretia fossalis abundance also varies from year to year depending on precipitation and the inundation/drying time of the vernal pool. (USFWS, 2010)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: We have minimal information on the dispersal of Navarretia fossalis seeds. However, we know the seed has a layer that becomes viscous and sticky when wet. The seed could stick to an animal or bird passing through the vernal pool, providing a method of dispersal. On the other hand, theories also suggest the layer helps secure the seed during seed establishment (Sorenson 1986, p. 444). (USFWS, 2010)

Population Information and Trends

Population Trends:

Long-term trends suggest a decline of >90%, while short-term trends indicate a decline of 50-70% (NatureServe, 2015)

Number of Populations:

55 extant occurrences; 17 presumed extant (USFWS, 2023)

Population Narrative:

Currently, there are 48 extant occurrences of N. fossalis. It is estimated that greater than 90 percent of the vernal pool habitat in southern California has been lost due to human activities (Bauder and McMillan 1998, Keeler-Wolf et al. 1998 cited in USFWS 2005). Long-term population trends suggest a decline of >90%, while short-term trends indicate a decline of 50-70%. Individual plants numbering 375,000 were estimated at one California occurrence in 1991-1992 and 100,000 individuals at another in 1998; these occurrences, both in Riverside County, are the largest known for the species (USFWS 2005). Other occurrence counts have indicated a range of sizes from 20 to 50,000+ individuals, but overall most occurrences outside the two largest are believed to be relatively small (< 1,000) (USFWS 2005). The total California population might be around 500,000-600,000 individuals in a wet year, but given that this species is an annual and that single sites are known to vary greatly in population size due to year-to-year variations in precipitation and temperature (USFWS 2005), estimates of plant numbers based on short-term data should be used very cautiously. (USFWS, 2010; NatureServe, 2015). In 2009, of 51 occurrences that were examined, 48 occurrences were considered extant. This included 17 occurrences that had not been known at listing, 12 occurrences where suitable habitat remained but the species had not been located during surveys, and 7 occurrences that had not been surveyed since listing. The 2009 review did not include 9 occurrences in Baja California, or 12 occurrences that had not been seen since prior to listing. In addition, the 2009 review considered the occurrences at Cruzan Mesa, the San Jacinto River, Upper Salt Creek, and Otay Lakes each to be single populations, while this review includes multiple occurrences at those locations. Currently, of 100 Navarretia fossalis populations we examined, 55 are extant, 17 are presumed extant, 6 are possibly extirpated, and 22 have been extirpated. Of the 22 extirpated occurrences, 12 had not been seen since prior to listing, though two of these (EO 2, 58) were included as extant in the 2009 review. In addition, 3 were in Baja California, and 2 were extirpated in the early 2000s (EO 77, EO 1) but the adjacent mitigation areas (EO 20, 53) were addressed as extant in the 2009 review. Finally, 3 were documented as extirpated in the 2009 review; However, one of these (EO 69) was observed in 2020 but has since been extirpated. Two additional populations (EO 46, EO 76) have been extirpated in the time since the last review (USFWS, 2023).

Threats and Stressors

Stressor: Urbanization (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The threat of development has lessened since listing due to a limited amount of permanent protection and some conservation measures now in place, although urbanization is still a predominant threat to N. fossalis. Components of urbanization include the direct loss of habitat from development, alteration of hydrology, transportation and flood control projects, grading, pipeline construction, and OHV use. The population of Riverside County is predicted to

grow 46.3 percent from 2000 to 2020 while Los Angeles and San Diego Counties are predicted to grow 20.2 and 14.6 percent, respectively (California Department of Finance 2007, Table 2). These predictions suggest urbanization pressures will continue to rise within the range of Navarretia fossalis, posing an increasing threat to remaining populations near growing cities in southern California. (USFWS, 2010)

Stressor: Direct habitat loss to development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Since listing, three (possibly four) Navarretia fossalis occurrences were extirpated by development (S. Brown, U. S. Fish and Wildlife Service, pers. obs. 2008). Wickerd Pool in Riverside County was affected by the installation of a water pipeline across the occurrence (USFWS 2001a, p.1). Also, 9 of the 48 occurrences are proposed for development (San Jacinto River, Stetson-Warren/Hemet, Menifee, Scott Pool, Date Street, Los Caballos, Pacific Street, Montgomery Field, J 29-30). Development plays a role in the fragmentation and habitat isolation of Navarretia fossalis. Habitat fragmentation within Navarretia fossalis occurrences or groups of nearby occurrences may also disrupt hydrological systems and create barriers to dispersal. The Service encourages project proponents to develop projects that avoid isolating vernal pools or dividing occurrences into ecologically separate fragments, and to configure preserved or restored sites adjacent to and continuous with existing preserve areas. Whenever vernal pools in a complex are impacted by development, some degree of fragmentation occurs within and among complexes. Fragmentation and associated impacts to hydrology and dispersal continue to threaten N. fossalis throughout its range. Since listing, many Navarretia fossalis occurrences impacted by development have been restored or partially restored. These restorations help offset impacts from development of vernal pool habitat. The threat to N. fossalis habitat from urbanization has decreased since listing, although habitat loss from development is an ongoing predominant threat. (USFWS, 2010)

Stressor: Agricultural Conversion (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Conversion of land for the purposes of grazing or farming was cited in the listing rule as a threat to Navarretia fossalis, especially in Riverside County (USFWS 1998b, p. 54985). These factors continue to threaten the San Jacinto River and flood plain in Riverside County, but are not threats in San Diego or Los Angeles Counties (Table 2). Five occurrences in Riverside County are documented as affected by agricultural practices (San Jacinto River, Stowe Pool, Menifee Pool, Wickerd Pool, and Johnson Ranch). (USFWS, 2010)

Stressor: Discing (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Discing for weed abatement, fire suppression, and dry-land farming were listed as threats to Navarretia fossalis in the final listing rule (USFWS 1998, 63 FR 54984). Discing turns up the soil and inhibits N. fossalis from germinating. It can destroy vernal pools and affect the long-term viability of N. fossalis. Vernal pools are frequently selected as sites to implement fire

prevention measures, such as discing, because they are in open areas near development and often support a considerable cover of highly flammable, nonnative grass. Since listing, discing along roads and around development for weed abatement or fuel modification has continued. Discing for agricultural conversion is most abundant in Riverside County, where often such land is considered historically agricultural and therefore is exempt from many of the conservation measures in the Western Riverside County Multiple Species HCP (Western Riverside County MSHCP). Navarretia fossalis habitat was observed to be disced at Stowe Pool, historically one of the most abundant occurrences of the species (Brown, pers. obs. 2006a). Discing continues to be a threat to N. fossalis. (USFWS, 2010)

Stressor: Manure dumping (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Although not identified at the time of listing, manure dumping has become a threat to the longterm viability of Navarretia fossalis in some areas of western Riverside County. This threat is especially evident along the San Jacinto River, which harbors the most extensive occurrences of N. fossalis (Roberts 2005, p. 4 and Attachment A; Brown, pers. obs. 2006b; F. Roberts, USFWS, pers. comm. 2008; A. Braswell, pers. obs. 2008; E. Kashac, Santa Ana Regional Water Quality Control Board, pers. comm. 2008). The Wickerd Pool occurrence has also been affected by manure dumping. When manure or water that leaches through it washes into the flood plain and river, it changes the pH and the soil composition. This inhibits germination of N. fossalis and increases nutrients, which promotes the growth of invasive nonnative plant species such as Chenopodium spp. (goosefoot), Brassica nigra (black mustard), and Salsola tragus (Russian thistle) (Roberts 2004, p. 7). (USFWS, 2010)

Stressor: Alteration of hydrology (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Increased urban runoff and channelized drainage of lands can change the inundation of a pool (USFWS 1998b, pp. 54984-54985). At listing, alteration of hydrology was considered a predominant threat to Navarretia fossalis. Instances of wetlands drainage for purposes of agriculture or development in Riverside County resulted in the loss of N. fossalis populations (USFWS 1998b, p. 54985). The Service considered the remaining wetlands available to N. fossalis as smaller and more vulnerable to the effects of surrounding development than they were earlier in the century. Since listing, there have been five accounts (San Jacinto River, Scott Pool, Mesa de Burro, Pacific Street, and Sweetwater High School) of direct alteration of hydrology to vernal pools or complexes that support Navarretia fossalis. Development can alter the timing, frequency, and duration of vernal pool inundation as well as water temperature. Modifications to the uplands surrounding a vernal pool can negatively affect the pool's hydrology, even if such modifications occur outside the pool's surface watershed. For example, grading cuts near pools can accelerate the flow of water out of the subsoil (Bauder 1986b, p. 210). As such, graded slope-cuts adjacent to the watersheds of depressional features may result in "leakage" of water out of the watersheds. Such grading of the watershed was observed at the Mesa de Burro occurrence when a road adjacent to the vernal pool was graded in 2003 without authorization (D. Stadlander, U. S. Fish and Wildlife Service, pers. obs. 2003). Disturbance may also allow invasive plants or non-vernal pool species to occupy the pools and compete with vernal pool

plant species (Bauder 1986a, pp. 21-22), or may also alter the composition of native species of a vernal pool. As an obligate wetland species, Navarretia fossalis depends on compatible, seasonal inundation. Navarretia fossalis is vulnerable to changes in water levels and periods of inundation. Although some watersheds have been conserved and instances of runoff avoided through section 7 consultations, alteration of hydrology remains a predominant threat to many N. fossalis occurrences. (USFWS, 2010)

Stressor: Transportation and flood control projects (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The listing rule identified SR 125 construction on Otay Mesa as a project that could impact Navarretia fossalis habitat. This transportation project is completed and directly impacted the occurrences at Sweetwater Reservoir and J 29-30 vernal pool complexes. State Route 11 is planned southeast of SR 125 on Otay Mesa. Though habitat is present, N. fossalis was not detected and Caltrans anticipates future potential indirect impacts in the form of edge effects to occurrences if they are discovered in the area (USDOT and Caltrans 2008, pp. 3.20-11-3.20-15). Scott Road in Riverside County was also widened, threatening but not destroying the Scott Pool occurrence (Terra Nova 2007, Exhibit 6). The San Jacinto River Improvement Project is an ongoing proposal identified at the time of listing that is not yet complete. The proposed project will affect some sections of N. fossalis habitat along the San Jacinto River, and preserve other sections (Dudek and Associates 2003, pp. 7-59). State Route 79 was proposed to run through the Upper Salt Creek occurrence in Hemet prior to the listing of N. fossalis, but now an alternate route is being proposed. Through mitigation and avoidance measures, the Service believes that transportation and flood control projects are not a predominant threat to N. fossalis at this time. (USFWS, 2010)

Stressor: Grading (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The grading of vernal pool habitat was identified as a threat to Navarretia fossalis in the listing rule (USFWS 1998b, p. 57984). Grading can change vernal pool hydrology, turn up the soil, and destroy the habitat and vegetation. Since listing, Service files indicate that three occurrences have been graded: 1) the Cruzan Mesa occurrence; 2) the Arjons area, which is along the east edge of the Carroll Canyon Preserve occurrence; and 3) the aforementioned grading at the Mesa de Burro occurrence (Table 2). Since grading continues to occur, we still consider it a threat to N. fossalis. (USFWS, 2010)

Stressor: Pipeline construction (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A pipeline project was identified as a threat to Navarretia fossalis in the listing rule (USFWS 1998b, p. 54984). Since that time, there have been two cases of pipeline construction through a vernal pool (Table 2). First, a pipeline was run directly through Wickerd Pool in Riverside County with no mitigation for the effects of the project (USFWS 2001b, p.1). Second, a proposed storage pond and pipeline for a recycled water storage system would destroy 200 acres

(81 hectares) of land on the San Jacinto River Wildlife Area (USFWS 2008, p.1). Since listing, pipeline construction has affected the habitat of N. fossalis without mitigation or avoidance of vernal pools and we still consider pipeline construction a threat. (USFWS, 2010)

Stressor: Off-highway vehicles (OHV) (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, OHV use was described as an ongoing threat to Navarretia fossalis in Riverside and San Diego Counties (USFWS 1998b, p. 54984). This type of activity may alter the hydrology, degrade habitat, and compromise the existence of N. fossalis within vernal pools (e.g., crush plants). Currently, OHV impacts fall into three categories: recreational (often illegal) on private or public property, Border Patrol activities, and emergency response actions. Since listing, OHV activity has impacted the majority of pools in the Otay Mesa region, and is documented in 12 pools in San Diego County and 1 pool in Los Angeles County (Table 2). Most of these accounts are from recreational vehicles trespassing on protected property, despite efforts of landowners to deter illegal trespass. However, vernal pools at Otay Mesa are threatened by OHV use associated with Border Patrol activities (City of San Diego 2006, pp. 136-140). These roads are often used and expanded by recreational OHV users. Despite attempts to deter this activity using fencing and signage, off-highway vehicle activity remains a threat to N. fossalis. To a lesser degree, OHV use for emergency response (e.g., fire suppression and aviation emergencies) and law enforcement actions may impact Navarretia fossalis habitat. Many vernal pools occur within areas that are prone to fire, such as the vernal pools at Otay Lakes that burned in the 2003 Otay Fire. Fire suppression activities may impact vernal pools and N. fossalis due to vehicle and people/equipment movement through pools or creation of firebreaks. Additionally, aviation emergency response may occur at vernal pools near the Ramona, Montgomery Field, and Marine Corps Air Station (MCAS) Miramar airports. Today, OHV use remains a threat to Navarretia fossalis, especially from Border Patrol and recreational activities near vernal pools on Otay Mesa. Installation and maintenance of fencing and signage are needed to help protect N. fossalis habitat from the impact of OHV users. (USFWS, 2010)

Stressor: Grazing (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Sheep herbivory and cattle grazing were reported at listing as threats to Navarretia fossalis under Factor A, but are treated under Factor C in this 5-year review. There has been only one reported incident of grazing affecting N. fossalis since listing. Sheep grazed on Stowe Pool and reportedly ate the flowering heads of N. fossalis and trampled the pool (Roberts, pers. comm. 2005). Disease and predation are not considered wide spread or rangewide threats for N. fossalis. (USFWS, 2010)

Stressor: Competition with invasive non-native plants (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The listing rule stated that nonnative species of grasses and forbs invade many plant communities often as an indirect result of habitat disturbance (USFWS 1998b, p. 54988). At

listing, many vernal pools on Otay Mesa or in the City of San Macros were dominated by the nonnative Lolium perenne (perennial ryegrass). The ryegrass displaced Navarretia fossalis in many vernal pools because ryegrass is more tolerant of inundation. The listing rule cited another nonnative grass, Crypsis schoenoides (swamp pricklegrass), as replacing N. fossalis in the San Jacinto River Wildlife Area in Riverside County (USFWS 1998b, pp. 54988-54989). Approximately 60 percent (29 of 48) of the existing N. fossalis occurrences are threatened by invasive nonnative plants. Invasive nonnative plants that may impact Navarretia fossalis are divided into three groups: (1) upland species with less tolerance for inundation, (2) plants with inundation tolerance comparable to native vernal pool species, and (3) marsh or wetland species that require a long inundation period (Bauder 1996, p. 2). Altered hydrology can change the inundation period of an area and indirectly affects species that are less or more water tolerant than native vernal pool species, resulting in elimination from or invasion into vernal pool habitat (Bauder 1986b, p. 210). Alternatively, if natural hydrology persists, the number of nonnatives able to invade may be limited by the inundation period (Bauder 1996, p. 2). Development and OHV use (both discussed under Factor A), human access, and disturbance effects (see below) typically alter the hydrology of vernal pools. Additionally, manure dumping can change soil chemistry and facilitate invasives in normally unfavorable areas. These alterations lead to a higher disturbance level and therefore a greater likelihood of invasion by nonnative species (Bauder 2005, p. 2134). Depending upon conditions, certain invasive nonnative plants, such as the grasses discussed above, may replace Navarretia fossalis. Therefore, we consider invasive nonnative plants to be a continuing threat to N. fossalis. (USFWS, 2010)

Stressor: Human access and disturbance effects (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Separation of Navarretia fossalis occurrences through habitat loss and fragmentation is often accompanied by the introduction or exacerbation of indirect effects associated with human access, or disturbance associated with adjacent development. Examples include trash dumping, trampling, and nonnative plant invasions. In the listing rule for N. fossalis, trash dumping, trampling, and invasive nonnative plant species were cited as threats to the species (USFWS 1998b, p. 54988). All known occurrences of Navarretia fossalis may potentially be affected by human access and disturbance impacts from surrounding development (Table 2). Since listing, impacts associated with adjacent development have been documented to occur at 35 (71 percent) of the N. fossalis occurrences (Table 2). For example, asphalt was dumped at the Upham occurrence in San Macros during road repairs in 2001 (J. Upham, owner, pers. comm. 2001). This small property is completely surrounded by development and is highly impacted by human-related disturbance. Pedestrians can introduce invasive nonnative plants that result in altered hydrology and competition with native plants. Protective fencing is used in many conserved occurrences to protect vernal pool complexes. Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still pose a predominant threat to N. fossalis. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:

Narrative: The listing rule stated that drier conditions and drought are threats to Navarretia fossalis, which relies on seasonal rainfall and the pooling of water. Drier conditions physiologically stress the species and reduce its germination and survival rates (USFWS 1998b, p. 54989). Additionally, other threats may have an increased impact when combined with impacts from climate change. Data from 1986 to 1992 indicate drought was related to a decrease in the abundance of N. fossalis (USFWS 1998b, p. 54989; Table 1). However, there is no evidence to suggest that this was caused by climate change rather than normal climatic cycles. Currently, drier conditions and drought remain a threat to all occurrences of Navarretia fossalis. Predictions for California indicate prolonged drought and other climate-related changes will continue in the future (e.g., Field et al. 1999, pp. 8–10; Lenihen et al. 2003, p. 1667; Hayhoe et al. 2004, p.12422; Breshears et al. 2005, p. 15144; Seager et al. 2007, p. 1181; IPCC 2007, p. 9). In habitat such as vernal pools that is isolated and dependent on certain hydrological regimes, these climatic changes are expected to become even more dramatic and intense (Graham 1997). It is expected that climate change will alter the hydrology of the region, and therefore threaten the existence of vernal pool habitat and associated species such as Navarretia fossalis (Bauder 2005, pp. 2133-2134). While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including N. fossalis) or sites at this time. However, it is possible that drying could be expected to adversely affect the long-term viability of N. fossalis in its habitat. (USFWS, 2010)

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:
1. All the existing vernal pools and their watersheds should be secured from further loss and degradation in a configuration that maintains habitat function and viability (as determined by prescribed research tasks). (USFWS, 1998)

2. Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased. (USFWS, 1998)

3. Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. (USFWS, 1998)

Recovery Actions:

- Design and establish a vernal pool habitat preserve system within each Management Area that will maximize the ecological distribution for each listed and proposed species, minimize risk of habitat loss, retain genetic differentiation, and provide the opportunity for expansion of populations. (USFWS, 1998)
- Within each Management Area, reestablish vernal pool habitat to historic structure and composition to increase genetic diversity and population stability. (USFWS, 1998)
- Within each Management Area, rehabilitate and enhance secured vernal pool habitats and their constituent species. (USFWS, 1998)
- Manage protected habitat. (USFWS, 1998)
- Monitor protected habitat and listed species. (USFWS, 1998)

- Coordinate with Riverside County and city governments to enact ordinances banning manure dumping in areas containing sensitive species, such as the San Jacinto River flood plain. Such a measure could reduce threats and meets Criteria 1 and 2 for the Recovery Plan. (USFWS, 2010)
- Determine the breeding system, distribution of genetic diversity of Navarretia fossalis, and best management practices to maintain genetic diversity within the species. This would allow a better understanding of the methodology needed to meet Criterion 4. (USFWS, 2010)
- Consider revising the Recovery Plan by incorporating new information and addressing issues discussed in Recovery Criteria section of this review. Consider revising recovery criteria to be threats-based and to include quantifiable thresholds to down list and delist. Additionally, areas of high value to the species should be identified and preserved. (USFWS, 2010)
- In order to analyze trends in abundance, standardize methods for sampling abundance of Navarretia fossalis. Use quantitative indices in data collection protocol. Any empirical approach in methodology will prove a more reliable method to analyze population data required in Criteria 3 and 4. (USFWS, 2010)
- Work with partners to help conserve Navarretia fossalis, by conducting surveys of all occurrences within the next 5 years to have more information (abundance, spatial distribution, and threats) about the status of the species. Recovery Plan Criteria 3 and 4 require that populations are monitored and stabilized. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS These actions are intended to help reduce impacts from threats to Navarretia fossalis over the next 5 years. We recognize that cooperation and coordination with our partners will aid future restoration efforts for this species. The recommended actions listed below includes actions from the past 5-year review and new actions that are relevant to the conservation of N. fossalis: 1. Work with partners to identify opportunities for conservation of Navarretia fossalis occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire Navarretia fossalis habitat. 2. Survey or monitor occurrences to provide more information about the status of the species (abundance, spatial distribution, and threats) and assess management effectiveness. Recovery Plan Criteria 3 and 4 require that populations are monitored and stabilized. a. Standardize methods for sampling abundance of Navarretia fossalis to analyze abundance trends. Use quantitative indices in data collection protocols (Supports Recovery Plan Criteria 3 and 4). 3. Adaptively manage vernal pool habitat to maintain, enhance, or restore habitat and maintain population viability over time. a. Manage nonnative plants in vernal pool habitat. Coordinate with partners to develop best practices for nonnative species prevention and eradication to benefit Navarretia fossalis habitat. 4. Maintain or enhance Navarretia fossalis genetic diversity. Conduct a population genetics study to characterize genetic variation and structure in N. fossalis and determine the species' breeding system. Based on study results, develop best management practices to maintain genetic diversity within the species (Supports Recovery Plan Criterion 4). 5. Work with partners in Baja California, Mexico to survey additional areas for Navarretia fossalis and identify conservation opportunities (USFWS, 2023).

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SPECIES ACCOUNT: *Navarretia leucocephala ssp. pauciflora (=N. pauciflora)* (Few-flowered navarretia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A much-branched, spreading annual herb, about 1-4 dm tall, with linear, or linear-lobed, leaves. The inflorescence is a cluster of 2-15 blue or white flowers, subtended by long, spiny, leaf-like bracts. Blooms May-June. (NatureServe, 2015)

Current Range

Volcanic ash vernal pools in Lake County, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering occurs from May to June (USFWS, 2023)

Reproduction Narrative

Adult: Flowering occurs from May to June and the fruit is a papery capsule that breaks open only when wet. Few-flowered navarretia has fewer flowers per head and fewer lobes on the outer bracts than the closely related many-flowered navarretia (Navarretia. leucocephala ssp. plieantha) which is also federally-listed as endangered. However, some plants exhibit characteristics intermediate between the few-flowered navarretia and the many-flowered navarretia and cannot be assigned definitively to either subspecies (USFWS, 2023).

Habitat Type

Adult: Vernal Pools (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Vernal Pools (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (Inferred from NatureServe, 2015)

Habitat Narrative

Adult: Vernal pools with a volcanic ash substrate in chaparral, grassland, or mixed coniferous forest communities. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

10 (USFWS, 2023)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Adaptability:

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015)

Population Narrative:

Volcanic ash substrate very vulnerable to erosion. (NatureServe, 2015). Currently, the Diversity Database reports ten presumed extant occurrences of the species; eight in Lake County and two in Napa County (see Table 1; Diversity Database 2022). Two occurrences (occurrence #11 and #12) in Lake County have been added to the Diversity Database since the 2008 status review; these occurrences are within the known range of the species and do not change our understating of the species distribution. Occurrence 11 is located along Highway 29 between two previously identified occurrences (occurrence #4 and #5). This occurrence is known from an observation in 2003 and a Caltrans survey in 2011 (Diversity Database 2022). Occurrence 12 was added to the Diversity Database for the Breems Lake historical record. This occurrence is mapped to a general area at the west base of Mount Konocti as the exact location of the historical observation remains unknown (Diversity Database 2022). As mentioned in the 2008 5-year review, the historical records have extremely vague locality descriptions and may represent other already known sites by different names (Service 2008, p. 12). It is also possible that few-flowered navarretia have been extirpated from the historical occurrences (occurrence #3, #10, and #12). There is no new information regarding the Cobb area locality, which is discussed in the 2008 status review but is not reported in the Diversity Database, or the Loch Lomond Vernal Pool Ecological Reserve (occurrence #1) and Boggs Lake (not reported in the Diversity Database) occurrences, which may contain many-flowered navarretia or an intermediate (USFWS, 2023).

Threats and Stressors

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events. However, it is possible that either scenario would result in negative effects to vernal pool species. Cooling and drying trends could adversely affect fewflowered navarretia through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions with higher precipitation could increase the area of vernal pools, which would not necessarily be a negative effect because increased vernal pool area could increase available habitat for few-flowered navarretia. There could also be increased competition from nonnative plants. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most

appropriate to ensure the sustainability of vernal pool species, including few-flowered navarretia (USFWS, 2008).

Stressor: Habitat destruction and modification (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Threats to the habitat of few-flowered navarretia include alteration of hydrology, effects from road maintenance activities, agriculture land conversion, construction of a stock pond, off-road vehicle use, inappropriate grazing regimes, and competition from invasive weedy plant species (USFWS, 2008).

Stressor: Nonnative plants (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Competition from invasive plant species continues to pose a threat to this species. The localities at Hesse Flat and Manning Flat have been reported to be threatened by invasive plant species such as yellow star thistle (Centaurea solstitialis). Although specific information regarding adverse effects from invasive plant species is not available for all sites, it is likely that many of the localities of few-flowered navarretia are currently threatened by invasive plants to some degree. Further research and monitoring are necessary to determine the degree that this species is threatened by non-native invasive plant species (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Small numbers of localities makes it difficult for this species to persist while sustaining the impacts from competition from nonnative plant species, intensive grazing, changes in hydrology, adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance environmental disturbances. If a locality of fewflowered navarretia has several consecutive years of poor rainfall, intensive grazing, changes in hydrology from adjacent development, or intense competition from other plant species, it is possible that the locality will become extirpated. Populations that decline to zero may not always be capable of rebounding from the soil seed bank and the population is likely to become extirpated (USFWS, 2008).

Recovery

Reclassification Criteria:
Recovery Priority Number: 3

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the few-flowered navarretia. Some of these recommendations have already been discussed in the Recovery Plan for Vernal Ecosystems of California and Southern Oregon and the 2008 status review (Service

2005, pp. III-5–III-93; Service 2008, pp. 18–19) and remain valid. 1. Erosion control measures should be implemented at Manning Flat to prevent further erosion of this site and to prevent the destruction of the few-flowered navarretia locality found there. 2. The majority of known localities of this species are on private land and not protected. Preservation of suitable habitat in core areas should be pursued to preserve known localities that are currently not protected. 3. Once additional sites are protected, management plans should be prepared for the protected sites. Results from standardized monitoring discussed in item 4, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. 4. Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the Navarretia leucocephala group. 5. Regional vernal pool working groups should be created for the Lake-Napa Vernal Pool Region where few-flowered navarretia is known to occur to aid with monitoring and management efforts. 6. Comprehensive mapping of Lake County and Napa County vernal pool habitat should be completed to better understand the amount of suitable habitat available for the species within the recovery core areas. 7. The Recovery Plan describes both down- and de-listing criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the few-flowered navarretia and develop stepdown success parameters, if appropriate, that reflects the species' life history and narrow range to help us better understand the status of the species (USFWS, 2023).

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SPECIES ACCOUNT: *Navarretia leucocephala ssp. plieantha* (Many-flowered navarretia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/18/1997; California/Nevada (Region 8) (USFWS, 2015)

Physical Description

Navarretia leucocephala ssp. plieantha forms mats 5 to 20 cm (2.0 to 7.9 in) across and 1 to 3 cm (0.4 to 1.2 in) high. The stems have a peeling, white surface and are highly branched. Stem thickness is 0.8 to 1.4 mm (0.03 to 0.06 in) and is more or less uniform throughout its length. The leaves are 3 to 4 cm (1.2 to 1.6 in) long and are either entire or have a few thread-like lobes. Flower heads are 1.5 to 2 cm (0.6 to 0.8 in) across and contain between 10 and 60 pale blue flowers. Each flower in the head is 5 to 6 mm (0.20 to 0.24 in) long. The capsule and seeds are similar to those of N. leucocephala ssp. pauciflora; each fruit may contain as many as three seeds (Mason 1946, Day 1993b). (USFWS, 2005)

Taxonomy

The name first assigned to many-flowered navarretia was Navarretia plieantha. The type locality for the species is Boggs Lake, in Lake County (Mason 1946). Day (1993a) later reduced many-flowered navarretia to the rank of subspecies, under the name Navarretia leucocephala ssp. plieantha. As explained in the species account for Navarretia leucocephala ssp. pauciflora, some populations of Navarretia consist of individuals intermediate in characteristics between two subspecies. Dr. Day (in litt. 1997) has distinguished two types of intermediate specimens, which others have identified as N. leucocephala ssp. plieantha. One group is intermediate between N. leucocephala ssp. pauciflora and N. leucocephala ssp. plieantha, and the other is intermediate between N. leucocephala ssp. plieantha and N. leucocephala ssp. bakeri (Baker's navarretia). (USFWS, 2005)

Historical Range

Typical Navarretia leucocephala ssp. plieantha was known historically only from Boggs Lake (A. Day in litt. 1993, 1997). The other reported occurrences include six sites with plants that are intermediate between N. leucocephala ssp. plieantha and other subspecies, and two sites where Dr. Alva Day does not have access to specimens to confirm the identity of the plants (A. Day in litt. 1993, 1997). Three historical occurrences in Lake County (Loch Lomond, Mount Hannah Lodge, and Siegler Springs Road) have plants intermediate between N. leucocephala ssp. pauciflora and N. leucocephala ssp. plieantha. At least three occurrences in the Santa Rosa area, in Sonoma County, consist of plants intermediate between N. leucocephala ssp. plieantha and N. leucocephala ssp. bakeri (A. Day in litt. 1993, 1997). (USFWS, 2005)

Current Range

The five occurrences reported as extant in the final rule (U.S. Fish and Wildlife Service 1997b) were Boggs Lake, Loch Lomond, Mount Hannah Lodge, Siegler Springs Road, and Stienhart Lake, which are in the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998). These occurrences are still believed to be extant, although only three populations have been revisited since 1989 (California Natural Diversity Data Base 2005). (USFWS, 2005)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 2009)

Breeding Season

Adult: May to June (NatureServe, 2015)

Reproduction Narrative

Adult: Navarretias are an annual herb of the phlox family that bloom from May to June. Each fruit may contain as many as three seeds (Mason 1946; Day 1993b). (USFWS, 2009; NatureServe, 2015)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland, temporary pools (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Requires temporary pools or wet ground in forest openings (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: The many-flowered navarretia is extremely rare. This species is found only on substrates of volcanic origin and is dependent on vernal pools, vernal lakes, and swales for survival. Its life history is closely linked to the hydrology of these wetlands. Extant localities of this species are located in Lake and Sonoma counties (USFWS, 2023)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

8 (USFWS, 2023)

Population Narrative:

The five occurrences reported as extant in the final rule (U.S. Fish and Wildlife Service 1997b) were Boggs Lake, Loch Lomond, Mount Hannah Lodge, Siegler Springs Road, and Stienhart Lake, which are in the Lake-Napa Vernal Pool Region (Keeler-Wolf et al. 1998). These occurrences are still believed to be extant, although only three populations have been revisited since 1989 (California Natural Diversity Data Base 2005). The typical population of Navarretia leucocephala ssp. plieantha at Boggs Lake has not declined (Baldwin and Baldwin 1991, California Natural Diversity Data Base 2005). (USFWS, 2005). Currently, the Diversity Database reports eight known occurrences of this species: six in Lake County and two in Sonoma County (Diversity Database 2022). All eight occurrences are presumed extant. One occurrence (Occurrence #14) has been identified since the 2009 status review (Diversity Database 2022). This occurrence is located in proximity to other previously known occurrences and is found within the Boggs Mountain Demonstration Garden managed by the California Department of Forestry and Fire Protection. Two of the many-flowered navarretia occurrences are protected within reserves. One of the protected populations occurs at Boggs Lake Ecological Reserve that is co-owned and managed by California Department of Fish and Wildlife and The Nature Conservancy (Diversity Database 2022, occurrence # 1). The second protected population documented in the Diversity Database is at Loch Lomond Vernal Pool Ecological Reserve which is managed by the California Department of Fish and Wildlife (Diversity Database 2022, occurrence #4). The other five documented populations are on private lands (Diversity Database 2022, occurrence #5, 9, 10, 11, 12). Since the 2009 status review, the presence of the species has been verified at five occurrences and recent abundance estimates are available for three of those occurrences. See Table 1 for the most recent occurrence and survey data. Status surveys and updates continue to be infrequent. More monitoring is needed to identify abundance and population trends for many-flowered navarretia throughout its current distribution (USFWS, 2023).

Threats and Stressors

Stressor: Invasive species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The primary threat to Navarretia leucocephala ssp. plieantha at Boggs Lake is infestation by invasive species including Cirsium spp. (thistle), Centaurea spp. (knapweed), and Typha spp. (cattail) (CNDDB 2007). Competition from invasive plant species continues to pose a threat to this species. The localities at Mt. Hannah Lodge and Boggs Lake have been reported to be threatened by invasive plant species (CNDDB 2007) including infestation by invasive Centaurea solstitialis (star thistle) and Taeniatherum caput-medusae (medusahead). Although site specific information regarding adverse effects from invasive plant species is not available, we believe it is likely that many of the localities of Navarretia leucocephala ssp. plieantha are currently threatened by invasive plants to some degree. (USFWS, 2009)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: The primary threat to Navarretia leucocephala ssp. plieantha at this site is offhighway vehicles (OHV's) and California Department of Transportation activities next to the preserve (CNDDB 2007). The occurrence is adjacent to State Route 175, where road maintenance activities could still result in the loss of plants. Occasional fence vandalism and vehicle trespass still occur at Loch Lomond (S. Zalusky, Northwest Biosurvey, pers. comm. 2008). (USFWS, 2009)

Stressor: Urban lane use (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Plants at Seiglers Springs are threatened by urban land use (CNDDB 2007). (USFWS, 2009)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Pyke 2005). However, climatic conditions for smaller sub-regions such as California remain uncertain (Pyke 2005). It is unknown at this time if climate change in California will result in a localized, relatively small cooling and drying trend, or a warmer trend with higher precipitation events (Pyke 2005). However, it is possible that either scenario would result in negative effects to vernal pool species (Pyke 2004; Pyke and Marty 2005). Cooling and drying trends could adversely affect Navarretia leucocephala ssp. plieantha through decreased inundation periods that do not allow the species sufficient time to complete its life cycle. In contrast, warmer conditions with higher precipitation could increase the area of vernal pools, which would not necessarily be a negative effect because increased vernal pool area could increase available habitat for N. leucocephala ssp. plieantha. There could also be increased competition from nonnative plants. Monitoring of vernal pool ecosystems to determine effects from climate change is necessary to determine what adaptive land management practices would be the most appropriate to ensure the sustainability of vernal pool species (Pyke and Marty 2005), including N. leucocephala ssp. plieantha. (USFWS, 2009)

Stressor: Small numbers of localities/stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations (e.g., Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). In particular, small numbers of localities makes it difficult for this species to persist while sustaining the impacts from competition from nonnative plant species, intensive grazing, changes in hydrology, adjacent development, drought, or other unknown factors. Such populations may be highly susceptible to extirpation due to chance events or additional environmental disturbance (Goodman 1987; Gilpin and Soule 1988). If a locality of Navarretia leucocephala ssp. plieantha has several consecutive years of poor rainfall, intensive grazing, changes in hydrology from adjacent development, or intense competition from other plant species, it is possible that the locality will become extirpated. (USFWS, 2009)

Stressor: Cattle grazing (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Threats to the Saunders Road locality include cattle grazing, wastewater irrigation, and potential urban development. Additionally, grazing has eliminated many native species (CNDDB 2007). Threats to Shiloh Ranch include grazing, trampling, and urban development (CNDDB 2007). (USFWS, 2009)

Stressor: Neonicotinoid pesticides (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: In June 2022, the Environmental Protection Agency (EPA) released the final biological evaluation on clothianidin, imidacloprid, and thiamethoxam, a group of insecticides known as neonicotinoids (EPA 2022a, entire; EPA 2022b, entire; EPA 2022c, entire). All three neonicotinoids are registered for use on a variety of agricultural crops, as well as some nonagricultural applications. These three neonicotinoids are highly toxic to terrestrial and aquatic invertebrates but are much less toxic to other vertebrate and plant taxa. The EPA evaluated the effects of labelled use of these neonicotinoids to determine whether they may affect one or more species listed under the Endangered Species Act or their designated critical habitats. The reliance of listed species on invertebrate species as prey or pollinators was considered in the biological evaluations. The EPA determined through moderate evidence that these neonicotinoids are likely to adversely affect (LAA) many-flowered navarretia (EPA 2022a, entire; EPA 2022b, entire; EPA 2022c, entire). The LAA determination means that the EPA reasonably expects that at least one individual animal or plant, among a variety of listed species, may be exposed to the pesticide at a sufficient level to have an effect, which will be adverse. However, the overall importance of pollinating insects for many-flowered navarretia is poorly understood and additional research is needed. The EPA anticipates releasing amended proposed interim decisions in 2023, which will include updates to some of the previously proposed mitigation measures to reduce neonicotinoid exposures for listed species. Mitigation measures will be finalized in the interim decisions, which the EPA expects to release in 2024 and the Service will consider these final mitigations during consultation (USFWS, 2023).

Recovery

Reclassification Criteria:
1. Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species localities distributed across the species geographic range and genetic range are protected. Protection of extreme edges of populations protects the genetic differences that occur there. Reintroduction and introductions must be carried out and meet success criteria. Additional localities that are detected (and determined essential to recovery goals) are permanently protected. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through at least one multi-year period that includes above average, average, and below average

local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring. (USFWS, 2009)

2. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected. Mechanisms are in place to provide for management in perpetuity and long-term monitoring. Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria. (USFWS, 2009)

3. Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average local rainfall, a multi-year drought, and a minimum of 5 years of post-drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning also must be ameliorated or eliminated. (USFWS, 2009)

4. Research actions necessary for recovery and conservation of the covered species have been identified (these are research actions that have not been specifically identified in the recovery actions but for which a process to develop them has been identified). Research actions (both specifically identified in the recovery actions and determined through the process) on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed (for species where necessary – for reintroduction and introduction, seed banking) and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected. Research necessary to determine appropriate parameters to measure population viability for each species have been completed. (USFWS, 2009)

5. Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool region working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 14. (USFWS, 2009)

Recovery Priority Number: 3

Delisting Criteria:
Same as reclassification criteria.

Recovery Actions:

- Recovery actions are not available.
- The majority of known localities of this species are on private land and not protected. Preservation of Zone 1 core areas should be pursued to preserve known localities that are currently not protected. (USFWS, 2009)
- Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the 2005 Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species, and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the Navarretia leucocephala group. (USFWS, 2009)
- Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in item 3, below, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. (USFWS, 2009)
- Regional vernal pool working groups should be created in regions where Navarretia leucocephala ssp. plieantha is known to occur to aid with monitoring and management efforts. (USFWS, 2009)
- Potential habitat should be surveyed for new populations and if located, those populations should be protected. (USFWS, 2009)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the many-flowered navarretia. Some of these recommendations have already been discussed in the Recovery Plan and the 2009 status review (Service 2005, pp. III-5–III-93; Service 2009, p. 19) and remain valid. 1. The majority of known localities of this species are on private land and not protected. Preservation of suitable habitat in the core areas should be pursued to preserve known localities that are currently not protected. 2. Conduct research at as many of the extant localities as possible to incorporate research recommendations outlined in the Recovery Plan. The following research should be prioritized over the next five years: a. Develop a standardized monitoring method to monitor species status and population trends at all known locations. This will better our understanding of potential threats to the species and will aid in the development of methods to ameliorate these threats. b. Conduct research on the genetic structure of the species to determine the taxonomic status of the N. leucocephala group. 3. Once additional sites are protected, management plans should be prepared. Results from standardized monitoring discussed in recovery criterion 2A, above, should be included in the management plans for these protected sites. Grazing management and invasive weed control should be primary components of these management plans. 4. A regional vernal pool working group should be created for the Lake-Napa Vernal Pool Region where many-flowered navarretia is known to occur to aid with monitoring and management efforts. 5. Comprehensive mapping of Lake County and Sonoma County vernal pool habitat should be completed to better understand the amount of suitable habitat available for the species within the recovery core areas. 6. Potential habitat should be surveyed for new populations and if located, those populations should be protected. 7. The Recovery Plan describes both down- and de-listing

criteria as preliminary that will need periodic reassessment because data was lacking at the time the Recovery Plan was developed. Therefore, reassess both down- and de-listing criteria for the many-flowered navarretia and develop stepdown success parameters, if appropriate, that reflects the species' life history and narrow range to help us better understand the status of the species (USFWS, 2023).

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USFWS. 2023. 5-YEAR REVIEW Many-Flowered Navarretia (Navarretia leucocephala ssp. plieantha). Sacramento Fish and Wildlife Office. Sacramento, California. 12 pp.

SPECIES ACCOUNT: *Neraudia ovata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

It is a sprawling, rarely erect, shrub with 1 to 3 meters (3.3 to 10 feet) long stems or it can develop into a small tree. The leaves are grayish to greenish on the lower surface, thin, ovate to elliptic-ovate or elliptic. They are 4 to 12 centimeters (1.6 to 4.7 inches) long and 2.0 to 6.4 centimeters (0.8 to 2.5 inches) wide. This species is mostly dioecious, male and female flowers occurring on separate plants. Male flowers are short with a densely haired calyx and female flowers are sessile, are also densely haired, and have a boat-shaped calyx. The fruit is an achene. The lack of a conspicuous tuft of hairs at the base of the leaves, the distribution of the hairs on the lower surface, and the shape of the female flower are diagnostic characteristics for the N. ovata (U.S. Army 2003a).

Taxonomy

Neraudia ovata is in the Urticaceae, or nettle family.

Historical Range

See current range/distribution

Current Range

Neraudia ovata is known currently and historically only from the island of Hawaii. The species is found on the Kona coast from North Kona to Kau. There are only 13 individuals persisting on the island of Hawaii. There is one individual in Kaloko, North Kona; one individual in the Manuka Natural Area Reserve; 10 individuals in three locations at PTA, and one individual on State land outside of PTA (U.S. Army 2003a).

Critical Habitat Designated

Yes; 7/2/2003.

Legal Description

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Neraudia ovata on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for Neraudia ovata includes two units totaling 7,294 acres in Hawaii County, Hawaii. The units are Hawaii 10—Neraudia ovata—a and awaii 18—Neraudia ovata—d. One of the units, Hawaii 18—Neraudia ovata—d, currently is occupied. This unit is essential to the conservation of N. ovata because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. The remaining unoccupied unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from other critical habitat for this island-endemic species within its historical range in order to reduce the

likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event. The two units for this species that we are designating on the island of Hawaii provide for habitat for a total of four populations, each with 300 mature, reproducing individuals of the N. ovata.

Hawaii 10—Neraudia ovata—a [1,859 ha (4,493 ac)]: This unit contains no named natural features and lies completely within the Kiholo watershed. This unit, plus the excluded Kamehameha Schools land, provides habitat for 2 populations of 300 mature, reproducing individuals of the N. ovata and is currently unoccupied. This unit provides the northernmost critical habitat within the species' historical range.

Hawaii 18—Neraudia ovata—d [1,134 ha (2,801 ac)]: This unit contains no named natural features and is completely within the Kauna watershed. This unit provides habitat for 2 populations of 300 individuals of N. ovata and is currently occupied by one individual. The unit provides the southernmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Habitat features that are essential for this species include, but are not limited to, open Metrosideros polymorpha-Sophora chrysophylla dominated lowlands, montane dry forests, and Metrosideros-shrub woodland.

Special Management Considerations or Protections

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for theis species. However, both the Act and the relevant court orders require the Service to to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Plants have been observed in vegetative form during fall and winter, and in flower and fruit during spring and summer. Limited observations suggest plants are not truly dioecious, but facultatively monoecious, bearing male and female flowers at different times on the same plant (U.S. Army 2003a).

Habitat Type

Adult: Dry, subalpine forest

Habitat Narrative

Adult: Neraudia ovata occurs in dry forests, on open lava flows, and in subalpine forests on the leeward side of the island of Hawaii at elevations from 115 to 1,520 meters (377 to 4,987 feet). At PTA, the species grows in Open Metrosideros Treelands with a sparse shrub understory and in Myoporum Shrublands. Most plants are found on Mauna Loa aa flows that are approximately 4,000 years old (U.S. Army 2003a).

Dispersal/Migration

Population Information and Trends

Number of Populations:

4 (USFWS, 2020)

Population Size:

104 wild individuals. Almost 2,000 reintroduced with unknown viability (USFWS, 2020)

Population Narrative:

Fragility unknown. Currently 11-12 plants observed. 2 current (between 1982 and 1997) and 9 historical occurrences. (NatureServe, 2015). During the 2003 to 2007 surveys 11 wild individuals of Neraudia ovata were found at Puu Anahulu on State owned lands (State of Hawaii Department of Land and Natural Resources [DLNR] 2015a). These individuals are protected within individual fences and will be enclosed by a larger fence in the future. In 2014, 6 of the 10 individuals were relocated and monitored (Plant Extinction Prevention Program [PEPP 2014]). In fiscal year 2009, there were 116 individuals of Neraudia ovata at Pohakuloa Training Area (PTA) (U.S. Army Garrison Pohakuloa [US Army] 2010). In fiscal year 2010, 90 individuals remained. The loss of 26 individuals in Area of Species Recovery 24 between monitoring cycles represents 22 percent of the known population. Within the large-scale fence units are Areas of Species Recovery (ASRs), which are defined as 100-meter (328-foot) buffers around known federally-listed plant population where management is focused (US Army 2014). The primary factors in the decline of this species are dry conditions due to drought combined with increased ungulate pressure (US Army 2010). In fiscal year 2013, there were approximately 75 individuals (32 mature and 43 immature) (US Army 2014). At least 11 of the 75 individuals are female and seed collections have been from 10 of these plants (US Army 2014). Since 2004, there are 25 male and female individuals in the PTA greenhouse representing 15 founders from the wild population (USFWS, 2015). Currently, there are four wild populations of Neraudia ovata totaling 104 individuals on the island of Hawai‘i. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that N. ovata is vulnerable to the effects of climate change. All wild and reintroduced individuals are provided protection from feral ungulates by exclosures; however, these must be monitored for ingress. Some nonnative plant control is ongoing within exclosures. Seed and cuttings collection, propagation, and reintroduction are ongoing. Almost 2,000 plants have been reintroduced, but the survival of all those individuals and the amount of reproduction within those populations is unknown. Infestation by spittlebugs is observed to be a new threat with no known control for this insect.

(USFWS, 2020)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The threats to Neraudia ovata are heavy browsing and the resulting habitat modification by feral sheep and goats; competition from non-native species such as Pennisetum setaceum, Leucaena leucocephala, and Schinus terebinthifolius; insect damage (e.g., from Aleurodicus dispersus; spiraling whitefly); reduced reproductive vigor; residential development; fire; and due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic (U.S. Army 2003a).

Stressor: Climate change destruction or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Neraudia ovata is minimally vulnerable to the impacts of climate change (USFWS, 2015).

Stressor: Stochastic events
Exposure:
Response:
Consequence:
Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on N. ovata (PEPP 2010; J. Wagner, pers. comm. 2015; US Army 2014) (USFWS, 2015)

Stressor: Collecting impacts
Exposure:
Response:
Consequence:
Narrative: Illegal collection for scientific, horticultural or other purposes threatens the populations of N. ovata, as well as possible excessive visitation. For instance, on two occasions in 2013, five reintroduced individuals of N. ovata were uprooted in the Mauna Kea area and those five plants were stolen along with other common and federally listed plants (P. Peshut and S. Evans, US Army, pers. comm. 2013) (USFWS, 2015).

Recovery

Recovery Actions:

- New management actions: Surveys / inventories – A survey was conducted for new individuals of N. ovata in Kau (PEPP 2014). At least two mature individuals were discovered and fruits were collected from those plants (PEPP 2014). Ungulate monitoring and control – In 2009, four exclosures were constructed for N. ovata at Puu Anahulu (PEPP 2009). Each exclosure was 9 meters by 9 meters (30 feet by 30 feet) in size. In 2014, the fenced exclosure was maintained and inspected for any damages (PEPP 2014). Invasive plant monitoring and control – Annual weed control is ongoing in North Kona on private property (J. Wagner, pers. comm. 2015) and at Pohakuloa Training Area (US Army 2014). Population viability monitoring and analysis o Monitoring of the 11wild individuals at Puu Anahulu revealed that severe drought was affecting the plants as noted by wilting (PEPP 2010). In 2014, the plants were revisited and monitored (PEPP 2014). o The wild individual on private land in North Kona was monitored (PEPP 2012). Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013) has 36 plants propagated in their nursery representing five locations. The Facility propagated 20 plants for reintroductions next year. Meanwhile, eight individuals were reintroduced on private property in Kona. In 2014, the Volcano Rare Plant Facility (2014) had the same number of plants propagated in their nursery representing five locations. The Facility propagated 17 plants for reintroductions next year and a single individual was reintroduced at Puu Waawaa. o The Lyon Arboretum's Seed Conservation Lab (2014) has 10 seeds in genetic storage. o The Hawaii Volcanoes National Park (2014) has 12 cuttings and 30 plants in their nursery. o Pohakuloa Training Area has 97 seeds from two founders in genetic storage (US Army 2014). In total more than 286,000 seeds, representing 122 accessions from 38 founders, have been collected and are in storage at Pohakuloa Training Area (US Army 2014). Pohakuloa Training Area also provided the following plants for reintroduction efforts: 30 plants to Hawaii Volcanoes National Park, 10 plants and 29 cuttings to Jill Wagner, 320 cuttings to the US Forest Service's Environmental Security Technology Certification Program, and 2 plants to the State Department of Forestry and Wildlife (US Army 2014). o Propagation of N. ovata by cuttings is 50 percent successful but highly dependent on the founder (US Army 2014). However, propagation of N. ovata by seeds has been less successful with low germination rates observed after 10 years of being sown. o Fruits were collected from 3 of the 10 wild individuals at Puu Anahulu (PEPP 2014). The fruits were given to the Volcano Rare Plant Facility for propagation. o In Kau, fruits from two wild individuals were collected and given to the Volcano Rare Plant Facility for propagation (PEPP 2014). Reintroduction / translocation o Two individuals of N. ovata were reintroduced in a Natural Area Reserve System on Hawaii Island (DLNR 2014). o The Hawaii Volcanoes National Park (2014) reintroduced 30 individuals in the Park. o At Puu Waawaa, 270 individuals was reintroduced in 2014 (DLNR 2015b) o During 2002 to 2004, four individuals were reintroduced at Pohakuloa Training Area (US Army 2014). An additional 46 individuals was reintroduced in 2014. There were 48 individuals remaining in 2014 with a natural recruitment of 20 seedlings of N. ovata (US Army 2014). o Near Saddle Road, there are 63 reintroduced individuals (US Army 2014). o On State owned lands in North Kona, there are two reintroduced populations containing a total of 50 mature and 13 immature individuals. At the first population between 2004 and 2009, 42 individuals were reintroduced. In 2014, none of those reintroductions survived but two mature naturally recruited individuals were observed (US Army 2014). The second reintroduced population contained 111 individuals in 2005 to 2012. In 2014, 21 individuals were reintroduced. There are 48 individuals remaining at the site with a natural recruitment of 13 immature individuals (US Army 2014). o On County lands in North Kona, there are 28 reintroduced individuals with a natural

recruitment of 11 mature and 86 immature individuals (US Army 2014) (USFWS, 2015).

- Recommendations for Future Actions: ▯ Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. ▯ Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. ▯ Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. ▯ Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. ▯ Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. ▯ Fire monitoring and control – Develop and implement a fire management plan at the existing exclosure. ▯ Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. ▯ Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).
- Important conservation actions needed for Neraudia ovata include the following: protective fences to be constructed around the known occurrences of N. ovata, and removal of feral ungulates and non-native plants from habitat. A commitment from all landowners on whose land this species grows should be developed for long-term stewardship and conservation of these areas once they have been enclosed. Insect damage must be controlled, such as that caused by the spiraling whitefly. In addition, the following conservation actions are needed: propagation and maintenance of genetic stock ex situ; augmentation of extant occurrences and establishment of new occurrences within the species' historical range; control or eradication of non-native plants; protection from fire and human disturbance; implementation of a comprehensive monitoring program; surveys to identify individuals and/or occurrences that may exist in former habitats, or that may be present in areas that have not been surveyed recently (Service 1998b). A State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of N. ovata is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: The Volcano Rare Plant Facility has three plants in cultivation from the Manuka population and eight plants from the Kona population. Fifteen plants grown at the facility were outplanted at Manuka in 2002. The Hawaii Department of Agriculture has conducted a very successful biocontrol program for the spiraling whitefly which has significantly reduced damage caused by this insect. The spiraling whitefly remains a problem on certain preferred host plants, particularly in the summer, or on windy coastal areas where biocontrol efforts are not effective (Service 1998b).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Predation by spittlebugs is observed as a new threat to Neraudia ovata; however, there is no other significant new information regarding the species' biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2020. • Surveys and inventories—Continue to survey geographical and historical range of Neraudia ovata for a current assessment of the species' status. • Ungulate monitoring and control—Maintain existing exclosures and monitor for ungulate ingress. • Ecosystem-altering invasive plant monitoring and control—Eradicate invasive plants within exclosures and maintain exclosures as nonnative, invasive plantfree. • Fire protection—Continue to improve and implement the fire management plan

developed for PTA and develop and implement fire management plans for other sites with wild and reintroduced populations. • Drought protection—Continue to monitor and control feral ungulates and nonnative plants to protect and increase vigor of N. ovata during times of drought. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery. • Predation and herbivory by invertebrates—Determine effects of invertebrates and develop and implement effective control methods within the vicinity of all known N. ovata populations if necessary. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—Continue to establish new populations in historical and other suitable habitat, and augment wild populations on the island of Hawai‘i. • Population biology research—Continue to conduct studies to determine possible causes for lack of seed viability. • Alliance and partnership development—Continue to work with the U.S. Army Garrison at PTA and other partners and land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—The U.S. Army Garrison monitors Neraudia ovata at the Pōhakuloa Training Area (PTA) (U.S. Army Garrison 2010, p. 4-15). PTA reported conducting surveys over nine census periods from 2016 to 2019 to assess the status of N. ovata (U.S. Army Garrison 2020, pp. 20–21). • Captive propagation for genetic storage and reintroduction— o In 2013, PTA reported collection of 331 seeds representing nine founders from two areas of species recovery (ASR 14, 24) for genetic storage (U.S. Army Garrison 2013, p. 14). Collections for 2019 include 1,409 seeds representing 13 founders for storage and 313 cuttings representing 32 founders for propagation (U.S. Army Garrison 2020, p. 35). A complete count including previous collections indicates 6,130 seeds in storage collected from plants in the field and 236,474 seeds collected from plants grown in the greenhouse (U.S. Army Garrison 2020, pp. 35–36). o Lyon Arboretum Seed Conservation Laboratory reports 10 seeds in storage with the previously collected 1,977 seeds in their collection either tested or withdrawn (Lyon Arboretum 2019). o Hawai‘i Volcanoes National Park (HVNP) acquired propagative material (31 plants, 4,855 seeds) from the PTA Rare Plant Propagation Facility and Volcano Rare Plant facility for storage or propagation for reintroduction (HVNP 2019). o In 2018, the plant nursery for Ka‘ūpūlehu Dryland Forest Preserve (DFP) reported a flat of plants in propagation representing one founder (Ka‘ūpūlehu DFP). o In 2018, the plant nursery for Pu‘uwa‘awa‘a reported collection and storage of 447 seeds representing three founders (Pu‘uwa‘awa‘a 2018). o The Volcano Rare Plant Facility (VRPF) reported 37 plants representing 13 founders, 15 plants sent to Future Forests Nursery for storage or reintroduction, one plant sent to the Pu‘uwa‘awa‘a, and 15 plants grown for reintroduction at other sites (VRPF 2019). • Reintroduction— o PTA reported reintroduction in the training area or within two exclosures on adjacent lands at Pu‘uanahulu of 63 individuals, 48 indivduals reintroduced at the Mixed Tree unit, four on the east range, and three to five individuals planted at Pu‘uhuluhulu (U.S. Army Garrison 2013, p. 17; U.S. Army Garrison 2020, p. 43; PTA Rare Plant Facility 2019). o There are several reintroduced populations within exclosures managed by the State at Pu‘uwa‘awa‘a. These include 141 plants at Uhiuhi, 946 plants at Hauaina, 310 plants at Kīpuka ‘Owē‘owē, 16 plants at Pu‘uwa‘awa‘a Cone, seven plants at Ma‘ohauhele, 141 plants at Uhiuhi I/Wiliwili, and three plants not within a unit (USDA Forest Service 2015; Pu‘uwa‘awa‘a 2018). These reintroduced populations total as many as 1,564 individuals (Adkins 2020, in litt.). o In 2016, the Plant Extinction Prevention Program (PEPP) reported assisting staff at Ka‘ūpūlehu with reintroduction of 10 individuals of N. ovata (PEPP 2016). In 2019, PEPP reintroduced an additional 20 individuals at Pu‘uwa‘awa‘a and three individuals at Kīpuka ‘Owē‘owē (PEPP 2019). o There are 28 plants reintroduced at West Hawai‘i Veteran’s Center (PEPP 2019). o From 2014 to 2019, 106 individuals of N. ovata were

planted at four sites in exclosures at Palamanui (Future Forests Nursery 2019). o Approximately 119 individuals were reintroduced on private land near Kaloko (PEPP 2019). o Thirty plants were reintroduced at Kapāpala Lower in Hawai'i Volcanoes National Park (HVNP 2019). • Viability monitoring and analysis— o PTA conducted four germination trials using 354 seeds from N. ovata, and reported that five seedlings were produced, indicating a very low germination rate (1 percent) (U.S. Army Garrison 2020, p. 40). The estimated seed longevity is 10 years (U.S. Army Garrison 2013, p. 16). Trials using 308 cuttings produced 97 plants (31 percent success), but results varied depending on the founder used (U.S. Army Garrison 2013, p. 16; U.S. Army Garrison 2020, p. 40). o Losses from juveniles and adult age classes, as well as transition from the juvenile to the adult age class, appears to drive patterns in the numbers of plants present at a location (U.S. Army Garrison 2020, pp. 20–21). (USFWS, 2020)

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SPECIES ACCOUNT: *Neraudia sericea* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub 3-5 m tall. Leaf undersides densely covered with silky hairs. Male and female flowers are borne on separate plants (NatureServe, 2015).

Taxonomy

A member of the nettle family (Urticaceae) (USFWS 2003a-c). In a taxonomic revision of the genus Neraudia, Richard Cowan (1949) restored N. sericea to full species status and surmised that N. kahoolawensis, for which the type (and only) material was no longer available, was likely a Kahoolawe representative of N. sericea, based on its written description. Wagner et al. (1999) accepted N. sericea as a full species and synonymized N. kahoolawensis as a Kahoolawe population of N. sericea (USFWS, 2012).

Historical Range

Historically, Neraudia sericea was known from Kamalo and near Waianu on Molokai; Kaiholena on central Lanai; Olowalu Valley on West Maui (portions of which have been surveyed on several occasions without success [Hank Oppenheimer, pers. comm. 2010]) and the southern slopes of Haleakala on East Maui; and from an unspecified site on Kahoolawe (USFWS 1994) (USFWS, 2012).

Current Range

Currently occurs on Molokai, Lanai, and Maui (USFWS, 2012).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Neraudia sericea under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Neraudia sericea includes 14 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by Gouania hillebrandii, Hibiscus brackenridgei, Kanaloa

kahoolawensis, Neraudia sericea, Sesbania tomentosa, or Vigna owahuensis, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry— Unit 2 is not known to be occupied by Gouania hillebrandii, Hibiscus brackenridgei, Kanaloa kahoolawensis, Neraudia sericea, Sesbania tomentosa, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Cenchrus agrimonioides, Flueggea neowawraea, Melicope adscendens, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or

biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Canavalia pubescens, Colubrina oppositifolia, Ctenitis squamigera, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Sesbania tomentosa, Solanum incompletum, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Canavalia pubescens, and Hibiscus brackenridgei, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant Canavalia pubescens, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of

east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Canavalia pubescens, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Gouania hillebrandii, Kadua coriacea, Remya mauiensis, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and Tetramolopium capillare, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by Ctenitis squamigera, Cyanea obtusa, Hesperomannia arbuscula, Hibiscus brackenridgei, Lysimachia lydgatei, Neraudia sericea, Schiedea salicaria, Sesbania tomentosa, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants Hibiscus brackenridgei and Schiedea salicaria, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Ctenitis squamigera, Cyanea obtusa, Gouania hillebrandii, Hesperomannia arbuscula, Kadua coriacea, Lysimachia lydgatei, Neraudia sericea, Remya mauiensis, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Spermolepis hawaiiensis, Tetramolopium capillare, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Mesic—Unit 1 (and) Palmeria dolei—Unit 42—Montane Mesic (and) Pseudonestor xanthophrys—Unit 42— Montane Mesic This area consists of 257 ac (104 ha) of State land, and 559 ac (226 ha) of privately owned land from Kamiloloa to Makolelau in central Molokai. These units are occupied by the plants Alectryon macrococcus, Bidens wiebkei, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Cyanea dunbariae, C. mannii, C. procera, C. solanacea, Cyperus fauriei, Kadua laxiflora, Melicope mucronulata, Neraudia sericea, Plantago princeps, or Stenogyne bifida, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 1 (and) Palmeria dolei—Unit 2—Lowland Wet (and) Pseudonestor xanthophrys—Unit 2— Lowland Wet This area consists of 6,616 ac (2,677 ha) of State land, 7,425 ac (3,005 ha) of privately owned land, and 2,038 ac (825 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Kipahulu Valley on the northern and eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plants Bidens campylotheca ssp. waihoiensis, Clermontia samuelii, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. kunthiana, C. maritae, C. mceldowneyi, Huperzia mannii, Melicope balloui, and M. ovalis. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 1 is not known to be occupied by the plants Clermontia oblongifolia ssp. mauiensis, C. peleana, Mucuna sloanei var. persericea, Phyllostegia haliakalae, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) Palmeria dolei—Unit 18—Montane Mesic (and) Pseudonestor xanthophrys—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the

plants Argyroxiphium sandwicense ssp. macrocephalum, Asplenium dielerectum, A. peruvianum var. insulare, Clermontia lindseyana, Cyanea horrida, C. obtusa, Cyrtandra ferripilosa, C. oxybapha, Diplazium molokaiense, Geranium arboreum, G. multiflorum, Huperzia mannii, Melicope adscendens, and Neraudia sericea. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, Cyanea glabra, C. hamatiflora ssp. hamatiflora, C. kunthiana, C. mceldowneyi, Phyllostegia bracteata, P. mannii, Santalum haleakalae var. lanaiense, Wikstroemia villosa, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 5 (and) Palmeria dolei—Unit 29—Dry Cliff (and) Pseudonestor xanthophrys—Unit 29— Dry Cliff This area consists of 1,298 ac (525 ha) of State land, from Helu and across Olowalu to Ukumehame Gulch, on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). They are occupied by the plant Tetramolopium capillare, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 5 is not currently occupied by the plants Bonamia menziesii, Diplazium molokaiense, Hesperomannia arbuscula, Isodendrion pyrifolium, Kadua laxiflora, or Neraudia sericea, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 6 consists of 279 ac (113 ha) of State land along the east wall of Ukumehame Gulch on west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 6 is not currently occupied by the plants Bonamia menziesii, Diplazium molokaiense, Hesperomannia arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Neraudia sericea, or Tetramolopium capillare, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Neraudia sericea critical habitat consists of four components. (Lowland dry (east Maui, west Maui, Lanai and Kahoolawe), Lowland mesic

(Molokai), Montane mesic (east Maui and Molokai) and (Dry cliff (west Maui and Lanai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae,

Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G.

multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2012)

Breeding Season

Adult: Unknown (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Unknown (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years). Its flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors remain unknown (USFWS 2003a, 2003b, 2003c) (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Lowland dry to mesic ohia-aalii-pukiawe shrubland or forest, koa forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 650 - 5,439 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits dry and moist forests in gulches (NatureServe, 2015). On Molokai, the general habitat of Neraudia sericea is described as gulch slopes and gulch bottoms in lowland dry to mesic Metrosideros polymorpha (ohia)-Dodonaea viscosa (aalii)-Leptecophylla tameiameiae (pukiawe) shrubland or forest between 691 and 1,043 meters (2,266 and 3,421 feet) elevation. On Maui, the habitat is described as dry to mesic Metrosideros polymorpha-Dodonaea viscosa-Leptecophylla tameiameiae shrubland or forest or Acacia koa (koa) forest between 198 and 1,658 meters (650 and 5,439 feet) elevation (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:
Not available

Species Trends:
Declining (USFWS, 2023)

Number of Populations:
5 (USFWS, 2023)

Population Size:
8 (USFWS, 2023)

Population Narrative:
As of 2009, the population status of Neraudia sericea was reported as nine populations containing approximately 27 individuals, but acknowledges that the population trend is downward, and the species may be close to extinction (USFWS 2010; USFWS, 2012). A new population was discovered on west Maui at Launiupoko (PEPP 2014). Currently there are about five populations totaling 14 individuals on east and west Maui (Keir et al. 2016; PEPP 2013, 2014, 2015, 2016, 2017). There are two populations totaling about 16 individuals on Molokaʻi (Keir et al. 2016; PEPP 2013, 2014, 2015, 2016, 2017a) (USFWS, 2018). Numbers of wild individuals continue to decline on Mauna Kahālāwai and Haleakalā (west and east Maui) and Molokaʻi, although new individuals were recently found on Mauna Kahālāwai at Panaʻewa (1) and Honokōhau (3) and on Haleakalā at Manawainui Gulch (2) (Maui Plant Extinction Prevention Program [Maui PEPP] 2021, 2023; Oppenheimer 2023, pers. comm.). Currently, there are approximately eight wild individuals at five locations on Mauna Kahālāwai and Haleakalā, and nine wild individuals at one location on Molokaʻi (Maui PEPP 2021, 2023; Coelho and Adams 2019a, 2019b; Oppenheimer et al 2016; Oppenheimer and Bustamente 2013). • Currently, there are four founders (wild plants) from four populations on Mauna Kahālāwai and Haleakalā represented in ex situ storage and propagation, and nine founders from one population on Molokaʻi represented in ex situ storage and propagation (USFWS, 2023).

Threats and Stressors

Stressor: Habitat degradation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Wood and Perlman (2002) reported that the Makolelau region where the Neraudia sericea population lives had been severely impacted by a large feral goat population and that the status of the species was uncertain. Pigs, axis, deer, and cattle activity are also impacting habitat. Ecosystem-altering invasive plant species are also degrading habitat (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Landslides and flooding; On Maui a large fire in July 2010 burned 2,510 hectares (6,200 acres) in the Pohakea area, but Oppenheimer (pers. comm. 2010) is unsure whether the known Neraudia sericea population site was involved (USFWS, 2012).

Stressor: Predation (USFWS, 2012).
Exposure:
Response:
Consequence:
Narrative: Ferla goats, axis deer, and rats (USFWS, 2012).

Stressor: Drought loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Drought is noted as a threat to populations of Neraudia sericea on west Maui (PEPP 2014, 2015). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over 9 percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011). Recent episodes of drought have also driven deer farther into urban and forested areas in search of food, increasing their negative impacts to native vegetation from herbivory and trampling (Waring 1996, in litt; Nishibayashi 2001, in litt.) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that Neraudia sericea is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.751 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1999).

Recovery Priority Number: 5

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on islands where it now occurs or occurred historically (USFWS, 1999).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 300 for short-lived perennials (USFWS, 1999).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1999).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1999).
- Expand existing wild populations (USFWS, 1999).
- Conduct essential research (USFWS, 1999).
- Develop and maintain monitoring plans (USFWS, 1999).
- Reestablish wild populations within the historic range (USFWS, 1999).
- Validate and revise recovery criteria (USFWS, 1999).
- Construct exclosures to protect populations against feral ungulates (USFWS, 1999).
- Control competing alien plant species (USFWS, 1999).
- Protect endangered plants from fire (USFWS, 1999).
- Maintain adequate genetic stock (USFWS, 1999).
- Enhance wild populations and establish new populations (USFWS, 1999).
- New Management Actions: • Surveys and inventories—The Plant Extinction Prevention Program (PEPP) surveys for and monitors individuals of Neraudia sericea on Maui and Molokaʻi (PEPP 2013, 2014, 2015, 2016, 2017a). • Invasive plant monitoring and control—PEPP monitors all known populations on Maui and Molokaʻi and removes invasive nonnative plants. • Captive propagation for genetic storage and reintroduction— o In 2017, Lyon Arboretum reported 15 containers of propagules of N. sericea from populations at Launiupoko (west Maui) and Mākolelau (Molokaʻi) in storage. The Lyon Seed Conservation Laboratory reports 58 seeds in storage from the same populations (Lyon Arboretum 2017). o The Plant Extinction Prevention Program (PEPP) has collected from one founder at Kalaʻe (Molokaʻi), six founders from one subpopulation at Mākolelau (Molokaʻi) and from four founders at a second subpopulation at Mākolelau (PEPP 2017b). o PEPP collects seeds, cuttings, and vouchers from all known populations (PEPP 2013, 2014, 2015, 2016, 2017a). o The National Tropical Botanical Garden (NTBG) continues to store over 1,000 seeds collected from individuals on Molokaʻi in 2002 (NTBG 2017). The viability of these collections is uncertain. o Olinda Rare Plant Facility (ORPF) reports propagation of plants from cuttings and fruit taken from individuals on west Maui at Lihau, Manawainui Gulch, Launiupoko, and ʻĪao Valley; from east Maui at Manawainui Gulch; and from Molokaʻi at Makolelau (ORPF 2013, 2014, 2015, 2017). • Stochastic events—Build resiliency and redundancy— o PEPP has augmented populations or created new sites for reintroduction of N. sericea and reintroduced nearly 100 individuals. Of those outplanted, the current survivors on west Maui are at Launiupoko (six individuals), Kauaʻula (eight individuals), ʻĪao Valley (10 individuals), and Olowalu (six individuals); and on east Maui at five sites at Waiʻōpai Gulch

(12 individuals) (PEPP 2016, 2017a). On Molokaʻi, PEPP has reintroduced one individual at Kalae, five individuals at east Kawela, and 14 individuals at Mākolelau (PEPP 2016, 2017a). o ORPF has distributed at least 23 propagated plants for reintroduction into Olowalu Valley, ʻĪao Valley, Kauaʻula, and west Mākolelau (ORPF 2013, 2014, 2015, 2017). • Habitat and natural process management and restoration—Pūlama Lānaʻi provides conservation benefits to plant and animal species on Lānaʻi, as demonstrated by the ongoing conservation efforts on the island, the commitment to develop the Lānaʻi Natural Resources Plan (LNRP), and a memorandum of understanding (MOU) with the Service (USFWS 2015). The fenced area at Lānaʻihale may provide suitable habitat for reintroduction of N. sericea to Lānaʻi once fence repairs are made, ungulates are removed, and nonnative plant control is conducted (USFWS, 2018).

- Recommendations for Future Actions: Habitat destruction by drought and herbivory by slugs are reported to be threats to this species; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for 5-year review for 2018. • Surveys and inventories—Continue to survey for additional populations of Neraudia sericea in areas of potentially suitable habitat on Lānaʻi and Molokaʻi. Regularly monitor known populations. • Ungulate monitoring and control—Complete the Lānaʻihale summit fencing project and remove all feral ungulates from the fenced area to protect N. sericea from the impacts of feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative species that compete with the species around all populations, especially focusing on Clidemia hirta (Koster's curse), Hedychium gardnerianum (kāhili ginger), Leptospermum scoparium (Australian tea tree), Morella faya (firetree), Psidium cattleianum (strawberry guava), and Tibouchina herbacea (glorybush). • Predator and herbivore monitoring and control—Develop and implement effective control methods for the black twig borer and slugs. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Explore alternate methods of propagation (e.g., cuttings, air-layering, and tissue culture). • Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species to determine future landscape needed for recovery of the species. • Alliance and partnership development—Continue to work with land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2018).
- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. A portion of the seeds stored at National Tropical Botanical Garden should be used for germination trial (USFWs, 2012).
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).

- Ungulate control: Now that the East Molokai fence line is complete, control feral ungulates inside the fence. Once the Lanaihale fencing project is complete, remove feral ungulates from inside the fence (USFWS, 2012).
- Ungulate exclosure: Continue to construct ungulate-proof fenced exclosures around each population. Complete the Lanaihale fencing project. Monitor all fences for any signs of breaching (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Implement effective control methods for rodents (USFWS, 2012).
- Surveys / inventories: Continue to search for Neraudia sericea in habitats where it has historically been found on Molokai and Maui. On Molokai, also investigate mesic gulches east of Kamalo, from Wawaia to East Ohia Gulches. Survey for remaining individuals of N. sericea within the fenced exclosure at East Molokai (USFWS, 2012).
- Competitive invasive plant species control – Control invasive introduced plant species in the immediate vicinity of Neraudia sericea populations (USFWS, 2012).
- Threats monitoring – Investigate the status of the Pohakea, Maui, population, following the July 2010 fire (USFWS, 2012).
- Site / area / habitat protection – Implement erosion control measures to prevent landslides (USFWS, 2012).
- Fire protection – Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2012).
- Population biology research: Study Neraudia sericea populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors. Research the life history of Neraudia sericea in reference to designating the taxon from a short-lived perennial to long-lived perennial (USFWS, 2012).
- Alliance and partnership development – Work with the Hawaii Division of Forestry and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2023. • Surveys and inventories—Continue to survey for additional populations of Neraudia sericea in current and historical range on Maui and Moloka‘i and in areas of potentially suitable habitat on Lāna‘i for a thorough assessment of the species' status. • Ungulate monitoring and control—Continue to construct and maintain exclosures and remove all feral ungulates from the exclosures to protect N. sericea from their negative impacts. • Invasive nonnative plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species, and those that compete with N. sericea, at all populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and determine future landscape needed for its recovery. • Rodent monitoring and control—Implement effective control measures for predation and herbivory by rodents at all populations. • Invertebrate monitoring and control—Develop and

implement effective control methods for the black twig borer and slugs. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and translocation into protected suitable habitat within historical range. o Continue to experiment with alternate methods of propagation (e.g., cuttings, air-layering, and tissue culture). • Translocation and augmentation—Continue population augmentation and translocation of individuals into suitable habitat within historic range that is being managed for known threats to this species. • Build resiliency, redundancy, and representation—Increase numbers of populations and individuals throughout historic range to reduce impacts of ungulate and rodent and invertebrate predation, and low numbers. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2023).

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SPECIES ACCOUNT: *Nesogenes rotensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/08/2004; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Nesogenes rotensis is a low-growing herbaceous (non-woody) plant with small, opposite, broadly lanceolate (lance-shaped), coarsely toothed leaves. Flowers are axillary (located on a stem in the area between the stem and the petiole) and tubular in shape, with five white petals and male and female components (Figure 2). Often a flowering branch grows upright, which might aid in pollination or seed dispersal (Raulerson and Rinehart 1997). Plants typically branch near the base at about five to seven nodes, and stature may range from not quite flat-growing (subprostrate) to upward-growing (ascending), scrambling over flattened (appressed) shrubs, with whole plants up to almost 1 meter (3 feet) in diameter (Fosberg and Herbst 1983). (USFWS, 2007)

Taxonomy

The familial placement of Nesogenes has shifted between Verbenaceae, Chloanthaceae (Dicrastylidaceae, an illegitimate name), Nesogenaceae, and Orobanchaceae (Marais 1980; Fosberg and Herbst 1983; USFWS 2004a; Bennett and Matthews 2006). (USFWS, 2012)

Historical Range

See current range/distribution. New in 2017: In addition to the two above-described locations where the species has been confirmed since the 2004 listing, in the late 1970s or early 1980s Nesogenes was also observed at two other locations along the east coast of the island. These locations (Puntan As Fani and Puntan Haiña) were reported to be similar to Poña Point and Puntan Fina Atkos, in terms of similar coastal vegetation on exposed limestone karst (Estanislao Taisacan, pers. comm. 2016). (USFWS, 2017).

Current Range

Known from a single collection at Haaniya Point (Poña Point Fishing Cliff), Palie area, Rota, Mariana Islands (USFWS, 2012). Also known to occur at Puntan Fina Atkos at the island's northeast tip. (USFWS, 2017); USFWS. 2017. 5-Year Review Short Form Summary, Nesogenes rotensis (no common name). USFWS, Region 1, Honolulu, Hawai'i. 9 pp.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Includes the months of March, April, May, and November (USFWS, 2012)

Reproduction Narrative

Adult: Based on information from collections and observations, N. rotensis flowers in March, April, May, and November (Raulerson and Rinehart 1997; G. Koob, in litt. 2005; L. Williams, CNMI Division of Fish and Wildlife, pers. comm. 2005). It has been observed in fruit in January, March, and November (Raulerson and Rinehart 1997; G. Hughes, in litt. 1998; G. Koob, in litt. 2005). All of the available information and recent observations suggest that these plants are perennials, but their above-ground parts die back annually. (USFWS, 2012)

Habitat Type

Adult: Terrestrial (USFWS, 2007)

Habitat Vegetation or Surface Water Classification

Adult: Limestone flat above seaside cliff (USFWS, 2007)

Environmental Specificity

Adult: High, with several key requirements (USFWS, 2007)

Habitat Narrative

Adult: This species has been found in two locations, Poña Point on Rota's southern coast and Puntan Fina Atkos on Rota's eastern coast. At both locations a small population exists on an exposed, raised limestone flat above a 7.6- to 30.5 meter (25- to 100-foot) seaside cliff. Although these flats are up to 30.5 meters (100 feet) above the sea, they are subject to scouring winds during severe storms. Nesogenes rotensis grows in association with Scaevola taccada, Terminalia samoensis, Hedyotis strigulosa, Pogonatherum paniceum, and Bikkia tetrandra (Resources Northwest 1997). (USFWS, 2007)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

2 (USFWS, 2012). 2 (USFWS, 2020)

Population Size:

30-40 (USFWS, 2012). As of 2017: 341 individuals, 126 of which are mature plants. (USFWS, 2017). 555 (USFWS, 2020)

Additional Population-level Information:

Population counts vary over time, an dis subject to repeated typhoon disturbance. (USFWS, 2017). • Field surveys conducted at Poña Point by DLNR and CNMI-DFW staff documented in excess of 100 individual Nesogenes plants in February 2016 (Lainie Berry, CNMI Department of Lands and Natural Resources, pers. comm. 2016). That fieldwork was focused on distribution and was not a complete census. (USFWS, 2017). • In August 2016, two groupings of Nesogenes

plants were observed at Poña Point. Each cluster included at least 7-13 individuals, with the first group being located at the east end of the point, in the public park area most immediately accessible to the public, while the second group was located 325 m to the WSW of the first group. This was not a complete census. Both this and the previous February 2016 survey confirm that the current distribution of Nesogenes population(s) at Poña Point spans over 400m (Lainie Berry and Bethany Chagnon, CNMI Department of Lands and Natural Resources and Division of Fish and Wildlife, pers. comm. 2016; and McBride field notes and GPS points, August 26, 2016). (USFWS, 2017). • In January 2017, the Nesogenes at Poña Point were surveyed by CNMI DLNR. A total of 403 individuals were recorded, distributed in three discrete patches; among these, 152 individuals were observed to be flowering and/or fruiting. (Lainie Berry, CNMI Department of Lands and Natural Resources, pers. comm. 2017). (USFWS, 2017).

Population Narrative:

There are only two populations of Nesogenes rotensis known to exist, with a current total population size estimated to be 30 to 40 individuals. (USFWS, 2012). Currently, there are one to two populations, one population of 403 individuals at Poña Point, including 152 reproductive individuals, and another population at Puntan Fina Atkos, when surveyed in 2016 could not locate individuals and more surveys are needed to determine its status. There has been some propagation via seeds and outplanting to Poña Point. There is some management and restoration at Poña Point to minimize disturbance of the area. (USFWS, 2020)

Threats and Stressors

Stressor: Land use practices (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Native vegetation, including open coastal scrubland habitat for Nesogenes rotensis on Rota, has undergone extreme alteration due to past and present land use practices, including ranching, deliberate and unintentional nonnative animal and plant introductions, agriculture, and military activities during World War II (Falanruw et al. 1989). (USFWS, 2007)

Stressor: Human activities (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Coastal habitat for Nesogenes rotensis is under increased pressure of development and is threatened by fragmentation and degradation associated with human use, development, and recreational activities. The species occurs in an area adjacent to a trail that is increasingly subject to bonfires, collecting, and trampling by fishermen and tourists, all human-caused threats to its habitat. (USFWS, 2007)

Stressor: Typhoons (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Rota has a long history of disturbances by tropical typhoons (Weir 1991). While native species are adapted to these events, these typhoons, in combination with human-caused

disturbances and the relatively new presence of invasive species, threaten the continued existence of Nesogenes rotensis. Within the past decade, frequent typhoons have made landfall on Rota, severely affecting the island. Most recently, in 2003 supertyphoon Pongsona affected the Mariana Islands, particularly Guam and Rota, with winds of up to 296 kilometers (184 miles) per hour. (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Nesogenes rotensis is particularly susceptible to extirpation or extinction from a natural disaster because of its limited distribution and small numbers of individuals. (USFWS, 2007)

Stressor: Invasive plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Nesogenes rotensis is also threatened by Casuarina equisetifolia (gagu or ironwood), which is becoming established in the coastal scrubland habitat at Poña Point Fishing Cliff. This tree is known to spread by root suckers and, as observed in other areas with similar habitat, may change the coastal scrubland into a monotypic gagu forest. Casuarina equisetifolia forest habitat is characterized by an absence of understory vegetation due to the restriction of available sunlight and soil nutrients, and possibly the release of a chemical agent that prevents other plants from growing beneath the trees (Smith 1985; L. Williams, pers. comm. 2004). Additionally, the native parasitic vine Cassytha filiformis (agasi) has been reported to parasitize individuals of N. rotensis, but deleterious effects have not been documented (L. Williams, pers. comm. 2005). (USFWS, 2007)

Stressor: Human activities (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: One population of Nesogenes rotensis is located in a public park (Poña Point). Human activities not only threaten the habitat for the species at this location, but the plants may also experience direct mortality and lower reproductive success due to trampling from foot traffic and bonfires set by tourists and fishermen. The small population size and extremely limited distribution of this species makes it particularly vulnerable to extinction from reduced reproductive vigor. With only 2 populations of 15 to 20 individuals each, a decline of successful reproduction in N. rotensis could lead to the extinction of the species (USFWS 2004). (USFWS, 2007)

Recovery

Reclassification Criteria:
1. A total of two populations of Nesogenes rotensis are naturally reproducing and stable, or increasing in numbers. Each population of N. rotensis must consist of at least 300 mature, reproducing individuals. A total of two populations of Osmoxylon mariannense are naturally

reproducing and stable, or increasing in numbers. Each population of O. mariannense must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as 8 or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)

2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)

3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Delisting Criteria:
1. A total of four populations of Nesogenes rotensis are naturally reproducing and stable, or increasing in numbers. Each population of N. rotensis must consist of at least 300 mature, reproducing individuals. A total of four populations of Osmoxylon mariannense are naturally reproducing and stable, or increasing in numbers. Each population of O. mariannense must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as 8 or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)

2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)

3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Recovery Actions:
- Coordinate and monitor recovery efforts. (USFWS, 2007)
- Address factors affecting viability of the wild populations. (USFWS, 2007)
- Monitor the extant Nesogenes rotensis and Osmoxylon mariannense populations, establish new populations, and augment existing populations. (USFWS, 2007)
- Provide educational and informational opportunities to build public support for conservation. (USFWS, 2007)
- 2017 recommended action 1: Survey protocol development: Given the recognized seasonal die-back exhibited by this species, and consequent variation in detectability through the calendar year, develop guidance defining season(s) when the species can be more reliably observed, and consistently counted. (USFWS, 2017).
- 2017 - 2: Resurvey and reconfirm the population at Puntan Fina Atkos, including its current condition, numbers, and distribution. (USFWS, 2017).
- 2017 - 3: Population monitoring – Monitor annually the number of individuals in the Poña Point Fishing Cliff and Puntan Fina Atkos populations. (USFWS, 2017).
- 2017 - 4: Survey for additional populations of Nesogenes in other areas of similar habitat, including the exposed limestone karst coastal cliffs that are common along the eastern shore of Rota. Revisit and reconfirm the two historical occurrences of Nesogenes at Puntan Haiña and Puntan As Fani. (USFWS, 2017).
- 2017 - 5: Habitat requirements research – Conduct research on Nesogenes rotensis habitat requirements, with emphases on identifying key suitability parameters in order to a) inform

effective management of the existing populations at the two confirmed (and any additionally-found) sites, and b) recognize appropriate sites for successful re-/establishment of the species. (USFWS, 2017).

- 2017 - 6: Conduct studies to clarify whether Nesogenes functions hemi-parasitically, and if so, which host species may be essential for its survival. (USFWS, 2017).
- 2017 - 7: Conduct studies to determine if parasitic or pioneering plant species such as Cassytha filiformis or Casuarina equisetifolia are negatively affecting populations of Nesogenes, either directly or via impacts to potential host plant species. (USFWS, 2017).
- 2017 - 8: Monitor to determine whether other invasive plant species in the vicinity of either population may be negatively affecting Nesogenes. Particular attention should be given to species not previously documented at those sites, or those species whose numbers appear to be increasing. (USFWS, 2017).
- 2017 - 9: In the event that plant interactions such as those described above are found to negatively affect Nesogenes, develop and implement control techniques to limit or eliminate such affects. (USFWS, 2017).
- 2017 - 10: Disturbance ecology: Consider the roles of typhoon events for this species. The known distribution of Nesogenes rotensis is in sites highly subject to the periodic major disturbance events of typhoons, and its recovery from such events has been documented. Beyond a degree of typhoon-resilience, might N. rotensis be somewhat typhoon-dependent? (i.e., Does it need periodic re-establishment of early-seral conditions to compete with other plants and persist on a site?) If some type(s) of disturbance is found to be important to the species' persistence on a site that perspective could indirectly inform decisions about managing other forms of disturbance. (USFWS, 2017).
- 2017 - 11: Captive propagation for genetic storage and reintroduction: o Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2017).
- 2017 - 12: Captive propagation protocol development – Conduct studies to determine how to propagate the species and maintain the species in nurseries. (USFWS, 2017).
- 2017 - 13: Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, maintain detailed provenance information. (USFWS, 2017).
- 2017 - 14: Reintroduction / translocation site identification – While surveying for new populations, determine which sites are least invaded by invasive plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2017).
- 2017 - 15: If Nesogenes host species are identified, then seed areas of suitable habitat where the host species is present, but where Nesogenes rotensis is lacking. (USFWS, 2017).
- 2017 - 16: Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2017).
- 2017 - 17: Site / area / habitat protection – Develop and implement effective measures to reduce the impact of urban development, typhoons, and human disturbance if and where these are found to be detrimental to the species. (USFWS, 2017).
- 2017 - 18: Alliance and partnership development – Work with the CNMI Department of Lands and Natural Resources, Division of Forestry, Division of Fish and Wildlife, and other land managers to coordinate planning and support implementation of ecosystem level restoration and management to benefit this species. (USFWS, 2017).

- 2017 - 19: Conduct systematic inventories of multiple Nesogenes populations to measure progress toward recovery goals and determine if and when downlisting criteria have been met. (USFWS, 2017).
- 2017 - 20: Regulatory protections – Work with CNMI authorities to ensure that federal and local regulations provide the necessary protections to support the recovery of Nesogenes rotensis, whether by adding the species to the CNMI Threatened and Endangered Species list, or by other means. (USFWS, 2017).
- 2017 - 21: Review the recovery plan (USFWS 2007) to determine if any new information suggests any need to update the plan to more effectively attain recovery goals (e.g., if Cassytha is determined to be a substantial issue for recovery, then Recovery Criteria 3 may need to address parasitic and/or pioneering as well as non-native species.) (USFWS, 2017).
- Continue to collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2007)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2007)
- Conduct studies to determine how to propagate the species and maintain the species in nurseries. (USFWS, 2007)
- Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records. (USFWS, 2007)
- While surveying for new populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. (USFWS, 2007)
- Conduct research on the possible hemiparasitic nature of the species and determine its host species. (USFWS, 2007)
- If the host species is determined, then reseed areas of suitable habitat where the host species is present, but where Nesogenes rotensis is lacking. (USFWS, 2007)
- Conduct intensive surveys for Nesogenes rotensis in potentially suitable habitat on Rota to determine if additional populations exist. (USFWS, 2007)
- Monitor annually the number of individuals in the Poña Point Fishing Cliff and Puntan Fina Atkos populations. (USFWS, 2007)
- Monitor and control invasive nonnative plant species in the vicinity of both populations, paying particular attention to species not previously documented or those whose numbers appear to be increasing. (USFWS, 2007)
- Conduct research on Nesogenes rotensis habitat requirements. (USFWS, 2007)
- Develop and implement effective measures to reduce the impact of urban development, typhoons, and human disturbance. (USFWS, 2007)
- Revise the hunting regulations of CNMIs Division of Fish and Wildlife to add Nesogenes rotensis to the list of protected wildlife and plant species. (USFWS, 2007)
- Revise recovery plan and recovery criteria with any updated information. (USFWS, 2007)
- Work with Commonwealth of the Northern Mariana Islands Division of Fish and Wildlife and other land managers to initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this species. (USFWS, 2007)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: • Survey protocol development: Given the recognized seasonal die-back exhibited by this species, and consequent variation in detectability through the calendar year, develop guidance defining season(s) when the species can be more reliably observed, and consistently counted. • Resurvey and reconfirm the population at Puntan Fina Atkos, including its current condition, numbers, and distribution. • Population monitoring – Monitor annually the number of individuals in the Poña Point Fishing Cliff and Puntan Fina Atkos populations. • Survey for additional populations of Nesogenes rotensis in other areas of similar habitat, including the exposed limestone karst coastal cliffs that are common along the eastern shore of Rota. Revisit and reconfirm the two historical occurrences of Nesogenes rotensis at Puntan Haiña and Puntan As Fani. • Habitat requirements research – Conduct research on Nesogenes rotensis habitat requirements, with emphases on identifying key suitability parameters in order to a) inform effective management of the existing populations at the two confirmed (and any additionally-found) sites, and b) recognize appropriate sites for successful re-/establishment of the species. • Conduct studies to clarify whether Nesogenes rotensis functions hemiparasitically, and if so, which host species may be essential for its survival. • Conduct studies to determine if parasitic or pioneering plant species such as Cassytha filiformis or Casuarina equisetifolia are negatively affecting populations of Nesogenes rotensis, either directly or via impacts to potential host plant species. • Monitor to determine whether other invasive nonnative plant species in the vicinity of either population may be negatively affecting Nesogenes rotensis. Particular attention should be given to species not previously documented at those sites, or those species whose numbers appear to be increasing. • In the event that plant interactions such as those described above are found to negatively affect Nesogenes rotensis, develop and implement control techniques to limit or eliminate such affects. • Disturbance ecology: Consider the roles of typhoon events for this species. The known distribution of Nesogenes rotensis is in sites highly subject to the periodic major disturbance events of typhoons, and its recovery from such events has been documented. Beyond a degree of typhoon-resilience, might N. rotensis be somewhat typhoon-dependent? (i.e., does it need periodic re-establishment of early-seral conditions to compete with other plants and persist on a site?) If some type(s) of disturbance is found to be important to the species' persistence, that information could indirectly inform decisions about managing other forms of disturbance. • Captive propagation for genetic storage and reintroduction: o Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Collect seeds from all existing populations and send to at least two or three different facilities for propagation and storage. • Captive propagation protocol development – Conduct studies to determine how to propagate the species and maintain the species in nurseries. • Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, maintain detailed provenance information. • Reintroduction / translocation site identification – While surveying for new populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. • Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. • Site / area / habitat protection – Develop and implement effective measures to reduce the impact of urban development, typhoons, and human disturbance if and where these are found to be detrimental to the species. • Alliance and partnership development – Work with the CNMI Department of Lands and Natural Resources, Division of Forestry, Division of Fish and Wildlife, and other land managers to coordinate planning and support implementation of ecosystem level restoration and management to benefit this species. • Regulatory protections – Work with CNMI authorities to ensure that federal and local regulations provide the necessary protections to support the recovery of Nesogenes rotensis, whether by adding the species to the CNMI Threatened and Endangered Species list, or by other means. •

Review the recovery plan (USFWS 2007) to determine if any new information suggests any need to update the plan to more effectively attain recovery goals (e.g., if Cassytha is determined to be a substantial issue for recovery, then Recovery Criteria 3 may need to address parasitic and/or pioneering as well as non-native species.) (USFWS, 2020)

- New management actions: • In the spring of 2016, James Manglona of CNMI Forestry was able to successfully germinate Nesogenes rotensis seeds, in a sandy soil bed at the Rota Forestry nursery. Germination required approximately five months. The persistence and ultimate longevity of these seedlings is yet unknown. (James Manglona, CNMI Forestry, pers. comm. 2016). • Efforts to propagate the species have been ongoing since 2016. Propagation activities include seed collection, propagation trials (including with potential host plant species), outplanting in suitable habitat at Poña Point, and initial monitoring were attempted. • As of June 2020, Rota Forestry had no nursery stock or outplantings to report (James Bamba, CNMI Department of Lands and Natural Resources, pers. comm. 2020). (USFWS, 2020)

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SPECIES ACCOUNT: *Nitrophila mohavensis* (Amargosa niterwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb. Leaves ovate, small, bright green. Flowers small, inconspicuous, pink, becoming white. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known only from the Amargosa River drainage in extreme southeastern Inyo County, California (Reveal, 1989) and from Nye county in bordering Nevada. (NatureServe, 2015)

Critical Habitat Designated

Yes; 5/20/1985.

Legal Description

On May 20, 1985, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Nitrophila mohavensis (Amargosa niterwort) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (50 FR 20777-20794).

Critical Habitat Designation

The critical habitat designation for Nitrophila mohavensis includes one CHU in Inyo County, California (50 FR 20777-20794).

California, Inyo County, Ash Meadows: W ½ sec. 5. E ½ sec. 6, NE ¼ and E ½NW ¼ sec. 7, NW ¼ sec. 8, T25N, R6E.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Nitrophila mohavensis critical habitat consists of one component (50 FR 20777-20794):

Known primary constituent elements include salt-encrusted alkaline flats.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering occurs in the late spring (USFWS, 1990).

Reproduction Narrative

Adult: Flowering occurs in the late spring; flowers are small, apetalous, and axial (Munz and Roos 1955, Reveal 1978c) (USFWS, 1990).

Habitat Type

Adult: Alkaline flats (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits playas (clay, mesic) (Skinner, 1997). Alkaline flats associated with Distichlis spicata var. stricta, Cordylanthus tecopensis, and Cleomella brevipes (Reveal, 1989). (NatureServe, 2015). High ecological integrity of the population and site fidelity and low tolerance ranges are inferred based on the restricted geography this specie inhabits along with the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2007)

Number of Populations:

4 Population Services (USFWS, 2020)

Population Size:

~235,628 (USFWS, 2020)

Population Narrative:

Wetland habitat (Bittman 1998). Populations described as containing thousands of plants (Bittman 1998). Known from two occurrences in California (Bittman 1998), and three in Nevada. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations and restricted geographic range.

Threats and Stressors

Stressor: Threats from Groundwater Development (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Given our current understanding of Amargosa niterwort demographic and hydrologic trends at the Lower Carson Slough population, coupled with the rate of groundwater extraction in the Amargosa Valley, the relative magnitude and imminence of groundwater development are considered high (USFWS, 2007).

Stressor: Threats of Habitat Loss or Degradation from Surface Mining (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Given the importance of the Lower Carson Slough and Crystal Reservoir populations and the threat posed by mineral claims on roughly 25 percent of the critical habitat , we conclude the magnitude of this threat is high. Currently, the economic viability of mineral extraction is unknown; therefore, we consider the imminence of this threat to be unknown (USFWS, 2007).

Stressor: Threat of Habitat Degradation from Ash Meadows Road (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, Ash Meadow Road did not pose a threat to the Amargosa niterwort. In late 1999 and early 2000, the California Department of Transportation (Caltrans) improved Ash Meadows Road where it crosses the Lower Carson Slough and Amargosa niterwort habitat. Caltrans imported fill and raised the roadbed where it crosses the Lower Carson Slough and in doing so, impacted individual Amargosa niterwort plants. The raised roadbed now poses an indirect threat to the Amargosa niterwort population by altering sedimentation patterns in the Carson Slough during thunderstorms or rare high flow events. Several low-water crossings with drainage pipes are present under the highway; however, during unusually high-volume flows the pipes may be filled with sediment, causing the roadbed itself to act as a dam that retains sediment that could bury a portion of the Lower Carson Slough population (Service 1999). Given the importance of the Lower Carson Slough population, the magnitude of this threat is high. However, given the relative infrequency of flash floods, the overall magnitude and imminence of this threat is low (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The 1985 final rule recognized establishment of the Refuge did not provide any protection for the Amargosa niterwort (50 FR 20777-20794) because the only known population for the Amargosa niterwort was located in California. Presently, with the discovery of the Crystal Reservoir population, a small portion, roughly 5 percent, is now protected on the Refuge and within the adjacent BLM Area of Critical Environmental Concern. Protection under the Act continues to be the most important regulatory mechanism for protecting the Amargosa niterwort because it is the only regulatory mechanism that spans both California and Nevada

state jurisdictions and it is the only mechanism that is able to protect Amargosa niterwort habitat from mining and groundwater pumping in certain situations. For this reason we conclude the magnitude of the threat posed by inadequate regulatory mechanisms is high. We consider this threat to be imminent because groundwater pumping is now at 200 percent above sustainable levels (USFWS, 2007).

Stressor: Trampling by wild horses and OHV activity (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Amargosa niterwort populations on the Refuge are relatively well protected; however, the Crystal Reservoir population was impacted by illegal OHV activity in the early 2000s. The effects of OHV activity on this population were scattered over a 0.5 acre area, but were less than 0.01 acre in total. The Tecopa population appears to be at the highest risk to damage from OHV activity. The area is unfenced and tire tracks have been observed going through the small Amargosa niterwort population (Edwards 2006). Given the fencing that has been installed to protect the lower Carson Slough population and the Refuge, which together compose roughly 98 percent of the known distribution, we consider the magnitude and threat posed by trampling by wild horses and OHV activity to be low and non-imminent (USFWS, 2007).

Stressor: Invasive Species and Fire (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat/loss of indivduals
Narrative: Invasive species were described as a threat in the rule to list the species in 1985. Amargosa niterwort habitat consists of barren, salt-encrusted mudflats with little to no vegetation. With the exception of salt cedar (Tamarix sp.), most invasive species present at Ash Meadows lack the special adaptations needed to survive in Amargosa niterwort habitat. Salt cedar is known to be a significant threat to wetlands in the vicinity (Service 2006a). However, salt cedar does not currently appear to be establishing in Amargosa niterwort habitat in either the Lower Carson Slough or below Crystal Reservoir (Servic2006a). Neither the Refuge nor BLM has an active program to remove salt cedar in or near occupied habitat. Fire has recently been identified as a threat to other Ash Meadows endemic plant species due to the increase in non-native species that would carry a fire (e.g., Ash meadows gumplant 5-year review, Service 2007); however, given the sparse cover and open structure of Amargosa niterwort habitat, fire is not expected to pose a significant threat. Given the available information, we conclude the threats posed by non-native species and fire are low and non-imminent (USFWS, 2007).

Stressor: Failure of Crystal Spring Dam (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals/Loss of habitat
Narrative: A breach of the reservoir would affect the area immediately below the dam, Lower Crystal Marsh, as well as the Lower Carson Slough at Ash Meadows Road (Service 2005). Given the severity of a potential impact, the magnitude of this threat is considered high. However, given the infrequent nature of catastrophic flash flooding and earthquakes in the vicinity that could cause the failure of Crystal Spring Dam, and the absence of human habitation or structures, we consider the imminence of this threat to be low. Nonetheless, Amargosa niterwort habitat

occurs in low-lying areas susceptible to flooding. The Amargosa niterwort population in the Lower Carson Slough has likely survived previous flash floods. However, because the Lower Carson Slough population is now smaller than it was in the 1950s and 1960s, when it was described as extensive, it is less protected against stochastic events such as flash flooding. Further compounding potential impacts from a flash flood event are the hydrologic modifications at Ash Meadows Road (see discussion under Factor A). Given the severity of a potential impact, the magnitude of this threat is considered high. However, given the infrequent nature of catastrophic flash flooding in the vicinity, the imminence of this threat is low (USFWS, 2007).

Recovery

Reclassification Criteria:
All non-native animals and plant species must be eradicated from essential habitat (USFWS, 2007).

Secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer (USFWS, 2007).

Essential habitat must be secure from detrimental human disturbance including mining, off-road vehicles, and introduction of non-native species (USFWS, 2007).

Amargosa niterwort is present in all localities that it has occupied historically as identified in Appendix A, Table XV, of the Recovery Plan (USFWS, 2007).

Delisting Criteria:
Criteria shown above for downlisting from endangered to threatened (USFWS, 2007).

Secure, protect, and maintain in natural vegetation, corridors, and adjacent buffer areas for gene flow and dispersal of listed plant species within the essential habitat (USFWS, 2007).

Native plant communities and aquatic communities have been reestablished to historic structure and composition within all essential habitat (USFWS, 2007).

All of the listed plant species are present in all the sites that they have historically occupied as identified in Appendix A, Table XV, of the Recovery Plan, and within each critical habitat unit, the listed plant has a frequency value equal to or greater than the frequency value determined by Recovery Plan Task number 644 needed as an indicator of a selfsustaining plant species. Task number 644 requires that for each listed plant species, frequency data must be gathered from examples of vegetation that is unaltered, to quantify recovery objectives. Sampling method must be determined, including the size/shape of sampling units and the number of units needed to accurately estimate frequency values (USFWS, 2007).

Recovery Actions:

- Downlisting criterion #1, the removal of all non-native animals and plant species from essential habitat, has been partially achieved (Factor E). While non native species are not currently a direct threat to the Amargosa niterwort, salt cedar (Tamarix ramosissima) is generally a problem in the Carson Slough and wetlands on the Refuge. The Refuge has

recently prepared an Integrated Pest Management Plan (Service 2006a). This plan provides a framework for managing invasive species, including salt cedar. In addition, the Refuge recently secured funding for salt cedar removal activities. These activities have only recently been implemented and have not yet produced on-the-ground results. The Bureau of Land Management (BLM) Las Vegas District has recently completed an Interagency Agreement with the Lake Mead National Recreation Area Exotic Plant Management Team for spot removal of non-native species within the Upper Carson Slough watershed. This work is ongoing (USFWS, 2007). Delisting is contingent on completion of the downlisting criteria described above. Delisting criterion #1, successful completion of the downlisting criteria, has not been completed. Criteria #2, 3 and 6 which address establishing corridors and re-establishing historical plant community structure are beginning to be addressed but have not been completed. The Refuge recently completed a Geomorphic and Biological Assessment for the Refuge (Service 2006b) which describes targets states for hydrologic and biologic functioning. The Refuge also recently completed an Integrated Pest Management Plan which outlines a strategy for managing weeds on the Refuge (Service 2006a). These efforts are just beginning and no tangible on-the-ground results have been achieved (USFWS, 2007).

- Downlisting criterion #2, secure and protect the Ash Meadows aquifer so that all spring flows return to historic discharge rates and the water level in Devils Hole is maintained at a minimum level of 1.4 feet below the copper washer, has only partially been achieved (Factor A). See discussion in section II.C.2.a. Protecting a minimum water level in Devils Hole will protect Amargosa niterwort occurrences on the Refuge; however, it may not protect critical habitat and the Lower Carson Slough occurrence which depend in part on subsurface flows from the Amargosa Valley (USFWS, 2007).
- Downlisting criterion #4, securing essential habitat from detrimental human disturbance including mining, off-road vehicles, and introduction of non-native species, has been partially achieved (Factor A). See discussion under section II.C.2.a. Occurrences on the Refuge receive protection from off-road vehicles and surface mining on lands where the Service owns mineral rights. The Lower Carson Slough population receives limited protection from fencing installed on both sides of Ash Meadows Road. Active mining claims are present adjacent to the Lower Carson Slough population; this population could be indirectly affected by dewatering or other mining activities. Public minerals are available and minerals claims can be made on the Crystal Reservoir population; the economic incentive for these claims is unknown (USFWS, 2007).
- Downlisting criterion #6 has not been completed. Amargosa niterwort is not present in all localities that it has occupied historically as identified in Appendix A, Table XV (USFWS, 2007).
- For the Amargosa niterwort, implementing population monitoring and investigating the factors that affect recovery are crucial (as described in tasks 4 and 6 in the Recovery Plan). Determining population trends for this species as described in the Recovery Plan is imperative and should be the first priority and should be performed over the next five years. Groundwater pumping will likely continue to increase in the Amargosa Valley. Documenting population trends will be paramount to identify any changes associated with such pumping. Before monitoring surveys are implemented, a long-term population monitoring plan for the Amargosa niterwort should be prepared to ensure that the necessary statistical rigor is included. Permanent plot markers were placed as part of the mapping and sampling plots set up during a demographic study by San Diego State University (SERG 2004). These plots offer a unique opportunity to gather quantitative population trend data for the species. This

study should be incorporated into the longterm population monitoring plan (USFWS, 2007).

- Additional research into the hydrology of the Central and Lower Carson Slough as it relates to the Ash Meadows and Alkali Flat/Furnace Creek hydrologic subbasins is needed. This should be the second priority for this species. Additional groundwater monitoring wells should be installed in the Central and Lower Carson Slough as part of the research (USFWS, 2007).
- Limiting potential flash flood or failure of Crystal Spring Dam impacts to the Lower Carson Slough population is critical. To accomplish this, modifications to Ash Meadows Road should be pursued to restore the natural hydrology that supports the Amargosa niterwort. Additionally, the repair, modification or removal of Crystal Spring Dam should be studied and implemented. These actions should be the third priority for this species (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: I. Monitor compliance with Nevada Revised Statute Order 1197A (January 12, 2018), Curtailment of New Appropriations of Groundwater within the Amargosa Valley Hydrographic Basin 230, that prohibits new applications for water or water diversions within 25 miles of Devils Hole (and by proximity Ash Meadows NWR). Order 1197A supersedes 1197, which imposed similar regulations at 10 miles from Devils Hole. Water levels in Devils Hole are affected by pumping centers in the Amargosa Desert and the Ash Meadows groundwater basins (Halford and Jackson 2020). II. Collaborate with the Ash Meadows NWR to implement the Desert National Wildlife Refuge Complex – Ash Meadows, Desert, Moapa Valley, and Pahranagat National Wildlife Refuges Final Comprehensive Conservation Plan and Environmental Impact Statement, Volume I – August 2009 (Service 2009) and also the Draft Ash Meadows Natural Resource Management Plan in review (Service 2020); and III. Support Amargosa niterwort research across its range to monitor populations as identified in the Recovery Plan for the Endangered and Threatened Species of Ash Meadows (Service 1990); and IV. Monitor the future activity of mineral rights in the Ash Meadows area. The BLM ACEC surrounding the refuge is withdrawn from mining and entry until 2029 (PLO# 7737, signed November 2nd, 2009), but requires renewal every 20 years. Mining can still occur on private inholdings within the refuge, but no active mining permits exist at this time. (USFWS, 2020)

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SPECIES ACCOUNT: *Nototrichium humile* (Kulu`i)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Nototrichium humile is a long-lived perennial shrub in the Amaranthaceae (amaranth) family. It is a basal-branching shrub 1 to 2 m (3.3 to 6.6 ft) tall, with upright or arching branches. The green, ovate to oblong leaves are 3 to 9 cm (1.2 to 3.5 in) long, and lack the silvery hairs characteristic of the other two Nototrichium species. The flowers are borne in slender, terminal spikes 3 to 14 cm (1.2 to 5.5 in) long. The perfect flowers (with both male and female reproductive parts) are small and inconspicuous, and the dry fruits are not much larger (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Historical Range

Historically it occurred throughout the Waianae Mountains of Oahu and on East Maui (56 FR 55770, 68 FR 25934) (USFWS, 2016).

Current Range

Current range: Waianae Mountains of Oahu; also known historically from Lualailua Hills on Maui (NatureServe, 2015). The status of N. humile on Maui is uncertain as no reports have been documented since 1979 (68 FR 25934). When the species was listed in 1991, 11 occurrences were estimated to contain up to 3,000 individuals on Oahu. Since then, 16 population units have been identified with a total of about 1,296 individuals. These population units are found on Federal, State, and city/county lands (68 FR 35950). No information is available on the current existence or numbers of N. humile on Maui (USFWS, 2016).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Nototrichium humile (Kulu`i) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Nototrichium humile (Kulu`i) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Nototrichium humile (77 FR 57648-57862). The critical habitat designation includes 17 critical habitat units, which encompass approximately 7,808 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Nototrichium humile includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for Nototrichium humile includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Cenchrus agrimonioides, Flueggea neowawraea, Melicope adscendens, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Canavalia pubescens, Colubrina oppositifolia, Ctenitis squamigera, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Sesbania tomentosa, Solanum incompletum, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Canavalia pubescens, and Hibiscus brackenridgei, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant Canavalia pubescens, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var.

lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Canavalia pubescens, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat desisgnation for Nototrichium humile includes 17 critical habitat units, covering one ecosystem type, which encompasses approximately 7,808 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11; Oahu— Lowland Mesic—Units 1, 2, 3;Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland

Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Nototrichium humile critical habitat consists of one component. Lowland dry (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Nototrichium humile critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Nototrichium humile occurs within the Lowland dry, Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola,

Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for Nototrichium humile to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes,

landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowering in N. humile is generally heaviest in the spring and summer, and the fruits mature a few weeks after flowering (USFWS, 2016).

Reproduction Narrative

Adult: Flowering in N. humile is generally heaviest in the spring and summer, and the fruits mature a few weeks after flowering. Pollination vectors for this species are not known, nor is it known if the plants are self-compatible. Based on observations of particular individuals, the plants live for at least one or two decades (Makua Implementation Team 2003). Other demographic information for N. humile in the wild is unknown, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Dry forest gulch (USFWS, 2016)

Habitat Narrative

Adult: Open, remnant dry or mesic forest, on cliff faces, in gulches, or on steep slopes. (NatureServe, 2015). Nototrichium humile is found on gulch slopes and gulch bottoms in the understory of dry forests dominated by Diospyros sandwicensis or Sapindus oahuensis, dry shrublands near ridge tops, and open dry cliffs and cliff ledges sparsely vegetated with shrubs and grasses. Small groups or isolated plants sometimes occur in mesic habitats. On cliffs, N. humile is somewhat protected from feral ungulates, invasive alien weeds, and fire. This species usually is found on north-facing slopes at elevations of 60 to 700 m (197 to 2,298 ft) (Makua Implementation Team 2003) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2016)

Number of Populations:

10 (USFWS, 2020)

Population Size:

880-950 (USFWS, 2020)

Population Narrative:

Currently there are 880 to 950 wild individuals on Oʻahu, and this number has been steadily declining since listing. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that Nototrichium humile is highly vulnerable to the effects of climate change. A wildfire in 2018 approached populations. Wild and reintroduced populations are provided protection from feral ungulates by fencing and ungulate control. Nonnative plants are controlled within five managed areas. Seed collection, propagation, and reintroduction are ongoing, with three populations nearing the ANRP's collection goals. Germination and seed storage studies are ongoing (USFWS, 2020) Currently, there are 880 to 950 wild individuals in 10 populations in the Waiʻanae mountains of Oʻahu (U.S. Army 2018, appendices; Army Natural Resources Program-Oʻahu (ANRP) 2019, Appendix 4-1).

Threats and Stressors

Stressor: Fire (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Threats include fires (USFWS, 2016)

Stressor: Climate change loss or degradation of habitat (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Nototrichium humile is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.675 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2020)

Recovery

Reclassification Criteria:
Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a) (USFWS, 2016).

Delisting Criteria:
Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Fire has increased in significance as a threat (after the previous 5-year review in 2013) since a large wildfire approached known populations in 2018. There is no other significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2020. • Surveys and inventories—Continue to conduct thorough surveys of all historical and suitable habitat for new occurrences. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with Nototrichium humile. • Fire monitoring and control—Establish populations in areas where damage or destruction by fire is less likely. Continue to develop and implement fire prevention management plans and coordinate effective fire suppression efforts, especially for Mākaha and Waiʻanae Kai. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Slug control—Continue to develop and implement effective control measures for slugs. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Determine optimal sites and continue to reintroduce individuals into areas that are being managed for known threats. • Population biology research— o Determine the number of genetically distinct plants in the populations of N. humile. o Study N. humile with regard to population size and structure, geographical distribution, breeding system, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. Continue germination trials and seed storage studies. o Determine suitability of habitat on Maui for reintroduction. • Alliance and partnership development—Continue to work with partners in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)
- New Management Actions: • Surveys and inventories—The ANRP continues to monitor wild and reintroduced populations of Nototrichium humile in the Waiʻanae mountains of Oʻahu, pursuant to the requirements of the Service's Biological Opinion for military training at Mākua Military Reservation of 2003 and the reinitiation in 2007 (USFWS 2007). • Ungulate monitoring and control—Ungulate monitoring and control is ongoing in the ANRP's population units and in the management units Kaluakauila, Waiʻanae Kai, Mākua South, Manuwai, and Kolekole (U.S. Army Garrison Hawaiʻi 2010, pp. 2-141, 2-146-147; ANRP-Oʻahu 2019, p. 16, Appendix 3-1). The Kahanahāiki and Palikea management units are ungulate-free with regular fence monitoring (ANRP-Oʻahu 2019, Appendix 3-1). • Established ecosystem altering invasive plant species control—Nonnative plants are controlled within the exclosures at Kahanahāiki, Kaluakauila, Mākaha, Waiʻanae Kai, and Manuwai (ANRP-Oʻahu 2019, Appendix 4-7). • Fire threat control by ANRP includes removing fuel (nonnative grasses), marking areas for water drops, and installing fuel breaks in fallow lands along accessible roads (ANRP-Oʻahu 2019, Appendix 4-7). Currently, one management unit, Kaimuhole-Palikea that includes N. humile has reached 100 percent of fire management goals and Waiʻanae Kai has reached 92 percent of fire management goals. • Captive propagation for genetic storage and reintroduction— o The ANRP reported collection of more than 4,500 seeds representing 19 founders from five populations in three locations (Punapōhaku, Kaimuhole-Palikea, Kolekole) and are close to collection goals (ANRPOʻahu 2019, appendix 4-8). In 2018, 424 plants were propagated representing 124 founders from seven populations (U.S. Army 2018). o The National Tropical Botanical Garden (NTBG) reported three individuals of Nototrichium humile in a living collection at the Southshore Garden (NTBG 2019). o The Waimea Valley Arboretum

reported between 67 to 86 individuals of N. humile representing six wild individuals in refugia (Waimea Arboretum 2013, 2014, 2017, 2018). • Reintroduction and translocation—Between 2018 and 2019, the ANRP reported reintroduction or establishment of a living collection at botanical gardens of 435 plants representing approximately 190 individuals from seven populations (U.S. Army 2018). Currently, 256 of the individuals survive, 113 individuals in two reintroduction sites (one with 106 individuals), and the remaining of which are in the living collections at Schofield Barracks, Koko Crater Botanical Garden, and Waimea Valley Arboretum collections (U.S. Army 2018). • Population biology research—Germination trials are ongoing, currently with a minimum viability of 66 percent. Bulk seed collections provide material for processing protocol and for storage and longevity research (ANRP-O'ahu 2019, pp. 124–125) (USFWS, 2020)

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SPECIES ACCOUNT: *Oenothera deltoides ssp. howellii* (Antioch Dunes evening-primrose)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A biennial herb that forms tufts of coarse, heavily-branched, drooping stems. Lower leaves grayish, pubescent, form basal rosette. Flowers bell-shaped, acquiring a blush of pink with age (Smithsonian Institution 1980). (NatureServe, 2015)

Taxonomy

Oenothera deltoides subsp. howellii is a short-lived perennial in the primrose family (Onagraceae) (USFWS, 2019).

Historical Range

See current range/distribution.

Current Range

Endemic to the Antioch Dunes, known from Contra Costa County and introduced in Sacramento County, California (Skinner 1997). (NatureServe, 2015)

Critical Habitat Designated

Yes; 8/31/1978.

Legal Description

On August 31, 1978, the U.S. Fish and Wildlife Service, designated critical habitat for Oenothera deltoides ssp. howellii (Antioch Dunes evening-primrose) under the authority of the Endangered Species Act of 1973 (43 FR 39042 - 39044). Critical habitat was designated for one unit in California.

Critical Habitat Designation

One critical habitat unit is designated in California, described as: An area of land, water, and airspace in Contra Costa County with the following components: T. 2 N. R. 2 E. SW 1/4 section 17, E 2/3 of S 1/3 of section 18 (43 FR 39042 - 39044).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements are not described (43 FR 39042 - 39044).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-incompatible, requiring cross-pollination for viable seed, insect pollinated (USFWS, 1984; 2019)

Reproduction Narrative

Adult: The Antioch Dunes evening-primrose is vespertine; the flowers open in early evening and close by mid-morning. In the garden, the plant flowers from “March to May and briefly in September’ (Roof 1969). This Oenothera is self-incompatible (Klein 1970) and thus requires cross-pollination for sound seed. Arnold (pers. Comm. 1982) believes that bees are the primary pollinating agent at Antioch. Although hawkmoths were not known on the dunes until 1983, they have been reported as pollinators of other Oenothera species (Gregory 1963). Their role as pollinators of Antioch Dunes evening-primrose has not been documented. Studies are needed to determine the phenology, pollinators and seed dispersal mechanisms of this subspecies (USFWS, 1984).

Habitat Type

Adult: Interior dunes on the "Antioch Dunes" along the shore of the San Joaquin River in Contra Costa County, California , occurring in nearly pure and shifting sand (USFWS, 2019).

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits inland dunes; this species will not mature where adult plants have previously grown unless fresh sand is deposited (Smithsonian Institution 1980 and Skinner 1997 in NatureServe, 2015). O.d. subsp. howellii is considered almost entirely restricted to the reamaining Anitoch Dunes habitat at the Anitoch Dunes Natural Wildlife Refuge, which encompasses 67 acres (the 41-acre Stamm Unit, owned by the Service and the 26-acre Sardis Unit, of which 14 acres are owned by the Service and 12 acres are owned by Pacific Gas and Electric)(USFWS, 2019).

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Number of Populations:

4 (Stamm Unit, Sardis Unit, transplanted location on Browns Island, and Brannan Island)(USFWS, 2019).

Population Size:

2,368 (as of 2017)(USFWS, 2019)

Population Narrative:

According to the CNDDB (2018a), Oenothera deltoides subsp. howellii is known from 10 EOs, nine of which are presumed extant and one of which is considered likely extirpated (Table 2). Of

the nine presumed extant EOs, six are considered natural occurrences and three are considered transplanted outside of native habitat and/or range. The total population in 2017 was estimated at 2,368 individuals, with 2,334 plants counted at the ADNWR (2,008 at the Stamm Unit and 326 at the Sardis Unit) and 34 plants at one of the transplanted locations at Browns Island (Table 2). Population numbers have shown some improvement since the 2008 Five-Year Review, as illustrated by plant count numbers from ADNWR (Figure 5; Service 2018a, Service No Date). However, despite the improvement, the overall population is still not considered stable or self-sustaining due to the overall low population numbers, low redundancy of populations, and continuing and increasing threats (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction from sand mining, industrial and urban/suburban development, and/or conversion to agriculture
Exposure:
Response:
Consequence:
Narrative: Habitat for the Lange's metalmark, O.d. subsp. howellii, E.c. var. angustatum, and pollinators, and area available for habitat restoration is threatened by destruction and conversion to other uses. This threat is largely ameliorated on the ADNWR and other properties with protection/management agreements in place, but not on properties without such agreements (USFWS, 2019).

Stressor: Habitat degradation due to loss of natural disturbance regime
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The reduction in sand deposition in Antioch Dunes habitat as a result of water management/use (dams, levees, etc.) in the Sacramento/San Joaquin River Delta system and reduced effectiveness of wind-driven dispersal of sand and disturbance of dunes has and continues to reduce overall size and connectedness of the dune natural community (USFWS, 2019).

Stressor: Habitat degradation due to non-native and native invasive vegetation
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive vegetation colonizes open sand habitat, reducing available suitable Lange's metalmark, O.d. subsp. howellii, E.c. var. angustatum, and pollinator, habitat. Invasive plants out-compete native species, including Lange's metalmark host and food plants, and O.d. subsp. howellii and E.c. var. angustatum, for sunlight, space, nutrients, and moisture. They also stabilize the sand/soil, eliminating the natural disturbance regime and may cause soils to become more eutrophic (Thomson 2005a, Thomson 2005b, Chin 2012, McNally 2014). The 2008 Five-Year Review notes that the proliferation of non-native invasive plants has been increasing rapidly since 1998 (Service 2008) and these conditions continue (Chin 2012, McNally 2014, Service 2018a, Service 2018b, Service 2018c, Service 2018d). The use of herbicides to control non-native and native invasive vegetation may also present potential threat to Lange's metalmark host and food plants, O.d. subsp. howellii, and E.c. var. angustatum occurring in the same vicinity. Applying

herbicides selected for the target species and using appropriate rates and technique should minimize effects to non-target Lange's metalmark host and food plants, O.d. subsp. howellii, and E.c. var. angustatum. These practices have been instituted at the ADNWR, so this threat is considered largely ameliorated there (Service 2008), but it may pose a risk to current and future occurrences of these listed species elsewhere. Additionally, some herbicides may pose threat directly to Lange's metalmark. In a study of Behr's metalmark, a close relative of Lange's metalmark butterfly, the herbicides triclopyr, sethoxydim, and imazapyr were found to reduce the number of adults that emerged from pupation by 24-36% after exposure to typical field application rates (Stark et al 2012 in Richmond et al 2015) (USFWS, 2019).

Stressor: Habitat degradation due to gypsum dust deposition from neighboring plant (facility)
Exposure:
Response:
Consequence:
Narrative: The 2008 Five-Year Review reported that gypsum dust building up on plants may reduce exposure to sunlight and decrease photosynthesis. It may also alter soil chemistry due to introduction of calcium and sulphates, which may affect the growth of Lange's metalmark host and food plants, O.d. subsp. howellii and E.c. var. angustatum and promote colonization by invasive species. Deposition is noted as affecting mostly the Sardis Unit. The ADNWR staff have met with Georgia-Pacific (G-P) about concerns over the dust and G-P increased efforts to reduce airborne gypsum (beyond the standards for air pollution control) by keeping it wetted down when possible during production activities. At the time of the 2008 Five-Year Review, staff noted a reduction in dust from G-P efforts. The review noted that there was no evidence that gypsum dust was adversely affecting any of the three species (Service 2008). However, it also cited a study that demonstrated that dusts may adversely increase transpiration through the cuticle of insect larvae and cause desiccation and abrasion of the cuticle (Wigglesworth 1945 in Service 2008), which may affect Lange's metalmark and pollinators of O.d. subsp. howellii or E.c. var. angustatum. The ADNWR staff reported an increase in gypsum dust deposition at ADNWR in 2017-2018 (Susan Euing pers. comm. December 12, 2018). In 2018, staff noted that gypsum was being deposited on the refuge at concentrations that coats plants, leading to cancellation of surveys for the Lange's metalmark in some parts of the refuge (Susan Euing pers. comm. August 17, 2018). In 2019, after several weeks into the Lange's metalmark survey season, ADNWR staff confirmed that no surveys had been canceled due to concerns about gypsum dust deposition (Louis Terrazas pers. comm. September 10, 2019). The magnitude of this potential stressor requires further investigation and Service partnership with G-P is ongoing (USFWS, 2019).

Stressor: Habitat degradation due to rogue hiking/trails
Exposure:
Response:
Consequence:
Narrative: This activity may cause direct injury or mortality to the Lange's metalmark, to its host and food plants, and to O.d. subsp. howellii and E.c. var. angustatum from trampling while also increasing potential for accidental introduction of wildfire from hikers. These threats and stressors were significantly reduced when ADNWR was fenced in 1986 and the 2008 Five-Year Review (Service 2008) no longer considered recreational and pedestrian traffic to be a significant threat. However, ADNWR staff note that incidence of trespassing and human encampments at ADNWR has increased in the past several years (Susan Euing pers. comm. December 12, 2018) (USFWS, 2019).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes
Exposure:
Response:
Consequence: Extirpation
Narrative: These activities represent a threat to the Antioch Dunes species from direct mortality of any individual(s) collected and a reduction in annual recruitment by killing or injuring reproductive individuals (USFWS, 2019).

Stressor: Disease or predation
Exposure:
Response:
Consequence:
Narrative: Evidence exists of O.d. subsp. howellii infestation by beetles (possibly family Chrysomelidae), which feed on petals, pollen, and seed pods. Also, in the early 1980s up to 50% of O.d. subsp. howellii was infested with small mirid bugs (family Miridae of the insect order Hemiptera) that prey upon O.d. subsp. howellii, and these insect predators remained an identified threat in 2008 (Service 2008). The magnitude of this stressor requires further investigation (USFWS, 2019).

Stressor: Wildfire
Exposure:
Response:
Consequence:
Narrative: Wildfire may cause direct mortality of O.d. subsp. howellii and E.c. var. angustatum plants during vulnerable life stages. These stages include the period from germination during the beginning of the wet season in December through the deposition of seeds in mid-summer. However, historical evidence indicates that the native plants may recover rather quickly from a wildfire (Service 2008). Any mortality would also result in reduced annual recruitment by killing or injuring reproductive individuals. The threat extends to pollinators and other pollinator plant species (USFWS, 2019).

Stressor: Fuelbreak discing
Exposure:
Response:
Consequence:
Narrative: Fuelbreak discing may cause direct injury or mortality to Lange's metalmark, its host and food plants, and to O.d. subsp. howellii, and E.c. var. angustatum. However, it also creates open, disturbed, sand/soil that may be suitable for colonization by O.d. subsp. howellii and E.c. var. angustatum, as well as invasive vegetation. The net impact of this activity to listed plant resilience is unquantified (USFWS, 2019).

Stressor: Loss of pollinators
Exposure:
Response:
Consequence:
Narrative: Lange's metalmark is addressed as a pollinator for this discussion of the potential threat posed by possible insecticide drift from mosquito abatement spraying on neighboring

properties (Richmond et al 2015). The Mosquito Abatement District allows for spraying of insecticides to reduce the incidence of West Nile Virus at a wetland adjacent to the Stamm Unit of the ADNWR. The spray could drift on to the refuge and affect pollinators, such as Lange's metalmark and those that pollinate O.d. subsp. howellii or E.c. var. angustatum. While ADNWR staff have worked with county mosquito control staff to minimize effects from this potential threat, the magnitude of this stressor requires further investigation. As of the 2008 Five-Year Review, there was no evidence that lack or loss of pollinators has negatively impacted O.d. subsp. howellii or E.c. var. angustatum (Service 2008), but both species require cross-pollination, so an adequate pollinator population is necessary. Bees are suspected pollinators for both species and hawkmoths may also be pollinators for the primrose; however, actual pollinator taxa are unknown. This potential threat requires investigation (USFWS, 2019).

Stressor: Low population numbers
Exposure:
Response:
Consequence:
Narrative: Oenothera deltoides subsp. howellii and E.c. var. angustatum are threatened by few and small populations that are limited to a small and localized distribution, which increases the risk of extirpation and extinction due to: (1) Reduced resiliency (the ability of a species to withstand stochastic disturbance; resiliency is positively related to population size and growth rate and may be influenced by connectivity among populations); (2) Low redundancy (spreading risk among multiple populations or a large area to minimize the potential loss of the species from catastrophic events); and (3) Low representation (the breadth of genetic and environmental diversity within and among populations that influences the ability of a species to adapt to changing environmental conditions over time) (USFWS, 2019).

Stressor: Climate change
Exposure:
Response:
Consequence:
Narrative: Oenothera deltoides subsp. howellii and E.c. var. angustatum are threatened by multiple environmental effects anticipated with climate change, which may result in loss of habitat, altered temperature and moisture regimes causing direct mortality and/or impaired reproduction, and altered temperature and moisture regimes causing indirect mortality and/or impaired reproduction via phenological mismatches with pollinators and between pollinators and their host and/or other nectar plants (Richmond et al 2015) (USFWS, 2019).

Recovery

Reclassification Criteria:
There are at least five separate self-sustaining (all plants are naturally recruiting*) populations, including: at least three populations, each with a 15-year moving median of at least 4,800 flowering plants; and at least two populations, each with a 15-year moving median of at least 1,500 flowering plants (USFWS, 2019).

A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations (USFWS, 2019).

Populations should be protected and have in place a long-term management plan for the conservation of O.d. subsp. howellii and commitment for implementation of the plan (USFWS, 2019).

Delisting Criteria:
There are at least seven separate self-sustaining (all plants are naturally recruiting (*Any flowering individuals counted as naturally recruiting would have to be ≥ two flowering seasons post-outplanting. This would indicate the individual has completed the life cycle in situ.)) populations including: at least five populations, each with a 15-year moving median of at least 4,800 flowering plants; and at least two populations, each with a 15-year moving median of at least 1,500 flowering plants. OR, population viability analysis determines that O.d. subsp. howellii has a range-wide 95% probability of persistence over a 100-year period. a. A distance of at least 1,500 feet and a natural and/or man-made firebreak separates individual populations. b. Populations should be protected and have in place a long-term management plan for the conservation of the O.d. subsp. howellii and commitment for implementation of the plan. (USFWS, 2019)

A post-delisting monitoring plan for the species has been developed (USFWS, 2019).

Recovery Actions:

- The final supporting actions for Primary Action 1 include identification of other essential habitat and developing an MOU with the landowner to develop protective alternatives and actions. Since listing, the only new habitat identified for conservation is the property owned by the Pioneer Companies, Inc., and currently occupied by the McCullogh-Kemwater North American Company. All three of the Antioch Dunes species have been surveyed on this property (USFWS 2005). Currently, this property is for sale and the Service is considering alternatives that include purchasing this valuable habitat (USFWS, 2008).
- The initial supporting actions for Primary Action 2 are essentially the same for all three endangered Antioch Dunes species, and include conducting annual census of population and habitat; captive breeding (Lange's metalmark butterfly) or propagation and outplanting (Antioch Dunes evening-primrose, Contra Costa wallflower); developing and implementing a habitat restoration plan; and conducting studies of the biology of the species which include life history (Lange's metalmark butterfly), autecological studies (Antioch Dunes evening-primrose, Contra Costa wallflower), habitat requirements (Lange's metalmark butterfly), population biology (Lange's metalmark butterfly), and reproductive studies (Antioch Dunes evening-primrose, Contra Costa wallflower). Out-planting buckwheat host plants is also needed for Lange's metalmark butterfly. All of these actions have been ongoing and are discussed below in section IIC. Another group of supporting actions includes rebuilding the natural dune substrate and topography to the degree feasible by negotiating with the Army Corps of Engineers (Corps) and the Port of Stockton for sandy dredged material, preparing the sites for deposition of dredged material, and surveying the sites for candidate and listed species in order to ameliorate any negative effects. Several sources of sand were used in restoration efforts since listing the three species. Dredged material was found to contain a substantial amount of fine non-silica sediment which proved to stabilize too quickly for use as a substitute for the original dune sand (C. Smith in litt. 2007). Antioch Dunes NWR staff recently located several sources of local high-silica content sand that should prove useful in the restoration; however, although funding sources are being sought for purchasing and delivering the sand, current plans tentatively include testing the composition of the

imported sand prior to using it to supplement the refuge. (C. Smith in litt 2007; L. Terrazas, USFWS, pers. comm. 2008). Other actions include removal of a vineyard and removal of other non-native invasive vegetation throughout the Antioch Dunes NWR. The vineyard was removed in 1983 and removal of non-native invasive vegetation has been an ongoing effort (see section IIC for updated status on the restoration) (USFWS, 2008).

- Supporting actions for this include erecting interpretive signs, printing and distribution of leaflets describing the Antioch Dunes NWR's unique dune ecosystem and the need for restoration, and the development of an environmental education program. These actions were completed in the early 1980s; however, the public awareness effort is a dynamic and ongoing process (USFWS, 2008).
- Continue restoration of riverine dune habitat at Antioch Dunes NWR (USFWS, 2008)
- Conduct controlled propagation of the Lange's metalmark butterfly until natural populations at Antioch Dunes NWR are at a self-sustainable level (USFWS, 2008)
- Continue research into life history, habitat requirements, and population studies, including annual population monitoring surveys (USFWS, 2008)
- Acquire the McCulloch/Kemwater property abutting the eastern boundary of the Sardis Unit of the Antioch Dunes NWR (USFWS, 2008)
- Consider revising the Recovery Plan for the three endangered species endemic to Antioch Dunes, California (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Several areas of future action are suggested over the next five years, which build on the actions articulated in the revised recovery plan (Service 1984) and the riverine dune ecosystem conservation strategies articulated in Service (2019b). These areas include: continuing to restore riverine dune habitat at ADNWR and considering nearby locations for restoration activities; continuing research on the habitat requirements, life history, and seed bank dynamics of Antioch Dunes evening-primrose; improving statistical analysis and numerical modeling related to Antioch Dunes evening-primrose; considering development of a publicly-accessible website for documents, literature, and data related to Antioch Dunes evening-primrose; and establishing an Antioch Dunes Recovery Implementation Team or recovery working group. Continued research on the habitat requirements and seed bank dynamics of Antioch Dunes evening-primrose could include identifying areas for possible development of new populations of Antioch Dunes evening-primrose. For example, the Service's experience with dune restoration at the Refuge in combination with the work of Jones et al. (2019) provides a strong foundation for expanding dune restoration work over the coming years. This future work could include an analysis of how environmental variables, such as precipitation and temperature patterns influence population dynamics in currently occupied areas and colonization of newly restored dunes. It is also not currently clear which invertebrate species are the most important pollinators of Antioch Dunes evening-primrose. A study of the current pollinators of primrose at Antioch Dunes would help add to our understanding of the natural history of this subspecies and identify which potential pollinators to monitor to ensure that healthy pollinator populations continue to occur at and near the Antioch Dunes ecosystem. Statistical and numerical modeling, such as with habitat suitability analysis and population dynamics modeling, can provide insights into possible future locations for development of Antioch Dunes evening-primrose populations, and future dynamics of these populations. Jones et al. (2019) began developing habitat suitability models for primrose using remote sensed vegetation metrics (NDVI; Normalized Difference Vegetation Index). It is possible that a continuation of this line of investigation will lead to improved insights into where and how to develop additional restored

sand dunes that will support the recovery of this subspecies. It may also be useful to consider developing population viability analyses (PVA) that are specifically developed for Antioch Dunes evening-primrose. For example, it is possible that the stagestructured matrix population model developed by Thomson (2005a) could be used to form a foundation for PVA analysis. It is also possible that building and parameterizing such a model, and then projecting this model into various possible futures, including under the influence of changing climate conditions, could help provide insights beyond the PVA's suggested by recovery criteria in Service (2019a). As part of efforts to improve statistical analysis and modeling, creating a well-vetted and archived dataset of all Antioch Dunes evening-primrose surveys, and resolving any discrepancies in counts identified during this review will be critical to progressing on this objective. In late 2019, staff of the Bay-Delta Fish and Wildlife Office met with the staff of the ADNWR and considered formally convening a recovery implementation team (RIT) for the listed species that occur at the Refuge, including Antioch Dunes evening-primrose. The primary purpose for convening this group would be to encourage Service biologist and managers and external experts to consider recovery priorities for these species and the Antioch Dunes ecosystem, and continue to stay abreast of emerging research related to primrose, riverine dune ecology, and other relevant topics. This group would also help develop a recovery implementation strategy for Antioch Dunes. (USFWS, 2020)

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SPECIES ACCOUNT: *Opuntia treleasei* (Bakersfield cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A flat-padded (beavertail) opuntia cactus, with the eye-spots (which are not sunken) having spines as well as bristles. Typically flowers in May. (NatureServe, 2015)

Taxonomy

USFWS treats as Opuntia treleasei (8/93). (NatureServe, 2015)

Historical Range

The distribution of Bakersfield cactus was not estimated historically. Based on written descriptions (Twisselmann 1967), historical photographs (Britton and Rose 1920; Benson 1982), topography, and deductions from plant morphology, the populations were likely more or less continuous east of Bakersfield (Service 1998). According to Twisselman (1967), Bakersfield cactus "once grew in dense almost impenetrable colonies on the mesas east of Bakersfield." Densely-spaced clumps of Bakersfield cactus once covered about two square miles from the Caliente Creek floodplain onto Sand Ridge. (USFWS, 2011)

Current Range

California: San Joaquin Valley (central Kern County). Other reports are no longer considered to be this taxon (cf. Munz 1974; Benson 1982; Brown and Cypher 1997).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated/Vegetative reproduction (USFWS, 1998)

Lifespan

Adult: at least 48 years (USFWS, 1998)

Breeding Season

Adult: Bakersfield cactus typically flowers in May (Munz and Keck 1959) (USFWS, 1998).

Reproduction Narrative

Adult: Bakersfield cactus is a perennial. The life span of wild plants has not been determined, but clumps in cultivation at the Rancho Santa Ana Botanic Garden in Claremont, California, survived for 48 years, until extremely wet winter weather caused the pads to rot (R. van de Hoek pers. comm.). Bakersfield cactus typically flowers in May (Munz and Keck 1959). Reproductive biology of this taxon has not been studied, but certain other Opuntia species

require cross-pollination for seed-set and many are pollinated by bees (Benson 1982, Spears 1987, Osborn et al. 1988). One potential pollinator of Bakersfield cactus is the native solitary bee Diadasia australis ssp. caIifornia, which is known to occur in Kern County and which specializes in collecting pollen from Opuntia species (Thorp in litt. 1998). Vegetative reproduction, which is the production of new plants from sources other than seed, is typical in Bakersfield cactus and several related species (Benson 1982). Fallen pads root easily if sufficient water is available (Twisselmann 1967, Benson 1982, Mitchell 1988), but Bakersfield cactus does not survive prolonged inundation (ESA Planning and Environmental Services 1986a). Bakersfield cactus produces seeds infrequently. Van de Hoek (pers. comm.) noted that the frequency of seed set in extant populations is similar to the proportion of seeds he observed in herbarium specimens. Cactus seeds require warm, wet conditions to germinate, a combination which is extremely rare in the Bakersfield area (Benson 1982). Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986a), but seed dispersal agents are unknown (USFWS, 1998).

Habitat Type

Adult: Grasslands (USFWS, 1998)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits sandy soils or sand flats and low hills mostly in grassland at 120-550 m (Benson 1982; Brown and Cypher 1997). Characteristic in Sierra-Tehachapi Saltbush Scrub community, but also in Blue Oak Woodland and a riparian woodland. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on its specific habitat needs and low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Pads may be dispersed by flood waters (ESA Planning and Environmental Services 1986), but seed dispersal agents are unknown (USFWS, 2011).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

51 (USFWS, 2020)

Population Narrative:

Twenty-nine occurrences are presumed extant; about half have not been surveyed for over 20 years (USFWS 2011; CNDDB 2012). (NatureServe, 2015)

Threats and Stressors

Stressor: Agricultural Conversion and Urbanization (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The primary threats to Bakersfield cactus over its entire habitat range continue to be residential development and conversion to agriculture. Continuing threats to localized populations that were identified in the listing rule include urbanization events such as; road expansion and maintenance (Oildale Area (within the MBNKR Recovery Site), Wheeler Ridge, and Sand Ridge), expansion of the Kern River Power Plant (Kern Canyon), the county airport (MBNKR), and the Bena landfill (Caliente-Bena Hills); as well as oil and gas development (Oildale Area (within the MBNKR) and Wheeler Ridge), Off road vehicle use (MBNKR and Cottonwood Creek), sand and gravel mining (Sand Ridge) and California Aqueduct right-of-way maintenance (Wheeler Ridge) (Cypher pers comm. 2010). All of these activities continue to threaten Bakersfield cactus by the modification of its habitat, the removal of Bakersfield cactus clumps, and the further fragmentation of existing populations. Table 2 summarizes land ownership and protected status (USFWS, 2011).

Stressor: Oil and Gas Extraction and Conveyance (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Oil and gas extraction and conveyance continue to threaten Bakersfield cactus. Adverse effects of oil and gas development on Bakersfield cactus include the loss of habitat, change in habitat quality, destruction of individuals or populations and their seedbank, habitat fragmentation, and increased competition from nonnative plant species due to habitat degradation. According to our HCP database (Service 2010), there is one HCP that covers oil and gas production that includes Bakersfield cactus as a covered species. The Nuevo Energy Company and Torch Operating Company (Nuevo/Torch) HCP was permitted in 1999 for a 30-year permit term. The project size is 21,800 acres with 1,700 acres impacted. The mitigation includes 800 acres to be created, enhanced, or restored, and 840 acres to be protected. Approximately 1,328 acres of the total 21,900 acres in the Nuevo/Torch Plan Area may be suitable for Bakersfield cactus (Nuevo/Torch 1999). Only those Nuevo/Torch lands east of Highway 99 overlap with reported occurrences of Bakersfield cactus. Bakersfield cactus has a limited range and is only found in western Kern County. Therefore Nuevo/Torch proposed avoidance and minimization measures are particularly important for this species. Oil and gas development is often limited and linear in nature in terms of well pads and pipeline construction but where oil and gas fields are developed into production sites, the cumulative impact can be large. Three of the five largest U.S. oil fields are in Kern County and span more than one million acres (USFWS, 2011).

Stressor: Conservation Efforts (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Approximately 1068.40 acres (74.6 percent) of occupied presumed extant Bakersfield cactus habitat is on private land that is not protected from agricultural conversion, urbanization, oil and gas development, and off road vehicle use. About 144.35 acres (10.1 percent) of occupied presumed extant Bakersfield habitat is on private land that is protected. About 115.03 acres (8 percent) of presumed extant Bakersfield cactus habitat is on public land that is not protected from oil and gas development, off road vehicle use, and utility operation and maintenance; 104.37 acres (7.3 percent) is on protected public lands (USFWS, 2011).

Stressor: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: At the time of listing we stated that many cacti are collected and cultivated by plant collectors, or offered for sale or trade by cactus growers. Although there have been no reports of such trade in Bakersfield cactus, the species may still be collected and cultivated (Service 1990). Currently, we have no evidence whether this has occurred. Currently, the lack of monitoring means that we probably would not detect collection or vandalism, especially on private land (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, the Endangered Species Act is the primary Federal law that provides protection for this species since its listing as endangered in 1990. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2011).

Stressor: Nonnative annual grasses and increased fire frequency (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Nonnative annual grasses directly threaten the survival of mature cactus plants and hinder the establishment of new plants (ESA Planning and Environmental Services 1986; Mitchell 1988). In 2002-2004, mortality of Bakersfield cactus clumps and low rates of vegetative and sexual reproduction at Sand Ridge Preserve were attributed to competition with nonnative annual grasses for water during years with below-average precipitation (Cypher and Fiehler 2006; Cypher pers. comm. 2006). Nonnative annual grasses also indirectly affect Bakersfield cactus in three ways. First, indirect effects from nonnative annual grasses include increased fire frequency (Service 1998; Brooks 1999; Brooks and Pyke 2001; Brooks 2003), damage from insects (Burger and Louda 1994), and rot of cactus pads during wet years (Service 1998). Fire suppression has allowed the extensive growth of nonnative grasses in some areas to the detriment of Bakersfield cactus (Moe 1989). Also, nonnative annual grasses, which are adapted to fire, increase the fuel load in fire-intolerant saltbush (Atriplex sp.) habitat, where Bakersfield cactus is found, resulting in an increase in fire frequency (Brooks 1999; Brooks and Pyke 2001; Brooks 2003). Although the

effect of repeated fires on Bakersfield cactus has not been determined, the survival of Bakersfield cactus plants was monitored following single fire events at Sand Ridge (R. Hewett, Sand Ridge Preserve Manager, in litt. 1987) and near the Rio Bravo Hydroelectric Power Plant in Kern Canyon (Lawrence 1987; George Lawrence and Associates 1988). All of the Bakersfield cactus clumps survived the fires at both sites, despite wilting and browning of the pads. During the following spring, Bakersfield cactus plants that were subjected to low-intensity flames flowered; however, those subjected to moderate-intensity flames produced only vegetative growth. Second, dense grass also may harbor insects that damage cactus, as was observed with related species of Opuntia in Nebraska grasslands (Burger and Louda 1994), but not yet studied in Bakersfield cactus. Third, the dense grass cover creates a moist microclimate which may promote the growth of decay organisms and cause cactus pads to rot more in years of above-average precipitation (Service 1998) (USFWS, 2011).

Stressor: Loss of genetic diversity (USFWS, 2011)
Exposure:
Response:
Consequence: Extirpation
Narrative: The destruction of Bakersfield cactus habitat by agriculture and urban sprawl has left the remaining populations highly fragmented and small. The small size of many of the populations (Moe 1989; CNDDB 2010), presumed lack of gene flow between populations, and infrequent sexual reproduction (Menges 1986) may result in a lack of genetic diversity (Service 1998) although this has not been tested in Bakersfield cactus. Populations that are low in genetic variation are more vulnerable to diseases and parasites (Burdon and Marshall 1981) and to chance events, including environmental fluctuations, catastrophes, and genetic drift (Menges 1991). Several of the occurrences have few individuals (CNDDB 2010) and could be subject to loss of genetic diversity (USFWS, 2011).

Stressor: Flooding (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Bakersfield cactus populations located in floodplains are threatened by flooding. Bakersfield cactus plants cannot survive long periods of inundation (ESA Planning and Environmental Services 1986; Service 1998). Populations within the Caliente Creek floodplain have been extirpated due to flooding, and flooding continues to be a threat for the Caliente - Bena Hills populations (Service 1998; CNDDB 2010). Populations of Bakersfield cactus within the California Aqueduct right-of-way are also potentially threatened by flooding. Kern County identified earthquakes as highly significant hazard to all regions of Kern County. Large earthquakes can cause secondary hazards including landslides, fire, and flooding. The California Aqueduct crosses the White Wolf Fault at Wheeler Ridge and parallels the San Andreas Fault within 25 miles for most of its length in Kern County (Kern County Fire Department Office of Emergency Services 2005). The largest concentration of clumps in the Wheeler Ridge population is located adjacent to an overflow drain for the Aqueduct, which could lead to flooding if an earthquake occurred anywhere along its length (Service 1998) (USFWS, 2011).

Stressor: Air pollution (USFWS, 2011)
Exposure:
Response:

Consequence: Reduced reproduction
Narrative: The Recovery Plan cites Messick (1987) as stating that air pollution is suspected to have contributed to the decline of Bakersfield cactus. Messick noted that populations of Bakersfield cactus appeared to be reproducing less and losing vigor and that soft tissues may be adversely affected by acid deposition or ozone. He suggested that study of possible air pollution effects was needed (USFWS, 2011).

Stressor: Reproductive threats (USFWS, 2011)
Exposure:
Response:
Consequence: Reduced reproductive success
Narrative: Reproduction of Bakersfield cactus may be threatened by the loss of pollinators. The reproductive biology of Bakersfield cactus has not been studied, but other Opuntia species are known to require cross-pollination for seed-set and many are pollinated by bees (Benson 1982; Spears 1987; Osborn et al. 1988; Thorp in litt. 1998). Pollinators are threatened by the use of both regulated (e.g., malathion) and unregulated pesticides (e.g., pyrethroids) (Service 2000; DPR 2006; Keith 2006). Malathion, a broad spectrum insecticide, has been used to control the beet leaf-hopper (Circulifer tenellus) in rangeland habitat, fallow fields, oil fields, and cultivated areas on both public (BLM) and private lands in the San Joaquin Valley, and in adjacent valleys and foothills. Increasingly, malathion is used to kill agricultural pests and mosquitoes, which are documented as vectors of the West Nile Virus. Its application therefore, is not limited to agricultural areas but includes residential and commercial zones thereby increasing the regional areas in which it is used. Hymenopterans (ants, wasps, bees, etc.) are particularly susceptible to malathion exposure (Dobroski and Lambert 1984) (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate models predict for California an overall warming of 1.7 degrees to 5.8 degrees Celsius (3.0 degrees Fahrenheit to 10.4 degrees Fahrenheit) by 2100 (Cayan et al. 2006), but they vary in their predictions for precipitation. VanRheenen et al. (2004) predict a decrease in precipitation in the southern San Joaquin Valley. Bakersfield cactus seeds require warm, wet conditions to germinate (Benson 1982). Therefore, a sufficient decrease in precipitation could hinder Bakersfield cactus growth by sexual reproduction. Additionally, studies at Sand Ridge Preserve revealed increases in Bakersfield cactus mortality and lowered rates of vegetative and sexual reproduction in years of below-average precipitation due to competition for water with nonnative annual grasses (Cypher and Fiehler 2006; Cypher pers. comm. 2006). Conversely, increases in annual precipitation would possibly promote the growth of decay organisms resulting in the rot of cactus pads (Service 1998). Bakersfield cactus cannot tolerate prolonged periods of inundation as observed in the Caliente Creek floodplain (ESA Planning and Environmental Services 1986; Service 1998; CNDDB 2010). The effect of such changes in climate on nonnative species and parasites is unknown, but could accelerate their establishment in Bakersfield cactus habitat. If such changes in climate occur, and the resulting changes in precipitation occur, Bakersfield cactus could be extirpated with no available refugia (USFWS, 2011).

Recovery

Reclassification Criteria:
1) Secure and protect specified areas from incompatible uses A) 95 percent of occupied habitat on public lands; 75 percent of Bakersfield cactus clumps and 75 percent of occupied habitat in the Caliente-Bena Hills, Comanche Point, Kern Bluff, Sand Ridge, and Wheeler Ridge areas (addresses Listing Factor A) (USFWS, 2011);

2) A management plan has been approved and implemented for the recovery areas that includes survival of the species as an objective (addresses Listing Factors C and E) (USFWS, 2011);

3) Population monitoring in specified recovery areas shows: stable or increasing populations at all protected sites for a 5-year period (addresses Listing Factor E) (USFWS, 2011).

Delisting Criteria:
1) 90 percent of existing clumps and occupied habitat in the areas specified in the downlisting criteria (i.e. Caliente-Bena Hills, Comanche Point, Kern Bluffs, Sand Ridge, and Wheeler Ridge areas) and in the Fuller Acres, Cottonwood Creek, Granite Station, and Kern Canyon populations are protected (as defined in the downlisting criteria) (USFWS, 2011);

2) 100 or more clumps each in other populations north and south of the Kern River are protected (USFWS, 2011);

3) A management plan exists for all protected areas identified as important to the continued survival of the species; and (USFWS, 2011)

4) All protected populations show evidence of reproduction (USFWS, 2011)

Recovery Actions:
- 1. Protect populations within Bakersfield City limits in the Kern Bluff area and south of highway 178 (USFWS, 2011).
- 2. Work with willing land owners to establish a conservation easement or fee title to the property at the mouth of Kern Canyon (USFWS, 2011).
- 3. Complete the draft Department of Water Resources Habitat Conservation Plan (USFWS, 2011).
- 4. Conduct census of known populations and monitor the reproductive status of known populations (USFWS, 2011).
- 5. Determine suitable management methods for reducing nonnative annual grasses and increasing native perennials, including Bakersfield cactus, and communicate the benefits of such management to rangeland landowners (USFWS, 2011).

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Protect existing habitat in the San Joaquin Valley for Bakersfield cactus. 2. Survey both extant and extirpated occurrences that have not been visited in the past few years to determine the status of these occurrences. Conduct yearly surveys at extant locations utilizing a standardized methodology to determine trends in the range-wide status as well as population/occurrence abundance. 3. Determine suitable management methods for reducing

nonnative annual grasses and increasing native perennials, including Bakersfield cactus, and communicate the benefits of such management to rangeland owners. (USFWS, 2020)

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SPECIES ACCOUNT: *Osmoxylon mariannense* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/08/2004; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Osmoxylon mariannense is a spindly, soft-wooded tree in the ginseng family (Araliaceae), which can reach 10 m (33 feet) in height. It has several upward-growing (ascending), gray-barked branches that bear conspicuous leaf scars. Leaves vary in size; mature leaves are palmately lobed (hand-shaped) and about 30 cm (1 foot) long and 50 cm (1.7 feet) wide. The seven to nine lobes are coarsely toothed, and each lobe has a conspicuous, depressed mid-vein. The leaves are alternate or whorled and grow only at the branch tips. The petioles are 35 to 40 cm (1 to 1.5 feet) long and based in distinctive, conspicuous green multiple "sockets" (Raulerson and Rinehart 1991). The flowers are yellow and have both male and female components. They are borne in many-branched, compact terminal cymes or umbels. The fruits are round and maroon in color when ripe (Raulerson and Rinehart 1991). (USFWS, 2007)

Taxonomy

The species Osmoxylon mariannense (Kanehira) Fosberg and Sachet was first described as Boerlagiodendron mariannense by Kanehira. Fosberg and Sachet (1980) made the generic transfer to Osmoxylon. (USFWS, 2012)

Historical Range

See current range/distribution.

Current Range

Endemic to Rota in the Mariana Islands (USFWS 2004b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: The species is dioecious, with male and female flowers being produced on separate trees. Trees have been observed flowering in February, March, and October and fruiting in November, December, January, February, and March (Raulerson and Rinehart 1997; G. Hughes, in litt. 1998; G. Koob, in litt. 2005). The seeds of O. mariannense are difficult to germinate and this may be due to production of "false seeds" (structures that appear to be seeds but aren't) or low viability rates (J. Manglona, CNMI, pers. comm. 2005; L. Raulerson, pers. comm. 2005). (USFWS, 2007)

Habitat Type

Adult: Terrestrial (USFWS, 2007)

Habitat Vegetation or Surface Water Classification

Adult: Limestone forests, forest edges, cliffs (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations of approximately 425 meters (1,400 feet) and higher; prefers partial shade and forest edges (USFWS, 2012)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 2007; USFWS, 2012)

Habitat Narrative

Adult: Osmoxylon mariannense prefers partial shade or grows on the edges of forests, including areas near cliffs (Manglona no date [n.d.]). Osmoxylon mariannense is found in limestone forests at approximately 425 meters (1,400 feet) elevation and higher, where moisture and humidity levels are high (Koob 2005; Manglona n.d.). These forests occur in patches in the formerly mined Sabana and are dominated by Hernandia labyrinthica and Elaeocarpus joga (yoga) interspersed with Pandanus (kafu) thickets. Mixed with the Elaeocarpus and Hernandia are a few Ficus spp., Artocarpus spp., and Hibiscus tiliaceus (pago). Understory species include Macaranga thompsonii (pengua) and Pipturus argenteus (amahadyan). Epiphytes are abundant and include Freycinetia reineckei (no common name), Asplenium nidus (galak), Davalia solida (pugua-machena), and other ferns; Coelogyne guamensis (no common name) and other orchids; and mosses (Falunruw et al. 1989). (USFWS, 2007; USFWS, 2012)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The fruit may provide food for birds and bats, which may also be the dispersal agents, though this is not confirmed (Raulerson and Rinehart 1991; Resources Northwest 1997; J. Manglona, pers. comm. 2005). (USFWS, 2007)

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

1 (USFWS, 2019)

Population Size:

135 (2 wild) (USFWS, 2019)

Additional Population-level Information:

There have been no systematic surveys for Osmoxylon, and very few field visits to known wild plant locations for several years (Estanislao Taisacan, pers. comm. 2016). During July-August of 2016, one wild Osmoxylon tree was observed alive along the north rim of the Mount Sabana plateau (James Manglona, pers. comm. 2016), and a second one further east along the rim was observed alive and bearing fruit (McBride, personal observation). Another Osmoxylon was found in the Assoro area on the south part of the Sabana plateau “five or six years ago” (Robert Ulloa,

pers. comm. 2016). Two other trees, in As Mundo and Fanlagon areas, were alive when last seen sometime between 2005 and 2010 (Estanislao Taisacan, pers. comm. 2016). Impediments to recruitment: wild reproduction has been limited or prevented by vegetative competition, as well as herbivory by Cuban slugs, which are pervasive throughout forested areas. Also, trampling and browsing by Philippine deer are now the principal ungulate issues for this species as hunters have suppressed or eliminated feral goat and pig populations (James Manglona, pers. comm. 2016). (USFWS 2017)

Population Narrative:

An unknown number of trees currently exist in cultivation, and 2 trees that were outplanted in 2002 adjacent to wild individuals of Osmoxylon mariannense continue to survive, bringing the total number of currently known individuals in the wild to 10. (USFWS, 2007). Currently, there is only 1 known population, with a total of 2 naturally occurring and 133 outplanted individuals. Fruit collection, propagation, and outplanting are ongoing. There is some protection from ungulates through fencing efforts.(USFWS, 2019)

Threats and Stressors

Stressor: Land-use activities (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Native vegetation, including Sabana limestone forest habitat for Osmoxylon mariannense, has undergone extreme alteration due to past and present land use practices, including ranching, deliberate and unintentional nonnative animal and plant introductions, agriculture, and military activities during World War II (Falanruw et al. 1989). Rota was subject to extensive agricultural development (particularly the cultivation of sugar cane in the lowland areas) by the Japanese prior to World War II. Currently, Rota retains less than 60 percent of its historical native forest (Falanruw et al. 1989). Continued loss of native forest is attributable to application of the Agricultural Homestead Act of 1990, which allows for the distribution of 1-hectare (2.5-acre) parcels of public land to eligible participants. (USFWS, 2007)

Stressor: Introduced ungulates (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Throughout the Mariana Islands, introduced goats (Capra hircus), pigs (Sus scrofa), cattle (Bos taurus), and Philippine deer (Cervus mariannus) have severely damaged forest vegetation by browsing on plants, causing habitat degradation and erosion (Kessler 1997; Wiles et. al. 1999, 2005; Worthington et. al. 2001) that then retards forest growth and regeneration (Lemke 1992). Of these nonnative ungulates, deer and feral pigs are degrading the forests of the Sabana (L. Williams, pers. comm. 2005, G. Wiles in litt. 2006). These animals may also directly browse on young individuals of Osmoxylon mariannense. (USFWS, 2007)

Stressor: Unidentified pests (USFWS, 2007)
Exposure:
Response:
Consequence:

Narrative: Defoliation (due to the poor health of the leaves), the lack of seedlings and juveniles of O. mariannense, and the death of several previously mapped older individual plants are suspected to be caused by unidentified invertebrate pests, mice (Mus musculus), rats (Rattus spp.), or disease (D. Grout, pers. comm. 1997). (USFWS, 2007)

Stressor: Deer browsing (USFWS, 2007; USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Deer are reported to browse on seedlings of Osmoxylon mariannense (USFWS 2004; L. Williams, pers. comm. 2004). The bark of Osmoxylon mariannense may be subject to stripping by deer before reaching reproductive age (Hess and Pratt 2006). Cooperative efforts between the U.S. Fish and Wildlife Service and the Rota Division of Fish and Wildlife have resulted in the construction of fenced exclosures around two individuals in the wild. The remaining eight individuals are not currently fenced (USFWS 2004). (USFWS, 2007; USFWS, 2012)

Stressor: Natural disasters (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: While O. mariannense is expected to have adapted to high winds and typhoons, its distribution and numbers have been reduced significantly due to human activities, making the few remaining individuals particularly susceptible to extirpation or extinction from a natural disaster. Destruction of the Sabana forest canopy by typhoons has adversely affected O. mariannense, altering sub-canopy vegetation conditions over the long term by opening up and drying out older, closed forest habitat (E. Taisacan, pers. comm. 1998; L. Williams, pers. comm. 2004). As discussed above for Nesogenes rotensis, all evidence points to the increasing frequency and intensity of the threat from typhoons in this region. (USFWS, 2007)

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Osmoxylon mariannense is threatened by competition from invasive, nonnative plant species including Momordica charantia (bitter melon), Mikania scandens (climbing hempvine), and Passiflora suberosa (corky-stem passionflower). In opened forest areas, these opportunistic, weedy vines cover the ground (Fosberg 1960; G. Hughes, pers. comm. 1998) and may alter the conditions necessary for seed germination and seedling growth provided in closed-canopy, high-stature forests covered with mosses and various epiphytic species. (USFWS, 2007)

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Small population size and limited distribution make this species particularly vulnerable to extinction from reduced reproductive vigor or random environmental events. There are currently only 10 known individuals of Osmoxylon mariannense remaining in the wild, 2 of which were outplanted from past controlled propagation efforts. A single adverse environmental event

or a decline of successful reproduction in O. mariannense could lead to the extirpation of this species. (USFWS, 2007)

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2007)

Recovery

Reclassification Criteria:
1. A total of two populations of Nesogenes rotensis are naturally reproducing and stable, or increasing in numbers. Each population of N. rotensis must consist of at least 300 mature, reproducing individuals. A total of two populations of Osmoxylon mariannense are naturally reproducing and stable, or increasing in numbers. Each population of O. mariannense must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as 8 or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)

2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)

3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Delisting Criteria:
1. A total of four populations of Nesogenes rotensis are naturally reproducing and stable, or increasing in numbers. Each population of N. rotensis must consist of at least 300 mature, reproducing individuals. A total of four populations of Osmoxylon mariannense are naturally reproducing and stable, or increasing in numbers. Each population of O. mariannense must consist of at least 100 mature, reproducing individuals. A stable or increasing population is defined as having a finite rate of increase (known as 8 or lambda) greater than or equal to 1 over the requisite 10-year time period. (USFWS, 2007)

2. Sufficient habitat is protected and managed to achieve criterion 1 above. (USFWS, 2007)

3. Management and control of nonnative species by local, regional, Commonwealth, and Federal authorities are demonstrated to be successful and sufficient to achieve criterion 1 above. (USFWS, 2007)

Recovery Actions:
- Coordinate and monitor recovery efforts. (USFWS, 2007)
- Address factors affecting viability of the wild populations. (USFWS, 2007)

- Monitor the extant Nesogenes rotensis and Osmoxylon mariannense populations, establish new populations, and augment existing populations. (USFWS, 2007)
- Provide educational and informational opportunities to build public support for conservation. (USFWS, 2007)
- Propagation and outplanting programs: through the Rota Rare Plants project (Partners Grant No. F14AC00510) from June 2015 through August 2016, 118 young Osmoxylon have been outplanted at locations on and around the Sabana; these plants are currently 1-2 years old, and are protected by fencing enclosures (Manglona 2016). Note also, that there are 35-40 older Osmoxylon (12-15 years old) that were outplanted in multiple locations (James Manglona, pers. comm. 2016). (USFWS 2017).
- Also in 2016, Lainie Berry of CNMI Department of Lands and Natural Resources began work on surveys and propagation of Osmoxylon, under a USFWS Section 6 grant (F16AP00687). In addition to surveys for previously unknown individuals as well as all previously-known natural and outplanted trees, efforts to propagate the species will also be undertaken. Anticipated propagation activities include seed collection, propagation via established techniques, outplanting in conservation areas, and initial monitoring. Existing fencing will be restored as needed, new fencing and signage established, and invasive plants hand-cleared where necessary to protect individual trees. This work is scheduled to conclude in 2018. Ongoing fence maintenance will be carried out by Rota Forestry, as well as longer-term monitoring if additional federal funding is secured (USFWS 2016). (USFWS 2017)
- Ungulate exclosure – Continue to construct and maintain ungulate-proof fenced exclosures around the remaining individuals or populations (USFWS 2017).
- Other currently-recognized herbivory concerns: develop and implement control programs for slugs and rodents (rats), at least within localized areas around established wild or outplanted trees (USFWS 2017).
- Threats research: o Conduct research to determine the impact of invertebrates on Osmoxylon mariannense populations. o Conduct research on methods to control invertebrates, if necessary. o Develop and implement an invertebrate control and /or eradication program, if necessary. (USFWS 2017).
- Established invasive plant species control – Control invasive plant species around all populations (USFWS 2017).
- Mitigation of risks from potential disturbance factors: o Evaluate whether there is evidence of typhoons being a significant risk factor for this species, at least in the current state of very limited population. If this is judged to be the case, develop and implement effective measures to mitigate the impact of typhoons, such as establishing multiple and relatively widelydistributed populations, to improve resiliency at the species level. o Maintain fencing around individuals on the Sabana, as well as those that might be harmed by highway maintenance. o Work with local DPW to ensure that road construction and maintenance activities do not harm existing individuals. (USFWS 2017)
- Population biology research: Identify the pollination mechanisms for the species, including flowering periods, specific pollinators, and other factors (USFWS 2017).
- General outreach: o Develop public outreach programs to inform residents of Rota of the importance of native species and their habitat. o Work with private landowners to help them conserve this species on their property. (USFWS 2017)
- Alliance and partnership development – Work with the CNMI Department of Lands and Natural Resources, Division of Forestry, Division of Fish and Wildlife, and other land managers to coordinate planning and support implementation of ecosystem level

restoration and management to benefit Osmoxylon (USFWS 2017).

- Assess the modeled effects of climate change on this species, for which records of historic distribution suggest a very restricted elevational—and thus, areal—range on Rota. Consider trends suggested by available climate models when evaluating future landscape needs for the recovery of the species (USFWS 2017).
- Regulatory protections – Work with CNMI authorities to ensure that federal and local regulations provide the necessary protections to support the recovery of Osmoxylon mariannense, whether by adding the species to the CNMI Threatened and Endangered Species list, or by other means (USFWS 2017).
- Review the recovery plan (USFWS 2007) to determine if any new information suggests a need to update the plan to more effectively attain recovery goals (USFWS 2017).
- Continue to collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. (USFWS, 2012)
- Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. (USFWS, 2012)
- Determine where populations could be reintroduced on Rota. (USFWS, 2012)
- Continue to reintroduce the species back into its known historical range. (USFWS, 2012)
- Conduct surveys for Osmoxylon mariannense in potentially suitable habitat on Rota that may have been overlooked previously. (USFWS, 2012)
- Survey all remaining individuals (native and reintroduced) to gain a better sense of the ratio of male to female trees. (USFWS, 2012)
- Continue to construct ungulate-proof fenced exclosures around the remaining population and monitor the fences for any signs of breaching. (USFWS, 2012)
- Protect all populations against disturbances from feral ungulates. (USFWS, 2012)
- Implement effective control methods for rodents. (USFWS, 2012)
- Develop and implement a slug control program, if necessary. (USFWS, 2012)
- Conduct research to determine the impact of invertebrates on Osmoxylon mariannense populations. (USFWS, 2012)
- Conduct research on methods to control invertebrates, if necessary. (USFWS, 2012)
- Develop and implement an invertebrate control and /or eradication program, if necessary. (USFWS, 2012)
- As individual wild trees begin the process of senescence they should be closely watched to determine what factors may be contributing to their demise. (USFWS, 2012)
- Control invasive introduced plant species around all populations. (USFWS, 2012)
- Develop and implement effective measures to reduce the impact of typhoons. (USFWS, 2012)
- Maintain fencing around individuals near Sabana and those that might be harmed by highway maintenance. (USFWS, 2012)
- Prevent the widening of the undeveloped roads that occur near individuals. (USFWS, 2012)
- If fruit set begins to decline overall, then monitor the exact flowering times of each tree to determine whether there is a decrease in the overlap of flowering times between male and female trees. (USFWS, 2012)
- Identify the pollination mechanisms and pollinators for the species. (USFWS, 2012)
- Develop public outreach programs to inform residents of Rota of the importance of native species and their habitat. (USFWS, 2012)
- Work with private landowners to help them conserve this species on their property. (USFWS, 2012)

- Work with private landowners, Mariana Public Lands Authority, the Division of Fish and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2012)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: With the historically-known wild population being so small, and the status of those trees being so poorly known today, all previously recommended future actions remain in effect, with a few additions or modifications: • Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist. o Conduct surveys for Osmoxylon mariannense in potentially suitable habitat on Rota that may have been overlooked previously. o Inventory all remaining individuals (wild and propagated) to assess survival, noting observable conditions or factors that appear to be accelerating the senescence or mortality of individual plants. • Continue propagation and outplanting programs to establish Osmoxylon in a range of locations, particularly within the known historic distribution around the Mount Sabana plateau on Rota. o Continue to collect cuttings or seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and storage. o Evaluate seed viability under storage conditions, and develop protocols for effective storage parameters for propagation programs. • Ungulate exclosure – Continue to construct and maintain ungulate-proof fenced exclosures around the remaining individuals or populations. • Other currently-recognized herbivory concerns: develop and implement control programs for slugs and rodents (rats), at least within localized areas around established wild or outplanted trees. • Threats research: o Conduct research to determine the impact of invertebrates on Osmoxylon mariannense populations. o Conduct research on methods to control invertebrates, if necessary. o Develop and implement an invertebrate control and /or eradication program, if necessary. • Established invasive plant species control – Control invasive introduced plant species around all populations. • Mitigation of risks from potential disturbance factors: o Evaluate whether there is evidence of typhoons being a significant risk factor for this species, at least in the current state of very limited population. If this is judged to be the case, develop and implement effective measures to mitigate the impact of typhoons, such as establishing multiple and relatively widely-distributed populations, to improve resiliency at the species level. o Maintain fencing around individuals on the Sabana, as well as those that might be harmed by highway maintenance. o Work with local DPW to ensure that road construction and maintenance activities do not harm existing individuals. • Population biology research: Identify the pollination mechanisms for the species, including flowering periods, specific pollinators, and other factors. • General outreach: o Develop public outreach programs to inform residents of Rota of the importance of native species and their habitat. o Work with private landowners to help them conserve this species on their property. • Alliance and partnership development – Work with the CNMI Department of Lands and Natural Resources, Division of Forestry, Division of Fish and Wildlife, and other land managers to coordinate planning and support implementation of ecosystem level restoration and management to benefit Osmoxylon. • Assess the modeled effects of climate change on this species, for which records of historic distribution suggest a very restricted elevational—and thus, areal—range on Rota. Consider trends suggested by available climate models when evaluating future landscape needs for the recovery of the species. • Regulatory protections – Work with CNMI authorities to ensure that federal and local regulations provide the necessary protections to support the recovery of Osmoxylon mariannense, whether by adding the species to the CNMI Threatened

and Endangered Species list, or by other means. • Review the recovery plan (USFWS 2007) to determine if any new information suggests a need to update the plan to more effectively attain recovery goals. (USFWS, 2019)

- New Management Actions: • Propagation and outplanting programs: through the Rota Rare Plants project (Partners Grant No. F14AC00510) from June 2015 through August 2019, 133 young Osmoxylon have been outplanted at locations on and around the Sabana; these plants are currently 1-5 years old, and are protected by fencing enclosures (Manglona 2016). Note also, that there are 35-40 older Osmoxylon (12-15 years old) that were outplanted in multiple locations (James Manglona, pers. comm. 2016). • In 2016, Lainie Berry of CNMI Department of Lands and Natural Resources began work on surveys and propagation of Osmoxylon, under a USFWS Section 6 grant (F16AP00687; USFWS 2016b). In addition to surveys for previously unknown individuals as well as all previously-known natural and outplanted trees, efforts to propagate the species has been ongoing since 2016. Seed collection, propagation via established techniques, outplanting in conservation areas with exclusion fencing has resulted in 133 outplantings of the species and 2 nursery stock plants representing two different wild trees from Fanlagon (James Bamba, CNMI Department of Lands and Natural Resources, pers. comm. 2020). (USFWS, 2019)

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SPECIES ACCOUNT: *Ottoschulzia rhodoxylon* (Palo de rosa)

Species Taxonomic and Listing Information

Listing Status: Endangered; 4/10/1990; Southeast Region (R4) (USFWS, 2015). Reclassified to Threatened on December7, 2022.

Physical Description

A small evergreen tree which has been reported to reach 15 meters in height and 41 centimeters in diameter. The average height of 178 trees measured was 6.21 meters and the average diameter was 8.94 centimeters. The leaves are alternate, glabrous, and elliptic to ovate, from 5 to 9 centimeters long, from 3 to 6 centimeters wide, rounded or blunt at the apex and the base, entire, thick and leathery. Flowers in this genus are bisexual, solitary or in clusters at the leaf bases, and composed of a cup-shaped corolla tube with five lobes. The fruit is a one-seeded drupe with a thin pericarp; the heartwood is reddish (USFWS, 1994).

Taxonomy

Member of the Icacinaceae or the Icacina family. This genus includes only three species (O. rhodoxylon, O. domingensis in Hispaniola, and O. cubensis in Cuba) (USFWS, 1994).

Historical Range

In Puerto Rico, first collected near Mayaguez, Puerto Rico, in 1876; when listed in 1990, known on the north coast near Bayamon; in several sites in the Guanica Commonwealth Forest, and in the Maricao Commonwealth Forest (USFWS, 1990).

Current Range

In Puerto Rico, known in the following areas of western Puerto Rico: Guaynabo; Quebradillas/Isabela; Cambalache Commonwealth Forest: Guanica Commonwealth Forest; Maricao Commonwealth Forest; Susua Commonwealth Forest; and the Sierra Bermeja in Cabo Rojo (USFWS, 1994).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: flowering and fruiting between May and July (USFWS, 2022)

Reproduction Narrative

Adult: When the palo de rosa recovery plan was written, information about the flowering and fruiting pattern was limited due to the species not being well-studied and the infrequent observation of reproductive events, although flowering was observed in May and July 1993 (USFWS 1994, p. 5). The species bears hermaphrodite flowers, flowers for a short period at the beginning of the rainy season and develops fruits subsequently until November (Breckon and Kolterman 1993, p. 15; Santiago-Valentı´n and Viruet-Oquendo 2013, p. 62). Few buds and

flowers occur from April to May with an explosive flowering in June coinciding with the beginning of the rainy season in May. Herbarium specimens demonstrated flowering and fruiting between May and July (Santiago-Valentin and Viruet-Oquendo 2013, p. 62). Flower and fruit production are documented in individuals with diameters at breast height greater than 5 in (12.7 cm). Despite the high number of adult individuals reported, only a few reach that stem size (USFWS, 2022).

Habitat Type

Adult: Terrestrial (USFWS, 1994)

Habitat Vegetation or Surface Water Classification

Adult: Found in humid canyon bottoms (in Guanica) or on drier upper slopes and summits (in Quebradillas/Isabela) (USFWS, 1994)

Dependencies on Specific Environmental Elements

Adult: Well-drained, alkaline, rocky soils (USFWS, 1994)

Geographic or Habitat Restraints or Barriers

Adult: At elevations ranging from 10 to ~625 meters (USFWS, 1994).

Environmental Specificity

Adult: Narrow range of moisture tolerance (USFWS, 1994)

Habitat Narrative

Adult: Trees are limited to well-drained, alkaline, rocky soils derived from limestone or serpentine, as are trees of the other two members of the genus in Cuba and Hispaniola. In both Guanica and the Sierra Bermeja, palo de rosa is restricted to the bottom of canyons, where conditions are more mesic than might be expected given the extremely low annual precipitation. In SusLia, with greater rainfall than Guanica, the populations are restricted to the lower slopes of the mesic ravines. In the limestone hills of the north coast, receiving more precipitation than Guanica or Susua, palo de rosa occurs on the upper slopes and near the summits, where more xeric conditions prevail. Trees, therefore, are found in drier habitats (upper slopes and summits of hills) in the more mesic northern limestone hills and more mesic habitats (canyon bottoms) in the dry forests of Guanica and the Sierra Bermeja, an indication of a narrow range of moisture tolerance. Trees are located elevations ranging from 10 to ~625 meters (USFWS, 1994).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Not available.

Population Growth Rate:

Low (inferred from USFWS 1994)

Number of Populations:

14 populations, 47 subpopulations (USFWS 2022).

Population Size:

The estimated number of adult individuals is at least 963 (USFWS 2017).

Additional Population-level Information:

As of the date of the publication of this 5-year review, we believe the status of 0. rhodoxylon is improving. The species is currently known from the Guanica, Susua, Guajataca, Cambalache and the Rio Abajo Commonwealth Forests, and several areas managed for conservation along the northern coast (i.e., Hacienda Esperanza and Fort Buchanan). The species is widely distributed along the northern karst region of Puerto Rico, and despite previous impacts to the populations due to deforestation for agriculture and urban development, some localities show clear evidence of recruitment. However, since palo de rosa is considered a late successional species with a slow growth rate, the populations that lie on private lands remain vulnerable to habitat modification (i.e., deforestation, habitat intrusion by exotics, habitat fragmentation, etc.). (USFWS 2017)

Population Narrative:

Approximately 200 individual trees are known from 16 populations in 10 areas in western Puerto Rico (USFWS, 1994). Based on the above information, we have determined the palo de rosa to be distributed across Puerto Rico in 14 populations composed of 66 subpopulations containing 1,144 individuals (not including seedlings). Following this approach, 8 of the 14 current populations (containing 47 subpopulations with approximately 804 individuals) occur in the geographical areas associated with the 16 populations (now defined as subpopulations) included in the Service's 1994 recovery plan. Since 1994, we have identified 6 additional populations (as currently defined) composed of 19 subpopulations (342 individuals) ranging in size from 5 to 124 individuals in areas associated with remnants of forested habitat suitable for the species. Thus, these additional occurrences are key in understanding the current condition of the species (USFWS, 2022).

Threats and Stressors

Stressor: Habitat modification or destruction (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Much of the island of Puerto Rico has been deforested, and today all of the known sites for Ottoschulzia rhodoxylon are found in areas of secondary forests. The north coast site lies just to the west of the San Juan metropolitan area, an area which is being rapidly developed. Undiscovered individuals in this area are likely to be destroyed before being discovered. Remaining individuals on the southwestern coast are found within the Guanica Commonwealth Forest, but they are found in sites such as dry stream beds and roadsides, which may be vulnerable to forest management practices that do not take the species into consideration (USFWS, 1990).

Stressor: Hurricanes and Climate Change (USFWS 2017)
Exposure:
Response:
Consequence:
Narrative: Due to the low number of populations and individuals, flashfloods were identified as a threat to palo de rosa on its listing rule. As an endemic to the Caribbean, this species should be well adapted to tropical storms, and associated disturbances such as flashfloods. However, the low number of populations and individuals known at the time of listing posed a threat to the species by making it more susceptible to stochastic events such as hurricanes. Current information indicates that at least 22 (40%) of the known sites for the species harbor 5 or less individuals, and these sites basically show no natural recruitment. making them susceptible to extirpation by stochastic events such as storms and flashfloods. The Service has evidence of uprooted adult trees of palo de rosa within the natural populations at Hacienda La Esperanza and Higuillar "Sabanera" (both in northern Puerto Rico), suggesting damage caused by hurricane winds (Monsegur, USFWS, personal observations 2009 and Ilianet Morales, UPRM, 2006). Moreover, impacts to seedlings due to flashfloods occur on the populations located in drainages and canyons along the southern coast (i.e., Hoya Honda, Las Trichilias, CORCO and Yauco Landfill) of Puerto Rico (Monsegur, USFWS, personal observations 2006-2016). Climate change is predicted to increase the frequency. and strength of tropical storms, but also cause severe droughts (Hopkinson et al. 2008), The vulnerability of species to climate change is a function of sensitivity to changes and exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). It is unlikely that small populations with little or no recruitment withstand the anticipated impacts of climate change and the shift in vegetation communities. Climate change may also compromise natural recruitment by affecting the establishment and survival of seedlings (USFWS 2017).

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
1. populations known to occur on privately owned land are placed under protective status (USFWS, 1994).

2. an agreement between the Service and the U.S. Army concerning the protection of the species on their land (Fort Buchanan) has been prepared and implemented (USFWS, 1994).

3. mechanisms for protection of palo de rosa have been incorporated into management plans (currently not existing for all forests) for the Maricao, Guanica, Susua, and Cambalache Commonwealth Forests. Given the recent discovery of additional populations, priority should be given to the enhancement and protection of existing populations in protected areas and the protection of privately owned sites (USFWS, 1994).

Recovery Actions:
- Protect habitat, through acquisition or conservation easements, for existing privately owned populations. and through the development of management plans for the species where it occurs on Federal or Commonwealth land (USFWS, 1994).

- Monitor known populations and continue to search for additional ones (USFWS, 1994).
- Continue to conduct research on the life history of the species and evaluate the necessity and feasibility of propagation (USFWS, 1994).
- If determined to be necessary and feasible, conduct propagation and enhance existing populations or establish new ones (USFWS, 1994).
- The recovery of palo de rosa should focus on the protection of known key populations that show evidence of natural recruitment. Protections may include the development of conservation easements with private landowners (USFWS 2017).
- Develop a refined GIS model is needed to identify remnants of pristine forest or old secondary forest areas along the northern karst belt that may harbor the species. Surveying those areas may result in the finding of additional populations of palo de rosa, and may also be used to identify areas for the reintroduction of the species (USFWS 2017).
- The populations that are actively reproducing need to be monitored for seed collection for propagation purposes. A species-specific seed collection protocol should be developed to avoid altering its natural recruitment, and to ensure that any propagation effort addresses the populations genetic variability and the species recovery (USFWS 2017).
- Since palo de rosa seems to require a long period for the establishment of seedlings and developing into an adult tree, it is recommended that all planted individuals are pennanently tagged and monitored for their survival (USFWS 2017).
- Cooperative Agreements (USFWS, 1994)

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SPECIES ACCOUNT: *Oxypolis canbyi* (Canby's dropwort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 2/25/1986

Physical Description

A perennial herb with strong, fleshy rhizomes. Plants have slender stems, often more than 1 m tall. Leaves are thin and quill-like. Herbage smells slightly of dill. From mid-August to October the plants bear compound clusters of small white flowers (sometimes tinged with red) (NatureServe, 2015).

Taxonomy

Molecular and morphological studies have shown evidence that the genus Oxypolis as currently circumscribed, including compound-leaved and rachis-leaved species, is not monophyletic: the rachis-leaved species of Oxypolis (which include O. canbyi) are transferred to their own genus, Tiedemannia (Feist and Downie 2008 and Feist et al. 2012) (NatureServe, 2015).

Historical Range

See Current

Current Range

Native to the coastal plain, from southwestern Georgia through South Carolina to southeastern North Carolina (mostly in the middle and inner Coastal Plain), and from eastern MD to (historically) Delaware (Weakley 2008). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Existing populations of Oxypolis canbyi are maintained mainly through asexual reproduction. This species is strongly clonal, reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. The flowers can be either unisexual or bisexual. Bisexual flowers may facilitate some self-pollination; however, the flowers are protandrous, which is indicative of some degree of outcrossing.; Existing populations of O. canbyi are maintained mainly through asexual reproduction. This species is strongly "clonalizing," reproducing vegetatively by means of stoloniferous rhizomes. Stems also become decumbent and root at the nodes, especially in drier sites where there is little or no water to support the stems. Perfect (bisexual) flowers are produced which may result in some self-pollination; however, the flowers are protandrous which may ensure some degree of outcrossing. The potential for outcrossing may be higher in those umbels which produce inner male flowers and outer female flowers. Outcrossing results in increased recombination and heterozygosity, thereby ensuring increased evolutionary potential. Sexual reproduction theoretically should act

as a sort of evolutionary buffer enabling the species to survive environmental changes. This may not be the case in O. canbyi due to a possible high selfing rate and/or the isolation of small populations. Predation by the caterpillar of the black swallowtail butterfly (Papilio polyxenes asterius) may be a factor in reducing the sexual reproductive potential of O. canbyi. This caterpillar chews through the stems just below the inflorescence (NatureServe, 2015).

Habitat Type

Adult: Coastal Plains (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (inferred from NatureServe, 2015)

Site Fidelity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: O. canbyi has been found in a variety of Coastal Plain habitats prone to long periods of inundation, including pond cypress ponds, grass-sedge dominated Carolina bays, wet pine savannahs, shallow pineland ponds and cypress-pine swamps or sloughs. The largest and most vigorous populations reported occur in open bays or ponds which are flooded throughout most of the year and which have little or no canopy cover. Many sites are on a sandy loam or loam soil which is underlain by a clay layer. Based on county soil surveys, known soil types which support populations of O. canbyi include Rembert loam, Portsmouth loam, McColl loam, Grady loam, Coxville fine sandy loam, and Rains sandy loam. These soil types are similar in that they have a medium to high organic content, high water table, and are deep, poorly drained, and acidic. Historically, fire was a key element maintaining the open nature of the habitat at many O. canbyi sites. The following species are frequently found associated with O. canbyi: Ilex myrtifolia, Nyssa biflora, Taxodium ascendens, Pinus serotina, Stillingia aquatica, Rhynchospora tracyi, R. inundata, Manisuris rugosa, Rhexia aristosa, Polygala cymosa, Pluchea rosea, Lobelia boykinii and Hypericum denticulataum (NatureServe, 2015). Moderate ecological integrity of the community, tolerance ranges and site fidelity are inferred based on the variety of habitat in which the species can be found.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The vectors of seed dispersal are not well understood, but at least some seed dispersal is by wind (USFWS, 1990).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

18 (17 natural and 1 introduced) (USFWS, 2022)

Population Size:

10,000 - 100,000 total individuals (NatureServe, 2015)

Population Narrative:

Historically, Canby's dropwort occurred in Delaware, Maryland, North and South Carolina, and Georgia. Today, Canby's dropwort only occurs in three states: Maryland, South Carolina, and Georgia. Further, Canby's range within these states has been reduced greatly overtime with Canby's dropwort being extirpated from 11 counties since the time it was listed. Habitat loss and wetland degradation combined with lack of habitat management through natural or prescribed fire has resulted in a continued decline of this species since its listing. To date, seventeen populations remain extant, and one population has been introduced, bringing the total number of extant populations to 18. Eleven Canby's dropwort populations are partially protected. Because many populations are owned by several landowners, protection and management of populations is difficult to achieve. Species experts defined a self-sustaining population as having a minimum of 1000 stems for five years. Currently, only five Canby's dropwort populations have 1000 stems or more. These populations occur in a small part of the species' former range in Maryland, South Carolina, and Georgia with populations being extirpated from Delaware and North Carolina. Because of existing and future threats and the limited number of populations that appear to be selfsustaining, this species still meets the definition of an endangered species. (USFWS, 2022)

Threats and Stressors

Stressor: Wetland draining (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The most significant threat to Canby' dropwort is the direct loss or alteration of its rare wetland habitat. Ditching and draining of wetland areas, primarily for agriculture and silviculture, have reduced the frequency, depth and duration of surface water, lowered the groundwater table, and changed the vegetative composition in many areas of the mid-Atlantic coastal plain where the species historically occurred. Reducing surface water, changing soil moisture levels and lowering of the water table enables other plants to become established, modifies vegetative succession, and makes sites less conducive overall to the plant's growth and reproduction (Murdock and Rayner 1990). As a result, many sites have been invaded by shrubs and some sites have been planted in pine. Other sites have been dredged thus breaking the clay hardpan and draining the wetland (Murdock and Rayner 1990, Gaddy 2006) (USFWS, 2015).

Stressor: Fire suppression (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: On sites that are not actively disturbed by logging, ditching or dredging, habitat management is often needed to prevent encroachment of shrubs or trees that increase evapotranspiration, lower the water table and shade out Canby's dropwort. Periodic fires probably limited this encroachment under natural conditions but many sites are no longer

surrounded by pine forest subject to regular fires and few sites are managed with prescribed burning. An example is the Big Cypress Meadow which is owned by The Nature Conservancy and is the only site in North Carolina. Young trees, shrubs and maidencane have invaded much of the meadow and the number of Canby's dropwort has declined from as many as 10,000 plants in 1986 to only a few plants in recent years and none in 2006 (Gaddy 2006) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of plants
Narrative: Black swallowtail butterfly, grasshoppers, rabbits and rodents have all been known to damage/eat these plants (USFFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: There is currently little regulatory protection of Canby's dropwort habitat. The U.S. Army Corps of Engineers (Corps) generally does not regulate dredge and fill activities in isolated wetlands because of a 2001 U.S. Supreme Court opinion. The 2001 opinion was issued in the Solid Waste Agency of Northern Cook County (SWANCC) v. the U.S. Army Corps of Engineers et al. and ruled in favor of SWANCC. The Corps' requirement for a Clean Water Act Section 404 permit to fill isolated wetlands to construct a landfill was overturned. The Corps had asserted jurisdiction on the isolated intrastate waters based solely on use by migratory birds (Findlaw 2007). Since that ruling isolated wetlands are generally not considered jurisdictional by the Corps. Therefore, there is no Federal nexus and consultation under section 7 of the Endangered Species Act is not required. Because Canby's dropwort grows only in isolated wetlands, there is currently no Federal regulatory control of actions that would affect its habitat. In South Carolina and Georgia, where almost all Canby's dropwort populations occur, there are no State laws that protect the isolated wetlands that provide Canby's dropwort habitat. Maryland and North Carolina, with one Canby's dropwort population each, do regulate isolated wetlands and therefore offer some protection to the habitat (Maryland Department of the Environment 2010, North Carolina Department of Environment and Natural Resources 2010). The Endangered Species Act prohibits the taking of endangered plants from Federal lands without a permit and regulates trade of listed plants. In addition, the Endangered Species Act prohibits the malicious damage or destruction of plants on Federal lands; and, their removal, cutting, digging, damaging, or destroying in knowing violation of any state law or regulation, including criminal trespass law. The State of Maryland prohibits taking of the species from private property without the landowner's permission and from State property without a permit and regulates trade in the species (Code of Maryland regulations 08.03.08). The State of North Carolina prohibits taking of the plant without a permit and the landowner's permission and regulates trade (North Carolina General Statute 19-B, 202.12-202.19). The State of Georgia prohibits digging, removal, or sale of State listed plants from public lands without the approval of the State management authority, and regulates sale or transport of State listed plants from private property (Georgia Wildflower Preservation Act of 1973). The State of South Carolina does not have any regulations that protect endangered plants on private land. However, regulations prohibit the unauthorized taking of plants from South Carolina Heritage Preserves and State Parks (South Carolina Code of Laws: Sections 50-11-2200, 50-11-2210, and 51-3-140) (USFWS, 2015).

Recovery

Delisting Criteria:

Canby's dropwort (Oxypolis canbyi) will be considered for delisting when there are at least 19 self-sustaining populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks. The populations should be distributed throughout the species' historic range. This recovery objective is considered an interim goal because of the lack of data on biology and management requirements of the species. As new information is acquired, the estimate of self-sustaining populations required for the species' survival may be readjusted. The recovery objective for 0. canbyi will be reassessed at least annually in light of any new information that becomes available (USFWS, 1990).

Recovery Actions:

- Conduct surveys and habitat assessments at all surveyed sites by Gaddy (2006) that are not routinely monitored to determine the species presence and to assess habitat quality (USFWS, 2015).
- Protect known Canby's dropwort populations on private lands with conservation easements or Wetland Reserve Program easements (USFWS, 2015).
- Assess moribund and extirpated sites as well as other isolated wetlands for suitable habitat and resource availability (USFWS, 2015).
- Improve our understanding of the relationship between precipitation (and other parameters) and Canby's dropwort population viability (USFWS, 2015).
- Determine objective, quantitative criteria for self-sustaining populations (USFWS, 2015).
- For populations confined within roadside or powerline right-of-ways, promote management actions that shift Canby's dropwort populations away from right-of-ways and towards the interior of adjacent wetlands (USFWS, 2015).
- Conduct demographic studies that further examine genetic variability, population structures, preproduction, and indeterminate growth factors (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES 1. Protect known Canby's dropwort populations on private lands with conservation easements or Wetland Reserve Program Easements such as Monkey Bay in Clarendon County, SC, Perrion Pond (Burke County), Layfield Pond (Dooly County), Forrester Flats (Lee County), Roadside Park (Lee County), West Daniels Pond (Burke County), Greater Unadilla Pond (Dooly County), and Harmony Church Pond (Dooly County), GA. 2. Improve extant populations with fewer than 1,000 individuals by removing shrub/tree encroachment with prescribed fire, canopy thinning, or other techniques: a. Crosby Heritage Preserve, Colleton County, SC. b. Monkey Bay, Clarendon County, SC. c. Black Pond, Jenkins County, GA. d. Harmony Church Road, Dooly County, GA. e. Greater Unadilla Pond, Dooly County, GA. 3. Search for new populations on property that has suitable habitat within the species range. 4. Propagate and reintroduce Canby's dropwort by rhizome cuttings in a way that retains genetic diversity (e.g., taking rhizome cuttings from multiple individuals). 5. Collect seeds from all populations across the range to safeguard at a Center

for Plant Conservation Site, such as North Carolina Botanical Garden (NCBG). (USFWS, 2022)

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SPECIES ACCOUNT: *Oxytheca parishii var. goodmaniana* (Cushenbury oxytheca)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb with a small basal rosette of leaves and leafless, wiry stems, mostly 0.5-3 dm tall. Flowers (May-September) are white, pink, or greenish, borne in clusters of 3-12, with each cluster subtended by a funnel-shaped, long-awned involucre. (NatureServe, 2015)

Taxonomy

At the time of listing, Cushenbury oxytheca was recognized as Oxytheca parishii var. goodmaniana first described by Ertter (1980, p. 90). Ertter recognized O. parishii as so distinct as to warrant its own section of the genus, Acanthoscyphus. An analysis of molecular as well as morphological data have shown that the sections recognized by Ertter (1980, pp. 70–102) are distinct from each other and in fact are more closely related to other taxa in the Eriogonoideae subfamily of the Polygonaceae (buckwheat family) than to each other (Pant 2000, pp. 1–94). In reviewing the taxonomic and nomenclatural status of the Eriogonoideae, Reveal (2004, p. 144) published names for the taxa found to be distinct from Oxytheca by Pant (2000, pp. 1–94). This systematic treatment was followed by Reveal (2005, p. 438) in his contribution to the Flora of North America and will be followed in the upcoming revision of the Jepson Manual Higher Plants of California. The name now recognized for Cushenbury oxytheca is Acanthoscyphus parishii (Parry) Small var. goodmaniana (Ertter) Reveal. The name change in no way changes the description or range of the taxon. The common name for the taxon will likewise remain the same. Based on Service convention and the need for continuity with the history of this taxon, 50 CFR 17.12 will be revised to read as follows “Acanthoscyphus (Oxytheca) parishii var. goodmaniana” (USFWS, 2009).

Historical Range

See Current

Current Range

Restricted to a carbonate belt in the northeastern San Bernardino Mountains extending from White Mountain in the west to at least Terrace Springs in the east; from Terrace Springs to Rattlesnake Canyon, var. goodmaniana occurs with var. cienengensis and some morphological intermediates (potential hybrids) between the two (USFWS 2002). Distribution includes occurrences near Cushenbury Spring; Cushenbury, Marble, Arctic, Wild Rose, and Furnace Canyons; Blackhawk, Mineral, and Tip Top Mountains; Terrace Springs; Rose Mine and Green Lead gold mine (USFWS 2002). Range occurs in and adjacent to San Bernardino National Forest; San Bernardino County, California; using GIS tools, range extent was calculated to be approximately 165 square km. (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/24/2002.

Legal Description

On December 24, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Oxytheca parishii var. goodmaniana (Cushenbury oxytheca) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 78570-78610).

Critical Habitat Designation

The critical habitat designation for Oxytheca parishii var. goodmaniana includes one CHU (29 subunits) in San Bernardino County, California (67 FR 78570-78610).

Northeastern Slope Unit, San Bernardino County, California. (i) From USGS 1:24,000 quadrangle maps Butler Peak, Fawnskin, Big Bear City, Rattlesnake Canyon, and Onyx Peak, California.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Oxytheca parishii var. goodmaniana critical habitat consists of three components (67 FR 78570-78610):

(i) Soils derived primarily from upslope limestone, a mixture of limestone and dolomite, or limestone talus substrates with parent materials that include Bird Spring Formation, Bonanza King Formation, middle and lower members of the Monte Cristo Limestone, and the Crystal Pass member of the Sultan Limestone Formation at elevations between 1,440 and 2,372 m (4,724 and 7,782 ft);

(ii) Soils with intact, natural surfaces that have not been substantially altered by land use activities (e.g., graded, excavated, recontoured, or otherwise altered by grounddisturbing equipment); and

(iii) Associated plant communities that have areas with a moderately open canopy cover (generally between 25 and 53 percent (Neel 2000)).

Special Management Considerations or Protections

The SBNF is planning a revision of their Resource Management Plan in the near future that, among other functions, would provide conservation benefits to the two carbonate plant species and their habitat in this unit. These lands, however, currently do not have approved management provisions for the carbonate plants and their habitat, and habitat degradation may still be occurring due to ongoing activities identified in the final listing rule for these species (see USFWS 2001b). Therefore, the subject lands continue to require special management and protection to ensure the conservation of these species and their habitat. The core occurrences of the two carbonate plants in this unit are important as potential sources for the colonization events (e.g., seed dispersal) necessary to maintain the natural population dynamics of the species. Every carbonate plant occurrence in this unit is important as a seed source to colonize unoccupied sites and therefore maintain an equilibrium between local colonization and extirpation events. Every carbonate plant occurrence in this unit potentially provides important genetic material through pollen and seed dispersal which may help maintain genetic diversity and reduce the likelihood of regional extirpation events.

Life History

Food/Nutrient Resources

Breeding Season

Adult: May through June is the flowering season (USFWS, 1997).

Reproduction Narrative

Adult: May through June is the flowering season (USFWS, 1997).

Habitat Type

Adult: Talus slopes (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs on gentle talus slopes (approximately 10-25 degrees) with no apparent aspect preference. Typically found on soils derived from limestone, dolomite, or a mixture of limestone and dolomite; occupied habitat is mostly correlated with the Bird Springs Formation, Bonanza King Formation, Monte Cristo Limestone, and Sultan Limestone, and Crystal Pass substrate. Plant communities include singleleaf pinyon- Utah juniper woodland, singleleaf pinyon-mountain juniper woodland, singleleaf pinyon woodland, and canyon live oak woodland. Associated species include Cercocarpus ledifolius (Curl-Leaf Mountain-Mahogany), Arctostaphylos glauca (Big-Berry Manzanita), Chrysothamnus viscidiflorus (Green Rabbitbrush), and Achnatherum coronatum (Giant Rice Grass). 1440 - 2370 m. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species unique habitat requirements and low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms need to be studied (USFWS, 2009).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

20 (USFWS, 2022)

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

May have 20,000 - 35,000 individuals in some years. However, because this taxon is an annual, the number and distribution pattern of individuals fluctuates greatly from year to year, depending on winter and spring rainfall and temperatures during the seed germination and seedling establishment season (USFWS 2002). Approximately 14 occurrences are believed extant, with another 1 historical and 1 of unknown status, when mapped using the separation distance of the California Natural Diversity Database (CNDDB). Other reports, using a much smaller separation distance, have broken the total population into a smaller number of "patches" (e.g. 93 patches reported by SBNF cited in USFWS 2002) (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known population and the limited geography in which this species is found. In summary, we consider there to be 20 known occurrences of Acanthoscyphus parishii var. goodmaniana. Of the 20 occurrences, 6 are extant (i.e., the species was observed during the past 10 years) and 14 are presumed extant (i.e., the species was not observed during the past 10 years, but suitable habitat is present) (Table 1). Two occurrences are fully protected and seven are partially protected as part of the Carbonate Strategy's Habitat Reserve (Figure 2; Table 1). Portions of four occurrences are known to be under active mining (i.e., are being actively mined or have approved plans to be mined) (USFWS, 2022).

Threats and Stressors

Stressor: Off-highway vehicle (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The final listing rule indicated off-road vehicle use and energy development projects were a threat to Cushenbury oxytheca and its habitat. Such activities could impact the species' habitat through ground disturbance or dust creation. About 7 acres (3 hectares) of occupied habitat and 36 acres (15 hectares) of designated critical habitat for Cushenbury oxytheca overlap with roads and motorized vehicle trails (USFWS 2005a, p. 267). The San Bernardino National Forest closed road 3N77 and placed signs and barriers on the other roads (USFWS 2001, p. 18), which should limit impacts due to off-road vehicle use. Additionally, road 3N11A is proposed for decommissioning, and roads 3N03D, 3N54, 3N88, and 3N88B are proposed for reclassification as administrative use only (USFWS 2009, p. 2), which should reduce vehicle activity in the area and further reduce the threat to the species (USFWS, 2009).

Stressor: Hydroelectric project (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: We are unaware of any energy development projects occurring since listing that affect Cushenbury oxytheca (USFWS, 2009).

Stressor: Mining (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Mining activity remains the primary threat for Cushenbury oxytheca (USFWS 2005a, p. 246). Mining activities can impact habitat for the plants through the removal of mined materials, disposal of overburden, and road construction (USFWS, 2009).

Stressor: Dust/artificial lighting (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Other impacts to the plants are associated with dust and artificial lighting (USFWS 1997, pp. 13, 15–18). Dust can affect Cushenbury oxytheca's habitat by altering soil chemistry and light penetration into seedbanks (USFWS 1997, pp. 17-18). Artificial lighting may affect Cushenbury oxytheca's growing conditions by altering the photoperiod response or the behavior of pollinators or seed dispersers (USFWS 1997, p. 18) (USFWS, 2009).

Stressor: Recreational activities (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Several threats such as dispersed target shooting, dispersed camping areas, fuelwood collection, and fire suppression activities have been identified since listing (USFWS 2001, pp. 4–11). These activities can result in trampling of Cushenbury oxytheca and can impact its habitat through ground disturbance or dust creation (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The threat of predation from burro grazing was identified after listing (USFWS 2001). However, burros are expected to have minimal effects to Cushenbury oxytheca due to the low numbers of burros present (about 60), the dispersal of the burros across a large area, the burros preference for wetter habitats, and the short stature and scarce nature of carbonate plants, which makes foraging on them unlikely (USFWS 2001, p. 39) (USFWS, 2009).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: While both CEQA and NEPA may provide some discretionary conservation benefit to Cushenbury oxytheca, the Act is the primary regulatory mechanism mandating Cushenbury oxytheca conservation. With the majority of suitable and occupied habitat on U.S. Forest Service lands (Figure 1), the Act remains the primary regulatory mechanism for ensuring that Cushenbury oxytheca is addressed during planning efforts for land management actions potentially affecting this species (USFWS, 2009).

Stressor: Stochastic extinction (USFWS, 2009)
Exposure:
Response:
Consequence: Extinction
Narrative: The final rule indicates the risk of stochastic extinction of Cushenbury oxytheca resulting from random events was considered high due to the low numbers of plants (USFWS 1994, p. 43662). Because this species is restricted to certain, limited soils, it is likely that its population has always been small. Despite this, the population has persisted. This suggests even though the magnitude of this threat may be high, its immediacy is low. However, the potential for stochastic extinction could be increased by habitat loss, fragmentation, and drought. Habitat fragmentation can result in areas too limited and isolated to support pollinators or other seed dispersal agents (USFWS 1997, p. 16).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Cushenbury oxytheca is endemic to isolated occurrences of particular carbonate soils in the San Bernardino Mountains. Therefore, any combination of environmental conditions, such as those attributed to climate change above, that force an upward shift in the distribution of the species, poses a profound threat to the taxon's persistence and recovery. If this species is affected by elevational shifts resulting from climate change, then there will be no suitable habitat when the elevational range exceeds the species' maximum elevation. As this occurs, the density and distribution may concentrate the species into a smaller area. This, in turn, may make the species even more susceptible to stochastic extinction. To date, no species-specific monitoring has been conducted to detect an elevational shift in its range (USFWS, 2009).

Recovery

Reclassification Criteria:
The priority ranked habitat areas have been protected. Priority for protection shall be determined according but not limited to: 1) population size; 2) habitat quality; 3) manageability/defensibility of site; and 4) connectivity. The initial preserve area should be 5,000 acres (2,000 hectares) based on known areas occupied by the plants and should include protection for the threatened species, Erigeron parishii (which is discussed separately under the delisting objective and criteria). Priority areas and populations include, but are not limited to, the following: 1) Sites within the White Mountain Management Unit; 2) populations just north/northeast of Hitchcock Spring; 3) upper Crystal Creek Drainage; 4) Upper Furnace Canyon and prioritized populations in the lower Furnace Canyon area; 5) populations just north of Holcomb Valley; 6) Arctic Canyon; 7) Marble Canyon; 8) Bertha Ridge and slopes to Big Bear Lake; 9) Monarch Flats and northern slopes; 10) eastern and western slopes of Cushenbury Canyon including the vicinity of Whiskey Springs; 11) Burnt Flat; 12) Blackhawk Mountain and slopes; 13) Round Mountain; 14) Grapevine Creek; 15) Top Spring/Lone Valley/Squirrel Spring; 16) Granite Spring; 17) Arrastre Creek/Rose Mine Valley; 18) Rattlesnake Canyon; 19) Sugarlump/Sugarloaf Mountain; and 20) the outlying populations of Erigeron parishii in the Little San Bernardino Mountains. The species and ecosystem-level attributes of these priority areas make them necessary for the survival and recovery of these species. Taxonomic assessment of

the eastern populations of Oxytheca parishii var. goodmaniana may affect the recovery priority and reserve needs of this variety. To count toward reclassification of the plants, reserves must have been designed to minimize or eliminate indirect threats due to adjacent land uses. This includes protection of carbonate plant habitat from human disturbance to hydrology, soil integrity, fire ecology, habitat microclimates, and light regimes. Appropriate management and restorative measures should reduce habitat-degrading effects such as surface disturbances, windblown sediments, fugitive night lighting, and off-highway vehicle use (USFWS, 2009).

Protect additional lands needed to complete otherwise isolated reserves, to protect new populations that may be discovered in the future, and to provide strategic buffer zones and potential population reintroduction and/or expansion areas. The interim estimate of additional lands needed to secure habitat connectivity, buffers, and natural community context is 4,600 acres (1,860 hectares), including lands to meet Delisting Criterion #2 for Erigeron parishii. This figure may be further refined as additional information becomes available (USFWS, 2009).

Adaptive population monitoring/adaptive management programs must be functioning so that early detection is assured for any population instability or other problems in the reserve system. Studies will have shown whether there is a need for reintroductions and/or augmentations of existing populations. Research results to support adaptive management will be available, including at least preliminary results on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology (USFWS, 2009).

Recovery Priority Number: 9C

Delisting Criteria:
The reserve system designed to allow downlisting is intended to suffice for delisting, provided that monitoring and research demonstrate that the reserves work as planned to remove the threats identified during the listing process. As monitoring and research results become available, delisting criteria will be established (USFWS, 2009).

Recovery Actions:

- Reclassification: This criterion implicitly addresses listing Factors A (habitat loss) and E (stochastic events). The U.S. Forest Service and Bureau of Land Management have partnered to develop the Carbonate Habitat Management Strategy. The goals of the Carbonate Habitat Management Strategy are to: 1) protect the listed plants and the habitat components they require; 2) guide impact minimization and compensation for unavoidable impacts; 3) streamline reviews of mining activities in carbonate plant habitat; 4) guide habitat restoration; and 5) plan and provide for long-term needs of both the mining industry and listed species conservation. One of the primary goals of the Carbonate Habitat Management Strategy is the establishment of conservation areas for carbonate plants. The Carbonate Habitat Management Strategy provides parameters for allowing mining while ensuring the protection of listed carbonate plant species in perpetuity through the establishment of habitat reserves. The Service provided a programmatic nonjeopardy and no adverse modification biological opinion on May 2, 2005, for the Carbonate Habitat Management Strategy regarding potential effects to Cushenbury oxytheca and other federally listed carbonate plant species. Upon successful implementation of the Carbonate Habitat Management Strategy, habitat preservation will meet or exceed Downlisting

Criterion #1 (USFWS 2005a, p. 247). This includes preservation of at least 425 acres (172 hectares) (82 percent) of occupied habitat and 2,157 acres (873 hectares) (69 percent) of designated critical habitat for Cushenbury oxytheca (USFWS 2005b, pp. 24 and 27). However, the Carbonate Habitat Management Strategy is a programmatic strategy to allow mining and protect carbonate plants; participation by mining interests is voluntary. The reserve system under the Carbonate Habitat Management Strategy is not yet developed and future projects may or may not be implemented under the provisions of the Carbonate Habitat Management Strategy. This criterion has not been met at this time (USFWS, 2009). Delisting: As documented above, a reserve system is planned, but not established. Thus, the necessary monitoring and research associated with the reserve has not been completed. This criterion has not been met at this time (USFWS, 2009).

- Reclassification: This criterion implicitly addresses listing Factors A (habitat loss) and E (stochastic events). In addition to the protection of occupied areas, the Carbonate Habitat Management Strategy provides for the conservation of suitable habitat including about 14,709 acres (5,953 hectares) for Cushenbury oxytheca (USFWS 2005b, p. 28). Because the Carbonate Habitat Management Strategy is only a programmatic strategy, these lands are not yet conserved. This criterion has not been met at this time (USFWS, 2009).
- Reclassification: This criterion addresses listing Factors A (habitat loss) and E (stochastic events). Because the reserve system is not yet in place, this criterion is not yet applicable. Further, focused research on pollination ecology, seed dispersal mechanisms, population dynamics, microclimate effects of vegetation removal/bare areas, seedbank dynamics, and fire ecology of Cushenbury oxytheca has not yet occurred. This criterion has not been met at this time (USFWS, 2009).
- Finalize Recovery Plan: Prepare a new threats-based recovery plan specific to Cushenbury oxytheca that identifies a recovery strategy, objectives, and criteria for reclassification to threatened, objectives and specific criteria for removal from the list of endangered and threatened species, and prioritizes recovery actions. In the interim, seek implementation of elements of the Carbonate Habitat Conservation Strategy that have direct benefit to the conservation of Cushenbury oxytheca (USFWS, 2009).
- Monitor Existing Populations: Work with the San Bernardino National Forest to conduct systematic monitoring of Cushenbury oxytheca throughout known and potentially occupied sites as necessary to track the status of the species and identify management priorities. There is a need to continue to obtain quantitative information regarding the status of this species to evaluate the effectiveness of conservation efforts over time, especially in light of potential effects associated with global climate change (USFWS, 2009).
- Management of Occupied Cushenbury Oxytheca Habitat: Work with partners, such as the San Bernardino National Forest, to help conserve Cushenbury oxytheca by identifying opportunities to: a) Continue monitoring programs for the effectiveness of measures to protect Cushenbury oxytheca from recreational activities and make adjustments to signs, barriers, and roads as necessary. b) Avoid new developments in or near Cushenbury oxytheca habitat (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5–10 years. Successful implementation of these actions will reduce threats to Acanthoscyphus parishii var. goodmaniana and provide information to better understand the biological and physical factors limiting population growth and distribution. We recognize that

conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. 1. Continue implementation of the Carbonate Strategy, particularly additions of A. p. var. goodmaniana habitat to the Habitat Reserve and withdrawal of mining claims on habitat with high conservation value. 2. Research the variety's susceptibility to climate change by determining climate tolerances (e.g., temperature, drought duration) and identify climate refugia to protect within carbonate habitat. 3. Determine appropriate monitoring frequency and implement a range-wide monitoring strategy that provides useful information about occupancy and population health. 4. Conduct a species status assessment to evaluate viability given climate change projections, conservation, and progress in threat reduction. The assessment may be used to revise recovery criteria, or to inform a downlisting or delisting decision. 5. Continue managing the threat of roads, off-road vehicle activity, or other recreational activities to carbonate habitat. This may be achieved through road decommissioning, installation and maintenance of signs and barriers, or other management. 6. Research the efficacy of restoring populations on reclaimed lands that have been restored after mining. 7. Finalize the establishment of the proposed Blackhawk Research Natural Area. 8. Collect additional seeds from different occurrences to expand the conservation seed bank (USFWS, 2022).

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SPECIES ACCOUNT: *Oxytropis campestris var. chartacea* (Fassett's locoweed)

Species Taxonomic and Listing Information

Listing Status: Threatened 09/28/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

A perennial herb with compound leaves and with herbage that is covered with dense, white-silky hairs, giving the plant a silvery-gray appearance. Spikes of rose-purple flowers, each about 2 cm long, bloom from late spring-early summer. (NatureServe, 2015)

Taxonomy

A distinct taxon. (NatureServe, 2015)

Historical Range

Historic populations in Bayfield and Waushara counties. (NatureServe, 2015)

Current Range

Restricted to small inland lakes at eight sites in central and northwestern Wisconsin: Waushara, Portage, and Bayfield counties. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2013)

Lifespan

Adult: Mean 1-4 years; up to 14 years (USFWS, 2013)

Dependency on Other Individuals or Species

Adult: Pollinated by bees and butterflies (USFWS, 2013)

Breeding Season

Adult: Flowers primarily late May to mid-June (USFWS, 2013)

Other Reproductive Information

Adult: Tippery (2015) found that seed germination in Fassett's locoweed is highly dependent on physical damage to the seed coat, similar to many other plants in the Fabaceae (legume) family. In germination experiments, seeds with an intact seed coat had a very low rate of germination (about 7.8%) when compared to germination rates of seeds cut with a razorblade (61.1%) or seeds rubbed between sandpaper (71.1%). Seeds with thicker seed coats will persist longer in

the seed bank, and since Fassett's locoweed relies on an extensive seed bank to recover from population crashes, this adaptation likely heavily contributes to the persistence of the species (Tippery 2015). Seed germination is also predicted by the ability of seeds to absorb water. During a trial, locoweed seeds that did not increase in size after being soaked in water overnight, were determined to have insufficient damage to the seed coat. Seeds that did absorb water had a germination rate of almost 100% (Tippery 2016). Ultimately, findings from these studies found that for germination to be successful, there must be absorption of water, which is not possible without scarification (nicking, breaking, softening, or weaking of the outer shell to speed up seed germination)(Tippery 2015, Tippery 2016). Tippery (2016) found that during the early stages of germination, Fassett's locoweed seedlings grow a root of 4 centimeters (cm)(1.6 inches (in)) or more in length. In germination experiments, seeds that were planted at the soil surface grew a hypocotyl (the part of the stem of an embryo plant beneath the stalks of the seed leaves and directly above the root) of 1 cm in length. In wild populations, there is no visible hypocotyl, and cotyledons (the embryonic leaf, first leaves to appear from a germinating seed) are usually visible just at the soil surface. This indicates that naturally seeds germinate at a depth of 1 cm (0.4 in) or more. In germination experiments, the effect of water depth on seedling establishment was tested using different length pipes to plant seeds. There were no observed differences in germination of seeds in 5 cm (2.0 in), 10 cm (3.9 in), or 15 cm (5.9 in) under water depth setups (USFWS, 2022).

Reproduction Narrative

Adult: Fassett's locoweed blooms primarily at the end of May through mid-June, although occasional plants bloom as late as November (Tracy Feldman, pers. obs., 2009-2012). The mean lifespan of Fassett's locoweed appears to vary from 1-4 years depending upon the life stage, the lake from which data were used, and the year data were collected, but the maximum can range to potentially over 14 years (Tracy Feldman, pers. comm., 2013). Seed production is variable, having the potential to vary from zero (even in a "reproductive" plant) to well over 10,000 seeds per plant, but actual numbers range from fairly low in small plants to several hundred (or even in the 1000s) of seeds for larger plants, on average (Tracy Feldman, pers. comm., 2012) (Feldman 2012). Data suggest that the seed banks on Plainfield and Pickerel Lakes are patchy but could be very large (Feldman 2010). While seed banks may be large, seed germination rates vary, and in the field germination rates may be low, from 50-95%; however, only 0-1% of intact seeds germinated in greenhouse and field germination experiments. Seeds appear to germinate in bands along the shoreline at some range of distances above the water line. (Feldman 2012) (USFWS, 2013)

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Open gravelly lake (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Fluctuating lake levels (USFWS, 1991)

Spatial Arrangements of the Population

Adult: Pure stands to scattered individuals (USFWS, 1991)

Environmental Specificity

Adult: Narrow. Specialist with key requirements common. (NatureServe, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 1991)

Habitat Narrative

Adult: Fassett's locoweed occurs on sandy or gravelly shorelines of small landlocked seepage lakes. It is apparently intolerant of competition and shading and dependent on lake level fluctuations to eliminate competition and maintain an open habitat. (NatureServe, 2015) In all cases, Fassett's locoweed occurs in areas which are completely exposed to sunlight or receive only partial shade from other species. Particularly along the open shorelines but also throughout the sandy lakeside habitat, the soil surface is subjected to extreme temperature fluctuations, high solar radiation, strong winds, and soil moisture stress. However, it is in these areas, where competition from other plant species appears to be very low, that Fassett's locoweed occurs in the densest colonies. (USFWS, 1991)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 1991)

Dispersal/Migration Narrative

Adult: The mature fruits release numerous, small black seeds which have no evident adaptation for dispersal. As in many other plant species (Harper 1977, Johnson and Anderson 1986), the seeds of Fassett's locoweed probably tend to disperse in a clumped pattern around the parent plant. However, they may be moved short distances by wind, rain, or lake water during periods of inundation. (USFWS, 1991)

Population Information and Trends

Population Trends:

Fluctuating, but apparently increasing (USFWS, 2013)

Species Trends:

Fluctuating, but apparently increasing (USFWS, 2013)

Population Growth Rate:

Fluctuating (USFWS, 2013)

Number of Populations:

9 (USFWS, 2022)

Population Size:

Approximately 190,000 in 2012 (USFWS, 2013)

Adaptability:

Low (USFWS, 2013)

Population Narrative:

Of the 10 lakes that support Fassett's locoweed, the plant currently occurs in highest numbers (thousands) at four lakes; Pigeon, Mountain, Plainfield, and Pickerel lakes. Populations of Fassett's locoweed have fluctuated considerably over time. From 2009 to 2012, populations at Plainfield and Pickerel lakes have been stable or increasing due to increases in the number of seedlings (in the thousands) and small plants, most of which do not survive long enough to reproduce (Feldman 2009, 2010, 2011, 2012). Numbers of reproductive plants have decreased over the last four years at these two lakes. Predictions using projection matrix population models indicate that these populations have the potential to decrease in the near future (Feldman 2012). Up to 2000 plants were observed at Second Lake from 2006-2008, however the current population level is unknown. Populations number in the hundreds at Weymouth and Sherman (Marks) lakes. Very small populations (30 plants or less) have been consistently recorded at Lake Huron, Deer Print Lake, and Wolf Lake. (USFWS, 2013)Fluctuations in water levels maintain habitat but also determine population size from year to year. In one year, unusually high water levels may reduce populations to only a few plants and in the next year, lower water levels may result in thousands of plants (USFWS 2009). (NatureServe, 2015). Fassett's locoweed is a rare endemic species with a very limited distribution. Found in only a maximum of 9 sites (7 in central Wisconsin and 2 in northwest Wisconsin), any factor that impacts its habitat adversely could have major consequences (USFWS, 2022)

Threats and Stressors

Stressor: Development (USFWS, 1991; 2013)
Exposure:
Response:
Consequence:
Narrative: Development, primarily construction of homes and cottages, was considered a significant threat in the Recovery Plan (USFWS, 1991). This threat has been reduced through acquisition of locoweed sites, conservation education and agreements, protective signage, designation of State Natural Areas which are managed to protect and maintain native landscapes. Residential development is still an issue for the Lake Huron site, although many homeowners at this site are caging plants, distributing information and occasionally pulling invasive weeds. (USFWS, 2013)

Stressor: Human impacts (USFWS, 1991; 2013)
Exposure:
Response:
Consequence:
Narrative: A county boat ramp on Pickerel Lake is a threat, along with fishing and swimming. A summer camp is also on this lake. In the past, Fassett's locoweed areas on camp property had been roped off (Darcy Kind, pers. comm., 2012), however no ropes were in place as of at least 2009. ATV use and hiking may trample plants. (USFWS, 1991; 2013)

Stressor: Other vegetation (USFWS, 1991; 2013)
Exposure:
Response:
Consequence:

Narrative: Invasive plants, such as the non-native sweet clover can spread readily in open areas. It is considered a threat to recovering prairies, because it may compete with native species for resources or otherwise alter the edaphic conditions of the plant community (Eckardt 1987). The invasive orange hawkweed is quite abundant a few meters above the high waterline and grows in association with Fassett's locoweed in that zone. This species is of concern because of its possible allelopathic properties and the potential impact on Fassett's locoweed (Waller 1989). Trees and other vegetation may grow sufficiently to block out sunlight required by the locoweed. (USFWS, 1991; 2013)

Stressor: Nutrient enrichment (USFWS, 1991; 2013)
Exposure:
Response:
Consequence:
Narrative: The Fassett's locoweed recovery plan (USFWS 1991) identified nutrient enrichment of shorelines supporting Fassett's locoweed resulting from run-off as a threat, as this may result in loss of habitat due to competition from other plant species that would not typically be able to compete with Fassett's locoweed in its nutrient poor habitat. (USFWS, 2013)

Stressor: Reduced groundwater levels (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Fassett's locoweed is found on sandy-gravel lakeshores of seepage lakes, fed by groundwater, with fluctuating lake levels. Fluctuating lake levels are critical in maintaining suitable open shoreline habitat for the species. Aggressive plant competitors may be eliminated during periods of high water. Fluctuating water levels also help maintain low substrate fertility (preferred by the species) and distribute seeds within the site. The amount of available habitat at each site depends on current and recent lake levels. Generally, lower lake levels expose more shoreline area which provides more suitable habitat for the species, resulting in higher population numbers, especially of seedlings. However, continued low water conditions may decrease habitat due to succession. High lake levels which eliminate shoreline habitat, generally reduce overall population numbers. In addition, water level fluctuations within seasons may cause mortality of plants through submersion or desiccation (Tracy Feldman, UW-SP, pers. comm., 2012.) Lake levels may be affected by the use of high capacity wells used for crop irrigation. (USFWS, 2013)

Stressor: Herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Flowers have been eaten from a number of plants at one site, possibly by deer (WDNR, unpublished data). At Plainfield and Pickerel lakes in 2009-2012, Feldman observed racemes removed from Fassett's locoweed plants, potentially by deer. Insect herbivores may also affect Fassett's locoweed plants and seeds. At Plainfield and Pickerel lakes between 2009 and 2012, Tracy Feldman (UW-SP) observed caterpillars on racemes, spittlebugs on leaves, and occasional chewed leaves or racemes. At Pickerel Lake in 2012 he also observed holes in mature Fassett's locoweed fruits, reminiscent of weevil damage. (USFWS, 2013)

Stressor: Herbicides (USFWS, 1991; 2013)
Exposure:
Response:
Consequence:
Narrative: Herbicide and pesticide use is heavy in the agricultural areas. In addition, many of the lakes with Fassett's locoweed are lined with residential properties and lawns. Problems are possible from spray drift or run-off onto Fassett's locoweed habitat. Any decrease in the protective wooded buffer around each lake could result in increased overland flow of sediment-laden run-off into the water. (USFWS, 1991) The threat from herbicides is ongoing. (USFWS, 1991; 2013)

Recovery

Reclassification Criteria:
Recovery Priority Number: 9

Delisting Criteria:
Removal of Fassett's locoweed from the list of US. Endangered and Threatened Species will be considered when six populations are permanently protected and managed, and monitoring indicates the populations to be self-sustaining. (USFWS, 1991)

Recovery Actions:
- Protect and manage Fassett's locoweed at all sites with naturally-occurring populations. This includes the six extant [now 10 (USFWS, 2013)] populations as well as any new occurrences which might be found. Adequate protection will be accomplished not only through legal agreements with landowners but by increasing public awareness on the high-use lake shorelines. Education must be seen as integral to protection. (USFWS, 1991)
- Management to maintain appropriate habitat, including such activities as fencing populations in certain areas or removing invading, nonnative species, will be necessary at some sites. (USFWS, 1991)
- It is essential to conduct research which will contribute to recovery. Included here are seed bank research and genetic studies. (USFWS, 1991)
- Introduction of the species may become a future priority if protection of extant populations cannot be achieved. (USFWS, 1991)
- Land protection and site monitoring (USFWS, 2013)
- Site protection (USFWS, 2013)
- Population monitoring at Plainfield and Pickerel lakes (USFWS, 2013)
- Population augmentation (USFWS, 2013)
- Searches for new sites and potential reintroductions (USFWS, 2013)
- Actions to address threats due to continued low lake levels (USFWS, 2013)
- Pollinator studies (USFWS, 2013)
- Seed storage (USFWS, 2013)
- Seed bank studies (USFWS, 2013)

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SPECIES ACCOUNT: *Packera franciscana* (San Francisco Peaks ragwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/22/1983; Southwest Region (Region 2) (USFWS, 1983)

Physical Description

A dwarf alpine perennial, 3.1-10.2 cm tall, with deeply lobed leaves; upper leaves smaller than lower leaves. Small yellow-gold flower heads, composed of 1-6 flowers. (NatureServe, 2015)

Taxonomy

The San Francisco Peaks ragwort was listed as Senecio franciscanus. (USFWS, 1983)

Historical Range

It is believed that the plant inhabits much of the same area it occupied when it was first described in 1884 (USDA 1987). (USFWS, 2010)

Current Range

Endemic to the San Francisco Peaks, a high altitude mountain range in Coconino County, northern Arizona; range about 4.44 sq km. (NatureServe, 2015)

Critical Habitat Designated

Yes; 11/22/1983.

Legal Description

On November 22, 1983, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Astragalus holmgreniorum (Holmgren milk-vetch) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Arizona (48 FR 52743-52747).

Critical Habitat Designation

The critical habitat designation for Astragalus holmgreniorum includes one CHU in Coconino County, Arizona (48 FR 52743-52747).

Coconino County; Coconino National Forest, Agassiz Peak and Humphreys Peak, T22N, R7E, N½ of NW¼ Sec. 5; T23N, R7E, W½ Section 32 and W½ Section 29.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Astragalus holmgreniorum critical habitat consists of one component (48 FR 52743-52747):

Primary constituent elements are the loose cinder talus slopes of the alpine tundra system of the San Francisco Peaks and the absence of disturbance and damage from hikers.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Primarily vegetative by rhizomes, but also sexual (NatureServe, 2015)

Breeding Season

Adult: August to mid-September (USFWS, 1987)

Reproduction Narrative

Adult: Reproduction is primarily vegetative by mat-forming rhizomes although sexual reproduction also occurs from matures achenes. (NatureServe, 2015)

Habitat Type

Adult: Scree/talus slopes (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Alpine tundra (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clustered (inferred from USFWS, 1987)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Site Fidelity

Adult: High (USFWS, 1987)

Habitat Narrative

Adult: The San Francisco Peaks groundsel occurs in alpine tundra areas on sparsely vegetated loose talus slopes, at 3350-3750 m. It is usually just above southwestern montane spruce-fir or bristlecone pine (Pinus aristata) forests. (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2010)

Dispersal/Migration Narrative

Adult: Personal observations indicate that the plant does occur in avalanche-disturbed areas and it is possible that these disturbances may allow for the plant to spread and/or take root in new areas. (USFWS, 2010)

Population Information and Trends

Population Trends:

Stable (USFWS, 2021)

Species Trends:

Stable (USFWS, 2021)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2021)

Population Size:

90,000 to 135,000 ramets (USFWS, 2021)

Adaptability:

Low (USFWS, 2010)

Population Narrative:

On the San Francisco Peaks, there are approximately 1,200 acres of tundra and P. franciscana occurs in a patchy distribution across approximately 213 acres within the lpine zone (Dexter 2007). On the San Francisco Peaks, ragwort plants occur on Humphreys, Agassiz, Fremont, and Doyle peaks, and along the north rim that extends northeast from Humphreys Peak. P. franciscana surveys have estimated a total population of 90,000 to 135,000 ramets (USFWS 2014). The species appears to be stable based upon the apparent persistence and density of ramets, the continuous occupancy of monitored areas, and implementation of conservation measures to protect the plant and its habitat (USFWS 2010, Fowler and Sieg 2011, Fowler et al. 2015, USFS 2018). (USFWS, 2021)

Threats and Stressors

Stressor: Trampling (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, the greatest threat to the species was thought to be the activity of summer hikers using a multitude of user-created trails and the lack of a designated trail to minimize effects to the San Francisco Peaks ragwort (USFWS 1983). Since the species was listed, trails, or plans for them, have been modified to avoid impacting areas where the plant occurs. Off trail use is expected to be minimal because of the steep and loose terrain. (USFWS, 2010)

Stressor: Ski area expansion (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: When the ragwort was listed, the expansion of the Arizona Snowbowl, a local ski area located on Humphreys Peak, was predicted to have a serious detrimental effect on P. franciscana (USFWS 1983). However, after listing, the planned improvements to the ski area were adjusted to not affect known populations or individual P. franciscana plants, but some activities will occur within designated critical habitat. (USFWS, 2010)

Stressor: Avalanches (USFWS 2010)
Exposure:

Response:
Consequence:
Narrative: Avalanches tend to create disturbance areas that can impact existing vegetation. However, the plant seems to be adapted to some amount of disturbance, and it is not understood if this is a disturbance that results in negative, positive, or neutral impacts to the plant. Negative results may occur if plants are uprooted and destroyed. Personal observations indicate that the plant does occur in avalanche-disturbed areas and it is possible that these disturbances may allow for the plant to spread and/or take root in new areas. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Global climate change may be the greatest threat to this alpine tundra-dependent species. Studies have shown that since 1950, the snowmelt season in some watersheds of the western U.S. has advanced by about 10 days (Dettinger and Cayan 1995, Dettinger and Diaz 2000, Stewart et al. 2004). In alpine habitats, climate change intensifies natural drought cycles and the ensuing stress placed upon high elevation specialist species (IPCC 2007, Cook et al. 2004, Breshears et al. 2005, Mueller et al. 2005). The San Francisco Peaks ragwort may be threatened with extinction in the future if climate change results in the loss of tundra habitat on the San Francisco Peaks. Since the highest peak on the mountain is at 3,850 m (12,633 ft), there is little habitat available for the plant to migrate upward in a warming climate scenario, and we have speculated that the species may be vulnerable to extinction due to climate change. (USFWS, 2010)

Recovery

Delisting Criteria:
Demonstrated long-term stability in population levels and habitat size and quality at current levels or greater through monitoring studies. (USFWS, 1987)

Actions identified in Alpine Tundra Management Plan are implemented. (USFWS, 1987)

Extend the improved trail system to the top of Humphrey's Peak; provide an alternate exit from the alpine zone. (USFWS, 1987)

Develop a cooperative agreement between the Forest Service and the Fish and Wildlife Service on monitoring and enforcement of closure. (USFWS, 1987)

Recovery Actions:
- Remove threats to San Francisco Peaks groundsel by enforcement of existing regulations and by management for protection. (USFWS, 1987)
- Study populations in their natural habitat. (USFWS, 1987)
- Establish and maintain an ex situ population of Senecio franciscanus. (USFWS, 1987)
- Develop public awareness, appreciation, and support for preservation of San Francisco Peaks Groundsel. (USFWS, 1987)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, and Coconino National Forest establish a statistically robust, baseline population size estimate

for the entire mountain and within the San Francisco Peaks Recreation Natural Area. This is necessary for us to better understand the true status and to accurately document responses and trends of the P. franciscana population. (USFWS, 2010)

- We recommend that the USFWS initiate revision of the Recovery Plan (which is 23 years old) and develop specific delisting criteria for P. franciscana. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, and Coconino National Forest conduct long-term monitoring of the P. franciscana population centroid determined by Fowler et al. (2009) to allow detection of altitudinal migration. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, Coconino National Forest, and other partners conduct research on the reproductive biology of P. franciscana evaluating the genetic diversity within and between colonies, the breeding system involved with sexual reproduction, pollination, and fertilization. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, Coconino National Forest, and other partners conduct research on P. franciscana seed viability, seedling establishment, survivorship, and fecundity to better understand the life history characteristics of this species. (USFWS, 2010)
- We recommend that the USFWS, U.S. Forest Service Rocky Mountain Research Station, Coconino National Forest, and other partners conduct research examining the effect of natural and manmade disturbance on P. franciscana persistence and distribution. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The foremost recommendation for action is that, if possible, given workloads, we conduct a Species Status Assessment for P. franciscana to guide the development of a recovery plan revision. In addition, the following recommendations for future actions are the result of discussions and/or published information regarding the species' needs with recognized experts from the RMRS, The Arboretum at Flagstaff, and managers from the Coconino National Forest. 1. We recommend that the Service, RMRS, and Coconino National Forest conduct longterm monitoring of the P. franciscana population centroid determined by Fowler et al. (2015) to allow detection of altitudinal migration. 2. We recommend that the Service, RMRS, Coconino National Forest, and other partners conduct research examining the effect of natural and human-caused disturbance on P. franciscana persistence and distribution, including damage potentially caused by trampling and habitat destruction by hikers and potential effects from the Arizona Snowbowl Ski Resort. 3. We recommend that the Service, RMRS, Coconino National Forest, and/or other partners conduct research on the reproductive biology of P. franciscana evaluating the genetic diversity within and between clones, and the breeding system involved with sexual reproduction, pollination, and fertilization. 4. We recommend that the Service, RMRS, Coconino National Forest, and other partners conduct research on ragwort seed viability, seedling establishment, survivorship, and fecundity to increase our understanding of the life history characteristics of this species. 5. We recommend that the Service work with The Arboretum at Flagstaff, and other partners to collect additional seed to replenish the seed in storage as well as for germination trials. 6. We recommend that the Service work with The Arboretum at Flagstaff, or other interested partners, to conduct a thorough population genetic analysis of P. franciscana to assess the extent of the hybrid zone with P. werneriifolia on the San Francisco Peaks, and to investigate whether phenology or elevational distribution of one or both species is changing due to climatic shifts. 7. We recommend that, if possible, given workloads, the Coconino National Forest work with us to develop a current

Wilderness Management Plan for the San Francisco Peaks wilderness that identifies management actions to protect P. franciscana and its habitat. (USFWS, 2021)

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SPECIES ACCOUNT: *Paronychia chartacea* (Papery whitlow-wort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 2/20/1987; Southeast Region (R4)

Physical Description

The papery whitlow-wort is mat-forming with many bright yellowish-green branches radiating flatly from a strong taproot (Kral 1983, Small 1933). The stems are 5 to 20 cm long and are wiry. The leaf blades are sessile, 1.5 to 3.0 mm long, ovate to triangular-ovate in shape, and strongly revolute. It has numerous small cream-colored to greenish flowers (Small 1933, FWS 1996) that produce a very thin-walled utricle (Kral 1983). There are two geographically isolated subspecies of this small herb: P. chartacea ssp. chartacea in central Florida and P. chartacea ssp. minima L. Anderson in the Florida panhandle. Much of the distinction between the two subspecies is a matter of degree (Anderson 1991). The P. chartacea ssp. minima is somewhat less pubescent than ssp. chartacea. There are also differences in their base stems, leaf width, and flower cluster (Anderson 1991). (USFWS, 1999)

Taxonomy

The papery whitlow-wort was first named by Small (1925) as Nychia pulvinata. In 1936 Fernald transferred the species to the genus Paronychia as P. chartacea because the name P. pulvinata was pre-empted (Anderson 1991). In 1991 Anderson formally described two geographically distinct subspecies, P. chartacea ssp. chartacea and P. chartacea ssp. minima. The subspecies P. chartacea ssp. minima was formally described by Anderson (1991), several years after P. chartacea had been listed as a threatened species. Because the entire species was listed as threatened, the newly described subspecies is also protected. (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

P. chartacea ssp. chartacea occurs in the Lake Wales Ridge in Highlands, Polk, Osceola, Orange, and Lake counties, Florida. P. chartacea ssp. minima occurs in the karst region of the Florida panhandle, Washington and Bay counties. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flowering and fruiting occur in late summer or fall (Anderson 1991) and the seeds mature in September or October (T. Race, Bok Tower Gardens, personal communication 1996). This species is a short-lived perennial (Anderson 1991 and observations by staff at the Historic Bok Sanctuary).

Habitat Type

Adult: Sand scrub/rosemary balds

Environmental Specificity

Adult: Narrow (Inferred from NatureServe, 2015)

Habitat Narrative

Adult: Papery whitlow-wort is most frequently seen in open, sunny gaps in rosemary balds within scrub vegetation (Abrahamson et al. 1984, Christman 1988, Menges and Kohfeldt 1995). At Archbold Biological Station, rosemary scrubs are found only on the higher ridges and knolls surrounded by scrubby flatwoods with dense oaks. The main soil types are St. Lucie and Archbold (Abrahamson et al. 1984), which are both well-drained white sands (U.S. Dept. of Agriculture, Soil Conservation Service 1989). The fire cycle in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982, Myers 1990). Rosemary scrub has abundant Florida rosemary (Ceratiola ericoides) and scrub oaks including Chapman oak (Quercus chapmannii), sand live oak (Q. geminata), Archbold oak (Q. inopina) and occasional sand pine (Pinus clausa). The open sandy areas of rosemary scrub contain small herbs and lichens (Abrahamson et al. 1984, Hawkes and Menges 1996). These gaps in the dense vegetation are more persistent in rosemary scrubs than in scrubby flatwoods (Hawkes and Menges 1996). Papery whitlow-wort also occurs in high pineland (upland longleaf pine vegetation, also called "sandhill") in the Walk in the Water tract of LWR State Forest (A. Cox, Florida Division of Forestry, personal communication 2002), at TNC's Crooked Lake Sandhill Preserve (B. Pace-Aldana, TNC, in litt. 2002), and at the Tiger Creek Preserve. In studies of the responses of plants to fire in rosemary balds, Johnson and Abrahamson (1990) and Ostertag and Menges (1994) identified two groups of scrub plants—those that resprout after a fire and those that return from seed. They found that papery whitlow-wort appeared in rosemary balds after fires, even though it had been rare or absent prior to the burn. This strongly indicates that papery whitlow-wort maintains seed banks in the soil, waiting for suitable germination conditions. Within about 9 to 12 years after a fire, papery whitlow-wort was displaced by Florida rosemary and reindeer lichens (Cladonia and Cladina) (Johnson and Abrahamson 1990). Some gap plants such as snakeroot and Highlands scrub hypericum disappear relatively quickly after fires and require large populations consisting of tens of thousands of plants to persist (Quintana-Ascencio and Menges 2000), but papery whitlow-wort persists longer after fire and it has many large populations over a relatively large geographic range, compared to other LWR endemic plants. The density of papery whitlow-wort increases in relation to available open space (Hawkes and Menges 1996; Menges and Kohfeldt 1995), so the species is most abundant in disturbed, sandy areas such as road rights-of-way and recently cleared high pine (Abrahamson et al. 1984; Christman 1988; Service 1996). Papery whitlow-wort can become very abundant after a fire or on disturbed sites such as along fire lanes or trails (Service 1996; Johnson and Abrahamson 1990) and is least likely of the federally-listed scrub plants to suffer local extirpations as open areas become covered by shrubs. Loose sand affects papery whitlow-wort. According to research by Petru and Menges (2004), "the demographic responses of the species to sand movements indicate that mobile sands create constantly shifting arrays of microsites that can influence post-dispersal seed germination, survival, and growth of Florida scrub herbs. Roadside habitats have more dynamic patterns of sand movement than natural gaps and may alter selection regimes important for demographic variation of endemic Florida scrub plants." Papery whitlow-wort persists on road edges in the absence of fire in the vegetation. These roadside sandy areas constitute habitats that are significantly different from the bare areas within the vegetation, and may be less suitable for

persistence of the species. This research bolsters the already-substantial evidence that prescribed fire is essential to maintain Florida scrub vegetation and its biota, including other federally listed plants and animals. Management for papery whitlow-wort requires burning regimes that mimic the natural fire cycles of rosemary scrub. Relationships among fire, open space, and plant distributions within a xeric scrub are complex and need to be studied further (Hawkes and Menges 1996). Management practices for rosemary scrub should include fire at intervals suitable for a variety of plants and animals, rather than at intervals optimized for just a single species (Hawkes and Menges 1996; Quintana-Ascencio et al. 2003).

Dispersal/Migration

Population Information and Trends

Number of Populations:

< 24 EORs (Element Occurrence Records) (USFWS, 2021)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Found in disturbed sites; can tolerate and probably promoted by fire. (NatureServe, 2015)

Population Narrative:

Papery whitlow-wort occurs on the Lake Wales and at least one smaller nearby ridge (Kral 1983), in Highlands, Polk, Osceola, Orange, and Lake Counties (Anderson 1991). It is present on the small ridge at the Lake McLeod tract of LWR National Wildlife Refuge, but not on the Bombing Range Ridge on Avon Park Air Force Range. On the LWR, it is present in essentially all of the scrub conservation lands. Since the last comprehensive survey (Schultz et al. 1999), it has been found in high pineland at the Walk in Water tract of LWR State Forest (Anne Cox, LWR State Forest, personal communication 2002). It is also present in high pineland on the Tiger Creek Preserve, owned by The Nature Conservancy. The northern range limit of papery whitlow-wort is in Lake County, where it occurs on the north side of Lake Louisa at Crooked River Preserve, owned by the Lake County Water Authority. It was possibly present at a nearby site, Schofield Sandhill, which had been proposed for acquisition under the Florida Forever program, but the acquisition proposal did not come to fruition. The only site on conservation lands in Orange County (also at the northern range limit) is the small Shadow Bay Park (formerly Lake Cane-Marsha Park) near where the Florida Turnpike crosses Interstate 4. The species was reported from localities in western Orange County, but the area has since become urbanized, and there are few if any opportunities for setting aside conservation lands in this area. The only papery whitlow-wort site in Osceola County for that has been proposed for State acquisition is at Lake Davenport, in the northwestern corner of the County. It has not been purchased (Florida Natural Areas Inventory 2005). Papery whitlow-wort is present on essentially all conservation lands with scrub on the LWR in Polk and Highlands Counties. The southernmost sites on conservation lands are Gould Road (part of the LWR Wildlife and Environmental Area operated by the FWC) and Archbold, both in Highlands County south of Lake Placid (Schultz et al. 1999). During 2003, the Florida Fish and Wildlife Conservation Commission and Archbold Biological Station purchased adjoining portions of a ranch that bordered the Biological Station's preserve to the west. The recently-acquired land provides an important buffer for Archbold, and it protects

additional habitat for this species, both occupied and restorable. Although FNAI data provide the best available overall view of the distribution of this species, intensive local inventories add important detail. The LWR State Forest is represented in the FNAI database by nine element occurrences, yet the Arbuckle tract of the Forest has 188 records of this plant in its GIS database, based upon an inventory by K. DeLaney in 1988 (data provided by A. Cox, LWR State Forest). Of the 188 records, 23 represented more than 100 individuals. Archbold Biological Station has not monitored this plant because it thrives in fire lanes that usually do not have exotic plant problems (E. Menges and M. Deyrup, Archbold, personal communication 1995, in Service 1996). The propensity of this species to occupy fire lanes, roadsides, and other artificially disturbed areas is a primary conservation concern for the papery whitlow-wort, because it tends to be far more abundant in such disturbed areas than within the vegetation itself. This situation was researched by Petru and Menges (2004), and they confirmed that prescribed fire is essential to create and restore open, sandy habitat for this and other plants. The papery whitlow-wort occurs in association with several other federally listed species: in scrub, Florida bonamia, Highlands scrub hypericum, wireweed, Florida perforate cladonia, snakeroot, and scrub blazing star. In high pineland at the Tiger Creek Preserve, pygmy fringe tree, pigeon wings, scrub buckwheat, Britton's beargrass, scrub plum, and Carter's mustard. Papery whitlow-wort is the most abundant and widespread of the listed LWR scrub and high pineland plants, and it has benefited greatly from acquisition of conservation lands in its range. Like several other scrub species, including Highlands scrub hypericum, is particularly abundant in human-disturbed areas such as road edges and fire lanes. Researchers based at Archbold Biological Station are interested in finding ways to lessen these plants' dependence on such artificial habitats through restoration of fire regimes.

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: For subspecies chartacea, about 30% of FNAI EORs are not protected from threats that are range-wide in scope. Fire suppression is pervasive at unprotected sites and gradually alters habitat over a period of years. Habitat loss through agricultural and residential development is immediate, ongoing, and cumulative. Seventy percent of FNAI EORs occur within one of the 26 managed areas listed in C(1)(d) above. Loss of populations off the LWR in Orange, Polk, and Glades Counties would constitute a significant curtailment of the historic range of chartacea (Turner et al. 2006). Some of these sites may already have been lost. For subspecies minima, it is unknown how many populations have already been lost and its historical range has apparently not been documented. Eight of 12 extant sites appear to be in imminent danger of being lost; all are on privately owned land and could be destroyed if development or habitat modification occurs on those lands. For both subspecies a range-wide survey is needed to determine the current status of populations and the threats to each. (USFWS, 2008)

Stressor: Inadequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:

Narrative: Papery whitlow-wort is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. Property owners are not prohibited under this law from destroying populations of listed plants nor are they required to manage habitats to maintain populations. Existing federal and state regulations prohibit the removal or destruction of listed plant species on public lands. However, they afford no protection to listed plants on private lands. In addition, state regulations are less stringent than federal regulations on land management practices that may adversely affect populations of listed plants. Existing regulatory mechanisms are inadequate to protect this species. (USFWS, 2008)

Stressor: Inadequate management (fire or mechanical disturbance)
Exposure:
Response:
Consequence:
Narrative: Maintenance of viable populations of imperiled plant species depends largely on the determination of the appropriate management regime of populations on managed areas. For subspecies chartacea, inadequate use of fire or the use of mechanical treatments as a surrogate for fire may reduce population sizes or adversely affect demographic performance. For subspecies chartacea, appropriate management means burning Florida rosemary scrub often enough to maintain large gaps within the rosemary shrub matrix. In the absence of data on the biology and autecology of subspecies minima, its management eeds cannot be determined. The preferred habitat of subspecies minima on the margins of karst ponds suggests that disturbances other than fire may be required for the maintenance of its populations. (USFWS, 2008)

Recovery

Reclassification Criteria:
Not relevant. (USFWS, 1999)

Delisting Criteria:
I. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to ensure 95% probability of persistence for 100 years. (USFWS, 1999)

2. When these sites, within the historic range of P. chartacea, are adequately protected from habitat loss, degradation, and fragmentation. (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support P. chartacea. (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Recovery Actions:

- Determine current distribution of P. chartacea. Some portions of P. chartacea's range have been well surveyed yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)

- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, has been isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of P. chartacea. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor populations of P. chartacea. Develop monitoring protocol to assess population trends for P. chartacea. Develop a quantitative description of the population structure of P. chartacea. (USFWS, 1999)
- Provide public information about P. chartacea. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about P. chartacea. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. chartacea and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)
- A taxonomic study evaluating the distinctiveness of the two subspecies should be conducted. (USFWS, 2008)
- A study of the reproductive biology of the two subspecies should be conducted to determine the degree of floral dimorphism/sexual gender and sex ratios of populations. (USFWS, 2008)
- For P. c. chartacea, surveys should be conducted to assess the status of the FNAI EORs that occur on unprotected sites and to evaluate the feasibility of protecting additional populations. Following Turner et al. (2006), extant parcels in the Green Swamp and at Fisheating Creek, Avon Park Lakes, Lake Davenport and other sites should be targeted for acquisition. Acquisition of these sites would also extend protection to other federally listed plants. (USFWS, 2008)
- For P. c. minima,It is unclear how well existing FNAI EORs reflect the historic range of the taxon. It is possible that additional surveys of areas with appropriate habitat are needed. The possibility of acquiring additional populations also needs to be assessed. (USFWS, 2008)
- Habitat maintenance requirements of P. c. minima need to be investigated. (USFWS, 2008)
- For both subspecies, the minimal monitoring should be establishment of level 2 monitoring (sensu Menges and Gordon 1996) to track changes in population sizes over time. Level 2 monitoring requires that surveys be repeated at defined intervals (e.g., annually, biannually, every five years, or both before and after imposition of management treatments) and that surveys take place within well-defined areas (e.g., within plots small enough to be searched thoroughly within a minimum of effort). ABS' s Population Dynamics of Endemic Plants (PDEP) project was designed as a model of level 2 monitoring that can be deployed by other

agencies. Presence/absence data (level 1 monitoring sensu Menges and Gordon 1996) or the periodic accumulation of GPS points cannot provide meaningful data for determining population trends or for quantifying responses to prescribed fire or other management activities.(USFWS, 2008)

- To conduct population viability analyses, detailed demographic data (level 3 monitoring sensu Menges and. Gordon 1996) should be collected from multiple populations of both subspecies. These data need to be collected across the full geographic range of both subspecies, from populations in contrasting habitats (e.g., rosemary scrub vs. roadsides for subspecies chartacea, pond margins vs. sandhill for subspecies minima), and in sites with differing management histories. (USFWS, 2008)
- Studies should be conducted to understand the genetic diversity of both subspecies; this may aid in the identification of new acquisition needs. (USFWS, 2008)
- Where monitoring is being conducted, data should be collected on fire management activities to aid in the interpretation of trends and identifying the most favorable treatments. (USFWS, 2008)
- A revised recovery plan should be developed to address the existence of two subspecies with separate geographic ranges and their potential need for differing management practices to ensure recovery. (USFWS, 2008)
- Habitat for P. c. chartacea needs to be maintained through burning Florida rosemary scrub within the modal fire return interval defined by other gap specialists and by Florida rosemary (Menges 2007). (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Conduct surveys for P. c. var. minima in areas with appropriate habitat and unknown occupancy to assess the possibility of additional populations and help identify the historic range of the variety. This could include a habitat suitability analysis to help guide surveys. • Purchase for conservation or work with private landowners to develop conservation agreements for unprotected lands with P. c. var. minima. • Manage Florida rosemary scrub habitat for P. c. chartacea through prescribed fire within a fire return interval of 10 to 30 years (Menges et al. 2019). • Investigate the habitat maintenance requirements of P. c. minima, particularly with respect to hydrology. • Institute or continue Level 1 monitoring for P. c. var. chartacea between August and November when plants are most abundant. • Conduct more intensive monitoring of P. c. var. minima. However, its short lifespan and the very dynamic nature of pond hydrology at most sites will make this monitoring challenging. Understanding seed dormancy in P. c. var. minima will be key to understanding its limits with respect to hydrological variation. • Conduct population viability analyses, including detailed demographic data (level 3 monitoring sensu Menges and Gordon 1996) collected from multiple populations of both subspecies. Collect data across the full geographic range of both varieties, from populations in contrasting habitats (e.g., rosemary scrub vs. roadsides for subspecies P. c. var. chartacea, pond margins vs. sandhill for subspecies P. c. var. minima), and in sites with differing management histories. Relate demographic research on P. c. var. chartacea to fire management parameters, including fire frequency, time-since-fire, fire intensity, and fire patchiness. Couple such data for P. c. var. minima with current and historical data on pond hydrology. • Conduct studies to understand the genetic diversity of both varieties; this may aid in the identification of new acquisition needs. • Conduct a study of the reproductive biology of the two varieties to determine the degree of floral dimorphism/sexual gender and sex ratios of populations. (USFWS, 2021)

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SPECIES ACCOUNT: *Parvisedum leiocarpum* (Lake County stonecrop)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A low annual herb, generally only 1-3.5 cm tall, with fleshy leaves that fall off the stem by flowering time. Flowers (April-May) are small and yellow. (NatureServe, 2015)

Taxonomy

USFWS tracks as Parvisedum leiocarpum (9/93). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known from only a small number of populations within a 10-square-mile area. This species occurs on more or less level sites in shallow depressions that retain water seasonally. Known microhabitats include Northern Basalt Flow and Northern Volcanic Ashflow vernal pools (Sawyer and Keeler-Wolf 1995), low areas in meadows and gravelly flats, and hollows in exposed rocks. A few plants were found on a man-made berm within a flat area that supported a large population. Substrates on which S. leiocarpa occur frequently are of volcanic origin and often are gravelly (Patterson 1986). The species occurs at elevations of 518 to 793 meters (1,700 to 2,600 feet). (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Terrestrial, palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Vernal pools and margins (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits margins of vernal pools and depressions in bedrock which act as shallow vernal pools and volcanic substrates (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Narrative:

At least 50% of the known populations have been destroyed in the last 60 years. Decline of 50-70% (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Altered hydrology (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Altered hydrology is listed as a threat to this species (USFWS, 2009).

Stressor: Road maintenance/widening (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Road maintenance/widening is listed as a threat to this species (USFWS, 2009).

Stressor: Agricultural land conversion (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural land conversion is listed as a threat to this species (USFWS, 2009).

Stressor: Off-highway vehicle use (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Off-highway vehicle use is listed as a threat to this species (USFWS, 2009).

Stressor: Trampling by cattle (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Trampling by cattle is listed as a threat to this species (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The final rule finds inadequacies with the Federal Clean Water Act, the California Environmental Quality Act, and the California Endangered Species Act in addressing threats to

this species (USFWS, 2009).

Stressor: Likelihood of Stochastic Extinction (USFWS, 2009)
Exposure:
Response:
Consequence: Extinction
Narrative: The combination of restricted range, few populations, and highly specific and vulnerable habitat makes this species vulnerable to destruction of all, or a significant part, of any population from random events such as floods or droughts (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change is listed as a possible threat to this species (USFWS, 2009).

Recovery

Delisting Criteria:
Habitat protection: Accomplish habitat protection that promotes vernal pool ecosystem function sufficient to contribute to population viability of the covered species. Suitable vernal pool habitat within each prioritized core area for the species is protected. Species localities distributed across the species geographic range and genetic range are protected. Protection of the extreme edges of the population protects the genetic differences that occur there. Reintroduction and introductions must be carried out and meet success criteria. Additional localities that are detected (and determined essential for recovery goals) are permanently protected. Habitat protection results in protection of hydrology essential to vernal pool ecosystem function, and monitoring indicates that hydrology that contributes to population viability has been maintained through atleast one multi-year period that includes above average, average, and below average local rainfall as defined above, a multi-year drought, and a minimum of 5 years of post-drought monitoring (USFWS, 2009).

Adaptive habitat management and monitoring. Habitat management and monitoring plans that facilitate maintenance of vernal pool ecosystem function and population viability have been developed and implemented for all habitat protected, as previously discussed in sections 1A-E. Mechanisms are in place to provide for management in perpetuity and long-term monitoring of 1A-E, as previously discussed (funding, personnel, etc.). Monitoring indicates that ecosystem function has been maintained in the areas protected under 1A-D for at least one multi-year period that includes above average, average and below average local rainfall, a multi-year drought, and a minimum of 5 years post drought monitoring. Seed banking actions have been completed for species that would require it as insurance against risk of stochastic extirpations or that will require reintroductions or introductions to contribute to meeting recovery criteria (USFWS, 2009).

Status surveys: Status surveys, 5-year status reviews, and population monitoring show populations within each vernal pool region where the species occur are viable (e.g., evidence of reproduction and recruitment) and have been maintained (stable or increasing) for at least one multi-year period that includes above average, average, and below average rainfall, a multi-year

drought and a minimum of 5 years of post drought monitoring. Status surveys, status reviews, and habitat monitoring show that threats identified during and since the listing process have been ameliorated or eliminated. Site-specific threats identified through standardized site assessments and habitat management planning must be ameliorated or eliminated (USFWS, 2009).

Research: Research actions necessary for the recovery and conservation of the covered species have been identified. Research actions on species biology and ecology, habitat management and restoration, and methods to eliminate or ameliorate threats have been completed and incorporated into habitat protection, habitat management and monitoring, and species monitoring plans, and refinement of recovery criteria and actions. Research on genetic structure has been completed and results incorporated into habitat protection plans to ensure that within and among population genetic variation is fully representative by populations protected in the Habitat Protection section of this document as previously described in sections 1A-E. Research necessary to determine appropriate parameters to measure population viability for each species have been completed (USFWS, 2009).

Participation and outreach: Recovery Implementation Team is established and functioning to oversee rangewide recovery efforts. Vernal pool regional working groups are established and functioning to oversee regional recovery efforts. Participation plans for each vernal pool region have been completed and implemented. Vernal pool regional working groups have developed and implemented outreach and incentive programs that develop partnerships contributing to achieving recovery criteria 1-4 (USFWS, 2009).

Recovery Actions:

- Protect habitat. Currently none of the known localities of the species are protected. Preservation of Zone 1 core area should be pursued to preserve known localities (USFWS, 2009).
- Control erosion (USFWS, 2009).
- Conduct research at as many of the extant localities as possible (USFWS, 2009).
- Collect seeds for future introduction and/or reintroductions into suitable habitat (USFWS, 2009).
- Formally change the name in the Code of Federal Regulations from Parvisedum leiocarpum to Sedella leiocarpa (USFWS, 2009).
- Correct the downlisting criteria, if necessary, to also apply to the Dry Lake core area (USFWS, 2009).

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SPECIES ACCOUNT: *Pectis imberbis* (Beardless chinch weed)

Species Taxonomic and Listing Information

Listing Status: Endangered (USFWS, 2021)

Physical Description

Pectis imberbis is an erect, many-branched, perennial herb growing 3-12 decimeters (dm) (12 to 47 inches (in)) from a woody caudex (stem base). The glabrous (without hairs) leaves are 1 to 5 cm (0.4 to 2 in) in length and 1 to 2 millimeters (mm) (0.04 to 0.08 in) wide with pointed tips, becoming smaller toward the tips. The leaves have a row of narrow, oval-shaped glands on the underside surface near each margin and a single, oval-shaped gland on the upper surface. Daisy-like flower heads containing yellow ray and disk flowers are solitary or in open, flat-topped clusters at the tips of the branches. The petals are also dotted with oil glands. Unlike other species in this genus, P. imberbis has no fine hairs fringing the base of the upper leaves; instead, it has a single pair of trichomes (hair-like growth) on the lower leaves.

Taxonomy

The beardless chinchweed is an erect, many-branched perennial of the Asteraceae (sunflower) family (USFWS, 2021).

Current Range

The beardless chinchweed is an erect, many-branched perennial of the Asteraceae (sunflower) family. It occurs on sunny, south-facing slopes in nativedominated grasslands, oak savannas, and oak woodlands in southern Arizona and northern Mexico. The species is particularly susceptible to competition from other plants and is impacted by nonnative, invasive grasses, which outcompete this species for light, water, nutrients, and space, and exacerbate unnatural high-severity fires. Nine populations have been extirpated since 1962, leaving 12 extant populations in Arizona and Mexico. The extirpated sites have high levels of invasion by nonnative grasses. Most populations are very small, with 92 percent of populations throughout the range of the species supporting fewer than 50 individuals. These small populations are particularly vulnerable to extirpation. The beardless chinchweed occurs between elevations of 3,799 to 5,699 ft. It requires steep, south-facing, sunny to partially shaded hillslopes with open areas and little competition from other plants. To maintain species' viability, populations with multiple subpopulations and overall high abundance must be distributed across the species range and represent a range of environmental conditions. These populations must experience recruitment that exceeds mortality. Beardless chinchweed requires habitat consisting of native-dominated plant communities on eroding limestone or granite bedrock substrate with precipitation adequate for germination, growth and reproduction. The nativedominated plant communities include plains, great basin, and semi-desert grasslands, oak savanna, or Madrean evergreen woodlands and communities dominated by bunchgrasses with open spacing and little competition from other plants. In addition, these communities must support sufficient beardless chinchweed pollinators (e.g., flies, bees, and butterflies) including plants for pollinator foraging and nesting within pollinator flight distance of beardless chinchweed populations (USFWS, 2021).

Critical Habitat Designated

Yes; 7/15/2021.

Life History

Food/Nutrient Resources

Habitat Type

Adult: grasslands, oak savannas, and oak woodlands (USFWS, 2021)

Dependencies on Specific Environmental Elements

Adult: Plants need space on steep, south-facing, sunny to partially shaded hillslopes, with eroding bedrock and open areas with little competition from other plants (USFWS, 2021).

Habitat Narrative

Adult: The beardless chinchweed is an erect, many-branched perennial of the Asteraceae (sunflower) family. It occurs on sunny, south-facing slopes in native dominated grasslands, oak savannas, and oak woodlands in southern Arizona and northern Mexico. The species is particularly susceptible to competition from other plants and is impacted by nonnative, invasive grasses, which outcompete this species for light, water, nutrients, and space, and exacerbate unnatural high-severity fires. Nine populations have been extirpated since 1962, leaving 12 extant populations in Arizona and Mexico. The extirpated sites have high levels of invasion by nonnative grasses. Most populations are very small, with 92 percent of populations throughout the range of the species supporting fewer than 50 individuals. These small populations are particularly vulnerable to extirpation. The beardless chinchweed occurs between elevations of 3,799 to 5,699 ft. It requires steep, south-facing, sunny to partially shaded hillslopes with open areas and little competition from other plants. To maintain species' viability, populations with multiple subpopulations and overall high abundance must be distributed across the species range and represent a range of environmental conditions. These populations must experience recruitment that exceeds mortality. Beardless chinchweed requires habitat consisting of native-dominated plant communities on eroding limestone or granite bedrock substrate with precipitation adequate for germination, growth and reproduction. The nativedominated plant communities include plains, great basin, and semi-desert grasslands, oak savanna, or Madrean evergreen woodlands and communities dominated by bunchgrasses with open spacing and little competition from other plants. In addition, these communities must support sufficient beardless chinchweed pollinators (e.g., flies, bees, and butterflies) including plants for pollinator foraging and nesting within pollinator flight distance of beardless chinchweed populations (USFWS, 2021).

Dispersal/Migration

Population Information and Trends

Resiliency:

Our analysis of the past, current, and future stressors on the resources that the beardless chinchweed needs for long-term viability revealed that there are a number of stressors influencing this species. All beardless chinchweed populations likely contain nonnative grasses with a competitive advantage over native grasses during periods of drought. Further, altered fire regime has the potential to affect all populations. This altered fire regime enhances the spread of nonnatives, and all populations of beardless chinchweed contain nonnatives. Consequently,

fire will aid in the spread of nonnatives, is currently a risk to all populations of the beardless chinchweed, and will be further exacerbated by nonnative grasses in the near future (approximately 10 years). Altered precipitation, increased temperatures, increased evapotranspiration, decreased soil moisture, and decreased winter and spring precipitation are current and ongoing environmental conditions impacting all populations of the beardless chinchweed and exacerbating an altered fire regime. Road maintenance is likely resulting in the loss of individuals in three populations (Ruby Road, Scotia Canyon, and Coronado National Memorial). In addition, all individuals in these three populations are currently being impacted by dust from the road. The Ruby Road and Scotia Canyon populations exhibit low resiliency, and the Coronado National Memorial population exhibits moderate resiliency. Two additional populations (McCleary Canyon-Gunsight Pass and McCleary Canyon-Wasp Canyon) will be impacted by Rosemont mining operations and dust in the near future (approximately 10 years; Westland 2010, p. iv). One of these populations currently exhibits low resiliency, and the other exhibits moderate resiliency. Rangewide (including Mexico), 11 of the 12 populations (83 percent) are small (fewer than 50 individuals). Synergistic interactions among wildfire, nonnative grasses, decreased precipitation, and increased temperatures cumulatively and cyclically impact the beardless chinchweed, and all stressors are exacerbated in small populations. Of the six extant populations in the United States, two exhibit moderate resiliency and four exhibit low resiliency (see table 1, below). A population with moderate resilience is one in which abundance ranges from 100–300 individuals the population contains 2 subpopulations, and spatial distribution is limited with few groupings; seed production is moderate; recruitment and mortality are equal such that the population does not grow; the ability to withstand stochastic events or recover from stochastic events is limited due to low abundance and recruitment and to a reduced seed bank; and there is some suitable habitat. A population with low resilience is one in which abundance is less than 100 individuals, the population contains a single subpopulation, and spatial distribution is limited; seed production is low; mortality exceeds recruitment such that the population is declining; the ability to withstand stochastic events or recover from stochastic events is unlikely due to low abundance and recruitment and to a limited seed bank; and there is limited suitable habitat. The categories of conditions used to determine population resiliency are further described in the SSA report (Service 2020, Table 5.10) and the proposed listing rule (84 FR 67060, December 6, 2019, p. 84 FR 67065) (USFWS, 2021).

Representation:

No genetic studies have been conducted within or among the 21 historical populations of the beardless chinchweed in southern Arizona and Mexico. Mountain ranges that have only one or two populations, or have only have one subpopulation per population, or low numbers of individuals per population with several miles between mountain ranges, may not be as genetically diverse because pollination or transport of seeds between populations may be very limited or nonexistent. Five of the six extant U.S. populations do not have multiple subpopulations. The Coronado National Memorial population has two subpopulations. The six extant U.S. populations are separated geographically into four ranges separated by 16 to 61 km (9.9 to 37.9 mi). There is likely genetic diversity among mountain ranges, but reduced genetic diversity within populations. Further, overall genetic diversity is likely reduced given that some populations are extirpated. Extant U.S. populations of the beardless chinchweed range in elevation from 1,158 m (3,799 ft) to 1,737 m (5,699 ft). Of the 15 historical U.S. populations, 8 (approximately 53 percent) fall below 1,457 m (1,500 ft) elevation. Of these eight, six have been extirpated in recent decades. This loss of lower elevation populations may mean the loss of

some local adaptation to warmer or drier environments and genetic differentiation among populations. In the Ruby Road, Scotia Canyon, and Coronado National Memorial populations, and the Tributary of O'Donnell subpopulations, plants have been reported over many decades, indicating that these populations may have the genetic and environmental diversity needed to adapt to changing conditions. However, both the Ruby Road and Scotia Canyon populations have been reduced in size in the past 30 years, and we have no previous count data at Coronado National Memorial for comparison (USFWS, 2021).

Redundancy:

The beardless chinchweed populations in the United States and Mexico are naturally fragmented between mountain ranges. Currently, six extant U.S. populations of the beardless chinchweed are spread across the Atascosa-Pajarito, Huachuca, and Santa Rita Mountains and the Canelo Hills. The Atascosa-Pajarito Mountains and the Canelo Hills have only one extant population each, while the Santa Rita and Huachuca Mountains have two extant populations each. Range separation makes natural gene exchange or re-establishment following extirpation very unlikely. In addition, six historical populations of the beardless chinchweed are distributed across two general areas in northern Chihuahua and Sonora, Mexico. Their status is unknown, but we expect they are small populations with poor habitat based on populations in the United States, which are small and dominated by nonnative species. Although this may imply some level of redundancy across the range of the beardless chinchweed, five of the six extant populations in the United States contain fewer than 50 individual plants. Further, nine populations and one subpopulation have been extirpated in recent decades, largely from the lower elevations of the species' range, and several populations have been reduced in size in recent decades. We note that, by using the SSA framework to guide our analysis of the scientific information documented in the SSA report, we have not only analyzed individual effects on the species, but we have also analyzed their potential cumulative effects. We incorporate the cumulative effects into our SSA analysis when we characterize the current and future condition of the species. Our assessment of the current and future conditions encompasses and incorporates the threats individually and cumulatively. Our current and future condition assessment is iterative because it accumulates and evaluates the effects of all the factors that may be influencing the species, including threats and conservation efforts. Because the SSA framework considers not just the presence of the factors, but to what degree they collectively influence risk to the entire species, our assessment integrates the cumulative effects of the factors and replaces a standalone cumulative effects analysis (USFWS, 2020).

Number of Populations:

12 extant populations in Arizona and Mexico (USFWS, 2021)

Population Size:

In Arizona, there are currently 387 individual beardless chinchweed spread across less than 2 ha (5 ac) within six extant populations spread across the four mountain ranges (USFWS, 2021).

Minimum Viable Population Size:

General conservation biology indicates that at least 500 individual are needed for a minimum viable population (USFWS, 2021).

Population Narrative:

The beardless chinchweed is an erect, many-branched perennial of the Asteraceae (sunflower) family. It occurs on sunny, south-facing slopes in native dominated grasslands, oak savannas, and oak woodlands in southern Arizona and northern Mexico. The species is particularly susceptible to competition from other plants and is impacted by nonnative, invasive grasses, which outcompete this species for light, water, nutrients, and space, and exacerbate unnatural high-severity fires. Nine populations have been extirpated since 1962, leaving 12 extant populations in Arizona and Mexico. The extirpated sites have high levels of invasion by nonnative grasses. Most populations are very small, with 92 percent of populations throughout the range of the species supporting fewer than 50 individuals. These small populations are particularly vulnerable to extirpation. The beardless chinchweed occurs between elevations of 3,799 to 5,699 ft. It requires steep, south-facing, sunny to partially shaded hillslopes with open areas and little competition from other plants. To maintain species' viability, populations with multiple subpopulations and overall high abundance must be distributed across the species range and represent a range of environmental conditions. These populations must experience recruitment that exceeds mortality. Beardless chinchweed requires habitat consisting of native-dominated plant communities on eroding limestone or granite bedrock substrate with precipitation adequate for germination, growth and reproduction. The nativedominated plant communities include plains, great basin, and semi-desert grasslands, oak savanna, or Madrean evergreen woodlands and communities dominated by bunchgrasses with open spacing and little competition from other plants. In addition, these communities must support sufficient beardless chinchweed pollinators (e.g., flies, bees, and butterflies) including plants for pollinator foraging and nesting within pollinator flight distance of beardless chinchweed populations (USFWS, 2021). The minimum viable population size for this species is unknown. General conservation biology indicates that at least 500 individual are needed for a minimum viable population. Currently, 11 of the 12 populations have fewer than 50 individuals. In Arizona, there are currently 387 individual beardless chinchweed spread across less than 2 ha (5 ac) within six extant populations spread across the four mountain ranges. Space, in the form of habitat described above, is needed for an increase in the number of populations and the number of individuals per population (USFWS, 2021). Space for individual and population growth is needed for the beardless chinchweed, including sites for germination, pollination, reproduction, pollen and seed dispersal, and seed banks in the form of open, native dominated plains, great basin, and semidesert grasslands, oak savannas, and Madrean evergreen or oak woodlands at 1,158 to 1,737 m (3,799 to 5,699 ft) in elevation (SEINet, entire) representing the ecosystems where beardless chinchweed occurs. In addition, plants need space on steep, south-facing, sunny to partially shaded hillslopes, with eroding bedrock and open areas with little competition from other plants. Native-dominated habitats have diverse assemblages of vegetation, each with different-shaped and -sized canopy and root system, which creates heterogeneity of form, height, and patchiness and provides openness. The diverse vegetation is dominated by bunchgrasses with open spacing (adjacent to and within 10 m (33 ft) of beardless chinchweed plants), providing beardless chinchweed with the necessary open habitat with little competition. The beardless chinchweed is presumed to be a poor competitor due to its preference for this open habitat and the inability to find the species under dense vegetation conditions (USFWS, 2021).

Threats and Stressors

Stressor: Habitat Loss Caused by Nonnative Grasses (USFWS, 2021)
Exposure:

Response:
Consequence:
Narrative:

Stressor: Altered Fire Regime (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Altered Precipitation, Drought, and Temperature (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Small populations (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Recovery Priority Number: 5C

1. Downlisting Criteria The following are objective, measurable criteria which, when met, would result in a determination that beardless chinchweed will be considered for reclassification as a threatened species: 1. Fifteen or more populations (see Justification for Recovery Criteria below for definitions of populations and subpopulations) occur throughout the species' geographic range in the U.S. and Mexico, including populations in the three representation areas as follows: a.i. Northern Representation Area in Arizona – at least eight populations, including: 1) McCleary Canyon - Gunsight Pass, 2) McCleary Canyon - Wasp Canyon, 3) Audubon Research Ranch, 4) Scotia Canyon, 5) Coronado National Memorial, 6) Copper Canyon, 7) Lampshire Well, 8) Ruby Road 1: Peña Blanca Canyon, or 9) up to two newly discovered populations in lieu of any two of the above-named populations. and a.ii. Northern Representation Area in Arizona – at least two populations fulfilled by any combination of the following: rediscovered or reintroduced populations within unoccupied critical habitat (Harshaw Creek, Washington Camp, and Ruby Road 2: Peña Blanca Canyon), newly discovered, rediscovered, or successfully introduced or reintroduced populations in other strategic sites. and a.iii. Central Representation Area in Sonora, Mexico – at least two populations. These populations may include newly discovered, rediscovered, successfully introduced, reintroduced, or augmented populations in strategic sites. and a.iv. Southern Representation Area in Sonora and Chihuahua, Mexico – at least three populations. These populations may include newly discovered, rediscovered, successfully introduced, reintroduced, or augmented populations in strategic sites. Of the fifteen populations referenced above, at least: a. One population needs to support a minimum of 2,500 individuals within two or more subpopulations. b. Six populations need to support a minimum of

over 300 individuals within three or more subpopulations. c. Eight populations need to support a minimum of 100 individuals within at least two subpopulations. These population numbers will be maintained for a total of at least 15 years over a 20-year period, as indicated by monitoring every 1 to 3 years during the flowering season, including during the three most recent monitoring events. To count toward achieving this criterion, existing, introduced, or re-introduced populations that are used to evaluate this criterion may be augmented for the first 10 years to achieve population and subpopulation numbers. To show that populations are viable, no augmentation can occur within populations being evaluated under this criterion in the last 10 years of the 20-year period for populations considered as contributing to possible downlisting (USFWS, 2023).

2. All of the populations referenced in downlisting criterion #1 above must have documented natural recruitment that is greater than or equal to documented plant loss during three or more monitoring events (every 1 to 3 years) of the 20-year period (USFWS, 2023).

3. A collection of seed representing the geographical, morphological, and genetic diversity of beardless chinchweed is regularly collected following Center for Plant Conservation guidelines (2019, p. 1-14) during the period of recovery and maintained in at least one Center for Plant Conservation partner botanical or seed storage institution for conservation purposes (USFWS, 2023).

4. A living collection of plants representing the geographical, morphological, and genetic diversity of beardless chinchweed and following Center for Plant Conservation guidelines (2019, p. 3-13) is established within 10 years of the finalization of this recovery plan and is maintained in perpetuity in at least one botanical institution for educational and conservation purposes (USFWS, 2023).

5. The land within a 500-meter radius around each of at least six populations supports ≥80 percent cover of native plant species. The land within a 1,000-meter radius around each of at least an additional five populations supports ≥65 percent cover of native plant species. The land within a 1,000-meter radius around each of at least the remaining four populations support ≥ 50 percent cover of native plant species (USFWS, 2023).

6. To ensure the continued existence of beardless chinchweed and to help meet populationbased criterion number one, conservation and management plans address the threat of desert grassland, oak savanna, and oak woodland habitat loss and degradation and the direct threats to beardless chinchweed and their pollinators. Specifically, the following must be met, as further quantitatively described in the 2023 Beardless Chinchweed Recovery Implementation Strategy: a. In areas supporting beardless chinchweed populations, land management and site-specific plans are developed and partially implemented, such that over a 20-year period: i. there is a reduction in nonnative vegetation and promotion of native vegetation and a natural fire regime to a level that ensures beardless chinchweed viability is not affected by competition or fires outside the normal fire regime, and that their vigor is not negatively affected (Factors A and E), ii. there is a reduction in beardless chinchweed herbivory by wildlife and grazing by livestock that ensures >80 percent of branches are intact and with seedheads (Factor C), iii. there is a reduction in erosion, sedimentation, burial, trampling, and removal of beardless chinchweed and associated native plants caused by border related activity, mining activity, livestock grazing activity, recreation activity, and other activities to a level that ensures beardless chinchweed

viability is not affected by these activities and their vigor is not negatively affected (Factor A), and iv. there is habitat restoration using locally sourced native plants and seed on lands impacted by the before mentioned threats to a level that ensures beardless chinchweed viability is not affected from nonnative plant competition and their vigor is not negatively affected (Factors A and E). b. data on the conservation and management of beardless chinchweed is collected and shared regularly among land managers and researchers (USFWS, 2023).

Delisting Criteria:

1. Fifteen or more populations occur throughout the species' geographic range in the U.S. and Mexico, including populations in the three representation areas as follows: a.i. Northern Representation Area in Arizona – at least eight populations, including: 1) McCleary Canyon – Gunsight Pass, 2) McCleary Canyon – Wasp Canyon, 3) Audubon Research Ranch, 4) Scotia Canyon, 5) Coronado National Memorial, 6) Copper Canyon, 7) Lampshire Well, 8) Ruby Road 1: Peña Blanca Canyon, or 9) up to two newly discovered populations in lieu of any two of the above-named populations. And a.ii. Northern Representation Area in Arizona – at least two populations fulfilled by any combination of the following: rediscovered or reintroduced populations within unoccupied critical habitat (Harshaw Creek, Washington Camp, and Ruby Road 2: Peña Blanca Canyon), newly discovered, rediscovered, or successfully introduced or reintroduced populations in other strategic sites. And a.iii. Central Representation Area in Sonora, Mexico – at least two populations. These populations may include newly discovered, rediscovered, successfully introduced, reintroduced, or augmented populations in strategic sites. And a.iv. Southern Representation Area in Sonora and Chihuahua, Mexico – at least three populations. These populations may include newly discovered, rediscovered, successfully introduced, reintroduced, or augmented populations in strategic sites. Of the fifteen populations referenced above, at least: a. One population needs to support a minimum of 2,500 individuals within two or more subpopulations. b. Six populations need to support a minimum of over 300 individuals within three or more subpopulations. c. Eight populations need to support a minimum of 100 individuals within at least two subpopulations. These population numbers will be maintained for a total of at least 25 years over a 30-year period, as indicated by monitoring every 1 to 3 years during the flowering season, including during the three most recent monitoring events. Note the down- and delisting criteria are the same with the exception that there is a longer period of recovery for delisting. To count toward achieving this criterion, existing, introduced, or re-introduced populations that are used to evaluate this criterion may be augmented for the first 10 years to achieve population and subpopulation numbers. To show that populations are viable, no augmentation can occur within populations being evaluated under this criterion in the last 20 years of the 30-year period for populations considered as contributing to possible delisting (USFWS, 2023).

2. All of the populations referenced in delisting criteria #1 above must have documented natural recruitment that is greater than or equal to documented plant loss during three or more monitoring events (every 1 to 3 years) of the 30-year period (USFWS, 2023)

3. A collection of seed representing the geographical, morphological, and genetic diversity of beardless chinchweed is regularly collected following Center for Plant Conservation guidelines (2019, p. 1-14) during the period of recovery and maintained in at least two Center for Plant Conservation partner botanical or seed storage institutions for conservation purposes (USFWS, 2023)

4. A living collection of plants representing the geographical, morphological, and genetic diversity of beardless chinchweed and following Center for Plant Conservation guidelines (2019, p. 3-13) is established within 10 years of the finalization of this recovery plan and is maintained in perpetuity in at least two botanical institutions for educational and conservation purposes (USFWS, 2023)

5. The land within a 500-meter radius surrounding at least six populations supports ≥80 percent cover of native plant species. The land within a 1,000-meter radius surrounding an additional five populations supports ≥65 percent cover of native plant species. The land within a 1,000-meter radius surrounding the remaining at least four populations support ≥ 50 percent cover of native plant species (USFWS, 2023).

6. To ensure the continued existence of beardless chinchweed and to help meet populationbased delisting criterion #1, conservation and management plans address the threat of desert grassland, oak savanna, and oak woodland habitat loss and degradation and the direct threats to beardless chinchweed and their pollinators. Specifically, the following must be met, as further quantitatively described in the 2023 Beardless Chinchweed Recovery Implementation Strategy: a. In areas supporting beardless chinchweed populations, land management and site-specific plans are developed and fully implemented, such that over a 30-year period: i. there is further reduction in nonnative vegetation and promotion of native vegetation and a natural fire regime to a level that ensures beardless chinchweed viability is not affected by competition or fires outside the normal fire regime, and that their vigor is not negatively affected (Factors A and E), ii. there is further reduction in beardless chinchweed herbivory by wildlife and grazing by livestock that ensures >90% of branches are intact and with seedheads (Factor C), iii. there is a further reduction in erosion, sedimentation, burial, trampling, and removal of beardless chinchweed and associated native plants caused by border related activity, mining activity, livestock grazing activity, recreation activity, and other activities to a level that ensures beardless chinchweed viability is not affected by these activities and their vigor is not negatively affected (Factor A), and iv. there is further habitat restoration using locally sourced native plants and seed on lands impacted by the before mentioned threats to a level that ensures beardless chinchweed viability is not affected from nonnative plant competition and their vigor is not negatively affected (Factors A and E). b. data on the conservation and management of beardless chinchweed continues to be collected and shared regularly among land managers and researchers (USFWS, 2023).

Conservation Measures and Best Management Practices:

-

Additional Threshold Information:

-
-

References

USFWS. 2021. Endangered and Threatened Wildlife and Plants

Endangered Status for the Beardless Chinchweed and Designation of Critical Habitat. Final Rule. FR Vol. 86, No. 113 Pages 31830-31868.

USFWS. 2023. Beardless Chinchweed (Pectis imberbis) Final Recovery Plan. Southwest Region, Albuquerque, NM, USA. 37 pp.

SPECIES ACCOUNT: *Pedicularis furbishiae* (Furbish lousewort)

Species Taxonomic and Listing Information

Listing Status: Endangered; Northeast Region (R5) (USFWS, 2015). Reclassified to Threatened June 9, 2023.

Physical Description

A perennial herb in the Scrophulariaceae (snapdragon family) that produces 1 or more flowering stems, up to 1 m tall, from a basal rosette of leaves. Leaves are deeply divided and have toothed edges. Yellow, 2-lipped flowers bloom in a spike at the top of the flowering stalk from mid-July to late-August. (NatureServe, 2015)

Taxonomy

The genus Pedicularis contains over 600 species, most of which are common in tundra, alpine, and subalpine floras in Asia, Europe and North America (Robart et al. 2015, p. 229). The center of Pedicularis species diversity is in the northern Himalayas, China, and Siberia. The Furbish's lousewort has the most restricted distribution of any species of the genus Pedicularis (Gawler 1983, p. 28). The Furbish's lousewort (Pedicularis furbishiae Sereno Watson 1882) is a member of the broomrape family, Orobanchanceae (formerly from the snapdragon family Scrophulariaceae)(Olmstead et al. 2001). The taxonomic identity of the Furbish's lousewort as a distinct species is unquestioned, but its taxonomic position within the genus Pedicularis is not certain (Macior pers. comm. in Stirrett 1980, p. 21) and has been a topic of considerable conjecture and discussion (Gawler 1983, pp. 28-29, Robart et al. 2015, p. 253). Dr. Peter Nelson at the University of Maine at Fort Kent and Rick Ree at the Field Museum in Chicago are continuing genetic research to identify the "sister species" and document the unique phylogeny of the Furbish lousewort. Dr. Nelson has collected samples at numerous subpopulations in Maine and New Brunswick to evaluate the genetic structure and variation within the Furbish's lousewort metapopulation. Similar to the electrophoretic genetic results published by Waller et al. (1987, entire), preliminary results indicate low genetic variability in the Furbish's lousewort population (P. Nelson email November 11, 2017). Additional results will be available in 2018. (USFWS, 2018)

Historical Range

See current range/distribution.

Current Range

Endemic to the Saint John River Valley of northern Maine and adjacent New Brunswick. The entire range of Pedicularis furbishiae covers 225 km of the St. John River, extending from a point 1.5 miles upriver of the confluence with the Big Black River in Aroostook County, Maine to the town of Andover, New Brunswick in Canada. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (outcrossing) and asexual (USFWS, 1991)

Dependency on Other Individuals or Species

Adult: Bombus vagans, a common bumblebee which also forages on other co-flowering species such as red clover, is the exclusive pollinator of Pedicularis furbishiae (Macior 1978a). (USFWS, 1991)

Breeding Season

Adult: July to August (USFWS, 1991)

Reproduction Narrative

Adult: Pedicularis furbishiae is a herbaceous perennial which takes several years to reach sexual maturity. Reproduction is solely by seed. Louseworts flower from mid-July to mid- August, with seeds dispersing in early September. Recent experiments (Waller et al. 1988) have shown that selfed and outcrossed flowers are equally successful at setting capsules, contradicting Macior's (1978) conclusion that Pedicularis furbishiae is self-incompatible. The success of capsule maturation varies widely among populations and years. On average an inflorescence will produce 7—17 capsules, each averaging 25 seeds (Menges et al. 1985, 1986; Gawler et al. 1986). (USFWS, 1991)

Habitat Type

Adult: Palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Herbaceous wetland, riparian, scrub-scrub wetland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: High soil moisture; flooding is essential for habitat (USFWS, 1991)

Geographic or Habitat Restraints or Barriers

Adult: Ice scouring and succession can limit habitat; low vegetative cover (USFWS, 1991)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 1991)

Habitat Narrative

Adult: This species inhabits the riverbanks of the Saint John River, mostly in the steep, highly diverse shrub- or forb-dominated zone between open river cobbles and boreal forest. The habitat is notable for the high frequency and the severity of disturbance by ice scour and vertical river bank slumping. (The Saint John River drains one of the largest watersheds in the northeast, yet it has relatively little headwater storage, making it subject to dramatic seasonal and longer-term fluctuations in water level and to severe ice-jams.) The zone in which Pedicularis furbishiae occurs bears the brunt of regular ice scouring - tree establishment does not occur here and

vegetation cover tends to be moderate. Plants grow on glacial lacustrine or till deposits. (NatureServe, 2015) Pedicularis furbishiae is a fugitive species, succeeding in early— to mid—successional vegetation, and relying on disturbance to open up new areas for colonization. The growth rate of a lousewort population depends largely on site characteristics, principally soil moisture and time since disturbance. Excluding effects of succession, populations on saturated soils grow most rapidly, those on moist soils grow moderately fast, and those on dry soils grow slowly or even decline (Gawler 1988). (USFWS, 1991; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds appear to be dispersed by wind and water (Waller et al. 1988).

Population Information and Trends

Population Trends:

Long-term trends suggest declines of 30 to 50%, whereas short-term trends indicate declines of 10 to 30% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Resiliency:

Narrow endemic species with only two small populations and limited geographical ranges. Count data from surveys over almost two decades indicate both are declining 9-12% annually. Occupancy of shoals has declined in the Conasauga, and fish in both systems have been extirpated or greatly reduced in abundance in the lower reaches of the historic range. Resiliency = low to very low (USFWS, 2018).

Representation:

Two declining populations genetically-isolated by Lake Allatoona. Representation = Low to Moderate (USFWS, 2018).

Redundancy:

Only two populations are known historically, and neither appears resilient to stochastic or catastrophic events and/or to current anthropogenic stressors. Redundancy = low (USFWS, 2018).

Number of Populations:

20 subpopulations distributed across 140 river-miles (USFWS, 2019)

Population Size:

~2397 (USFWS, 2018)

Adaptability:

Low (inferred from USFWS, 1991)

Additional Population-level Information:

All subpopulations at or near lowest recorded numbers since 1980. Two subpopulations good condition, 2 subpopulations fair/good, 3 subpopulations fair, and 8 subpopulations poor condition. Six upriver subpopulations maintaining resiliency and redundancy. Fourteen downriver populations losing resiliency and redundancy; absent from 6 subpopulations. Largest contiguous habitats upriver; smallest, fragmented, eroded habitats downriver. One upriver subpopulation partially protected. One downriver subpopulation partially protected and one New Brunswick site protected. Habitat degradation (erosion, poor riparian buffer) greatest in downriver habitats. (USFWS, 2018)

Population Narrative:

Although Furbish's Lousewort is adapted to this highly dynamic riparian habitat, the species is vulnerable to high degrees of the annual ice scouring and flooding. Little genetic variability has been detected in this species. Populations of Furbish's Lousewort have declined since historic times. Long-term population trends suggest declines of 30 to 50%, whereas short-term trends indicate declines of 10 to 30%. The number of stems fluctuate widely with varying hydrological or environmental changes but in Maine have ranged from over 6000 plants to just over 2000 plants over a 25-year period. In New Brunswick the numbers of plants have ranged from 68 to over 1000 plants. Two element occurrences (one historic & one extant) are known in New Brunswick, whereas it is estimated that about three or four extant EOs occur in Maine. Lousewort populations are notoriously difficult to delineate, because the linearity and dynamism of the habitat dictate that populations are rarely discrete units. (NatureServe, 2015)

Threats and Stressors

Stressor: Alterations in hydrology (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: The cycle of intermittent disturbance by floods is crucial to the survival of the species. Damming free—flowing waters of the St. John would not only inundate some populations, but would affect all populations by preventing the ice scour and floods which now shape riverbank vegetation. New Brunswick Power is still pursuing possible modification of the existing dam at Grand Falls, New Brunswick as well as the creation of an additional hydropower facility near Morrill, New Brunswick. Potential and known populations in Canada and the United States from Madawaska to Hamlin would be eliminated by implementation of these projects. (USFWS, 1991)

Stressor: Land use (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Aside from the continuing, albeit muffled, potential for dam construction on the St. John, widespread effects on lousewort populations resulting from changing land uses along the river as well as from increased river flows are the major concern at this time. changes in land use on the banks of the St. John River have occurred through the clearing of vegetation, especially trees, for individual houselots, views, and agricultural fields. The removal of trees to the river’s edge eliminates shade conducive to lousewort growth and reproduction, while the subdivision of the riverbank into residential and commercial building lots increases the difficulty of implementing conservation strategies. These land use practices within the St. John River

watershed appear to affect Furbish lousewort habitat and populations. (USFWS, 1991)

Stressor: Increased runoff (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: In addition, there is evidence that the spring flows of the St. John River have been increasing since the 1940's (Menges and Gawler 1986), possibly due to excess runoff. Increased runoff (Gawler and Menges 1984), perhaps caused by accelerated timber harvesting within the watershed, may exacerbate the disturbance impacts to lousewort habitat. For instance, deforested areas can reduce the water retention capability of the watershed; increased river flows and resultant bank slumping may then eliminate habitat and populations at an artificially high rate. (USFWS, 1991)

Stressor: Habitat alteration (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: More localized activities such as direct habitat alteration and the burial of individual plants by the dumping of refuse and slash continue to be minor threats to particular lousewort populations. Causes of habitat degradation associated with shorefront developing include dumping of refuse, slash, and fill; motorized vehicles, vegetation clearing, ATV use along the river bank, personal boat access, and impermeable surfaces that focus runoff. (USFWS, 1991; USFWS, 2007)

Stressor: All-terrain vehicles (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Impacts from all—terrain vehicle traffic and bank use by recreationists may become threats as these activities increase in the area. (USFWS, 1991)

Stressor: Residential development (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The conversion of farms for residential development, which alters the riparian forest or riverbank vegetation, is an increasing conservation concern. (USFWS, 2007)

Stressor: Invasive species (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Competition for invasive species is a threat to the unique riverbank ecosystem in the lower river segments. Phragmites, Japanese knotweed, non-native grasses, and purple loosestrife have all been documented in lousewort habitat. These invasive plant species are linked to human activities such as riverbank clearing, trails, and mowing, and spread of invasive species is one consequence of shorefront development. (USFWS, 2007)

Stressor: Forest management (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Forest management in the watershed could increase siltation and run-off (Menges and Gawler 1986). (USFWS, 2007)

Stressor: Climate change (USFWS, 2007; USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change is expected to affect the ice regime of northern rivers, including the St. John, by increasing the frequency of severe ice-scour events and patterns os spring ice breakup (Beltaos 1997, Beltaos and Prowse 2001). Beltaos (1999) did a hydroclimatic analysis for the upper St. John River using long-term climate and flow records and documented that a small rise in winter air temperatures over the past 80 years has already resulted in a substantial increase in the number of mild winter days and the amount of winter rainfall- previous rare occurrences in this region. These two factors have augmented river flows, causing increased breakup of ice cover and flow peaks in late winter and the frequency of spring ice jams and flooding. (USFWS, 2007); The Furbish's lousewort is identified as one of Maine's plant species most vulnerable to climate change (Jacobson et al. 2009, p. 33). The species depends on periodic disturbance of the riverbank from ice scour; not too frequent or too infrequent and not too severe (section 2.4). Climate change is expected to affect the ice regime of northern rivers, including the St. John, by increasing the frequency and severity of severe ice-scour and flood events (Beltaos 1997, entire; Beltaos and Prowse 2001, entire; Beltaos and Prowse 2009, entire). In summary, there is evidence suggesting that climate change is indirectly affecting the ice dynamics of the St. John River and these factors have the potential to increase the severity of the spring breakup and increased severity of flooding (Beltaos 2002, entire).We will evaluate climate change as a stressor further in our assessment of future scenarios. (USFWS, 2018)

Stressor: Increased frequency of ice jam events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The increased frequency of ice jam events is a particular concern. The frequency of flooding events on the St. John River has increased since the 1940s (Menges and Gawler 1986). Lousewort biology suggests that a disturbance interval of less than 6 to 10 years would interfere with maturation and seed production (Menges 1990). (USFWS, 2007)

Stressor: Development (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Changes in land use on the banks of the St. John River in downriver areas have occurred through the clearing of vegetation, especially trees, for agriculture, individual house lots, roads, and river views. These land use changes within the St. John River valley may have negatively affected some of Furbish's lousewort subpopulations' habitat through removal or

reduction of the forested riparian buffer and subsequent loss of shade critical to lousewort growth and reproduction. Areas cleared of forest and impermeable surfaces associated with development have led to erosion and subsidence of the unconsolidated glacial till soils, and caused slumping and erosion of Furbish's lousewort habitat. We will evaluate development as a stressor further in our assessment of future scenarios. (USFWS, 2018)

Recovery

Reclassification Criteria:
In light of the recommendation to reclassify the Furbish's lousewort as threatened, downlisting criteria in the 1991 Recovery Plan (USFWS 1991) are now obsolete. (USFWS, 2019)

Delisting Criteria:
Criterion 1. The metapopulation is viable, comprising a 30-year median of 4,400 flowering stems or greater, and distributed as follows: Upriver: a 30-year median of2,800 flowering stems or greater in at least 6 subpopulations with at least 3 good and 3 fair subpopulations; Downriver: a 30-year median of 1,600 flowering stems or greater in at least 9 subpopulations with at least 3 good and 6 fair subpopulations. Once the upriver and downriver criteria are reached, the median number of flowering stems for each respective river section will remain stable or increase over a period of at least 30 years (three generations) without augmentation, reintroduction, or hand pollinating of plants. Additionally, in New Brunswick there is a 30-year median of 1,100 plants distributed among at least 5 subpopulations (Resiliency and Redundancy). (USFWS, 2019)

Criterion 2. There is long-term habitat protection for all subpopulations in Maine that provides for the species' needs throughout its life cycle. Long-term habitat protection mechanisms must assure important species' needs: forest overstory shade conditions (about SO-percent sunlight) by protecting or restoring a forested riparian buffer of 250 feet adjacent to suitable habitat; moist soil conditions and seeps by limiting further shoreline erosion and bank slumping, and restoring suitable habitat where it has been damaged from past events; native vegetation that newly germinated Furbish's lousewort plants can parasitize; site conditions without excessive plant competition, especially from tall shrubs and robust herbs; populations of the half-black bumble bee sufficient to assure pollination and subsequent seed production. (USFWS, 2019)

Recovery Actions:
- I. Monitor the Furbish's lousewort population and demographics and periodically assess the status of the bumble bee pollinator to document trends. (USFWS, 2019)
- 2. Improve the health and viability of extant subpopulations and restore extirpated subpopulations throughout the historical range. (USFWS, 2019)
- 3. Achieve long-term habitat protection for each subpopulation. (USFWS, 2019)
- 4. Conduct scientific investigations to improve understanding of stressors, viability, propagation, restoration, and genetic needs. (USFWS, 2019)
- 5. Periodically review progress toward achieving recovery criteria and employ strategic conservation and adaptive management to address threats. (USFWS, 2019)
- Contingency recovery strategies will be implemented if the metapopulation in Maine falls below 1,200 flowering stems OR if there are 4 or fewer upriver subpopulations OR if there are 2 or fewer downriver subpopulations OR if seed production is not sufficient to achieve a

stable or increasing metaoooulation. (USFWS, 2019)

- 6. Establish new subpopulations in unoccupied areas having suitable habitat. (USFWS, 2019)
- 7. Store seeds and establish captive populations. (USFWS, 2019)
- 8. Enhance seed production. (USFWS, 2019)
- 9. Work with Canadian partners to implement strategies that prevent extinction. (USFWS, 2019)
- To be considered for delisting in the near future, the Service needs specific information on: 1) the degree of threat from residential development in river segments 2, 3, and 4; 2) the degree of threat from climate change and severe ice jams and flooding; and 3) population viability in the context of a dynamic environment. (USFWS, 2007)
- New recovery criteria should be developed based on current information on population viability and responses to habitat perturbations, specifically related to improving municipal shoreland zoning, addressing habitat restoration caused by catastrophic ice scour events, and controlling invasive species. (USFWS, 2007)
- Efforts to protect lousewort habitat in the lower river reaches should be emphasized. (USFWS, 2007)

Conservation Measures and Best Management Practices:

- USFWS. 2019a. Furbish's lousewort (Pedicularis furbishiae). 5-Year Review. U.S. Fish and Wildlife Service. Maine Field Office. East Orland, Maine. 6 pp.

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Reclassifying Furbish's Lousewort (Pedicularis furbishiae) From Endangered to Threatened Status With a Section 4(d) Rule.

USFWS. 2018. Species status assessment for the Furbish's lousewort (Pedicularis furbishiae).Version 1.1. Maine Field Office, East Orland, Maine. 59 pages + 3 appendices.

USFWS. 1991. Furbish Lousewort (Pedicularis furbishiae) Revised Recovery Plan. New England Field Office, Concord, New Hampshire

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USFWS. 2007. Furbish's lousewort (Pedicularis furbishieae) Five-Year Review: Summary and Evaluation. Maine Field Office, Old Town, Maine

USFWS. 2019. Recovery plan for the Furbish's lousewort (Pedicularis furbishiae). Second Revision. September, 2019. U.S. Fish and Wildlife Service, North Atlantic - Appalachian Region, Hadley, Massachusetts. 14 pages.

Recommendations for Future Actions: Continue to monitor the subpopulations of the species and document population trends. Maintain current long-term habitat protections for subpopulations in Maine. Work with Maine landowners and municipalities to develop conservation easements or fee title opportunities to protect additional subpopulations. Continue to evaluate the effects of climate change and development. (USFWS, 2019)

SPECIES ACCOUNT: *Pediocactus (=Echinocactus,=Utahia) sileri* (Siler pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/26/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Siler pincushion cactus is a small, solitary or occasionally clustered, globose cactus about 10 cm (4 in) tall and 7.5-10 cm in diameter. Each areole contains 3-7 brownish-black straight or slightly curved central spines, becoming pale gray or nearly white with age. There are, in addition, 11-16 whitish radial spines per areole. The central spines are about 2.5 cm long, the radials slightly less. Flowers are about 2.5 cm in diameter, with yellowish marginally scarious petals with maroon veins. Fruits are greenish-yellow, somewhat enlarged upwards, with scales toward the top. They are dry at maturity; seeds are gray. (USFWS, 1986)

Taxonomy

This species has been through several nomenclatural changes and has two recognized synonyms: Echinocactus sileri and Utahia sileri. This species was originally described as a species of Echinocactus (Coulter 1896), and was later placed in the genus Utahia by Britton and Rose (1922). Lyman Benson combined into the genus Pediocactus various species that formerly had been placed in six different genera due to their diversity in spination, body proportion, and flower color. This combination includes P. sileri. (USFWS, 1986)

Historical Range

See current range.

Current Range

The geographic range of Siler pincushion cactus extends from southeast of Fredonia, extreme northwestern Coconino County, Arizona, west for about 70 air miles in north-central Mohave County, Arizona. It also includes about 3 miles of southern Utah in Washington and Kane Counties (USFWS, 2008).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Blooms April-mid May. (USFWS, 1986)

Reproduction Narrative

Adult: Little variation exists within populations. These populations can be separated by distances of several miles even when there is suitable habitat. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced

in June to fall. This dispersal strategy may be disadvantageous for the genus, however, populations in the genus when left undisturbed seem to be healthy with all age classes represented (Heil et al. 1981). Flowers bloom from April to May. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, forest/woodland, grassland/herbaceous, woodland- conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Elevations between 2,800 and 5,400 ft (USFWS, 2008)

Spatial Arrangements of the Population

Adult: Solitary or occasionally clustered (USFWS, 1986).

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Habitat Narrative

Adult: Siler pincushion cactus grows on gypsiferous clay and sandy soils derived from the Moenkopi Formation. The majority of the plants are associated with the Shnabkaib Member of this particular formation. The Shnabkaib Member is composed of 65 percent siltstone, 25 percent gypsum, and 10 percent limestone and dolomite (Stewart et al. 1972). Siler pincushion cacti are also found scattered on the Middle Red Member of the formation, which is a reddish siltstone with thin to thick layers of gypsum. The cacti are found growing on elevations between 2,800 and 5,400 feet, in the Great Basin Desert Shrub community (USFWS, 2008).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Members of Pediocactus produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. (NatureServe, 2015)

Population Information and Trends

Species Trends:

Short-term trends indicate declines of 10-30% (NatureServe, 2015)

Number of Populations:

~ 25 NatureServe, 2015)

Population Size:

~10,000 or more individuals (USFWS, 2008)

Population Narrative:

Short-term population trends indicate declines of 10-30%. Several 100, possibly 10,000 or even more plants. In 2006, BLM estimated there were over 10,000 individuals (BLM 2006 cited by

USFWS 2008). BLM has documented approximately 22 occurrences in Arizona, and populations in the Kanab and St. George areas of Utah. In the NatureServe central database, there are approximately 25 extant occurrences (EO data in the NatureServe central database as of August 2013). (NatureServe, 2015)

Threats and Stressors

Stressor: Habitat modification from uranium mining and prospecting (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: From 1980-1985, 81 of 246 uranium mining plans of operations (MPOs) were located in Siler pincushion cactus habitat. Of those, 30 were modified to avoid or minimize impacts to Siler pincushion cactus. Only one of the MPOs occurred in a dense P. sileri area near Atkin Well; no cacti were damaged as a result of the drilling. The Service does not know how much Siler pincushion cactus habitat was affected or modified by these activities. The BLM reports that since 1990, there has been no uranium mining and very little gypsum exploration. The 2005-2006 resurgence in uranium mining was limited to Kaibab limestone near uranium mines that were already active since the 1980s and 1990s.In the Draft Environmental Impact Statement (DEIS), there is a map of uranium resource potential (U.S. Department of Interior 2005). There are two areas characterized on the map: 1) Sandstone uranium (SSU) high potential, abundant direct evidence, and 2) breccia pipe uranium (BPU) high potential, abundant direct evidence. All areas known to support Siler pincushion habitat are within these units. Based on this information, there is still potential for Siler pincushion plants and their habitat to be negatively affected by new uranium mining claims. (USFWS, 2008)

Stressor: Habitat modification from oil and gas leases (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: In the DEIS for the revised RMP, BLM states that known oil and gas reserves within the Planning Area are not significant and no economic occurrences of gas or oil have been encountered to date (U.S. Department of Interior 2005). The BLM rated oil and gas potential within the Planning Area; areas in the north central and extreme western portions were rated as moderate potential. Good potential was assigned to the Shnabkaib Member of the Moenkopi Formation, which corresponds to the geologic formation that supports habitat for Siler pincushion cactus. Although we do not consider oil and gas production to be a threat at this time, the Service cannot rule it out as a future threat due to the increasing interest in domestic sources of oil production. All areas that are mapped as having moderate potential for oil and gas are within Siler pincushion habitat. (USFWS, 2008)

Stressor: Habitat modification from gypsum mining (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: In the 2005 DEIS, BLM states that within the Planning Area potentially favorable areas for the occurrence of gypsum include sabkha environments associated with marine regressions in Permian and Triassic-aged rocks (U.S. Department of Interior 2005). Large gypsum deposits

occur in the northwestern portion of the Planning Area, associated with the Harrisburg Member of the Kaibab Formation (does not support Siler pincushion cactus) and the Moenkopi Formation. Again, the entire area beneath Siler pincushion habitat is classified as high gypsum potential, with abundant direct evidence. According to the BLM (2006), gypsum deposits within areas supporting Siler pincushion cactus were considered non-economically viable, at least in the 1980's when the mineral feasibility report was completed. While the Service does not consider gypsum mining a threat at this time, given the rapidly changing market for saleable minerals, the Service cannot rule it out as a future threat for Siler pincushion. (USFWS, 2008)

Stressor: Off-highway vehicles (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: This type of use has killed tagged Siler pincushion cactus within the Warner Ridge plot (Utah). The threat from OHV activity is very high in this area due to the proximity of St. George, which is experiencing rapid urban growth. There is increased use of open space around the city for recreational activities. The BLM (Dixie Resource Area) (1999) and the Arizona Strip RMPs established the Fort Pierce and Warner Ridge areas as Areas of Critical Environmental Concern (ACEC). The areas are closed to OHV use and are signed. The areas are patrolled regularly and on peak high-use weekends. The Warner Ridge ACEC is 4,281 acres in size and 1,790 acres are fenced. (USFWS, 2008)

Stressor: Livestock trampling (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Siler pincushion cacti can be trampled by livestock. A total of five Siler pincushion cacti mortalities attributable to livestock trampling were documented in all of the BLM monitoring plots for years 1986-2006. This number is small in comparison to the 258 and 322 mortalities attributed to rodent herbivory and natural causes (likely drought related), respectively. The highest mortality from livestock trampling (3) occurred in the Atkins Well grazed plot; the plot is located near a water tank, which typically receives high use. The Service assumes that additional plants are trampled outside of the monitoring plots, because almost all of Siler pincushion habitat is within grazing allotments. However, the Service suspects that the numbers trampled are small. (USFWS, 2008)

Stressor: Water pipeline (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: FWS has recently become involved with a permit request from the Utah Board of Water Resources to the Federal Energy Regulatory Commission (FERC) to construct a water pipeline from Lake Powell to St. George. This proposed pipeline plan is in the preliminary stages of development, and there are 3 alignments being considered at this time. One of the alignments would cross through the northern portion of BLM land on the Arizona Strip, which would go through Siler pincushion cactus habitat. Preliminary engineering studies were started in the summer of 2007, and by summer 2009, a completed license application will be submitted to FERC. Under the current timeline, construction would begin in 2013. The project will require

section 7 consultation with FWS, but the effects to Siler pincushion cactus and its habitat could be substantial, depending on which alignment is chosen. In addition, the assured water supply to St. George may contribute to increasing development in the general area, which would likely affect Siler pincushion cactus and its habitat near St. George. (USFWS, 2008)

Stressor: Herbivory and insect predation (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Herbivory and insect predation on Siler pincushion cacti are addressed in the HMP under "Natural Factors". Herbivory and insect predation result in death to individual cacti. Actions taken or recommended were the construction of raptor perches near dense populations of Siler pincushion cacti in order to reduce rodent herbivory and continued monitoring of the species. There were no actions described for reducing or eliminating insect predation. There have been observations of insect predation on Siler pincushion cactus. The BLM (2006) report indicates that insect larvae hollow out plants, resulting in cacti death. There are six species of Moneilema beetles recognized in North America, which were thought to be specialists on Opuntia spp. However, recent observations indicate the genus predates other cacti species as well. The Opuntia borer beetle (Moneilema semipunctatum) has been observed feeding on and killing the endangered Wright fishhook cactus (Sclerocactus wrightiae) in south central Utah (Kass 2001), and the threatened Mesa Verde cactus (Sclerocactus mesa-verdae) in New Mexico and Colorado (Smith 2001). Adult beetles feed on cacti and females lay eggs near the base of the plant. Once hatched, larvae tunnel into the plant, often causing death of the infested plant. Moneilema corrugans (no common name) has been known to kill the threatened Cochise pincushion cactus (Coryphantha robbinsorum) in southeastern Arizona (Zimmerman 1985). Additional research needs to be done to identify insects that infest Siler pincushion cactus and determine effects that insects have on cacti population dynamics. Insect infestations may be correlated with drought cycles; additional work is needed to examine if there is a relationship. The majority of mortalities (over 98 percent) observed in BLM monitoring plots were attributed to natural causes (likely drought), mammal herbivory, and insect predation. (USFWS, 2008)

Stressor: Drought (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Ongoing drought, which has been in place in much of the southwest since the late 1990's, has affected Siler pincushion cactus populations. Increased mortality and reduced or non-existent germination and recruitment have been observed on the monitoring plots. Other populations in Utah seem to have disappeared, likely due to drought. There are no recovery criteria that address this threat. The only action called for in the HMP is continued monitoring on BLM lands to quantify the effect. There are no actions to minimize or alleviate this threat to Siler pincushion cacti populations outside of BLM lands. (USFWS, 2008)

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: Periods of drought in the southwest are not uncommon. But, the frequency and duration of droughts may be altered by climate change. Global warming, and associated effects on regional climatic regimes, is not well understood, but weather predictions for the southwestern United States include less overall precipitation and longer periods of drought. Seager et al. (2007) predict, based on broad consensus among 19 climate models, that the southwest will dry in the 21st century and that this drier climate change is already occurring. Increased aridity associated with the current on-going drought and the 1950's drought will become the norm for the American southwest within a timeframe of years to decades if the models are correct. The 2007 Intergovernmental Panel on Climate Change (IPCC) report outlines several scenarios that are virtually certain or very likely to occur in the 21st century. These are: 1) over most land, there will be warmer and fewer cold days and nights, and warmer and more frequent hot days and nights, 2) areas affected by drought will increase, and 3) the frequency of warm spells/heat waves over most land areas will likely increase. The IPPC makes equally sobering predictions for ecosystems; the resilience of many ecosystems is likely to be exceeded this century by an unprecedented combination of climate change, associated disturbances (e.g. flooding, drought, wildfire, insects), and other global drivers (IPPC 2007). With medium confidence, IPPC predicts that approximately 20-30% of plant and animal species assessed so far are likely to be at an increased risk of extinction if increases in global average temperature exceed 1.5 – 2.5ºC (IPPC 2007). Almost certainly this species, along with its habitat, will be affected in some manner by climate change; the magnitude and extent of the change cannot be quantified at this time. (USFWS, 2008)

Recovery

Reclassification Criteria:
Not applicable; species was downlisted to Threatened status in 1993 (USFWS, 2008).

Delisting Criteria:
1. All known populations are maintained at a level that demonstrates stable or increasing plant abundance and maintain the current distribution of locations within each population. Plant abundance (measured by the number of plants) may fluctuate within locations and populations, but the defined populations should be stable or increasing over a consecutive 15-year period. (USFWS, 2019)

2. Ensure no more than two percent of the suitable gypsiferous and calcareous clay soil habitat (as defined in the Recovery Plan and final rule to reclassify the species: 58 FR 68476) within each of the populations is disturbed over a 15-year period. This disturbance will result in short-term modification of no more than 2,671 hectares (6,600 acres) rangewide and be of short-term duration such that habitat restoration is achievable, including the formation of biological crusts. (USFWS, 2019)

Recovery Actions:
- The development and implementation of habitat management plans that alleviate the threats of collecting and habitat modification. (USFWS, 1986)
- The enforcement of existing regulations on collecting and trade. (USFWS, 1986)
- The study of population biology to develop the understanding needed to sustain healthy populations in their natural habitat. (USFWS, 1986)

- The development of public awareness, appreciation and support for preservation of the Siler pincushion cactus. (USFWS, 1986)
- The 1986 Recovery Plan should be updated. The recovery criteria need to be measurable and threats based. In addition, the BLM has better maps and location information that should be in the Plan. (USFWS, 2008)
- Assistance (technical and monetary) should be provided to the Kaibab Pauite Indian Tribe to conduct surveys and develop conservation measures for Siler pincushion cactus on their lands. (USFWS, 2008)
- The BLM monitoring protocol should be revised in order to quantify seedling survivorship. Random plots/transects should be used in order to make estimates for the population as a whole. (USFWS, 2008)
- The Siler pincushion cactus population in Utah should be monitored on a regular basis, especially to quantify and address threats from climate change related drought. An adaptive management plan should be developed to address this issue. (USFWS, 2008)
- The BLM should pursue mineral withdrawals on the established ACECs or in the areas that support dense concentrations of Siler pincushion cactus. (USFWS, 2008)
- The BLM should close areas that support dense concentrations of Siler pincushion cactus to off-road vehicle use. (USFWS, 2008)
- Research to examine insect predators on Siler pincushion cactus should be conducted. (USFWS, 2008)
- Recovery Criteria The Service downlisted Siler pincushion cactus to threatened on December 27, 1993, and an explanation of how reclassification criteria were met can be found in the final reclassification rule (58 FR 68476). We will not be carrying forward any of the original downlisting criteria identified in the original Recovery Plan due to the 1993 reclassification of the species. Current recovery criteria The prime objective is to manage the essential habitat of Pediocactus sileri so that populations can be sustained in their natural habitat. Actions identified as necessary for meeting the prime objective and for delisting include: 1. Demonstrated long-term stability (or increase) in population levels and habitat through monitoring studies. 2. Suitability of downlisting actions demonstrated; plant stabilized in its habitat. 3. Continued assurance of no mining or new claims in known habitat. 4. Implementation of actions identified in Habitat Management Plan. (USFWS, 2019)

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USFWS. 2019. Recovery Plan Amendments for 20 Southwest Species.

SPECIES ACCOUNT: *Pediocactus bradyi* (Brady pincushion cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/26/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Pediocactus bradyi is a small, semiglobose cactus with single stems (although rare, 2 to 4), 3.2 to 6.2 cm long and 2.6 to 4 cm in diameter. The spines are dense (typically no central spine) with each elliptic areole (white or yellow-villous) numbering 13 to 16 radial spines, 3 to 5 mm long (white or yellowish tan). The straw-yellow flowers are 2 cm long and 1.5 cm in diameter and its smooth green fruit (7 to 10 mm long and 10 mm diameter) turns reddish-brown at maturity. The fruit is top-shaped and constricted at the base, the apex slightly convex, dehiscing by a vertical slit. Seeds are brownish black, 2.8 mm long and 1.7-2.0 mm wide (Heil and Porter 2001). (USFWS, 2012)

Taxonomy

In 1961-1962, Lyman Benson combined into the genus Pediocactus (including p. bradyi) species that formerly were distributed over six different genera due to their great diversity in spination, body proportions, and flower color. Benson recognized an overriding similarity; the structure and method of dehiscence of the fruits (dry at maturity and dehiscent usually both by a dorsal slit and by a ring around the circumscissile apex), as well as several other common characteristics (Benson 1962c). Pediocactus bradyi can readily be distinguished from its closest relative, p. winkleri, by the latter's peach-colored flowers and fewer spines (mostly g-11). Also, the radial spines of p. winkleri are less pectinate than those of p. bradyi. (USFWS, 1985)

Current Range

Restricted to a specific and limited limestone soil type and known only from Coconino County, in northern Arizona, along Marble Canyon. The species' range comprises an area approximately 23 kilometers (km) in length, north to south, and varies in width from 1.6 km to 4.58 km (USFWS 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015)

Lifespan

Adult: 10-20 years (USFWS, 2012)

Breeding Season

Adult: March to April (USFWS, 2012)

Reproduction Narrative

Adult: Little variation exists within populations. These populations can be separated by distances of several miles even when there is suitable habitat. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced in June to fall. This dispersal strategy may be disadvantageous for the species, however, populations in the genus when left undisturbed seem to be healthy with all age classes represented (Heil et al. 1981). P. bradyi breeding system as cross-pollinated and self-incompatible. Tepedino (2000) also found the cactus to be insect-pollinated, and sweat bees (Dialictus spp.) were observed to be the primary pollinators. Vegetative reproduction has not been documented in literature reviewed. If the conditions are favorable the cacti will flower typically between March and April (Spence 2008). The longevity of P. bradyi was not clearly understood in 1985. Information provided in the Recovery Plan indicates the cactus has a lifespan of 10 to 15 years (USFWS 1985). Spence (2008) describes the species as long-lived and suggests recruitment occurs perhaps once every 10 to 20 years. Roth estimates the cactus may live approximately 20 years. Long-lived and exhibits relatively low fecundity, which would increase the potential for a genetic bottleneck in conjunction with its isolated and restricted distribution (USFWS, 2012; NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers exposed, sunny locations; responds to summer rainfall events by expanding above soil (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 1170 and 1,370 m; vegetation is open and sparse (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Navajoan Desert on benches and terraces made up of Kaibab limestone chips overlying Moenkopi shale and sandstone-derived soils. The plants grow in gravelly alluvium on the gently sloping (0-10") benches, in exposed, sunny situations. The cactus occurs between 1,177 and 1368 meters (m) (3,861 and 4,488 feet [ft]) in elevation, which is the altitude of the Kaibab Formation (USFWS 1985). In the summer and winter months, P. bradyi spends most of its time below ground level covered by loose limestone fragments along the Marble Canyon plateaus of the Colorado River. The cacti typically respond to summer rainfall events by expanding above the soil (Heil et al. 1981). The vegetation where P. bradyi occurs is generally open and sparse, and characterized by low shrubs, grasses, and annuals. Associated plants include shadscale (Atriplex confertifolia), snakeweed (Gutierrezia sarothrae), and Mormon tea (Ephedra viridis). (USFWS, 1985; USFWS, 2012; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Members of Pediocactus produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. (NatureServe, 2015)

Population Information and Trends

Population Trends:

Short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Number of Populations:

8 (NatureServe, 2015)

Population Size:

<2,500 (USFWS, 2012)

Population Narrative:

Long-lived and exhibits relatively low fecundity, which would increase the potential for a genetic bottleneck in conjunction with its isolated and restricted distribution, and limited micro-habitat (USFWS 2012). Navajo Nation populations are typically found in small widely scattered groups of 2 to 15 cacti. In 2004, only one population contained over 100 plants (Roth 2004). Scattered populations throughout its limited range. Short-term population trends indicate a decline of 10-30%. There are approximately 8 extant occurrences in Arizona (EO data in the NatureServe central database as of August 2013). Total population abundance is still unknown. There are less than 2500 individuals (Butterworth and Porter 2013). (USFWS, 2012; NatureServe, 2015). Distribution The cactus occurs only in scattered populations along the rim of Marble Canyon, near Lees Ferry, in northern Arizona on lands administered by the Bureau of Land Management (BLM) and National Park Service (NPS), and on the Navajo Nation. The Arboretum at Flagstaff (Arboretum) conducted surveys to increase understanding of the population and distribution the cactus using 200 randomly selected plots within appropriate soil types that covered the known distribution of the cactus as well as suitable habitat (Haskins and Murray 2017, p. 4). The plots were distributed across BLM and NPS-managed lands (90 plots on BLM, 5 plots on NPS), and 105 plots located on the Navajo Nation. The Arboretum-led study located cacti at 18 of the 200 plots and found 80 occurrences of cacti (724 individuals) outside of survey plots (Haskins and Murray 2017, p.5). Including cacti at the survey plots, they located over 850 individuals, but of more significance, they located new occurrences of the cactus south of its previously known range. The U.S. Geological Survey (USGS) and Arizona Strip District Office of the BLM compiled 22 years' worth of monitoring and demographic data (Shryock et. al. 2014, entire). They tagged and measured 1,049 cacti over the study period, with annual population size ranging from a low of 152 cacti in 1992 to a high of 311 cacti in 2002 (Shryock et al. 2014, p. 1947). The cactus' survivorship was lowest during the first five years of life and after 15 years, with increased survivorship of cacti in between these ages. They found that the median survival age was eight years. Thirty-one cacti survived at least 20 years and 14 cacti were present for the entire length of the study, indicating that some cactus may live longer than 22 years. The growth rate (λ) was below unity (0.961), meaning the population is declining (a stable population is equal to 1 and a growing population is greater than 1). Within plots, the cacti generally occur in small, widely spaced clumps, surrounded by sparse vegetation dominated by low shrubs and grasses.

Vegetation in these occupied areas include shadscale (Atriplex confertifolia), broom snakeweed (Gutierrezia sarothrae), and Indian ricegrass (Achnatherum hymenoides) (Shryock et al. 2014, p. 1945; Haskins and Murray 2017, p. 8). Annual non-native grasses, including invasive species of Bromus spp. and Schismus spp., are also common (Shryock et al. 2014, p. 1945; Haskins and Murray 2017, p. 9). Non-native grasses can reduce native plant diversity and reduce pollinator availability (Aslan 2017, p. 15). Haskins and Murray (2017, p. 5) found some overlap between the cactus and the federally endangered Fickeisen plains cactus (Pediocactus peeblesianus var. fickeiseniae). They observed 28 Fickeisen plains cacti within and nearby their cactus survey plots (USFWS, 2022).

Threats and Stressors

Stressor: Off-highway vehicles (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Several reports discuss the current or potential threat from OHV use on BLM, NPS, and NN lands. Historically, the threat from OHV activity was described by BLM as random and sparse (BLM 1986); Spence (1992) mentions that the most immediate threat at the time was OHV traffic on NPS lands; and since the early 1990s NN has documented unauthorized public vehicles accessed in areas where P. bradyi and its habitat occur (Roth 2008). For BLM, improvements were made through road closures, and monitoring reports (2002, 2004, and 2007) have not documented any recent OHV activity that resulted in effects to P. bradyi (Hughes 2009). For the NPS, the location of P. bradyi near the Lee's Ferry road suggests that the potential for OHV damage could exist; however, there is no current monitoring or documentation of such occurrence. Unauthorized vehicle access to P. bradyi habitat on the NN has been a problem in the past. In 2008, the NDFW installed a low running cable to prevent vehicle access to the area. Provided the cable on the NN is effective and additional road closures on BLM lands remain in place, the Service believes the threat from OHVs to P. bradyi is low and are no longer considered significant. (USFWS, 2012)

Stressor: Uranium mining (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Historically, uranium mining and exploration were considered potential threats due to a number of exploration and mining permits near P. bradyi populations that were submitted for review in the mid-1980s (USFWS 1985). As stated previously, no active uranium mining occurs within P. bradyi habitat and the Secretary of the Interior approved a withdrawal of approximately one million acres of public land surrounding Grand Canyon National Park from mineral entry for 20 years (DOI 2012). No mines will occur in the House Rock Valley and, therefore, will not pose a threat to P. bradyi. Thus, the Service believes uranium mining has become an insignificant threat to the species and is not expected to occur in the foreseeable future. (USFWS, 2012)

Stressor: Livestock grazing (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Historical livestock use, prior to the 1930s, on the BLM's Portion of the Kane Ranch was estimated to have about 3,000 head of cattle until the Grand Canyon Cattle Company became the operators and the herd was increased to 20,000 head. By 1934, the Taylor Grazing Act set into motion public lands grazing regulations (BLM 1999). Currently, management actions such as the 1992 ACEC plan and subsequent 1994 plan, and the Biological Opinion for the Kane Ranch Allotment Management Plan provided actions to protect P. bradyi, including moving livestock waters, closing areas to vehicles, and monitoring to determine livestock trampling effects on the cactus (Hughes 2005). The most recent RMP (BLM 2007) provides management actions for special status plants (including P. bradyi) where disturbance, injury, or mortality of such plants from livestock grazing will be minimized or eliminated through the implementation of conservation measures. As discussed previously in section 2.2.3, livestock trampling transects on the Kane Ranch Allotment (completed in 2001, 2002, and 2003) identified a total of 15 cacti that were stepped on and only 1 of those resulted in mortality (Hughes 2005). Although livestock trampling is possible, BLM recognizes that the occurrence is infrequent to uncommon (BLM 2007). Thus we believe as long as grazing continues where P. bradyi occur, the threat from livestock will remain but the severity of impact is considered low and is not considered to increase in the foreseeable future due to current management practices on BLM lands. As of 1992, the NPS lands were not grazed by cattle, and no sign of livestock activity was seen in the area (Spence 1992). There is no additional information available to suggest that the status of livestock activity in the area has changed to date. Thus the Service believes livestock grazing on NPS lands will continue to be an insignificant threat to P. bradyi. (USFWS, 2012)

Stressor: Collection (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Threats related to collection of P. bradyi were discussed in reports from BLM (HMP 1986), NPS (Spence 1992), and the Recovery Plan (USFWS 1985). Historically collections were considered a serious threat; however, annual monitoring of the cactus indicates collection is rare on BLM and NPS lands (Hughes 2005 and Spence 2008) and Roth (2008) indicates illegal collection appears to be a minor threat on NN lands. Thus the Service believes the threat from collection is low and is no longer considered a significant threat to P. bradyi. (USFWS, 2012)

Stressor: Recreational off-highway vehicles (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Off-road vehicle recreational use has been reduced to a minimum on BLM and NPS lands but NN lands may continue to have violations if the low running cable to deter vehicles in P. bradyi habitat is ineffective. As stated previously, provided the cable on the NN is effective and additional road closures on BLM lands remain in place, the Service believes the threat from OHVs to P. bradyi is low and are no longer considered a significant threat. (USFWS, 2012)

Stressor: Filming crews and movie set locations (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: On the NN, the Navajo Office of Broadcasting Services (Navajo Nation Department of Parks and Recreation [NDFW]) regularly gives out permits for filming along the picturesque rims of Marble Canyon. These permits do not require film crews to clear an area through biological assessments or evaluations. Because of the short timeframe of the filming activities and the remoteness of the habitat, the NDFW may not be aware of all ground-disturbing activities in the habitat of P. bradyi (Daniela Roth, former NN botanist, summary of email communication, July 27, 2010). At this time the Service is not aware of any resolutions or changes in communication between the two departments, and threats from filming crews will likely continue in the future. As stated previously (section 2.2.3) disturbance occurred in 1993 and 1994 from a film crew and in 2001 from a stunt jumper. These ground disturbing activities resulted in mortality and in soil compaction which restricts recovery and seedling recruitment. The Service concludes that recreational and commercial filming activities are having and will continue to have impacts on P. bradyi on the NN. (USFWS, 2012)

Stressor: Predation (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Disease is not mentioned as a new threat; however, there have been instances where predation by rodents has impacted populations during times of drought. Significant mortality attributed to rodents reduced the total population in the North Canyon plot (on BLM lands) from 240 individual cacti in 1989 to 81 in 1990 with an additional 40 cacti removed through predation in 1991. Future interactions with climate could increase the likelihood of predation for the cactus. We believe the potential threat from rodents is significant and is likely to have adverse impacts to populations of P. bradyi in the future, particularly under drought conditions, when other sources of moisture for rodents become scarcer. (USFWS, 2012)

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 C (1.3 F) during the 20th century (IPCC 2007) and, since 1960, the annual average temperature across the United States has increased by more than 2 F (1.1C) (Global Climate Change Impacts in the United States [GCCIUS] 2009). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. Overall effects from climate change to P. bradyi are unknown, but diminished seedling recruitment and overall population numbers described above could be exacerbated by recent temperature increases and precipitation decreases. Depending on the specialization of the native bee pollinators of this cactus, changes in climate could alter the blooming and foraging phenologies between the cactus and its insect pollinators, leading to changes in pollination occurrence and efficiency, and ultimately, impacts to sexual reproduction. Interactions among population demographics should be monitored in conjunction with climate changes to understand and track the status of this cactus. Although the effects of climate change are not

clearly understood at this time, the Service believes the impacts to the populations of P. bradyi could be severe in the future. (USFWS, 2012)

Stressor: Invasive plant species (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The rapid increase in the exotic species Mediterranean grass (Schismus barbatus) in the locality P. bradyi may have been triggered by recent changes in climate. Spence (2008) states the proliferation of this exotic grass could negatively affect soil moisture within suitable habitat for P. bradyi, and increase the potential for fire in high density years. This information described by Spence (2008) is anecdotal and speculative in theory and there are no current data available to confirm or dispute the potential influences of exotic grasses to cacti at this time. But, as we describe above, other nonnative invasive grasses outcompete native species for soil nutrients and water (Melgoza et al.1990, Aguirre and Johnson 1991, Brooks 2000) and we expect that Mediterranean grass could have the same impact to P. bradyi. The impacts from altered pollinator behavior and a reduction of soil nutrients and water could adversely affect P. bradyi populations; however, the extent of these impacts is unknown at this time. Thus, we believe the threat is low to moderate and may continue to affect P. bradyi in the future. The potential for increased fire frequency and severity is a significant threat to P. bradyi since the habitat in which they reside is not fire adapted Invasions of annual, nonnative species are well documented to contribute to increased fire frequencies (Brooks and Pyke 2002, Grace et al. 2002, Brooks et al. 2003). The disturbance caused by increased fire frequencies creates favorable conditions for increased invasion by nonnative grasses. The end result is a downward spiral where an increase in invasive species results in more fires, more fires create more disturbances, and more disturbances lead to increased invasive species densities. The risk of fire is expected to increase from 46 to 100 percent when the cover of cheatgrass (Bromus tectorum) increases from 12 to 45 percent or more (Link et al. 2006). The invasion of nonnative grasses into the Mojave Desert of western North America poses similar threats to fire regimes, native plants, and other federally protected species (Brooks et. al. 2004). Brooks (1999) also found that high interspace biomass of nonnative grasses resulted in greater fire danger in the Mojave Desert. Brooks (1999) goes on to state that the ecological effects of nonnative grass-driven fires are significant because of their intensity and consumption of perennial shrubs. Although P. bradyi does not grow in the Mojave Desert, the studies above include Mediterranean grass. Furthermore, the Great Basin Desert Scrub community that P. bradyi occur in does not receive much more rainfall; therefore, the effects of Mediterranean grass on P. bradyi are anticipated to be similar to those described in the Mojave Desert. Although specific information on the genus Pediocactus and fire adaptations are unknown, we expect the invasion of annual, nonnative species will likely increase the frequency and severity of fire beyond historical conditions within the P. bradyi habitat. For example, the Paradine plain cactus (Pediocactus paradine) was impacted by the Warm Fire in 2006. The area burned experience high vegetation mortality and the Forest Service expects many of the cacti were killed since surveys did not produce any live cacti (USDA 2007). It was suggested that the modification of historical management practices resulted in vegetation changes and the spread of nonnatives that altered the fire behavior from low intensity to more severe fires (USDA 2007). Thus, we believe the threat from nonnative grasses and the potential for increased fire behavior is a severe threat to P. bradyi and is likely to increase in the future. (USFWS, 2012)

Stressor: Small population size and limited genetic mixing (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The species' low population level, restricted gene pool, and geographic limitations were described as natural factors affecting the population in the Recovery Plan (USFWS 1995). Although the reason for small population sizes and the potentially limited genetic mixing between P. bradyi has not been confirmed or evaluated, Benson (1982) suggests that the species of Pediocactus we have today are relicts of a more variable group of plants that once occupied suitable intervening sites between the present areas of distribution. For these relictual populations, the structural differences, extremely disjunct distribution, together with the lack of special means of seed dispersal and the physiological limitation of each species to a specific underlying rock or soil type, indicate long evolutionary periods of isolation. Although the specific reasons for small population sizes are unknown, the isolated distribution could create conditions of lowered connectivity among P. bradyi locations and depauperate genetic diversity. Thus, we believe small populations and potentially limited genetic mixing are likely a severe threat to P. bradyi; however, additional research is needed to determine the extent of the threat. (USFWS, 2012)

Recovery

Reclassification Criteria:
1. Permanent protection of 75 percent of the known habitat. (USFWS, 1985)

Recovery Priority Number: 2

Delisting Criteria:
1. All known populations are maintained at a level that demonstrates stable or increasing plant abundance and maintain the current distribution of locations within each population. Plant abundance (measured by the number of plants) may fluctuate within locations and populations, but the defined populations should be stable or increasing over a consecutive 15-year period. (USFWS, 2019)

2. No more than 10 percent of the Moenkopi shale and sandstone habitat (as defined in the Recovery Plan and final rule to list the species: 44 FR 61784) within each of the populations is disturbed over a consecutive 15-year period. This disturbance should occur outside of the habitat that occurs within the 75 percent permanent protection area and be of short-term duration such that habitat restoration is achievable, including formation of biological crusts. (USFWS, 2019)

Recovery Actions:
- Management of ORV use, livestock grazing, and mining within habitat of populations on Federal lands. (USFWS, 1985)
- Inventory for new populations of P. bradyi (USFWS, 1985)
- Monitor and study existing populations. (USFWS, 1985)
- Development of a cactus trade management plan for all cacti. (USFWS, 1985)
- The 1985 Recovery Plan should be updated with recovery criteria that reflect current threats to P. bradyi. Objective, measurable criteria for downlisting and delisting should be

established. (USFWS, 2012)

- Studies should be conducted to evaluate the climate data for each plot or plots at various elevations. Studies should focus on site specific climate changes such as precipitation, snowfall, and temperature that influence reproduction, retraction, and seed germination. Appropriate climate gauges should be installed throughout P. bradyi habitat within BLM, NPS, and NN lands. (USFWS, 2012)
- Studies should be conducted to evaluate the effectiveness of seed germination and seedling establishment and if new populations can be established by seed or require transplants of already established plants (Spence 2008). (USFWS, 2012)
- Studies should be conducted to evaluate the pollination ecology of P. bradyi and evaluate whether the species is pollinator limited due to its early flowering (March-April) (Spence 2008). (USFWS, 2012)
- Identify and implement the control or eradication of nonnative species where needed. (USFWS, 2012)
- Improve coordination and communication between the NDFW and Navajo Office of Broadcast Services for actions permitted within P. bradyi habitat. (USFWS, 2012)
- Establish consistent monitoring protocols that allow comparison of data for population trend analyses. (USFWS, 2012)
- Work with the NN to develop a grazing plan within P. bradyi habitat. (USFWS, 2012)
- Construct fencing exclosures with educational signage around P. bradyi populations that appear to be more exposed to film sets or that need protection from OHV use. (USFWS, 2012)
- Studies specific to genetics or trends in genetic variation should be completed. (USFWS, 2012)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • We recommend the Service and partners, the Navajo Nation, BLM, NPS, USGS, and Arboretum, develop a monitoring plan to detect population trends for the cactus (USFWS 2019). This action would address Delisting Recovery Criteria 1. • We recommend land managers implement management actions to protect cacti and their habitat from dispersed recreation. This action would address Recovery Action 1. • We recommend researchers collect cactus demographic information (e.g., survival, fecundity) to understand how the cactus has responded to past climatic fluctuations and enable predictions for how future climatic changes will affect demographic processes. This action would address Recovery Action 2. • We recommend researchers continue to bank seeds so that this material is available for propagation research and genetic analysis, especially for research of genetic variance across cactus populations. This action would address Recovery Actions 2 and 5. • We recommend further study of the zone of overlap between Brady pincushion cactus and Fickeisen plains cactus. The known area of overlap is relatively small, but does exist, so increasing our understanding of the respective species' microhabitats may provide valuable information for management and conservation. This action would address Recovery Action 2. • We recommend mapping and estimating the size of existing and potential suitable habitat, as well as the conservation status of these areas. This would include cooperation with the Navajo Nation Department of Fish and Wildlife, as well as federal land managers. This information would allow for better interpretation of the estimates of stochastic growth rates and quasi-extinction risks that Shryock et al. (2014, p. 1950) calculated as well as for tracking habitat disturbance. This action would address Recovery Action 2 and Delisting Recovery Criteria 2. • We recommend creating and conducting additional public outreach and education to reduce the risk of

illegal collection (poaching), and public awareness, appreciation, and support for the cactus. This action would address Recovery Action 4 (USFWS, 2022).

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SPECIES ACCOUNT: *Pediocactus despainii* (San Rafael cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/16/1987; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A small, spiny succulent. Stems can swell to up to 6 dm in height, but during dry or cold weather the plants may not appear above ground at all; the species is easily overlooked except in the spring, when bronze-tinted, yellow to peach-colored flowers are in bloom (NatureServe, 2015).

Taxonomy

The plant genus Pediocactus contains nine species (eFloras 2014). Winkler cactus and San Rafael cactus are very closely related with a blending of morphological characteristics where their ranges meet (Porter et al. 1999) (USFWS, 2015).

Historical Range

Endemic to south central Utah (USFWS, 2015).

Current Range

San Rafael cactus is found exclusively in Emery County, Utah. Overall, the known San Rafael cactus populations are found from Dripping Spring in the north, to Big Ridge South/Keesle Country to the south (approximately 122 km (78.5 mi) north to south), and from Mussentuchit Mine in the west, near the border of Sevier to the Humbug population in the east (approximately 88 km (48.5 mi) east-west) (USFWS, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2015)

Lifespan

Adult: 20+ years (USFWS, 2015)

Breeding Season

Adult: March - May (USFWS, 2015)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2015)

Reproduction Narrative

Adult: It is reported to have low fruit/seed output (USFWS 2007; NatureServe, 2015). Some monitored cacti lived at least 20 years after tagging, although the age of the cacti at the time of

tagging was unknown (Clark et al. 2015). The species reproduces sexually, is self-incompatible; cross pollination is needed to produce viable seeds (Tepedino 2000). Pollinators visiting San Rafael cactus include many species of bees, from multiple families. Flowering occurs from March to May with fruiting from May to June (Heil 1984) (USFWS, 2015).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Semi-arid grassland, desert pavements in pinyon-juniper woodlands (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 4,760-6,820 ft. elevation (USFWS, 2015)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2015)

Habitat Narrative

Adult: Inhabits desert pavements of cobble or pebble in pinyon-juniper woodlands (Flora of North America Editorial Committee 2003). Hills, benches and flats, of open, semi-arid grassland with scattered junipers and pinyon pines. (NatureServe, 2015). San Rafael cactus grows in a wide variety of soils, although it may favor fine textured mildly alkaline soils rich in calcium and derived from limestone substrates of the Carmel Formation and the Sinbad member of the Moenkopi formation. It has also been found on shale barrens of the Brushy Basin member of the Morrison, Carmel, Mancos and Dakota geologic formations and in areas of primarily alluvial and colluvium soils. It is found hill tops, and gentle slopes, and most abundantly on sites with a south exposure at elevations of 1450-2080 m (4760-6820 ft.). San Rafael cactus requires intact habitats relatively free of invasive species. This species also requires the presence of native plants which support their pollinators in order to successfully reproduction (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Members of Pediocactus produce dry, dull-colored fruit which are presumed not to be dispersed by birds or rodents, but rather wind or water. Further, dispersal within populations appears to be staggered throughout the growing season from shortly after seeds are produced in June, to fall (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

10 - 30% decline (NatureServe, 2015)

Number of Populations:

21 (USFWS, 2015)

Population Size:

~8,200 (USFWS, 2015)

Minimum Viable Population Size:

Unknown; probably 500 individuals per population (USFWS, 2015)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Little variation exists within populations. The fragile habitat makes the species vulnerable to disturbances. USFWS 2007). The short term population trend is decreasing (10 - 30%) (Butterworth and Porter 2013) (NatureServe, 2015). There are 20 populations of San Rafael cactus, with a total of approximately 8,200 documented individuals (BLM 2012, 2012a, 2013a; Truman 2014, 2015). Based on the most recent survey data, the estimated area of the known populations is approximately 152,971 ha (378,000 ac) (USFWS 2014). The minimum viable population size for this cacti species is unknown. It is likely that population sizes of at least 500 individuals per population are necessary to avoid extirpation (USFWS, 2015).

Threats and Stressors

Stressor: Recreation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The majority of the known San Rafael cactus individuals occur near established unpaved roads and are subject to dust effects. Pressures from recreation, including OHV use and biking are extremely high at the two largest known San Rafael cactus populations. All recorded individuals of San Rafael cactus occur on BLM (85 percent) or SITLA (15 percent) land that is open to OHV use on designated routes only. Two heavily used, unofficial OHV recreational areas are located adjacent to or within occupied habitat areas and are impacting individual plants and their habitat. In addition to OHV use, other forms of recreation, including camping and bike riding, exert pressure on some San Rafael cactus populations, particularly the Wedge and Millsite populations (USFWS, 2015).

Stressor: Livestock disturbance (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Trampling by livestock has been recognized as a threat to San Rafael cactus since at least 1981, with impacts to cacti documented regularly since that time (Heil et al. 1981; Spector 2013). Grazing is permitted throughout the known range of San Rafael cactus and evidence of livestock has been recorded in every population, although grazing pressure is not equal at every population or every surveyed site within a population. San Rafael cactus occurs on 19 grazing allotments managed by the BLM Price Field office (USFWS, 2015).

Stressor: Ungulate disturbance (USFWS, 2015)

Exposure:
Response:
Consequence:
Narrative: Deer prints have been documented within 15 cm (5.9 in) of San Rafael cactus at several sites and can locally be more abundant than livestock tracks but are not as widespread (Spector 2013). For example, in the Millsite/Clawson population, deer disturbance within 15 cm (5.9 in) was found in places at rates over 20 percent, including one survey site with a rate of 95% (BLM 2012); the survey sites are located near an area called Diversion Hollow (BLM 2012; Truman 2014). Deer winter in the area and spring use is high in some parts of the Millsite/Clawson population area. Impacts and disturbance to plants and habitat from wild horses and burros can be very similar to those of cattle and other livestock grazing. Wild horses and burros occur within a portion of San Rafael cactus range in the BLM Price Field Office planning area (BLM 2008a). (USFWS, 2015).

Stressor: Energy and mineral exploration and development (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Approximately 86 percent of the total population San Rafael cactus occurs on BLM land that is open to oil and gas leasing either with no additional constraints or subject to minor constraints, including the entirety of the two largest populations (The Wedge and Millsite/Clawson). Previous energy development activity in the Millsite area has destroyed individual plants and occupied habitat (BLM 2008a; Clark 2011). There is a high level of interest in development throughout the range and the majority of the species' occupied habitat is open to leasing. The negative impacts on cactus habitat from oil, gas, and mining development, are well documented (USFWS, 2015).

Stressor: Paleontological exploration (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: San Rafael cactus may be subject to some impacts from paleontological exploration and excavation. Emery County is the location of a number of paleontological sites, including the Cleveland-Lloyd Dinosaur Quarry near Price. Paleontological interest in the area has been increasing with recent finds on BLM land (Truman 2014). Disturbance to plants from paleontological activities can include direct injury or mortality of plants situated at an excavation site, effects from dust due to surface disturbance at excavation sites, and impacts from associated activities such as camping near and hiking into sites by paleontological field crews (USFWS, 2015).

Stressor: Invasive plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Non-native invasive species are known throughout the ranges of San Rafael cactus, the most common of which are cheatgrass (Bromus tectorum), halogeton (Halogeton glomeratus), and Russian thistle (Salsola tragus). San Rafael cactus inhabits sparsely vegetated areas that are not prone to fire, but the presence of invasive plants can alter local fire regimes

(Stoddart et al. 1951; Harper et al. 1996; Brooks and Pyke 2001; Brooks et al. 2003; Duda et al. 2003). Cacti are not adapted to frequent fires in their habitats and are therefore not expected to persist through more frequent and intense fire cycles. In addition, fires may produce intense heat that can kill seeds, thereby reducing seedbank viability (Brooks and Pyke 2001) (USFWS, 2015).

Stressor: Collection (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: This species is highly desired in cactus collections and gardens and are sought by hobby and commercial cactus collectors (Hochstatter 1990; Heil 1984). The fact that this species is difficult to maintain in garden settings stimulates a continual demand for replacement plants as cultivated garden and greenhouse plants die. Cactus collectors are active in the Colorado Plateau, going from the habitat of one species of Pediocactus to the next to collect a complete set of the genus (Heil 1994; 52 FR 32914, September 16, 1987; 63 FR 44587, August 20, 1998) (USFWS, 2015).

Stressor: Predation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The species is susceptible to infestations and mortality of insect larvae, including the flightless cactus borer beetle (Moneilema semipunctatum). The cactus borer beetle larvae enter the plant by eating tunnels, usually at ground level in the stem of the plant and ultimately ingest most of the plant stems' succulent cortex. Cactus-borer beetle predation can result in 25 to 30 percent mortality in cacti populations, and episodic die offs of significant portions of this species populations due to cactus borer beetles were observed within the past 25 years (Kass 1990; Neese 1987; USFWS 1995; 52 FR 32914, September 16, 1987; 63 FR 44587, August 20, 1998). San Rafael cactus is also predated by weevils. At the Wedge population, 3 percent were found to be infested with weevils which consume the flower buds thereby preventing reproduction. An additional 5 percent were noted to have damage from an unidentified rodent or insect, and several were observed to be infested with the cactus borer beetle (Robinson 2011) (USFWS, 2015).

Stressor: Small population size (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Of the known populations of San Rafael cactus, more than half consist of less than 100 recorded individuals and all but three consist of less than 500 individuals (even if the five populations in the McKay flats allotment were shown to be connected, that population would still consist of less than 500 individuals based on current data). This means a majority of populations of this species are moderately to extremely vulnerable to extirpation from known threats and stochastic events. Very little data on genetic diversity within this species exists, and none at all for many of these populations. The loss of any one population could constitute a major loss of genetic diversity for the species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)

Exposure:
Response:
Consequence:
Narrative: climate change and its impacts to the region are well documented and projected to continue and increase. There was a documented decline of Winkler cactus during the 1999-2003 drought, and the similarity of San Rafael to Winkler cactus suggests a comparable response. (Clark and Clark 2008). Additionally, rare plants have a negative response to drought (Roth 2003, 2004; Van Buren and Harper 2003, 2004), and drought severity and frequency is set to increase due to climate change (IPCC 2007; Karl et al. 2009) (USFWS, 2015).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
1. Based on analysis and modeling implemented under the recovery actions, trends for San Rafael cactus populations are shown to be stable or improving according to the following measures: a) Species presence is maintained at all known San Rafael cactus populations; and b) Within at least three-quarters of the known populations that represent the majority of the total known individuals (and including the Wedge, Millsite/Clawson, and all of the McKay Flats populations) and represent the range of geographical, morphological, and genetic diversity of San Rafael cactus, plant density within occupied habitat is stable or improving over a 20-year period. These populations would be designated as Recovery Populations and this measurement would be based on a standardized, long term monitoring protocol developed by the Recovery Team and managing agencies; and c) Predictive modeling using data from an additional 10-year period (30 years total), collected in accordance with a standardized monitoring protocol, provides an indication of long-term demographic stability as well as a projected survival probability of at least 95 percent over 100 years for the species (USFWS, 2015).

2. Based on best available data, the available habitat base for each recovery population of the species is of sufficient quality and large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and, where possible, among populations (USFWS, 2015).

3. Population and habitat management is implemented for all populations of the species in accordance with management plans developed under Recovery Action 1 (Section 3.4). The management plan will include a course of action that addresses the following needs: habitat protection and management, threats abatement, biological and threats monitoring, and reporting and evaluation (USFWS, 2015).

4. Federal land protection through long-term management agreements or plans is achieved for all known San Rafael cactus populations. Protection considerations from grazing impacts, development, mining, oil and gas, and recreation must be included in the management agreements and the protected areas must meet the size and connectivity parameters determined through research to be adequate to sustain those populations. These may include but are not limited to resource management plans, conservation agreements, recreation

management plans, and travel management plans (USFWS, 2015).

5. Management agreements or plans in place and being implemented for all San Rafael cactus populations on all federal lands must include measures to address and curtail illegal collection activities. These plans should include criteria for appropriate law enforcement at correct times and places to prevent illegal collection and sales of plants or any plant parts (USFWS, 2015).

6. Adverse population-level effects from herbivory, disease, or predation, if any, are identified, monitored and abated to the extent that at least three quarters of known San Rafael cactus population trends are stable or increasing, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under Recovery Action 2.4 (Section 3.4). Programs to control excessive herbivory or predation will be developed to adaptively manage each population per criterion P-3, and must take into consideration the degree which climate change may impact disease or herbivory levels in the future (USFWS, 2015).

7. Land protection covering the habitat of all populations for the species and/or statutory and regulatory protections for plants are such that the protections of the ESA are no longer needed to compensate for regulatory inadequacies (USFWS, 2015).

8. A long-term ex-situ conservation program is ongoing for all extant San Rafael cactus populations. This would include seed collection and storage, germination and viability trials, and development of a protocol for successful reproduction under greenhouse conditions. This would help avert the risk of extinction from stochastic events or environmental catastrophes (USFWS, 2015).

9. In conjunction with recovery criterion P-2 (criterion 2), the available habitat base for each of the populations designated under criterion P-1 (criterion 1) is of sufficient quality and large enough to offset the threat of loss or restriction of the species' pollinators. Effective measurement criteria will be developed through research under Recovery Action 3 (USFWS, 2015).

Recovery Actions:

- Protect and conserve known extant Winkler cactus and San Rafael cactus populations and their habitat (USFWS, 2015).
- Survey for additional populations, and monitor all populations in order to apply conservation measures where and when needed (USFWS, 2015).
- Conduct in depth research into the biology, requirements, threat responses, and life histories of both species in order to develop and implement appropriate management practices for the purposes of achieving recovery (USFWS, 2015).
- Promote communication by encouraging and creating dialog regarding these species between managing agencies, land owners, developers, and the public in order to raise awareness and aid recovery (USFWS, 2015).
- Coordinate and work together with all stakeholders to achieve recovery (USFWS, 2015).
- Survey and repeat inventory efforts were completed throughout the range of the species beginning in 1987. These were a responsibility of the Interagency team from 1998 through 2008, which then transferred to individual managing agencies from 2011-2013. Because of

these efforts, there is a better understanding of the status and distribution of the species as well as habitat requirements. Although many more occupied sites and populations are now known than at the time of listing, not all suitable habitat has been surveyed. There is currently no comprehensive, funded plan from any of the managing agencies for continued inventory and monitoring of the species (USFWS, 2015).

- A habitat modelling project for the species has been initiated by the USGS, with funding from USFWS and the support of the BLM and CRNP, which will use existing inventory and site data to help determine potential suitable habitat and delineate the range of San Rafael cactus. The model will identify the most influential environmental factors of presence/absence for the species. This will be useful in locating additional sites and populations, as well as helping determine the need for cactus surveys prior to proposed projects that impact potential habitat (USFWS, 2015).
- Seeds of San Rafael cactus have been collected for conservation purposes, most recently in 2013. Seeds are currently stored and maintained at the National Center for Genetic Resource Preservation in Ft. Collins, CO and at Red Butte Garden in Utah. No plants are currently being propagated (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Recommended future actions: We recommend rangewide surveys of known populations for Winkler cactus and San Rafael cactus, and that survey results be used to compile a robust, updated population estimate. Additional research that provides a better understanding of current population demographics, population trends, and the impact of and response to the primary threats is vital to evaluating these species' status in the future and to developing updated and meaningful recovery criteria and actions. The designation and management of protected areas that reduce impacts from identified threats may be necessary to facilitate this species' recovery. Additionally, we recommend updating and finalizing the draft recovery plan and specifically reevaluating the recovery goals and criteria based on new population numbers, habitat requirements, connectivity analysis, and recent and upcoming changes in management and conditions that may result in changes to threat intensity and scope (USFWS, 2019)

References

USFWS. 2016. Environmental Conservation Online System (ECOS) – Species Profile. http://ecos.fws.gov/ecp0/. Accessed July 2016

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

U.S. Fish and Wildlife Service (USFWS). 2015. Winkler cactus (Pediocactus winkleri) and San Rafael cactus (Pediocactus despainii) recovery plan. Technical/agency draft. U.S. Fish and Wildlife Service, Denver, Colorado. xii + 133 pp.

USFWS. 2019. 5-Year Review Short Form Species Reviewed: Winkler cactus (Pediocactus winkleri) and San Rafael cactus (Pediocactus despainii). 8 pp.

SPECIES ACCOUNT: *Pediocactus peeblesianus fickeiseniae* (Fickeisen Plains cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/31/2013; Southwest Region (Region 2) (USFWS, 2013)

Physical Description

The Fickeisen plains cactus is a small, unbranched to occasionally branched, globose (globular) cactus. At maturity, many plants are the size of a quarter making them difficult to locate even when their location is known. The stems of mature Fickeisen plains cactus are 2.5 to 6.5 cm (1.0 to 2.6 in) tall and up to 5.5 cm (2.2 in) in diameter; covered with tubercles (knoblike projections on the main stem) that form a spiral pattern around the plant. Each tubercle has 6 to 7 radial spines per areole (tip where spines develop), 4 to 7 millimeters (mm) (0.15 to 0.27 in) in length, and 1 central spine (15 to 18 mm (0.59 to 0.70 in) long) that is straight to strongly curved. Spines are soft and corky (spongy) and white to pale gray in color. Flowers are 2.5 cm (0.98 in) in diameter, cream-yellow or yellowish-green in color, and produced on the apex (top) of the stem. Fruits are turbinate (top-shaped), and turn reddish-brown at maturity. The seeds are dark brown to black, 3 mm (0.11 in) long, and 2 mm (0.08 in) wide. (USFWS, 2013)

Taxonomy

The Fickeisen plains cactus was first discovered near Cameron, Arizona, in the late 1950s. It was originally described in the scientific literature by Benson (1969), then later by Heil et al. (1981), who recognized the name and taxon in a review of the genus Pediocactus. The Flora of North America treats the taxon as a subspecies of Pediocactus peeblesianus, finding that the name “Pediocactus peeblesianus var. fickeiseniae” was not validly published by Benson. The Service considers Pediocactus peeblesianus var. fickeiseniae to be a valid taxon since it was classified as a candidate species in 1980. Our previous documentation referring to the Fickeisen plains cactus used the name “P. peeblesianus var. fickeiseniae”, and we will continue to use this name. Other synonyms of Pediocactus peeblesianus var. fickeiseniae that have been used are Navajoa fickeisenii and Toumeya fickeisenii.

Historical Range

Very little is known about its historical range. It has been described as widespread along the ledges of the Little Colorado and Colorado Rivers to the hills of the lower House Rock Valley; also with a range northern Arizona from the hills in northeast Mohave County to the vicinity of the Colorado and Little Colorado rivers near the Grand Canyon National Park and southeast Coconino County. (USFWS, 2013)

Current Range

The current range is in Coconino and Mohave Counties in northern Arizona, extending from Mainstreet Valley of the Arizona Strip (i.e., the area north of the Colorado River to the Arizona-Utah border) to House Rock Valley; along the canyon rims of the Colorado River and Little Colorado River; the area of Gray Mountain; and along the canyon rims of Cataract Canyon on the Coconino Plateau. (USFWS, 2013)

Critical Habitat Designated

Yes; 9/19/2016.

Legal Description

On August 18, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective September 19, 2016) for Pediocactus peeblesianus fickeiseniae (Fickeisen Plains cactus) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six critical habitat units (CHUs), in three counties in Arizona (81 FR 55266--55313).

Critical Habitat Designation

The critical habitat designation for Pediocactus peeblesianus fickeiseniae (Fickeisen plains cactus) includes six CHUs (including 10 sub-units) in Maricopa, Pima, and Pinal Counties, Arizona. This species' critical habitat encompasses approximately 17,456 acres (ac) (7,062 hectares (ha)). Brief descriptions are presented below. Maps depicting the CH units are available in the Final Rule. (81 FR 55266--55313)

Unit 1: Hurricane Cliffs: The Hurricane Cliffs Unit is located on the Arizona Strip in the north-central area of Mohave County, Arizona. The unit lies predominantly on the Shivwits Plateau and is bounded to the west by Mainstreet Valley and to the east by the Hurricane Cliffs. The unit consists of four subunits totaling 3,044 ha (7,524 ac) and includes small areas of private land, lands owned by the State of Arizona, and federally owned land managed by the BLM. The entire unit occurs within the area referred as the Arizona Strip that is managed by the BLM for multiple land use purposes such as livestock grazing, fuels management, energy, and recreation. The BLM manages grazing leases for large allotments comprised of a mix of their lands as well as State lands. Occupancy of the Hurricane Cliffs Unit by the Fickeisen plains cactus has been documented since 1986 (BLM 1986, p. 1). The taxon was considered generally rare, but in abundant numbers at Dutchman Draw with a few scattered individuals located in small clusters adjacent to Dutchman Draw populations. These smaller clusters include the Navajo, Ward, Salaratus Draw I, Salaratus Draw II, Temple Trail, and Toquer Tank populations. This entire unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. Subunit 1a: Dutchman Draw— Subunit 1a consists of 1,527 ha (3,774 ac) of land near Dutchman Draw in Mainstreet Valley. The subunit occurs within the Shivwits Plateau and along an exposed fault. Lands within this subunit were occupied at the time of listing. A monitoring plot was established at this site in 1986. The BLM has visited the plot regularly since then. Monitoring information has shown fluctuations in plant numbers between years, but among all years, there is an overall decline in plant numbers from a peak of 219 individuals in 1992 to 5 individuals in 2012. This subunit also includes the Navajo and Ward cluster plots that were established to note presence or absence of the cactus. These small plots were last visited in 2001, and 10 plants were found at each of the plots. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Occupied habitat areas in this subunit occur predominantly within the Plains and Great Basin grassland with a small portion in the Great Basin desertscrub vegetation communities. Plants occur amongst tall, dense clumps of grama grass with some desert shrubs. The subunit is located at the foot of a gently sloping hill in fine alluvium deposits. Most of the bedrock surface is limestone, siltstone, and gypsum of the Kaibab Formation. Subunit 1b: Salaratus Draw—Subunit 1b consists of 724 ha (1,789 ac) of land near Salaratus Draw. The subunit overlies an active fault on the Shivwits Plateau. Lands within this subunit were occupied at the time of listing and include Salaratus Draw I and Salaratus Draw II

populations. This site was visited only three times between 1986 and 2001. At most, 44 plants were located in this subunit when last visited in 1994. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 1c: Temple Trail—Subunit 1c consists of 443 ha (1,096 ac) of land in Lower Hurricane Valley. This subunit lies on the Hurricane Cliffs. It is bounded by the Shivwits Plateau to the west and the Uinkaret Plateau to the east, separated by an active fault that runs north along the Hurricane Cliffs. Lands within this subunit were occupied at the time of listing. This site was last visited in 2001 when seven individuals were found. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 1d: Toquer Tank—Subunit 1d consists of 350 ha (865 ac) of land in Lower Hurricane Valley. Lands within this subunit were occupied at the time of listing. This site was regularly monitored from 1986 to 1991, when abundance counts ranged from 7 to 13 plants. This site was last visited in 1994, and seven individuals were found. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 2: Sunshine Ridge: The Sunshine Ridge Unit is located on the Arizona Strip and lies on the Kanab Plateau in Mohave County, Arizona. The unit totals 754 ha (1,863 ac). This unit contains land that is federally and State owned. The entire unit is managed primarily by the BLM for multiple land use purposes such as livestock grazing, fuels management, energy, and recreation. Plants are located east of the Uinkaret Plateau and east of the range of the Pediocactus sileri (Siler pincushion cactus). Occupancy of the Sunshine Ridge Unit by the Fickeisen plains cactus has been documented since 1977 (AGFD 2011b, entire). This population has been regularly monitored since 1986, and has 34 plants as of 2011. Land within this unit was occupied at the time of listing and contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 3: Clayhole Valley: The Clayhole Valley Unit is located in Upper Clayhole Valley on the Arizona Strip and lies within the Uinkaret Plateau in Mohave County, Arizona. The unit consists of 414 ha (1,024 ac) of land that is federally and State owned. The entire unit is managed primarily by the BLM for multiple land use purposes including livestock grazing. Occupancy of the Clayhole Valley Unit by the Fickeisen plains cactus has been documented since 1980 (AGFD 2011b, entire). The population has been monitored annually since 1986. As of 2011, the population contains 42 plants. Land within this unit was occupied at the time of listing and contains all of the primary constituent elements of the physical or biological features essential to the conservation of the

Fickeisen plains cactus. This unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 4: South Canyon: The South Canyon is located on the eastern boundary of the North Kaibab Ranger District of the Kaibab National Forest in Coconino County, Arizona. It is bounded by the Colorado River near Marble Canyon at House Rock Valley. It includes land originally designated as the Grand Canyon National Game Preserve that is now referred to as the Buffalo Ranch Management Area. It contains 110 ha (272 ac) of federally owned land that is administered by the Kaibab National Forest. This unit contains at least 62 individual Fickeisen plains cactus scattered among 6 areas along the rim of South Canyon Point. This unit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. The primary land uses within this unit include big game hunting and recreational activities throughout the year. The area is very remote and may receive limited numbers of hikers, hunters, or campers. Under a memorandum of understanding, the Kaibab National Forest and the AGFD commit to managing the natural resources of this area, mainly big game species, to ensure that sensitive resources are not impacted and desired conditions are achieved (USFS 2012, p. 92). Livestock grazing by cattle and mining activities are not authorized within the Buffalo Ranch Management Area. Special management considerations or protection may be required within the unit to minimize habitat disturbance to the soil and associated native vegetation, and prevent invasion of nonnative plants. The features essential to the conservation of the species within this unit are threatened by nonnative, invasive species issues and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize conditions that may promote or encourage encroachment and establishment of nonnative, invasive species; and reduce the likelihood of wildfires affecting the population and nearby plant community.

Unit 5: House Rock Valley: The House Rock Valley is located on the eastern edge of the Arizona Strip near the North Rim of the Grand Canyon National Park in Coconino County, Arizona. The unit consists of four subunits totaling 1,893 ha (4,678 ac) of land. The unit consists of land that is federally and State owned. The entire unit is managed primarily by the BLM, mainly for livestock grazing. Lands within this unit were occupied at the time of listing and contain all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This entire unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. Occupancy of the Fickeisen plains cactus in the House Rock Valley Unit was first documented in 1979 (Phillips 1979, entire; AGFD 2011b, entire), at Beanhole Well, Marble Canyon, and South Canyon. These sites have not been visited for more than 21 years. However, we have no reason to believe these sites were not occupied at the time of listing for reasons provided in the ‘‘Distribution and Range’’ section of the final listing rule (78 FR 60608). Occupancy at the North Canyon Wash site was documented in 1986, and it has been regularly

monitored since. The House Rock Valley Unit is bounded by the Colorado River to the east, U.S. Highway 89A to the north, and the Kaibab National Forest to the west. Subunit 5a: Beanhole Well—Subunit 5a consists of 745 ha (1,841 ac) of federally owned land that is managed by the BLM, and 126 ha (312 ac) of Stateowned land. Lands within this subunit were occupied at the time of listing. Three plants were documented at Beanhole Well in 1979, and the site has been visited by Hughes since then, and while occupied habitat was observed, no plant numbers were reported to us (Calico 2012, pers. comm.). This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 5b: North Canyon Wash— Subunit 5b consists of 472 ha (1,166 ac) of federally owned land that is managed by the BLM. Lands within this subunit were occupied at the time of listing. This site has been regularly monitored since 1986. As of 2011, the site contains 39 Fickeisen plains cacti. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 5c: Marble Canyon—Subunit 5c consists of 214 ha (528 ac) of federally owned land that is managed by the BLM. Lands within this subunit were occupied at the time of listing. Eight plants were documented at Marble Canyon in 1979. This site has not been visited for many years. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 5d: South Canyon—Subunit 5d consists of 336 ha (831 ac) of Federal land in House Rock Valley along the rim of Marble Canyon. Lands within this subunit were occupied at the time of listing. A total of 52 plants have been documented at this site historically. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. The features essential to the conservation of the species within this unit are threatened by livestock grazing; nonnative, invasive species issues; small mammal predation on the cactus; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize habitat disturbance to Fickeisen plains cactus individuals, soil, and associated native vegetation; and to prevent or remove nonnative, invasive species within its habitat.

Unit 6: Gray Mountain: The Gray Mountain Unit is located in the vicinity of the town of Gray Mountain, Arizona, on Highway 89 in Coconino County. The unit consists of two subunits totaling 847 ha (2,095 ac). The unit includes a checkerboard mix of private land, lands owned by the State, and federally owned land managed by the BLM. Lands within this unit are considered occupied at the time of listing. Occupancy at the Gray Mountain unit was first documented in 1962, and consists of two very small populations on both sides of Highway 89. Occupied sites were visited in 2013, and a few plants in flower were observed. This unit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. This entire unit helps to maintain the geographical range of the species and provide opportunity for population growth. This unit also provides a core population of the species. Subunit 6a: Mays Wash—Subunit 6a is located southeast of Highway 89 and consists of 326 ha (807 ac) of land. The subunit includes private land, land owned by the State, and federally owned land managed by the BLM. The entire subunit lies within a cattle ranch and is managed privately for livestock grazing. Lands in this subunit are considered occupied at the time of listing. Occupancy at this site was documented in 1981 and 1984, when 31 plants were found (AGFD 2011b, entire). A site visit to BLM land in 2013 located a few plants in flower. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. Subunit 6b: Gray Mountain—Subunit 6b is located west of Highway 89 and borders the boundary of the Navajo Nation. This subunit

consists of 521 ha (1,288 ac) of land that is owned by the State and privately owned land. The entire subunit lies within a cattle ranch and is managed privately for livestock grazing. Lands in this subunit are considered occupied at the time of listing. Occupancy was documented in 2009 when three individuals were found (NNHP 2011a, p. 2). An individual in bloom was observed in 2013. This subunit contains all of the primary constituent elements of the physical or biological features essential to the conservation of the Fickeisen plains cactus. The features essential to the conservation of the species within this unit are threatened by livestock grazing by horses and sheep; nonnative, invasive species issues; mineral development and associated infrastructure; and long-term drought coupled with increased minimum winter temperatures. Special management considerations or protection may be required to minimize disturbance or destruction to the bedrock substrate and associated limestone soils; to prevent or remove nonnative, invasive species within its habitat; and protect the native vegetation communities.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Pediocactus peeblesianus fickeiseniae critical habitat consists of the following components (81 FR 55266--55313):

(i) Soils derived from limestone that are found on mesas, plateaus, terraces, the toe of gentle sloping hills with up to 20 percent slope, margins of canyon rims, and desert washes. These soils have the following features: (A) They occur on the Colorado Plateau in Coconino and Mohave Counties of northern Arizona and are within the appropriate series found in occupied areas; (B) They are derived from alluvium, colluvium, or eolian deposits of limestone from the Harrisburg member of the Kaibab Formation and limestone, siltstone, and sandstone of the Toroweap and Moenkopi Formations; (C) They are nonsaline to slightly saline, gravelly, shallow to moderately deep, and well-drained with little signs of soil movement. Soil texture consists of gravelly loam, fine sandy loam, gravelly sandy loam, very gravelly sandy loam, clay loam, and cobbly loam.

(ii) Native vegetation within the Plains and Great Basin grassland and Great Basin desertscrub vegetation communities from 1,310 to 1,813 m (4,200 to 5,950 ft) in elevation that has a natural, generally intact surface and subsurface that preserves the bedrock substrate and is supportive of microbiotic soil crusts where they are naturally found.

(iii) Native vegetation that provides for habitat of identified pollinators within the effective pollinator distance of 1,000 m (3,280 ft) around each individual Fickeisen plains cactus.

Special Management Considerations or Protections

When designating critical habitat, the Services assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical or biological features essential to the conservation of the Fickeisen plains cactus. In all of the described units, special management may be required to ensure that the primary constituent elements for the cactus are conserved and the habitat provides for the biological needs of the cactus. Some of the management activities that could ameliorate these threats include, but are not limited to, those discussed below. (1) Practice livestock grazing in a manner that maintains, improves, and expands the quantity and quality of desertscrub and grassland habitat. Special

management considerations or protection may include the following: Manage livestock grazing sustainably with the natural landscape by determining appropriate areas, seasons, and use consistent within the carrying capacity of rangeland in response to current and future drought and warming trends; improve monitoring and documentation of grazing practices; manage cattle and feral hoofed mammals (ungulates) (e.g., horses, burros) to reduce the risk of plants trampled and soil compaction; and manage for other small mammal species to restore desired processes to increase habitat quality and quantity. (2) Manage for nonnative, invasive species, such as Bromus tectorum (cheatgrass), Bromus rubens (red brome), or Erodium cicutarium (redstem filaree), by minimizing conditions that may promote or encourage encroachment or establishment of nonnative, invasive species and restore or reestablish conditions that allow native plants to thrive. Within the range of the Fickeisen plains cactus, the establishment and success of nonnative, invasive species has been a result of historic land use and management practices such as logging, grazing, wildfire suppression actions, mining, and ORV use. Actions have been taken by land management agencies to reduce the spread of invasive species and reduce the risk of wildfire they pose from creating fine fuel loads. Nonnative, invasive species occur near Fickeisen plains cactus habitat and may pose a threat through competition for resources or increase the risk of fire. Special management considerations or protection may include the following: Prevent or restrict establishment of nonnative, invasive species; minimize ground-disturbing activities that may facilitate their spread; implement post-disturbance restoration activities such as native plant propagation; practice active removal of nonnative, invasive plant species and targeted herbicide application (provided herbicides can be shown not to negatively impact the Fickeisen plains cactus or the native pollinators); and improve monitoring and documentation on a site-by-site basis where nonnative, invasive species are present in occupied habitat to assess any effect (beneficial or negative) they pose of the cactus. (3) Protect bedrock surfaces and associated limestone soils that provide suitable habitat from mineral development and associated infrastructure (new roads). Numerous breccia pipes (vertical, pipe-shaped bodies of highly fractured rock that collapsed into voids created by dissolution of underlying rock) are located across the Colorado Plateau and are expressed as circular collapse structures, minor folds, and other surface irregularities associated with the Kaibab and Toroweap Formations. Exploration and development of uranium has peaked and waned in accordance with market values. Areas of interest and oil and gas leasing/exploration overlap Fickeisen plains cactus habitat. These activities could result in direct habitat loss or alteration by removing or degrading limestone soils to such an extent that the soils would no longer support the growth of the Fickeisen plains cactus. Special management considerations or protection may include the following: Protect lands that support suitable habitat and site future development such that the destruction or removal of limestone from the Kaibab, Toroweap, and Moenkopi formations is minimized and depositional areas are preserved. (4) Manage or protect native desertscrub and plains grassland vegetation communities from recreational impacts. Special management considerations or protections may include the following: Managing trails, campsites, and ORVs; and reduce the likelihood of wildfires affecting the population and nearby plant community. These management activities will protect the physical or biological features essential to the conservation of the Fickeisen plains cactus by reducing the direct and indirect effects of habitat loss, alteration, or fragmentation; preserving the bedrock surfaces and associated limestone soils that form the basis of its habitat; and maintaining the native vegetation communities and its pollinators. In summary, the primary constituent elements of the Fickeisen plains cactus habitat may be impacted by livestock grazing; nonnative, invasive species; mineral development and associated transportation infrastructure; and recreation. We find that these activities may not be direct threats to the species as a whole, but may negatively impact

the primary constituent elements. The areas designated as critical habitat within the geographical area occupied by the taxon at the time of listing contain the physical or biological features essential to the conservation of the Fickeisen plains cactus. Special management considerations or protection may be required to eliminate, or reduce to a negligible level, the threats affecting each unit or subunit and to preserve and maintain the essential features that the critical habitat units and subunits provide to the cactus.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NaureServe, 2015)

Lifespan

Adult: The lifespan of the Fickeisen plains cactus is estimated to be between 10 to 15 years. (USFWS, 2013)

Breeding Season

Adult: Mid-April for flowering with fruiting in June (USFWS, 2013)

Other Reproductive Information

Adult: Reproduction has not been specifically studied on the Fickeisen plains cactus. For other species in the genus Pediocactus, reproduction occurs through cross-pollination by native bees. Insects observed visiting flowers of the Fickeisen plains cactus include species of hover flies (family Syrphidae) and bee flies (family Bombyliidae), mining bees (family Andrenidae), and sweat bees (family Halictidae). Although flies may pollinate flowers of the Fickeisen plains cactus, the primary pollinators of the plant are believed to be halictid bees from the genera Lasioglossum, Halictus, and Agapostemon, based on several studied species of Pediocactus. (USFWS, 2013)

Reproduction Narrative

Adult: Pediocactus peeblesianus var. fickeiseniae flowers in April to May and fruits mature in May to June. The cacti tend to produce abundant flowers (1-5 per plant) but not many seeds. Flowers generally open mid-morning (10-10:30 am) on fair, warm days but fail to open or only partially open in cold, cloudy or extremely windy weather (Navajo Natural Heritage Program 1994). Rainfall is very variable in the regions where Fickeisen Plains cactus grows and it exhibits episodic germination that is tied to the amount of precipitation. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (USFWS, 2013)

Habitat Vegetation or Surface Water Classification

Adult: Shallow, well-draining, gravelly loam soils derived from limestone (USFWS, 2013)

Dependencies on Specific Environmental Elements

Adult: Rainfall is very variable in the regions where it grows and it exhibits episodic germination that is tied to the amount of precipitation. (USFWS, 2013)

Geographic or Habitat Restraints or Barriers

Adult: 1200 - 1600 m elevation, 0 - 20 % slope (USFWS, 2013)

Environmental Specificity

Adult: Narrow endemic (USFWS, 2013)

Habitat Narrative

Adult: The Fickeisen plains cactus is a narrow endemic restricted to exposed layers of Kaibab limestone on the Colorado Plateau. Plants are found in shallow, well-draining, gravelly loam soils formed from alluvium, colluvium, or Aeolian deposits derived from limestone of the Harrisburg Member the Kaibab Formation and Toroweap Formation; Coconino Sandstone; and the Moenkopi Formation. Most populations occur on the margins of canyon rims, flat terraces, limestone benches, or on the toe of well-drained hills. Plants are found primarily on slopes of 0 to 5 percent but some also occur on slopes up to 20 percent at elevations between 1,280 to 1,814 m (4,200 to 5,950 ft). (USFWS, 2013)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The mechanisms of seed dispersal in the Fickeisen plains cactus have not been investigated and are poorly understood. Most site visits to areas occupied by the Fickeisen plains cactus have observed seedlings established very close to the adult plant. The general shared belief is that most species of Pediocactus, including the Fickeisen plains cactus, lack a good mechanism for seed dispersal, which is a contributing factor to its endemism and isolated, localized populations. (USFWS, 2013)

Population Information and Trends

Population Trends:

Short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Number of Populations:

37 (USFWS, 2020)

Population Size:

1,572 estimated in 22 pops on the Navajo Reservation (USFWS, 2020)

Population Narrative:

We received little information that changes our basic understanding about the Fickeisen plains cactus since we listed it in 2013. At listing, we knew of 33 populations (78 FR 60629) and currently we are aware of 37 populations range-wide, with two possibly extirpated. Also, while some populations are regularly monitored (such as those on the BLM Arizona Strip District), many are not monitored, or are evaluated infrequently or irregularly (78 FR 60629). We are encouraged by the recent increased survey and monitoring attention from the Navajo Natural Heritage Program and Babbitt Ranches/Landsward Foundation. Population sizes within the BLM Arizona Strip District monitoring plots appear to have declined by almost 50% since 2013. The enlargement of the Dutchman Draw plot in 2017 to include 22 additional plants complicates our

understanding of long-term trends. The BLM did not elaborate on the new plot size or reasons for the decline in total numbers. Their tally for recruitment, death, and/or missing plants does not explain what could be attributing to the decline. The Navajo Nation's comprehensive 2015 survey effort resulted in more discovered plants. Still, most of the Navajo Nation's populations are small and there is concern for low reproduction rates and seedling numbers, as well as the persistence of two populations. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The Fickeisen plains cactus and its habitat is threatened by direct loss of plants and habitat loss and modification due to the direct and indirect effects of livestock grazing and drought and climate change. These threats, in and of themselves, may not result in significant population-level impacts to the Fickeisen plains cactus. However, the above factors appear to be acting synergistically, placing a major stress on the known plants monitored rangewide with little indication of population growth and age-class diversity (USFWS, 2013).

Stressor: Herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Small mammal herbivory on cactus species is known to occur during dry conditions when animals seek available moisture from the plant or available food from cactus fruit. Although clear evidence is lacking of the scope of the impact that rodent predation has had on the Fickeisen plains cactus and its seeds, taken in conjunction with other habitat disturbances occurring across its range, low recruitment, and small population size, we find that rodent or rabbit predation is likely to rise to the level where it becomes a significant threat to the plant (USFWS, 2013)..

Stressor: Small population size (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Small populations that are restricted by habitat requirements are more vulnerable to the effects of climate change, such as prolonged droughts and increased fire frequencies. Although small population size makes the species intrinsically more vulnerable, it is uncertain whether this alone would rise to the level of threat. However, when combined with the threats from livestock grazing, drought and climate change, and rodent and rabbit predation, small population size likely exacerbates the effects of these threats on the Fickeisen plains cactus (USFWS, 2013).

Stressor:
Exposure:
Response:
Consequence:

Narrative:

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Recovery actions are not available.
- Conservation measures are not available.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Develop a recovery plan for the Fickeisen plains cactus to incorporate new information on biology, ecology, and management recommendations. Establish objective and measurable recovery criteria for down and delisting to address all relevant listing factors. • Continue to improve coordination and collaboration among all parties conducted land management actions or permitted activities in Fickeisen plains cactus habitat. • Continue to seek out new Fickeisen plains cactus populations and improve the monitoring of known populations using standardized methodology. • Conduct genetic studies between populations to determine variability and demographic studies to examine if low pollinator visits effects population size and if gene flow is limited. • Develop an off-site conservation program for seed banking and propagation techniques. Conduct studies to evaluate the effectiveness of seed germination and seedling establishment and whether new populations can be established by seed or require transplants of already established plants. • Investigate the need for pollinator restoration practices to increase abundance and diversity of pollinators and supporting habitat. • Examine the ability for the Fickeisen plains cactus to naturally disperse into unoccupied suitable habitat. Also, examine whether the quality of these unoccupied habitats can remain suitable under future climactic conditions. Develop management plans to conserve and protect those future habitats for the taxon's continuing persistence. Develop a systematic and standardized monitoring protocol to gather and collect long-term demographic information that improves the quality of data and helps formulate rangewide conservation practices to improve the taxon's status. • Establish coordination meetings with BLM Arizona Strip Field Office to discuss monitoring methods, results, and future management of the cactus. (USFWS, 2020)

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SPECIES ACCOUNT: *Pediocactus peeblesianus var. peeblesianus* (Peebles Navajo cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: PNC

Listing Status: Endangered; 11/28/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Peebles Navajo cactus is a very small, solitary globose cactus. Mature stems range from 13 to 35 millimeters (mm) in diameter and up to 29 mm in height above ground (Butterwick 1986; Phillips et al. 1985). Individual plants have 3 to 5 (commonly 4) spongy or corky radial spines that are 2 to 9 mm long, 0.5 to 1 mm wide, white to pale gray in color (Heil et al. 1981) and may appear as a twisted cross (AZGFD 2009) (Figure 1). The upper radial spine is often longer than the other radial spines, extending up to 7.5 mm in length (AZGFD 2009). Peebles Navajo cactus lacks a central spine which distinguishes this subspecies from its closest relative, Fickeisen plains cactus (Pediocactus peeblesianus ssp. fickeiseniae) (USFWS, 2022).

Taxonomy

The species that Lyman Benson combined into the genus Pediocactus in 1961-1962 formerly were in six different genera due to their great diversity in spination, body proportions, and flower color. Benson recognized an over riding similarity: the structure and method of dehiscence of the fruits (dry at maturity and dehiscent usually both by a dorrsal slit and by a ring a round the circumscissile apex) as well as several other character is tics in common (Benson 1962b). The Peebles Navajo cactus is separated from its nearest relative, P. peeblesianus var. fickeiseniae, primarily on the basis of spine characters, size, and distribution. Peebles Navajo cactus lacks a central spine, and has fewer of the corky radials [4 (3-5) versus 6 (7)] characteristic of the other variety. It is also smaller in all parts and grows in the vicinity of Holbrook, whereas var. fickeiseniae grows to the west in the vicinity of the Little Colorado and Colorado rivers and on the Arizona Strip (Benson 1962a). (USFWS, 1984)

Current Range

Endemic to Navajo County, Arizona near Joseph City and Holbrook (USFWS 2008). Its range is very small, approximately 7 miles in length by 1 mile in width (USFWS 2008). (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: The life span of a Peebles Navajo cactus is estimated to be at least 30 years (USFWS, 2022).

Breeding Season

Adult: Late April (NatureServe, 2015)

Other Reproductive Information

Adult: Pollinators of Pediocactus species are solitary native bees from the genera Agapostemon (metallic sweat bees) and Ashmeadiella, as well as Dialictus, a subgenus of sweat bees from the genus Lasioglossum (Peach et al. 1993; Tepedino et al. 1996; Tepedino 2000). The primary pollinators of the Peebles Navajo cactus have not been identified. Insects observed visiting open flowers have included a single, native bee of Lasioglossum, thrips (Order Thysanoptera), and ants (Forelius pruinosus) (Butterwick 1986). In 2021, the Museum of Northern Arizona placed insect traps near the Joseph City plots during the flowering period to document the arthropod diversity in association with Peebles Navajo cactus (Phillips 2021). This will help identify or elaborate on insects observed visiting its flowers. Approximately 80 to 120 arthropod specimens were collected and data will be analyzed in the near future (USFWS, 2022).

Reproduction Narrative

Adult: Flowers (late April) are yellow-green. Growth rates are slow and reproduction does not occur until plants are > 8 years old. (NatureServe, 2015; USFWS, 2008). Reproductive potential varies among individual Peebles Navajo cacti. Based on monitoring data, most plants become reproductive when they reach a diameter of 13 to 14 mm (Butterwick 1986). The smallest reproductive plant documented was 7 mm in diameter and produced a single flower bud (USFWS,2022).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, grassland/herbaceous (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers sunny exposed areas (USFWS, 2008)

Geographic or Habitat Restraints or Barriers

Adult: Occurs between 5,100 and 5,650 feet in elevation (USFWS, 2008)

Spatial Arrangements of the Population

Adult: Widely scattered, sometimes in clumps (USFWS, 2008)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (inferred from USFWS, 2008)

Site Fidelity

Adult: High (inferred from USFWS, 2008)

Habitat Narrative

Adult: Habitat requirements for the PNC have been determined to include well to extremely well drained soils that formed in mixed alluvium belonging to the Gypsiorthids-Torriorthents-Haplargids Association, low soil microelement values, and the presence of vesicular-arbuscular endomycorrhizae, such as Glomus deserticola, for colonization of the roots (Phillips and Phillips 1995). The PNC occurs between 5,100 and 5,650 feet above sea level on gentle slopes on all facing aspects (Stuart et al. 1972; USFWS 1984; AGFD 2004). This species prefers exposed sunny weakly alkaline, gravely soils of the Little Colorado paleochannels (Taylor, 2008), and above the Shinarump in weakly alkaline, very course sand to cobble gravel deposits that unconformably overlie the finer grained facies of the Chinle Formation (Burch and Anderson, 2002). It is found found in Great Basin desert scrub and desert grasslands (Flora of North America Editorial Committee 2003). PNC occurs at low to moderate densities that are often widely scattered, sometimes in clumps, even when apparently suitable habitat is contiguous (Heil et al. 1981). (USFWS, 2008; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Slow (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2022)

Population Size:

>150 (USFWS, 2022).

Additional Population-level Information:

We compiled count information on the Peebles Navajo cactus between 2021 and 2022. There are at least 150 Peebles Navajo cacti (Phillips 2021; Phillips et al. 2022) (Table 2). Some additional plants were found in 2022 but no numbers were provided so we assume it was a few individuals. Not all areas where the taxon has been found are searched annually. Many years may pass before an area is re-surveyed making it difficult to verify continued occupancy of an area. Earlier population estimates of approximately 1,000 individual plants rangewide cannot be substantiated with available information (Phillips et al. 1979; USFWS 1984). Based on abundance data from 1985 to 2022, the highest number of reported cacti among three monitoring plots peaked at 522 individuals in 1995, with 498 alive and 24 dead. Numbers of live cacti thereafter have continuously declined to 42 individuals presently (USFWS, 2022).

Population Narrative:

Growth rates are slow and reproduction does not occur until plants are > 8 years old. During the dry months, the cacti retreat below soil surface level. "Reproduction may be insufficient to maintain populations over the long term" (Arizona Ecological Services 2009). Less than 1,000 plants are known to exist in six small populations (three occurrences), in a tiny area in northern Arizona. (NatureServe, 2015). Peebles Navajo cactus is known from two core populations in Navajo County, Arizona (USFWS 2008). One population occurs on BLM-administered land near Joseph City and the second on private land near Holbrook (Figure 8). Both populations are within the Tanner Wash Area of Critical Environmental Concern (ACEC), which encompasses 4,650 acres of federal (950 acres), state trust (1,280 acres) and private (2,420 acres) lands (USFWS, 2022).

Threats and Stressors

Stressor: Habitat loss (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Progress has been made in identifying and protecting habitat on public and private lands that supports PNC populations since the Federal listing of this species. However, residential and commercial development, and its infrastructure, remains a potential threat to the PNC on private lands. To date, there are no long-term conservation programs, such as conservation easements, in place for these key parcels; but, stakeholders remain optimistic that such programs may be implemented in the future. Non-government organizations continue to negotiate with private property owners to this end. A total of 40 acres have been fenced from livestock, OHV, and gravel mining activities in the Tanner Wash ACEC which has effectively reduced risks to cacti from trampling or crushing. (USFWS, 2008)

Stressor: Non-native species (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Nonnative species, most notably camelthorn (Alhagi maurorum), have been identified as a potential future threat to the PNC (pers. comm. Dr. Barbara Phillips, Zone Botanist, Coconino, Kaibab, and Prescott National Forests). Commonly observed with other nonnative invasive plant species in the southwest, camelthorn may out-compete the PNC and other native species. A secondary risk of increased ground cover caused by a nonnative species is the enhanced risk of fire. The habitat in which the PNC occurs is not fire adapted and has not experienced significant fire losses to date (pers. comm. Dr. Barbara Phillips, Zone Botanist, Coconino, Kaibab and Prescott National Forests). Camelthorn has not been identified in habitat on the mesas that is occupied by PNC, but it has been observed “down below the mesas very abundantly, however, and spreading” (pers. comm. Dr. Barbara Phillips, Zone Botanist, Coconino, Kaibab and Prescott National Forests). (USFWS, 2008)

Stressor: Herbivory (USFWS, 2008)
Exposure:
Response:
Consequence:

Narrative: Small mammalian herbivores such as rabbits and/or rodents have been observed eating PNC as vegetative preferences in diet shift in response to drought conditions (Phillips and Phillips 1997; 2004). Due to the importance of precipitation on germination and recruitment of PNC cohorts, drought conditions not only adversely affect the PNC by limiting these key life history events, but synergistically amplify adverse effects of herbivory. This has the potential to appreciably affect populations of PNC because of the inherent risks associated with this species' limited recruitment potential. Predicted warming and increased drought conditions in the southwest due to global climate change are likely to accelerate and exacerbate these effects (see discussion under 2.3.2.5, below). As stated previously, predator control may also positively influence populations of rabbits and rodents, which could heighten levels of rabbit and rodent herbivory on PNC, especially during drought conditions. However, more research is necessary to confirm these relationships. (USFWS, 2008)

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence:
Narrative: Drought is identified above as a significant concern for the conservation and recovery of the PNC. Philips and Thomas (2005) provided streamflow records that indicate that the drought Arizona experienced between 1999 and 2004 was the worst drought since the early 1940s and possibly earlier. Prolonged drought conditions have been observed in the immediate region where the PNC occurs as well as other areas statewide (Phillips and Phillips 2004). Should current drought conditions persist for several years into the future, the recovery potential for the PNC may become severely compromised. The Intergovernmental Panel on Climate Change (IPCC) stated, "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (IPCC 2007). According to 18 of 19 regional climate models, the levels of aridity of recent drought conditions and perhaps those of the 1950s drought years will become the new climatology for the southwestern United States within years or decades and annual mean precipitation levels will continue to decrease over the next century (Seager et al. 2007). Persistent drought conditions over years are likely to reduce the frequency and duration of flowering and/or germination events, lower the recruitment of individuals, compromise the viability of populations, lessen the recovery potential for this species, and therefore adversely affect the long-term persistence of the PNC. Increased risk of invasive species such as camelthorn and an associated increased risk of wildfire in PNC habitat, as well as increased herbivory by rabbits and rodents are identified threats that may be exacerbated by long-term drought conditions associated with climate change. (USFWS, 2008)

Stressor: Alternative energy (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Future alternative energy development needs to be considered a threat as well. For example, a large wind farm is located about 2 miles north of the northern and western most occurrence. (NatureServe, 2015)

Stressor: Off-highway vehicles OHVs) (NatureServe, 2015)
Exposure:

Response:
Consequence:
Narrative: The two western populations are about 1 mile east of Joseph City north of I-40 with the northern site potentially impacted by off-road highway use. (NatureServe, 2015)

Stressor: Gravel mining NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: The eastern population, is located in close proximity to a gravel mining operation. (NatureServe, 2015)

Recovery

Reclassification Criteria:
1. The protection, maintenance, and enhancement of existing natural populations. (USFWS, 1984)

2. An increase in the numbers of the cactus from the present approximately 1,000 to 10,000. (USFWS, 1984)

3. Establishment of a program to curtail collecting through enforcement and through a commercial artificial propagation program. (USFWS, 1984)

Recovery Priority Number: 6

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Removal of off-road vehicle use, livestock grazing, and mining from the habitat of populations on Federal lands. (USFWS, 1984)
- Designation of a restricted use area (ACEC) on BLM lands. (USFWS, 1984)
- Development of management plans for all populations. (USFWS, 1984)
- Protection of habitat for privately owned populations. (USFWS, 1984)
- Monitoring and study of existing populations. (USFWS, 1984)
- Development of an artificial propagation program to provide stock for reintroductions and to provide techniques for use in the commercial cactus trade. (USFWS, 1984)
- The recovery plan for this species requires revision. The number of plants and populations referenced in the current recovery plan that are required for long-term viability of the species are unrealistic and should be revised. Recovery criteria should focus on habitat protection and acquisition, seed banking, researching dispersal mechanisms, seed collection and long-term storage, as well as inclusion of this species into the Center for Plant Conservation Collection. (USFWS, 2008)
- In addition, coordination with species experts needs to occur with an emphasis on conservation planning with respect to implementation of actions in the event of continuing long-term drought. These activities may include, but are not limited to, exploring new areas

for transplants, captive propagation and reintroduction, or other means to help secure existing populations using artificial means (water supplementation, etc.). (USFWS, 2008)

- Because the known historical and current distribution of the PNC is limited, the Service views these actions as essential, in conjunction with continued management and enforcement of protection measures. The Service also recommend concerted efforts be implemented to ensure long-term viability of this species on private lands through various conservation incentive programs available to private landowners. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. If possible, given workloads, a Species Status Assessment could be conducted to guide the development of a revised recovery plan. We recommend revision of Peebles Navajo cactus recovery criteria. Specifically, the number of plants and populations referenced in the current recovery plan as necessary for long-term viability of the species are unrealistic, based on our knowledge of the species, and should be revised. The recovery criteria for downlisting and delisting should be adjusted accordingly. 2. Improve coordination with BLM and develop creative approaches to protect the Peebles Navajo cactus, including investing necessary resources in mitigating bottom-ash deposition, ensuring exclosure fences are maintained, and working with local partners to increase conservation efforts aimed at recovery the cactus. 3. Continue to survey areas within the species' revised range to verify the presence or absence of suitable habitat. Surveys should also focus on areas that may support future reintroductions of the Peebles Navajo cactus for recovery purposes. 4. Establish an off-site conservation program to develop captive propagation techniques that follow the Center for Plant Conservation best management practices. Conduct studies to evaluate the effectiveness of seed germination and seedling establishment. Establish a new population within Peebles Navajo cactus native habitat as a pilot project to ensure the taxon remains extant. 5. Develop incentives in the Tanner Wash ACEC to manage livestock grazing and OHV use or other recreational activities in a manner that does not result in habitat disturbance to the Peebles Navajo cactus. 6. Investigate the pollination system of Peebles Navajo cactus to identify and understand potential factors that are contributing to low recruitment, poor seed set, and fruit abortion. 7. Evaluate and test new technologies that improve the detection of rare, cryptic plants. 8. Implement concerted efforts to ensure long-term viability of this species on private lands through various conservation incentive programs available to private landowners. 9. Establish coordination meetings with the USFWS, BLM Safford District Office, and Museum of Northern Arizona to improve collaboration, discuss annual monitoring results, and proactive management of the cactus. 10. Develop public awareness and support for the conservation of the Peebles Navajo cactus (USFWS, 2022)..

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SPECIES ACCOUNT: *Pediocactus winkleri* (Winkler cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/20/1998; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Winkler cactus (Pediocactus winkleri) was first discovered by Agnes Winkler in the late 1960's. It is a small, sub-globose cactus. Individuals range in size from 0.5 to 7 cm tall and 0.5 to 8 cm in diameter. Stems, which are ribbed with tubercles 0.4 - 0.7 cm long, are normally solitary but may be multi-stemmed, especially if damaged. Spine-bearing areoles are borne at the apex of the tubercles. The areoles are elliptic and densely wooly pubescent with spines obscuring or partially obscuring the stem. Central spines are lacking; radial spines commonly number 9 to 11. The spines are 1.5 - 4 millimeters (mm) long. Flowers are 1.7 to 2.2 cm in length with peach to pink color. Stamens are yellow and stigmas are green. The fruit is 0.7 to 1.0 cm long with a smooth surface, initially green turning reddish-brown with age. Seeds are shiny black. For a complete technical description of the Winkler cactus, please refer to Heil (1979) and Welsh et al. (2008).

Current Range

Winkler cacti grow on fine textured alkaline soils derived primarily from the following geologic formations: Dakota, Morrison, Summerville, Entrada and Emery sandstone member of the Mancos formation (Heil 1984, Neese 1987, Clark 1998b, Clark 1999). It is generally found at elevations between 1,500 and 2,130 meters (4,900 and 7,000 feet) on rocky, alkaline hill tops and benches, and gentle slopes on barren, open sites in salt desert shrub communities. Heil (1984) describe it as typically occurring on the tops and sides of rocky hills or benches in Atriplex (saltbush) dominated desert shrub communities. Winkler cactus is endemic to Wayne, Emery and Sevier counties in south central Utah. Populations of the species occur primarily on lands managed by the Utah BLM through the Richfield Field Office and by the NPS at CRNP. The range of Winkler cactus extends approximately 48 km (30 miles) in a narrow band from Notom in central Wayne County to the Last Chance Desert in southwestern Emery County, Utah. Plants are estimated to occupy only 80 hectares (200 acres) within this band (Spector 2013b). The majority of the known populations occur on lands managed by BLM.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: ~ 14 years

Breeding Season

Adult: Flowering occurs from April through mid-May and fruits are set mid-May to June.

Reproduction Narrative

Adult: Winkler cacti are typically only above ground during the growing season. When temperatures increase in mid-February or early March and rainfall is adequate, cacti emerge from below ground to flower. The cactus stem emerges up to 5 cm above ground. Flowering occurs from April through mid-May and fruits are set mid-May to June. The specific time varies from year to year apparently due to temperature and moisture conditions of late winter and early spring. After flowering, the plants shrink back to ground surface or below defending themselves against an annual cycle of extreme heat, drought and cold. Resurfacing in the spring appears to be dependent on winter and spring moisture (Clark 1999). Winkler cactus can survive underground for up to two years during drought conditions (Clark and Clark 2008a). We do not fully understand the factors leading to dormancy in Winkler cactus. Reproduction is presumed to be primarily sexual. No research has been conducted on pollination mechanisms, pollinators or seed germination success for Winkler cactus. Work conducted on the closely related San Rafael cactus found that species to be self-incompatible and pollinated by several native bee species. Pollination of species that reproduce sexually and are self-incompatible is necessary to produce viable seeds. Seedling ecology is unknown (San Juan College 1994). Winkler cactus is a long lived species. The lifespan of Winkler cactus is unknown but we know they live at least 14 years and most likely even longer. Information from a long-term study shows that Winkler cactus can survive at least 12-14 years (Clark and Clark 2008a). We do not know how old the Winkler cacti were when they were marked for the study and we do not know how long they lived after the study ended so it is highly likely the species can live longer than 14 years.

Environmental Specificity

Adult: Alkaline soils

Habitat Narrative

Adult: Winkler cactus is endemic to specific, fine textured soils derived from the Dakota formation and Morrison formation in the lower Fremont River in Wayne County and southeast Sevier Counties of south-central Utah. It is generally found at elevations between 1,500 - 2,130 meters (m) (4,900 - 7,000 feet (ft)) on rocky, alkaline hill tops and benches, and gentle slopes on barren, open sites in salt desert shrub communities. These communities are associated with species such as Indian rice grass (Achnatherum hymenoides), blue grama (Bouteloua gracilis), curly grass (Pleuraphis jamesii), alkali sacaton (Sporobolus airoides), sand hill muhly (Muhlenbergia pungens), prickly pear cactus (Opuntia polyacantha), Mormon tea (Ephedra torreyana), little-leaf mountain mahogany (Cercocarpus intricatus), shadscale (Atriplex confertifolia), four-wing salt bush (Atriplex canescens var. canescens), phlox (Phlox spp.), locoweed (Astragalus spp.), halogeton (Halogeton glomeratus), snakeweed (Gutierrezia sarothrae), and viscid rabbitbrush (Chrysothamnus viscidiflorus). It is also found among piñonjuniper (Pinus edulis-Juniperus osteosperma) woodland stands (Clark 2008; Welsh et al. 2003). (USFWS, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

4 (USFWS, 2019)

Population Size:

5700 (USFWS, 2019)

Population Narrative:

In 2016, we documented 5,700 individual Winkler cactus in 4 populations (USFWS 2016). Since that time, five new occurrences were documented within the Park, as well as additional individuals within existing occurrences. The total number of new individuals documented within the Park since 2016 is 244 (Borthwick 2017, pers. comm.). However, the Park and the BLM also documented declines in Winkler cactus at monitoring sites 2017 and 2018, but no mortality numbers are available (Borthwick and Livensperger 2019; Rooks 2019). (USFWS, 2019)

Threats and Stressors

Stressor: Off-highway vehicle (OHV) use and other recreational activities, and impacts associated with roads (USFWS, 2015)
Exposure: Moderate
Response: Basic need inhibited/injury/mortality
Consequence:
Narrative: In summary, and based on available information regarding OHV use in Winkler cactus habitat, OHV use has a documented detrimental effect on cactus and cactus habitat. Although direct impacts from OHV appears to be low, the little amount of compliance data for OHV use on BLM and SITLA land over the entire range where Winkler cactus occurs and the proximity of significant percentages of the population to unpaved roads and OHV routes is cause for concern. Therefore, we designate the threat level from OHV use and impacts associated with roads for Winkler cactus as moderate. This level may be reassessed if more detailed OHV use and compliance data near Winkler cactus occurrences is collected showing high rates of compliance. (USFWS, 2015)

Stressor: Livestock grazing (USFWS, 2015)
Exposure: Moderate
Response: Basic need inhibited/injury/mortality
Consequence:
Narrative: In summary, the negative effects to Winkler cacti from livestock grazing increase with increasing livestock use. Very few to no cacti were recorded as trampled during low to moderate livestock activity. As livestock activity increases, so does disturbance levels near cacti (Clark 2008b). There is extremely high grazing pressure throughout the majority of the species' range. The negative impacts of livestock grazing on the species and the habitat are well documented. Additionally, livestock grazing exacerbates other threat factors (including response to drought potentially caused by climate change and predation). Therefore, we designate a high threat level to Winkler cactus from livestock grazing and trampling. This threat level may be reassessed if changes in land use and grazing pressure on Winkler cactus populations occur. (USFWS, 2015)

Stressor: Native Ungulate Disturbance (USFWS, 2015)
Exposure: Small
Response: Basic need inhibited/injury/mortality
Consequence:
Narrative: Monitoring shows that elk and deer prints near listed cacti at Capitol Reef National Park are not as severe or regularly occurring as that from livestock. Elk prints within 15 cm (5.9

in) of Winkler cacti ranged from 2-10 percent of cacti surveyed in 2011-2012. Deer prints were found within 15 cm (5.9 in) of only 1-1.7 percent of Winkler cactus (NPS 2013). Between 2011 and 2013, five survey sites in the Hartnet population within CRNP had greater than 5 percent disturbance rates by native ungulates (22-31 percent), which correlated with the survey sites that had lower amounts of disturbance by livestock. Of the 2,380 plants surveyed in CRNP between 2011 and 2013, 15 were recorded as being trampled by elk (NPS 2013). In the Hartnet population outside of CRNP and in the Notom population, native ungulate disturbance was found at only 1 percent of surveyed cacti and no damage was recorded. This discrepancy may be due to the higher elevations of some of the survey sites at CRNP. Surveys for native ungulate disturbance have not been performed at the Blue Bench population. Due to the localized nature of native ungulate impacts, we designate a low threat level for native ungulate disturbance at this time. This level may be reassessed if native ungulate patterns change or additional populations in areas of high use by native ungulates are discovered. (USFWS, 2015)

Stressor: Energy and Mineral Exploration and Development (USFWS, 2015)
Exposure: Moderate
Response: Basic need inhibited/mortality
Consequence:
Narrative: In summary, the detrimental effects of energy and mineral exploration and development are well documented, but there is a general lack of current and historic mining activity and oil and gas development within the range of the species and low potential in the foreseeable future. Therefore, we designate a low threat level for energy and mineral exploration and development on Winkler cactus at this time. Surface disturbance permitting on active mining claims or the sale of leases for fluid or non-energy solid minerals within the range in the future could cause the threat level to increase, as could discovery of additional populations in areas with more active mineral development. (USFWS, 2015)

Stressor: Road and Utility Corridor Development or Other Construction (USFWS, 2015)
Exposure: Small
Response: Basic need inhibited/mortality
Consequence:
Narrative: Unauthorized utility and road development within the Notom population of Winkler cactus caused individual plant mortality and habitat degradation in 1995 (63 FR 44587, August 20, 1998). Currently, no plans for road or utility corridor development intersect with known San Rafael or Winkler cactus populations. One construction project exists that will impact San Rafael cactus. The Natural Resources Conservation Service is proposing to raise the level of the Millsite Reservoir Dam and this will affect several individual San Rafael cacti by flooding and increased recreational impacts; however, impacts from this project to the range-wide population of San Rafael cactus will be minimal (NRCS 2015). There are many existing roads within both species' habitat, primarily unpaved. Several populations or portions of populations of both species are located directly along dirt roads. Maintenance of these roads may impact individuals and care should be taken by local authorities to avoid cactus populations when performing this maintenance. Because there is no currently pending construction, road, or utility corridor development projects within known occupied habitat of Winkler cactus and only one pending project in known occupied habitat of San Rafael cactus, we designate a low threat level for road and utility corridor development or other construction for Winkler cactus and San Rafael cactus at this time. This level may be reassessed if new projects are put forward that would impact known cacti populations, or if new populations are discovered that would be impacted by road

and utility corridor development projects. (USFWS, 2015)

Stressor: Invasive Species (USFWS, 2015)
Exposure: Moderate
Response: Basic need inhibited
Consequence:
Narrative: In summary, there is a low incidence of invasive species in cacti habitat. There is also and the lack of high risk level at this time to any particular population or portion of a population, although there is legitimate concern that predation from insects or rodents on cacti may increase in the future. (USFWS, 2015)

Stressor: Commercial and Hobby Collecting (USFWS, 2015)
Exposure: High
Response: Mortaility
Consequence:
Narrative: In summary, there is a known historic impact on these species from illegal collect. The current scale of illegal collection is unknown, although many populations have locations well known to cactus collectors. However, new sites and populations have been discovered recently which are less accessible and not well known to collectors. Therefore, we designate a moderate threat level from illegal commercial and hobby collecting for Winkler cactus and San Rafael cactus. This threat level may be reassessed if hard data on collecting activities is obtained or new methods of protection for cactus at vulnerable sites are implemented (Factor D). (USFWS, 2015)

Stressor: Small mammal and insect predation (USFWS, 2015)
Exposure: Moderate
Response: Basic need inhibited/injury/mortality
Consequence:
Narrative: In summary, despite the potential for the cactus borer beetle to impact the cacti, we have found no conclusive information to indicate that it is having an unprecedented, population level effect on Winkler cactus or San Rafael cactus. The recently documented die-offs from beetle borer may be part of the species' natural life cycle. The recent levels of recorded damage or mortality to San Rafael cactus and Winkler cactus from insects and rodents during recent surveys are relatively low. Also, the predators thus far recorded have been species native to the ecosystem. Therefore, we designate a low threat level for insect and rodent predation on Winkler cactus and San Rafael cactus at this time. This threat level will be reassessed if data shows pressure from predation to be increasing due to climate change or other factors, or that predation poses a substantial threat to particular populations. (USFWS, 2015)

Stressor: Inadequacy of Federal, State, and Local Laws and Regulations (USFWS, 2015)
Exposure: Moderate
Response: Basic need inhibited/injury/mortality
Consequence:
Narrative: In summary, existing regulatory mechanisms, secured through the ESA, have reduced some threats on Federal lands. In the absence of the ESA's protective regulatory mechanisms, we believe the threats to the species would be amplified and cause further declines to both species. There are no state laws specifically protecting the species in Utah. Without the protection of the ESA, impacts to the species from OHV use, livestock grazing, and recreational activities would likely increase. These activities can kill or damage cacti, and degrade cactus habitat. In addition,

the lack of monitoring data makes it difficult to determine the species' needs and provide long-term protection. Reducing pressure on the species from collection and unauthorized access is difficult because of limited law enforcement resources and the remoteness of the habitat. Continued efforts are needed through law enforcement and habitat protection to ensure the species is protected over the long-term and the ESA provides the legal protection to the species to enforce unauthorized harvest. We therefore determine the inadequacy of regulatory mechanisms is a moderate threat to Winkler cactus and San Rafael cactus. This threat level may be reassessed if management policies that specifically address the protection of Winkler cactus and San Rafael cactus independent of the ESA are enacted throughout significant portions of their range. (USFWS, 2015)

Stressor: Climate Change (USFWS, 2015)
Exposure: High
Response: Basic need inhibited/mortality
Consequence:
Narrative: In summary, climate change and its impacts to the region are well documented and projected to continue and increase. There was a documented decline of Winkler cactus during the 1999-2003 drought, and the similarity of San Rafael to Winkler cactus suggests a comparable response. (Clark and Clark 2008). Additionally, rare plants have a negative response to drought (Roth 2003, 2004; Van Buren and Harper 2003, 2004), and drought severity and frequency is set to increase due to climate change (IPCC 2007; Karl et al. 2009). Therefore, we designate a high threat level from global climate change on Winkler cactus and San Rafael cactus. There are uncertainties in our threat evaluation since downscaled climate projections are not available for our specific location, and a vulnerability assessment has not been performed for these species. We will re-assess the degree of threat climate change poses when more specific information becomes available. (USFWS, 2015)

Recovery

Delisting Criteria:
P-1. Based on analysis and modeling implemented under the recovery actions trends for San Rafael cactus and Winkler cactus populations are shown to be stable or improving according to the following measures: Species presence is maintained at all known Winkler cactus populations and (1) These criteria must be met for all known Winkler cactus populations due to the low number of known populations at this time. If additional Winkler cactus populations are discovered in the future, it may be determined that delisting is appropriate even if some populations are not stable or increasing, and (2) Predictive modeling using data from an additional 10-year period (30 years total), collected in accordance with a standardized monitoring protocol, provides an indication of long-term demographic stability as well as a projected survival probability of at least 95 percent over 100 years for each species. (USFWS, 2015)

T-1. Federal land protection through long-term management agreements or plans is achieved for all known Winkler cactus populations. Protection considerations from grazing impacts, development, mining, oil and gas, and recreation must be included in the management agreements and the protected areas must meet the size and connectivity parameters determined through research to be adequate to sustain those populations. These may include but are not limited to resource management plans, conservation agreements, recreation

management plans, and travel management plans. (USFWS, 2015)

P-2. Based on best available data, the available habitat base for each recovery population of each species is of sufficient quality and large enough to allow for natural population dynamics, population expansion where needed, and the continued presence of pollinators, with sufficient connectivity to allow for needed gene flow within and, where possible, among populations. (USFWS, 2015)

T-2. Management agreements or plans in place and being implemented for all Winkler cactus populations on all federal lands must include measures to address and curtail illegal collection activities. These plans should include criteria for appropriate law enforcement at correct times and places to prevent illegal collection and sales of plants or any plant parts. (USFWS, 2015)

T-3. Adverse population-level effects from herbivory, disease, or predation, if any, are identified, monitored and abated to the extent that all known Winkler cactus population trends are stable or increasing, as evidenced by demographic monitoring results from studies that have adhered to monitoring protocols developed under recovery action 2.4. Programs to control excessive herbivory or predation will be developed to adaptively manage each population per criterion P-3, and must take into consideration the degree which climate change may impact disease or herbivory levels in the future. (USFWS, 2015)

T-4. Land protection covering the habitat of all populations for each species and/or statutory and regulatory protections for plants are such that the protections of the ESA are no longer needed to compensate for regulatory inadequacies. (USFWS, 2015)

T-5. A long-term ex-situ conservation program is ongoing for all extant Winkler cactus populations. This would include seed collection and storage, germination and viability trials, and development of a protocol for successful reproduction under greenhouse conditions. This would help avert the risk of extinction from stochastic events or environmental catastrophes. (USFWS, 2015)

T-6. In conjunction with recovery criterion P-2, the available habitat base for each of the populations designated under criterion P-1 is of sufficient quality and large enough to offset the threat of loss or restriction of the species' pollinators and impacts from climate change, if feasible. Effective measurement criteria will be developed through research under Recovery Action 3. (USFWS, 2015)

Recovery Actions:

- Protect and conserve known extant Winkler cactus and San Rafael cactus populations and their habitat.
- Survey for additional populations, and monitor all populations in order to apply conservation measures where and when needed.
- Conduct in depth research into the biology, requirements, threat responses, and life histories of both species in order to develop and implement appropriate management practices for the purposes of achieving recovery.
- Promote communication by encouraging and creating dialog regarding these species between managing agencies, land owners, developers, and the public in order to raise awareness and aid recovery.

- Coordinate and work together with all stakeholders to achieve recovery.

Conservation Measures and Best Management Practices:

- Recommended future actions: We recommend rangewide surveys of known populations for Winkler cactus and San Rafael cactus, and that survey results be used to compile a robust, updated population estimate. Additional research that provides a better understanding of current population demographics, population trends, and the impact of and response to the primary threats is vital to evaluating these species' status in the future and to developing updated and meaningful recovery criteria and actions. The designation and management of protected areas that reduce impacts from identified threats may be necessary to facilitate this species' recovery. Additionally, we recommend updating and finalizing the draft recovery plan and specifically reevaluating the recovery goals and criteria based on new population numbers, habitat requirements, connectivity analysis, and recent and upcoming changes in management and conditions that may result in changes to threat intensity and scope. (USFWS, 2019)

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SPECIES ACCOUNT: *Penstemon debilis* (Parachute beardtongue)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A mat-forming perennial herb with thick, blue-green leaves, each about 2 cm long and 1 cm wide. Funnel-shaped, white to pale lavender flowers bloom June-July (NatureServe, 2015).

Taxonomy

Parachute beardtongue was discovered in 1986, and was first described by O'Kane and Anderson in 1987 (USFWS, 2016). Traditionally, the genus Penstemon was included in the Scrophulariaceae (figwort) family. However, Penstemon is now considered to be within the Plantaginaceae (plantain) family due to recent research using DNA sequences (Oxelman et al. 2005, p. 415) (USFWS, 2013).

Historical Range

The historical range and distribution for this species is unknown (USFWS, 2016). Penstemon debilis is endemic to Garfield County, Colorado (NatureServe, 2015).

Current Range

All of the currently known occurrences occupy about 91.8 ac (37.2 ha) on the Green River geologic formation in Garfield County, Colorado (USFWS, 2016).

Critical Habitat Designated

Yes; 8/13/2012.

Legal Description

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Penstemon debilis (Parachute beardtongue) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

Critical Habitat Designation

The critical habitat designation for Penstemon debilis includes four CHUs in Garfield County, Colorado. This species critical habitat encompasses approximately 15,510 acres (ac) (6,277 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Brush Mountain Unit, consists of 1,437 ac (582 ha) of federally owned lands, managed by BLM through the Grand Junction Field Office. It is located approximately 16 mi (26 km) northwest of the town of DeBeque in Garfield County, Colorado. It is northwest of the intersection of Roan Creek Road (County Road 204) and Brush Creek Road (County Road 209). This Unit is not currently occupied. This Unit has all the physical and biological features essential to the conservation of the species, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent plant cover, suitable elevational ranges of 6,234 to 8,222 ft (1,900 to 2,506 m), outcrops of the Parachute Creek Member of the Green River Formation, steep slopes of these soil outcrops that lend to the

appropriate disturbance levels, pollinator habitat, and a climate with between 12 to 18 in. (30 and 46 cm) in annual rainfall and winter snow. Because of the presence of these features, we believe this may make a good introduction area for Penstemon debilis in the future and is needed to ensure conservation of the species. The primary threat to Penstemon debilis in this Unit is energy development and associated activities. Penstemon debilis consists of only 4,100 known individuals (little redundancy), and all occur within 2 concentrated areas (little resilience). For adequate redundancy and resiliency, we believe it is necessary for survival and recovery that additional populations be established. Therefore, we have identified this Unit as critical habitat for P. debilis.

Unit 2, the Cow Ridge Unit, is 4,819 ac (1,950 ha) of federally owned lands managed by BLM through the Grand Junction Field Office. It is located approximately 8 mi (13 km) northwest of the town of DeBeque in Garfield County, Colorado, and north of Dry Fork Road. This Unit is not currently occupied. This Unit has all the physical and biological features essential to the conservation of the species, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent cover, suitable elevational ranges of 6,273 to 8,284 ft (1,912 to 2,525 m), outcrops of the Parachute Creek Member of the Green River Formation, steep slopes of these soil outcrops that lend to the appropriate disturbance levels, habitat for pollinators, and a climate with between 12 to 18 in (30 and 46 cm) in annual rainfall and winter snow. Because of the presence of these features, we believe this may make a good introduction area for Penstemon debilis in the future and is needed to ensure conservation of the species. The primary threat to Penstemon debilis in this Unit is energy development and associated activities. Penstemon debilis consists of only 4,100 known individuals (little redundancy) and all within 2 concentrated areas (low resilience). For adequate redundancy and resiliency, we believe it is necessary for survival and recovery that additional populations be established. Therefore, we have identified this Unit as a CHU for P. debilis.

Unit 3, the Mount Callahan Unit, consists of 4,369 ac (1,768 ha) of Federal and private land. It is located approximately 2 mi (3 km) west of the town of Parachute on the south-facing slopes of Mount Callahan and westward along the cliffs of the Roan Plateau. Fifty-five percent of Unit 3 is managed by the BLM under the management of two field offices: 80 Percent of these Federal lands are managed by the Colorado River Valley Field Office and 20 percent are managed by the Grand Junction Field Office. Oxy has been a partner in the conservation of Penstemon debilis since 1987. We have excluded all Oxy lands based on: (1) This continuing partnership, (2) existing CNA Agreements (674 ac (273 ha)) for two CNAs (the Mount Callahan and Mount Callahan Saddle), (3) commitments to create a third CNA (the Logan Wash Mine Natural Area) totaling 82 ac (33 ha), (4) already-implemented and further commitments to develop Best Management Practices for the CNAs as well as other adjacent lands, and (5) commitments on Oxy lands to conserve newly discovered P. debilis populations with more than 75 individuals. This exclusion totals 3,350 ac (1,356 ha). These exclusions are discussed in further detail below under Exclusions. Three percent of this Unit falls on private lands. This Unit is currently occupied. Once Oxy lands were excluded, four parcels (two BLM and two private) of land remained along the northern edge of the CHU, as proposed. We have elected not to include three (both BLM and one of the two private parcels) of these four parcels in our critical habitat designation because: (1) They would be isolated from the rest of Unit 3; (2) they contain no suitable habitat for Penstemon debilis (only pollinator habitat); (3) the pollinator and habitat protection measures on Oxy lands will provide adequate protections for the pollinators on their lands, making these three parcels less important; and (4) they are distant (at least 2,133 ft (650 m)) from occupied

and suitable habitat; and (5) we believe they are not necessary for the conservation of the species. The remaining private parcel (137 ac (55 ha)) is closer to occupied habitat, contains suitable habitat, and, therefore, is included in our critical habitat designation. This Unit currently has all the physical and biological features essential to the conservation of Penstemon debilis, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent cover, suitable elevational ranges of 5,413 to 8,809 ft (1,650 to 2,685 m), outcrops of the Parachute Creek Member of the Green River Formation, suitable pollinators and habitat for these pollinators, steep slopes of these soil outcrops that lend to the appropriate disturbance levels, and a climate with between 12 to 18 in (30 and 46 cm) in annual rainfall and winter snow. The primary threat to Penstemon debilis and its habitat in this Unit is energy development and associated activities.

Unit 4, the Anvil Points Unit, consists of 4,885 ac (1,977 ha) of Federal and private land. It is located approximately 1 mi (2 km) north of the town of Rulison in Garfield County, Colorado. Seventy percent of this Unit is managed by the BLM, Colorado River Valley Field Office. Twenty-three percent of the Unit (1,102 ac (446 ha)) is within several potential BLM Areas of Critical Environmental Concern (ACECs). If these become ACECs, they would have several stipulations to protect Penstemon debilis, particularly from oil and gas development. These areas are discussed further in the proposed (75 FR 35732; June 23, 2010) and final listing rules (76 FR 45054). Thirty percent of this Unit is on private lands. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of Penstemon debilis, including the Rocky Mountain Cliff and Canyon plant community (NatureServe 2004, spatial data) with less than 10 percent plant cover, suitable elevational ranges of 6,318 to 9,288 ft (1,926 to 2,831 m), outcrops of the Parachute Creek Member of the Green River Formation, suitable pollinators and habitat for these pollinators, steep slopes of these soil outcrops that lend to the appropriate disturbance levels, and a climate with between 12 to 18 in (30 and 46 cm) in annual rainfall and winter snow. The primary threat to Penstemon debilis and its habitat in this Unit is energy development and associated activities. This Unit falls within the boundary of the BLM's Roan Plateau RMP. The RMP has two lease stipulations that directly address endangered, threatened and candidate plants. A no surface occupancy lease stipulation (NSO-12) protects occupied habitat and adjacent potential habitat from ground disturbing activities, with narrow exceptions. A controlled surface use stipulation (CSU-12) protects special status plant species and plant communities by authorizing BLM to impose special design, operation, mitigation and reclamation measures, including relocation of ground disturbing activities by more than 200 meters, with some exceptions. Special management considerations and protections are thus contemplated.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Penstemon debilis critical habitat consists of five components (77 FR 48356-48415):

(i) Suitable soils and geology. (A) Parachute Member and the Lower Part of the Green River Formation. (B) Appropriate soil morphology characterized by a surface layer of small to moderate shale channers (small flagstones) that shift continually due to the steep slopes and below a weakly developed calcareous, sandy to loamy layer with 40 to 90 percent coarse material.

(ii) Elevation and climate. Elevations from 5,250 to 9,600 ft (1,600 to 2,920 m). Climatic conditions similar to those of the Mahogany Bench, including suitable precipitation and temperatures.

(iii) Plant community. (A) Barren areas with less than 10 percent plant cover. (B) Other oil shale endemics, which can include: Mentzelia rhizomata, Thalictrum heliophilum, Astragalus lutosus, Lesquerella parviflora, Penstemon osterhoutii, and Festuca dasyclada. (C) Presence of Penstemon caespitosa for support of pollinators and connectivity between sites.

(iv) Habitat for pollinators. (A) Pollinator ground, twig, and mud nesting areas. Nesting and foraging habitats suitable for a wide array of pollinators and their life-history and nesting requirements. A mosaic of native plant communities and habitat types generally would provide for this diversity (see paragraph (2)(iii) of this entry). These habitats can include areas outside of the soils identified in paragraph (2)(i) of this entry. (B) Connectivity between areas allowing pollinators to move from one population to the next within units. (C) Availability of other floral resources such as other flowering plant species that provide nectar and pollen for pollinators. Grass species do not provide resources for pollinators. (D) A 3,280-ft (1,000-m) area beyond occupied habitat to conserve the pollinators essential for plant reproduction.

(v) High levels of natural disturbance. (A) Very little to no soil formation. (B) Slow to moderate but constant downward motion of the oil shale that maintains the habitat in an early successional state.

Special Management Considerations or Protections

The features essential to the conservation of this species (plant community and competitive ability, elevation, slope, soils, climate, reproduction, and disturbance regime) may require special management considerations or protection to reduce threats. Extremely low numbers and a highly restricted geographic range make Penstemon debilis particularly susceptible to becoming endangered in the foreseeable future. Threats to the species and its habitat include energy development, road maintenance, and inadequacy of existing regulatory mechanisms (76 FR 45054). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): The introduction of new Penstemon debilis populations; the establishment of permanent conservation easements or the acquisition of land to protect the species on private lands; the continuation and adequate management of P. debilis through the CNA Agreement with Oxy (see Exclusions section below); regulations and/or agreements that balance conservation with energy development in areas that would affect the species and its pollinators; the designation of protected areas with specific provisions and protections for the plant; the elimination or avoidance of activities that alter the morphology and status of the shale slopes; and avoidance of placing roads in habitats that would affect the plant or its pollinators. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, maintaining or restoring plant communities and natural levels of competition, protecting the plant's reproduction by protecting its pollinators, and managing for appropriate levels and types of disturbance.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination (USFWS, 2016); asexual: vegetative (inferred from NatureServe, 2015)

Lifespan

Adult: Long-lived (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Osmia brevis (NatureServe, 2015)

Breeding Season

Adult: June - July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Bee pollinators, several months of moist chilling (NatureServe, 2015)

Reproduction Narrative

Adult: This species is long-lived and thought to be slow to reach reproductive maturity. It is also thought that species with these life history characters have low reproductive rates (O'Kane and Broderick 2004). Penstemon debilis flowers from mid-June to mid-July (Scheck 1994) and fruits in mid July - August (CNHP 1998). The plants are bee pollinated and Osmia brevis is the primary pollinator. Amy McMullen at Utah State University is currently researching the biology of P. debilis. The following was compiled from her 1997 field season findings, unless otherwise stated: P. debilis requires several months of moist chilling to break dormancy. Breeding system experiments found low fruit production. This species does seem to be well adapted to its habitat, producing long rhizomes in response to a shifting substrate (NatureServe, 2015). Parachute beardtongue plants require cross pollination, and have many different pollinators that vary between occurrences (USFWS, 2016).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Parachute Creek Member of the Green River Formation (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: < 10% plant cover, > 15% slope, shifting slopes that maintain early successional habitat (USFWS, 2012); high insolation (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 5,250 to 9,600 ft. elevation (USFWS, 2013); > 10% plant cover (inferred from USFWS, 2012)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Inhabits oil shale outcrops, on south-facing, steep white shale talus on the Mahogany Zone of the Parachute Creek Member of the Green River Formation. The substrate is a mixture of thin shale fragments and clay. The barren, white surface of the slopes creates a very high insolation. Vegetation is sparse but other species, including at least 4 other oil shale endemics, occur as scattered individuals on the slopes. Associated species include: Agropyron spicatum, Cercocarpus montanus, Chrysothamnus viscidiflorus, Cymopterus hendersonii, Eriogonum lonchophyllum, Galium coloradoense, Holodiscus dumosus, Machaeranthera grindeliodes, Monardella odoratissima, Astragalus lutosus, Festuca dasyclada, Mentzelia argillosa, Thalictrum heliophilum (O'Kane and Anderson 1987), Penstemon caespitosus, and P. mensarum (A. McMullen, pers. comm. 1998). The environmental specificity is narrow; the substrate is relatively common in the region, but the plant is rare and may have other specific requirements (NatureServe, 2015). The Service has identified a suitable elevation range from 5,250 to 9,600 ft. (1,600 to 2,920 m) that allows for pollinator habitat and changing climate (77 FR 48368) (USFWS, 2013). Sparse vegetation (with less than 10 percent plant cover), assembled of other oil shale specific plants, including P. caespitosus, and not dominated by any one species; moderate to steep slopes, generally over 15 percent slope; slow to moderate, but constant, downward motion of the oil shale that maintains the habitat in an early successional state are physical or biological features for this plant (USFWS, 2012).

Dispersal/Migration

Dispersal

Adult: Low (inferred from USFWS, 2016)

Dispersal/Migration Narrative

Adult: Parachute beardtongue plants produce a small number of seeds that are dispersed by gravity (USFWS, 2016).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

10 - 30% decline (NatureServe, 2015)

Representation:

Representation describes the ability of a species to adapt to changing environmental conditions. A genetic study of the species suggests moderate levels of inbreeding, but no inbreeding depression (Wolfe et al. 2014). Genetic diversity among subpopulations is moderate. However, diversity within subpopulations is low, suggesting that the smaller, more isolated subpopulations may be at risk for inbreeding depression. The small geographic area and nearly identical geological substrate where Parachute beardtongue is found suggests that subpopulations exhibit little ecological variability and the species may not tolerate changes in habitat or climatic conditions. Therefore, maintaining genetic diversity within and among

subpopulations is especially important to preserve Parachute beardtongue representation. (USFWS, 2020)

Redundancy:

Redundancy describes the number and distribution of the populations and the ability of a species to withstand catastrophic events. Species with a greater number of populations that are more widely distributed are generally at lower risk to catastrophic events than species with fewer populations that are closely distributed. The six subpopulations of Parachute beardtongue we see today are what remain of a once larger continuous population. They are distributed across a very small geographic range, where a catastrophic event could impact multiple subpopulations. (USFWS, 2020)

Number of Populations:

5 subpopulations (USFWS, 2024)

Population Size:

4,546 individual plants rangewide (USFWS, 2024)

Adaptability:

Low (inferred from USFWS, 2013)

Population Narrative:

There are six known subpopulations of Parachute beardtongue, with an estimated total of 6,954 - 7,404 individual plants rangewide. Of the six known subpopulations of Parachute beardtongue, two have low resiliency and four are considered to have moderate resiliency. The small subpopulation sizes of Anvil Points Transplant Site and Mount Logan Road (one and three plants, respectively) play a large role in the low resiliency of these two subpopulations. The Mount Callahan subpopulation contains the vast majority of plants with an estimated 81 to 86 percent of the entire rangewide population. Although this subpopulation has more than 500 individuals, pollinator connectivity is low, average annual precipitation is low, and average annual temperature is moderate. (USFWS, 2020). The largest effort that has occurred for Parachute beardtongue since the 2019 5-year status review is the implementation of small Unmanned Aerial Systems (sUAS; drone) surveys for the Parachute beardtongue across the five occupied populations and the discovery of two new populations using those drone surveys. These efforts were conducted by CNHP, Aridlands, and EcoloGIS. These survey efforts were explored in 2019 but were not fully implemented until 2020 and 2021, in which drone surveys were flown over current occupied habitat and several areas of potentially suitable habitat based on similar geological characteristics. Drone surveys are particularly useful for surveying this plant species because of the cliffy, often inaccessible habitats upon which it grows. The sUAS took over 60,000 red, green, blue (RGB) photos, and 40,000 multispectral photos, that were then processed to identify 4,546 individual Parachute beardtongue across the study sites, including new detections in existing populations at Mount Logan, Logan Wash Mine, and Anvil Points. New detections in new populations were found at the Red Pinnacle and Anvil Creek study areas, where the group found 426 and 218 individuals, respectively. Abundance results from the drone surveys, when compared to an existing photo quadrat method, were found to be statistically significantly different, indicating that the drone surveying method, while useful for monitoring Parachute beardtongue, especially in remote populations, cannot provide complete census population estimates at a site (Swayze and Handwerk 2022) (USFWS, 2024).

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Natural gas wells on Mt. Callahan and the Mt. Callahan Saddle have been developed and managed according to Natural Areas agreements and best management practices, which have been effective in avoiding impacts to the plants and habitat (see II. C.). These 2 natural areas support 40 percent of the occupied habitat and 69 percent of the plants. The Smith Gulch population is not included in the Natural Areas agreement or the designated critical habitat. It has 15 percent of the occupied habitat and about 1 percent of the plants (76 FR 45064). The persistence of plants in Smith Gulch near a well pad on BLM land is uncertain because the plants are subject to natural erosion within an ephemeral (short-lived) streambed (USFWS, 2013).

Stressor: Oil shale extraction and mine reclamation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Anvil Points mine and Logan Wash mine were oil shale mines, which are now closed. Logan Wash mine road maintenance and reclamation activities have impacted habitat and destroyed plants on private and BLM land, and some of these activities are ongoing (76 FR 45054, CNAP 2012, p. 3) (USFWS, 2013).

Stressor: Vehicle access through occupied habitat (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Continuing use of the Anvil Points mine road to access a Garfield County communications facility prevents natural reclamation of the road by young plants on shifting shale. The road cuts through the middle of this largest population of plants on BLM land (USFWS, 2013).

Stressor: Climate change, drought, and impacts to the vegetative community (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Climate change is likely to affect long-term survival of native species, including beardtongue, especially if longer or more frequent droughts occur. However, species' response to climate change are complex and current information does not allow strong conclusions regarding the effects of climate change on Parachute beardtongue. Critical habitat for this species has been extended 328 ft. (100 m) upward and downward from the known occupied range in an attempt to provide areas where the plant could migrate, given shifting climates (77 FR 48368) (USFWS, 2013).

Stressor: Invasive species (USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: Invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). An invasion of large thistles among the beardtongue plants was observed one year on the bank above the Logan Mine road (USFWS, 2013).

Recovery

Reclassification Criteria:
Not available - recovery plan not yet developed.

Recovery Priority Number: 8C.

Delisting Criteria:
1. At least four subpopulations of Parachute beardtongue maintain stable or increasing growth rates (lambda equal or greater than 1), as described below: a. Four subpopulations of Parachute beardtongue maintain a stable or increasing growth rate (lambda equal or greater than 1) over a consecutive 10-year period. The abundance of Parachute beardtongue may fluctuate within individual sites, but overall, each subpopulation would have a stable or increasing growth rate over the 10-year time period. This 10-year period may start retroactively if existing monitoring data can be used to inform a consecutive 10-year period. b. Subpopulations used to meet this criterion could be any of the currently known subpopulations (the Anvil Points, Logan Wash Mine and Natural Area, Mount Callahan Natural Area, and Mount Callahan Saddle Natural Area subpopulations), or any new subpopulations identified through surveys and monitoring (Recovery Actions 1 and 4, below). Any new subpopulations that are discovered and used to meet this criterion must also maintain a stable or increasing growth rate over a consecutive 10-year time period, as described above under Criterion 1a. (USFWS, 2022)

Recovery Criterion 2: 2. At least four subpopulations, including the four subpopulations used to achieve Criterion 1, meet or exceed abundance estimates of at least 500 Parachute beardtongue individuals over the entire same 10-year time period applied to Criterion 1 (USFWS, 2022).

Recovery Criterion 3: 3. At least four subpopulations, including the four subpopulations used to achieve Criterion 1, have regulatory mechanisms or other protective measures in place that reduce or ameliorate threats to the Parachute beardtongue associated with habitat loss and fragmentation such that Parachute beardtongue habitats in each of the four identified subpopulations are of sufficient quantity and quality to support the demographic thresholds identified under Criteria 1 and 2. Examples of regulatory mechanisms or protective measures could include, but are not limited to, designated management areas, conservation plans, conservation easements, and conservation agreements (USFWS, 2022)

Recovery Criterion 4: 4. All known subpopulations, including currently known subpopulations and any newly discovered subpopulations, of Parachute beardtongue are represented in at least one exsitu (off site) seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004, entire). The ex-situ seed collection should be updated to represent genetic diversity across the range of the species if and when new subpopulations are discovered (USFWS, 2022).

Recovery Actions:

- Completion of a comprehensive plant survey on suitable habitat throughout the species' range (USFWS, 2013).
- Continue ongoing trend monitoring efforts and expand monitoring to include areas impacted by reclamation activities and invasive species (USFWS, 2013).
- Identify sites in urgent need of habitat protection, set protection priorities, and implement protective measures. Land management agencies should establish formal land management designations and stipulations to provide for long-term protection of important populations and habitat (USFWS, 2013).
- Oil and gas leasing and oil shale extraction activities should avoid occupied, critical, and suitable habitat (USFWS, 2013).
- Closed oil shale mines in plant habitat should remain closed (USFWS, 2013).
- Develop and implement standard conservation recommendations to minimize future project and use impacts on both private and federal lands (USFWS, 2013).
- Coordinate with land management agencies, project proponents, private landowners and other partners early in the planning process to limit direct and indirect impacts of planned activities (USFWS, 2013).
- Continue to implement Colorado Natural Areas agreements and extend best management practices for habitat adjacent to the CNAs to protect pollinators and habitat (USFWS, 2013).
- The Garfield County communications site on Anvil Points mine road should be moved out of occupied habitat and the site reclaimed in a manner that will allow recolonization of Parachute beardtongue (USFWS, 2013).
- Continue research into Parachute beardtongue life history and ecology, including pollinators (USFWS, 2013).
- Experiment with propagation techniques, soil (shale) and habitat conditions, and management needed to maximize the success of Parachute beardtongue introduction efforts with seeds, soil seed banks, seedlings, and transplants (USFWS, 2013).
- Study population dynamics and conduct a population viability analysis (USFWS, 2013).
- Encourage investigations that project the species' vulnerability and response to climate change (USFWS, 2013).
- Monitor changes in invasive species prevalence and impacts on Parachute beardtongue; explore approaches to minimize the risk posed by invasives and associated remediation actions (USFWS, 2013).
- Oil and gas development, reclamation or other activities on the Natural Areas will be conducted in accordance with best management practices (BMPs) included in the agreement. Termination of the agreements must be preceded by 2 years notice. These BMPs include specific provisions to minimize impacts to the species, pollinators, and habitat by the following measures: • Controlled collection of plant materials • Controlled surface disturbances • Reclamation and revegetation • Updated rare plant surveys, monitoring, and reporting • Noxious and invasive weed management and revegetation • Pollinator promotion –maintenance of nesting habitat • Placement of surface facilities • Fugitive dust control (USFWS, 2013).
- At Anvil Points mine BLM worked with the Service and contractors to minimize impacts to plants during closure of several mine tunnel openings, transplant unavoidable individuals, and monitor the effects to plants and habitat. One section of the road through plant habitat was ripped up to make it impassable to vehicles. The majority of transplants survived, some marked plants were buried by sliding shale, and the ripped road surface is not being

recolonized because too much soil is mixed in with the shale (DeYoung 2012, pers. comm.) (USFWS, 2013).

- Surveys and monitoring of plants at the Mt. Callahan populations and Anvil Points mine are conducted annually. Surveys at Logan Wash mine may not be complete; monitoring is not yet implemented. The current draft BMPs for Logan Wash may differ from those at Mt. Callahan because reclamation must continue around the mine site. In 2008, BLM designated the Anvil Points Area of Critical Environmental Concern (ACEC), as an area for management of sensitive resources including Parachute beardtongue (BLM 2008b, p. 4) (USFWS, 2013).
- Priority 1 Actions 1. Maintain or expand at least four viable Parachute beardtongue subpopulations. The total of four subpopulations may include any of the currently known subpopulations (Anvil Points, Logan Wash Mine and Natural Area, Mount Callahan Natural Area, Mount Callahan Saddle Natural Area), or any new subpopulations that may be discovered (Criteria 1, 2, and 3). 1.1. Analyze recovery potential of subpopulations and prioritize according to recovery potential. 1.2. Conduct research and develop biologically-relevant avoidance buffers and surface disturbance caps to protect plants, subpopulations, habitat function, and seedbanks. 1.3. Develop or improve conservation measures specifically for Parachute beardtongue in land management plans and other protective agreements or plans to reduce habitat loss and fragmentation. 1.4. Restore habitats or develop new habitats. 1.5. Develop and implement a rangewide strategy for subpopulation augmentation and introductions, if necessary. This action should be considered if subpopulation decline or loss has occurred. 2. Monitor all subpopulations (Criteria 1 and 2). 2.1. Develop standardized methodology for data collection and analysis. 2.2. Determine subpopulation abundance and trends. 2.3. Monitor quantity and quality of available habitat. 2.4. Evaluate stressors (USFWS, 2022).
- Priority 2 Actions 3. Develop ex-situ (off-site) collections of seeds and tissues to preserve Parachute beardtongue's genetic diversity (representation) and provide the capability to augment existing subpopulations or introduce new subpopulations in the wild, if necessary (Criterion 4). 3.1. Select and contract with organizations to collect and preserve seeds and tissues. 3.2. Investigate seed viability, germination requirements, and tissue propagation. 4. Survey for additional subpopulations of Parachute beardtongue (Criteria 1 and 2). 4.1. Perform surveys of suitable habitat to inform land management, project planning, and recovery efforts (USFWS, 2022).
- Priority 3 Actions 5. Maintain consistency and momentum of conservation efforts for Parachute beardtongue through Service communication and collaboration across jurisdictions and agencies with partners and stakeholders (Criteria 1, 2, 3, and 4). 5.1. Conduct meetings (virtual or in-person as appropriate) a minimum of twice yearly. 5.2. Complete and share status reports with partners (USFWS, 2022)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: We recommend updating the SSA report (Service 2020, entire) to incorporate the addition of new populations and the likely extirpation of the Anvil Points Mine Transplant Site population. Additionally, an examination of the metrics used to assess population resiliency may lead to improvements in this analysis. Other future actions could be to expand drone surveying across more suitable habitat, monitoring with drones, and conducting trend monitoring in more populations using drones or photo quadrats to better understand abundance trends across the range (USFWS, 2024).

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SPECIES ACCOUNT: *Penstemon haydenii* (Blowout penstemon)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/01/1987; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

The blowout penstemon (Penstemon haydenii), a member of the snapdragon family, is a hairless perennial that grows 1 to 2 feet high. The stems are often decumbent, simple, or branched, and very leafy. The stem leaves are linear to lanceolate, entire, 3 to 5 inches long by 1 to 3 inches wide, sessile and clasping. The inflorescence is a compactly crowded thyrse. A thyrse is composed of (1) a main axis of an inflorescence made up of flowers born on stalks of about equal length along an elongated axis that continues to grow during flowering and open in succession from below and (2) secondary and later axes of the inflorescence that terminate in single flowers. Floral bracts are ovate to lanceolate, nearly equaling the flowers. The corolla is milky blue to pale lavender (rarely pink or white) and 1.5 to 2 inches long. The sterile staminode is glabrous and/or hairy. Fruits are 0.5 to 0.6 inch long capsules, acute, with light brown, disc-shaped seeds having winged margins (Heidel 2005, USFWS 1987).

Current Range

Blowout penstemon is a regional endemic of the Nebraska Sandhills, the largest sand dune system in North America, located in north central Nebraska (Stokes and Swinehart 1997, Forman et. al 2001). The Nebraska Sandhills is an area of stabilized sand dunes covering 5 million hectares (approximately 12.4 million acres). In 2008, 32 blowout penstemon subpopulations (10 native and 22 introduced) were known to occur in the Sandhills (Stubbendieck 2008). In Wyoming, 3 populations (in addition to 6 subpopulations) of blowout penstemon are located in the Ferris Dunes of northwestern Carbon County, separated from the Nebraska Sandhills by about 175 miles (282 km). The Ferris Dunes cover an area less than 124,000 hectares (50,000 acres). See Figure 1 Geography below.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: flowers from mid-May to late June in Nebraska

Reproduction Narrative

Adult: The species flowers from mid-May to late June in Nebraska. The flowers have a strong, persistent fragrance that lures several kinds of bees and other pollinators. The fruit (capsule) matures and splits in early to mid-August and the seeds either fall near the base of the plant or are transported primarily by wind to other areas within the blowout or outside of the blowout. All healthy flowering plants are thought to produce seed (USFWS 1992). Most blowout penstemon plants begin to bloom at 2 to 3 years of age (Stubbendieck et al. 1993) and have been successfully cultivated in the greenhouse (Flessner and Stubbendieck 1989, 1992).

Flowering in Wyoming occurs later than in Nebraska (late June to early July), probably in response to drier and cooler climatic conditions (Fertig 2001). Each fruit of the blowout penstemon contains an average of 25-35 seeds with as many as 1500 seeds per plant. The seeds are winged presumably to aid in wind dispersal although, given the high degree of herbivory of this plant, some questions have been raised that animals might also be an important avenue of seed dispersal (Heidel 2005). Seeds are released from late August through September. The seeds, potentially remaining dormant in the sand for 20 years, have a thick outer coat and germination is enhanced after some degree of scarification. Axillary root branching may be an adaptation to survive burial by wind-blown sand rather than a common form of reproduction. By digging around individual blowout penstemon plants, Heidel (2005, 2012) did not find evidence of long-distance underground connectivity between adjacent plants.

Habitat Type

Adult: Sand dunes

Environmental Specificity

Adult: Very Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Characterized as a "primary" blowout species (Pool 1914) on active sand dunes in Nebraska sandhills prairie (Stubbendieck et al. 1989, Kuchler 1964). The term 'blowout' refers to a naturally occurring depression in the Nebraska Sandhills. These depressions are caused when vegetation at the upper slope of a hill is disturbed, typically by fire or grazing animals. The 'blowout' may take as many as ten years to be come a full scale and active blow out. The process is started when sand is deposited from the windward side of the slope to the leeward side, and this process continues until eventually the roots of the surrounding vegetation are exposed and finally ripped up by the force of the wind. Eventually, a crater is created where there is constant wind action, so succession is continually taking place (Stubbendieck et al. 1989). For a detailed description of blowout ecology, see Stubbendieck et al. (1989). Penstemon haydenii occurs within the blowout usually near the leeward side only after the sand has stabilized, and it declines once vegetation is established.All sites have less than 10% basal ground cover (Heidel 1981). Initial colonization of dunes is by Redfieldia flexuosa. Psoralea lanceolata is locally common where P. haydenii is found (Heidel 1981). Other common associates include: Andropogon hallii, Artemisia campestris, Asclepias arenaria, Astragalus longifolia, Calomovilfa longifolia, Cirsium plattensis, Helianthis spp., Hymenopappus corymbosus, Lathyrus polymorphus, Linum sulcatum, Lithospermum incisum, Lygodesmia rostrata, Oenothera serrulata, Oryzopsis hymenoides, Petalostemum villosum, Rume venosus, Tradescantia occidentalis, and Yucca glauca (Heidel 1981; Lichvar 1982). (NatureServe, 2015). Blowout penstemon was first collected along the North Loup River in the Sandhills area of Nebraska by Ferdinand V. Hayden, probably in 1857 (Sutherland 1988). This specimen was without flowers or fruits and was referred to as sharp leaf penstemon, Penstemon acuminatus. Senero Watson originally named and described the species as Penstemon haydeni, based on a collection made by H. L. Webber near the Dismal River in Thomas County, Nebraska in 1891 (Watson 1891). Later, Francis W. Pennell could not locate the original 1857 Hayden specimen, and he substituted the Webber specimen as the type collection (Pennell 1920). Both the Hayden specimen and type specimen were deposited at the Gray Herbarium at Harvard. A second "i" was later added to the specific epithet "haydeni" to make it etymologically correct (Sutherland 1988). The most recent morphological descriptions report a deep taproot and

stems which root adventitiously in shifting sand (Great Plains Flora Association 1991). No other populations of blowout penstemon were known outside of Nebraska until 1996. In 1996, the Bureau of Land Management (Frank Blomquist) discovered a small colony of blowout penstemon south of the Ferris Dunes (Fertig 1999). Plant samples were later collected and verified by Dr. Noel Holmgren of the New York Botanical Gardens for verification in 1999. Field identification was subsequently confirmed by additional specimens sent to Dr. James Stubbendieck of the University of Nebraska and Dr. Holmgren. There has been some reason to question whether the populations in Wyoming and Nebraska should be considered members of the same species. Blowout penstemon individuals in Wyoming have divergent flower traits that had not been previously reported (Heidel 2007). At the time of the Five year review, there were still questions as to whether the morphological differences between the Nebraska and Wyoming populations are due to phenotypic plasticity, genetic differences, or a combination of these factors affecting populations. Further consultation with taxonomic experts is ongoing. All known blowout penstemon sites are well-developed blowouts in dune complexes with active sand and accompanying environmental extremes in wind, temperature, evapotranspiration, and soil moisture stress. Blowout penstemon plants are most frequently in microsites that are, or recently have been, zones of sand accumulation. The plant apparently is successional and is a pioneer species that does not persist when a blowout becomes completely vegetated. The species survives burial in sand by sending off shoots at successively higher nodes. It withstands initial erosion and has a rhizomatous system with extensive lateral roots to survive erosion that may uncover much of its root length (USFWS 1987).

Dispersal/Migration

Population Information and Trends

Population Narrative:

Blowout penstemon is a short-lived perennial plant, which requires actively moving sand in blowouts to thrive. It grows from a tap root, initially producing a single stem that often becomes decumbent. The stem roots readily where nodes are buried in the sand. Buds located at the base of the stem break dormancy in the second spring, often producing multi-stemmed plants. These plants typically flower in the second or third year (Kottas 2009), and individual plants live for six to eight years (Stubbendieck et al. 1997). The lavender (or occasionally blue or white) flowers produce two-sided capsules (ovaries) bearing 14 to 35 discoid brown to black seeds (USFWS 1992; Kottas 2009). Seeds have a thick, hard seed coat and germination in the field is typically very low. The seeds are adapted to dispersal by wind, which often distributes seed downwind across the edge of the blowout into the area of sand accumulation. Wind and animals aid in the seed dispersal (Stubbendieck, pers. comm. 2009). Seed numbers are highly variable among years and sites (Kottas 2009). Individual plants may produce approximately 1,400 to 1,500 seeds (Kottas 2009; USFWS 1992), but seed viability can reduce reproductive potential to an average of approximately 530 viable seeds per plant (Kottas 2008). The number of seeds in the seedbank is typically low, due mainly to predation by small mammals at the time of seed rain (Kottas 2009; Stubbendieck, pers. comm. 2009). Kottas (2009) investigated the effects of floral herbivory by insects and fungal infection on seed production and viability. She reported that treatments of plants with insecticide or fungicide did not significantly affect total seed output, weight or viability (Kottas 2009). Consequently, site specific herbivore, granivore and fungal impacts may be important when seed production is low or when the surrounding vegetation invades blowout penstemon habitat, bringing additional herbivory with it (Kottas

2009). The genus Penstemon is endemic to North America. Of 275 species in the Penstemon genus, only the blowout penstemon and one other species are fragrant (Kottas 2009). The common name of the blowout penstemon comes from the blowouts in the Sandhills of Nebraska. Blowouts are round or conical eroded areas, depressions formed in the sand when prevailing northwesterly winds scoop out the sides of the hills (Pool 1914 in Kottas 2009). These eroded areas form on the sides of dunes when vegetative cover is removed or disturbed and wind action further exposes the slopes (Stubbendieck et al. 1989). Blowout penstemon is a pioneer species in these blowouts, frequently found among blowout grass (Redfieldia flexuosa) which is often the first pioneer in a blowout (Kottas 2009). Neither blowout grass nor blowout penstemon persists after other grasses begin to invade the blowout. The amount of suitable, active blowout habitat has declined markedly since settlement of the Sandhills region in the early 20th century (USFWS 2012). In Wyoming, blowout penstemon is found primarily on the rim and lee slopes of blowouts, or the rim and steep faces of sandy slough slopes. These deposits are found at the base of mountains or ridges, which represent topographic barriers. Shifting sand dunes are prevented from becoming fully stabilized and overgrown because of wind and gravity. The dunes may be 60 to 120 feet high at elevations between 5860-7440 feet (Heidel et.al 2007). The blowout penstemon is found in the early stages of plant community development which can be composed of blowout grass, lemon scurfpea, and thickspike wheatgrass or Indian ricegrass (Heidel 2005). The Wyoming sites differ from Nebraska Sandhills in that the populations occur at higher elevations, the mean annual precipitation is lower, and Wyoming has cooler minimum and maximum summer temperatures.

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: At the time of listing in 1987, the species was known to exist in only six population centers in four counties of the Nebraska Sandhills. Approximately 7000 plants occurred on less than 10 hectares (25 acres). Improved range management practices and fire suppression which promote blowout healing, were a major cause of the species decline in Nebraska and that remains a major threat today. Given the nature of the different habitats occupied by blowout penstemon plants in Nebraska as compared to those in Wyoming, the degree of threat to populations in these two states may differ. When the blowout penstemon was listed as endangered under the Act, only the Nebraska populations were known, therefore only the threats to populations in Nebraska were considered. In Nebraska, despite conservation strategies to increase numbers of plants and populations within the range, two main areas hamper recovery: 1) Continual loss of blowout habitat due to the stabilization of sand dunes (and lack of habitat management) 2) Lack of plans to guide habitat management and a way to include written agreements to implement such habitat management into conservation plans that could protect the species where it primarily occurs (private land). Additional threats identified and discussed in the 5 year review include: drought, overgrazing, ORV use, construction practices, pesticides, and natural outbreaks of the pyralid moth. In Wyoming, populations have basically been preserved in more or less a natural state because of the isolated, currently inaccessible nature of the sites. However, there is potential moderate to significant impacts from future energy development to the species. As with other forms of development, wind energy facilities, have the potential to affect the natural dynamics of a dune system by directly or

indirectly causing changes to the erosion and deposition of sand. Blowout penstemon may be negatively impacted by changes in the dynamics of the dune system (i.e. loss of key habitat attributes, competition, etc.).

Stressor: Mining
Exposure:
Response:
Consequence:
Narrative: Sand mining is currently not occurring in close proximity to any blowout penstemon sites, however more accessible sand deposits in the Rawlins Resource Area are currently being mined. The sand mined from those locations is used for golf courses and road maintenance. Presently, it seems impractical for sand mining to occur near blowout penstemon sites because of their relative isolation, rugged terrain, and limited access. Blowout penstemon populations in Wyoming are located over 7 miles from primary unpaved county roads to the north and east, and at least 15 miles from primary county roads to the west. Future changes in the accessibility to these habitats could affect the profitability and establishment of sand mines near blowout penstemon sites. Other valuable minerals located near the Seminoe Mountains to the south of the blowout penstemon populations include iron, copper, and gold (from Hausel 1989, in Heidel 2012).

Stressor: • Water Development
Exposure:
Response:
Consequence:
Narrative: Near blowout penstemon habitat at Bradley Peak, Bear Mountain, and Junk Hill in Wyoming are excavated ponds, as well as natural ponds and springs used for sources of livestock water. It would not be feasible to develop these water sources as irrigation water for cultivated fields or central pivot irrigation as is done in Nebraska. Nevertheless, further livestock water sources developed near blowout penstemon populations could potentially concentrate livestock near these habitats causing increased grazing or trampling effects to the plants (Heidel 2005).

Stressor: • Oil and Gas Leasing
Exposure:
Response:
Consequence:
Narrative: Oil and gas leasing occurs at the west end of the Bear – Mountain – Junk Hill – Ferris blowout penstemon population. This development includes pumps, pumping stations, and a pipeline corridor (Heidel 2012).

Stressor: • Off-Highway Vehicle Use
Exposure:
Response:
Consequence:
Narrative: Off-highway vehicle (OHV) use has been observed within a blowout penstemon population in Nebraska, and many plants were damaged (USFWS 1992). Hill climbing and associated OHV recreation activities may ensure continued disturbance and erosion of the sand hills and dunes, but driving over and crushing plants may cause severe negative impacts to the plants (USFWS 1992).

Stressor: • Changes in Habitat Quality
Exposure:
Response:
Consequence:
Narrative: Historically, fires removed the protective cover from the soil in the Nebraska Sandhills region resulting in shifting sand dunes and blowouts. Control of prairie fires followed the area's settlement period. Virtual elimination of fire from the Sandhills ecosystem allowed the vegetation to advance into the majority of the eroded areas and to stabilize the sand, resulting in a decline in suitable habitat for the species (USFWS 1992). However, continual summer grazing by cattle during the first half of this century caused enough disturbances to maintain many blowouts. More recently however, the increased use of planned grazing systems (rotational grazing) during the past 30 years has greatly reduced disturbance and has been responsible for decreasing wind erosion. Other advanced range management practices in Nebraska, including techniques to more evenly distribute livestock on rangeland, have been responsible for decreasing blowout penstemon habitat, as well as the numbers of populations, and the numbers of individual plants (USFWS 1992).

Stressor: • Livestock Trampling and Grazing
Exposure:
Response:
Consequence:
Narrative: Sheep previously grazed the allotments occupied by blowout penstemon in Wyoming. Cattle and horses are now commonly found on the rangelands of both Nebraska and Wyoming. The influence of horses on blowout penstemon has not been documented. Cattle, however, have frequently been observed near blowout penstemon plants. Many individual plants have been inspected during and after cattle grazing periods. When adequate other forage is available, cattle occasionally graze a portion of a plant but seldom does this cause major damage to the plant (BLM 2012, USFWS 1992). Under these normal range conditions, the use of high livestock stocking rates as a disturbance factor to maintain habitat for the blowout penstemon is considered beneficial (USFWS 1992). Advanced grazing methods, referred to as "holistic resource management", may further decrease blowout penstemon habitat by reducing active erosion. Techniques which more evenly distribute livestock on rangelands such as "planned grazing systems" or "management intensive grazing" may have been responsible for decreasing blowout penstemon habitat, numbers of populations, and numbers of individual plants in Nebraska (USFWS 1992). The occasional removal of a terminal portion of a shoot of a blowout penstemon plant by a grazing herbivore may be desirable because growth of other shoots is stimulated (USFWS 1992). However, during years of low precipitation, livestock forage may be limited and blowout penstemon plants may be more intensively grazed during those times. In Nebraska during times of limited forage availability, cattle have been observed to closely graze nearly every available blowout penstemon plant. One occurrence of close grazing by cattle may or may not impact blowout penstemon plants, but repeated years of close grazing will severely weaken plants and may be the direct cause of plant death (USFWS 1992) or reduce population numbers. o Cattle trampling of established plants has not been observed to be a problem. Infrequently, cattle will break a blowout penstemon shoot, which poses no threat to the plant (USFWS 1992). Livestock trampling damage is typically not significant to blowout penstemon plants because the plants are sparsely distributed in shifting substrate areas which cattle do not normally frequent. For Wyoming populations, it has been hypothesized that wildlife are the

primary source of blowout penstemon herbivory. Wild ungulates, such as deer and elk, may have a larger grazing impact on blowout penstemon plants than cattle in Wyoming. Fertig (2001) observed stem damage from deer and elk trampling on 10 percent of the population at Bear Mountain and on 60 to 80 percent of the stems at Bradley Peak. The tracks of elk and pronghorn antelope were repeatedly observed near browsed plants during survey efforts in Wyoming (Heidel 2005).

Stressor: • Over-collection
Exposure:
Response:
Consequence:
Narrative: The blowout penstemon is attractive and has been cultivated. Horticultural collecting is a potential threat for this species (USFWS 1987). To date, private and commercial collectors have had little impact on blowout penstemon. It would be an attractive and desirable landscape plant, but most of the plants are in locations which are too remote or inaccessible (USFWS 1992).

Stressor: • Pesticide Use
Exposure:
Response:
Consequence:
Narrative: The direct impact of herbicides on blowout penstemon is not known, although it is highly probable that broadleaf weed killers would negatively influence this plant (USFWS 1992). Herbicide use is thought to be minimally used on sand hills/dune regions due to the sparse cover of its habitat. It is doubtful that ranchers would even inadvertently apply herbicide to blowout penstemon, because most ranchers try to encourage the growth of all vegetation in blowouts. Use of insecticides could negatively impact the pollinators of blowout penstemon. Numerous types of insects may be responsible for pollination; however, it is unlikely that localized insecticide use would completely eliminate insect pollination (Heidel 2005).

Stressor: • Encroachment by other plants
Exposure:
Response:
Consequence:
Narrative: Non-native species in or adjoining blowout penstemon habitat in Wyoming included cheatgrass (Bromus tectorum) and Russian knapweed (Centaurea repens). Russian knapweed (C. repens) recently got introduced at the base of the Bradley Peak population site and could become a major infestation, possibly entering blowout penstemon habitat. Cheatgrass (B. tectorum) is one of the more common non-native species in the Pathfinder population and has been observed to be spreading in some of the Bear Mountain subpopulations (Heidel 2012). Weeds pose may pose threats as competitors. Any herbicides used to control the noxious weeds may pose a threat to the blowout penstemon.

Stressor: • Construction Activities
Exposure:
Response:
Consequence:
Narrative: The area between the Ferris and Seminoe Mountains is an area of particularly high mean turbulent kinetic energy, responsible for sand deposition on steep slip-face slopes

hundreds of feet high. In recent years, there have been wind energy permit applications that encompass blowout penstemon populations. Any alteration of on-site or upwind flow patterns, or related access development and construction, could affect the species and its habitat. There are four separate dead-end roads to occupied habitat, and if there were any road developments between them, it would provide more access to occupied habitat.

Stressor: • Vulnerability Based on Small Population Size
Exposure:
Response:
Consequence:
Narrative: At the time of listing in 1987, the species was known to exist in only six population centers in four counties of the Nebraska Sandhills. Approximately 7000 plants occurred on less than 10 hectares (25 acres). The small populations known at the time were thought to make the species vulnerable to localized environmental changes. In addition, the species occupies a successional niche in the development and eventual revegetation of blowout habitats. As the vegetation in these areas increases, blowout penstemon undergoes local extirpation. At the time of listing, the species was not only rare, but did not appear vigorous at the known localities in Nebraska, possibly because these blowouts had reached a stage of revegetation that exceeded the optimum habitat conditions for the species. Furthermore, the number of new blowouts was decreasing (USFWS 1987). In Wyoming, 3 populations (in addition to 6 subpopulations). The isolation of these populations from each other, as well as the isolation of these populations from other blowout penstemon populations in Nebraska, makes the Wyoming populations similarly vulnerable to the threat of random stochastic events (such as prolonged drought, introduction of invasive species) that could lead to reduction or loss of these populations.

Stressor: • Natural Threats
Exposure:
Response:
Consequence:
Narrative: Damaging insects and periods of drought may be the greatest natural threats to the survival of this species (USFWS 1992). Prior to the drought of the 1930's, the blowout penstemon was listed as one of the most common species in sand blowouts. Following the drought of the 1930's which severely influenced the vegetation of the Great Plains, the blowout penstemon was thought extinct until it was rediscovered in Nebraska in 1959. At one time, it was thought that a localized drought of a few years duration could eliminate most of the remaining blowout penstemon plants in Nebraska (USFWS 1992). o Destructive insects may be a primary cause of decline in populations (USFWS 1992). Several insects (and arachnids) have been observed feeding on blowout penstemon plants, including spider mites, grasshoppers, and an insect larvae which burrows into the inflorescence. Populations of invertebrates are generally at low levels. However, large numbers of penstemon aphids (Aphis pentstemonicola) were observed on two individual transplanted blowout penstemon plants growing in a blowout near Alliance, Nebraska. Foliage of the infested plants appeared wilted, grayish-green, and stunted. Several seed predators have also been found active on blowout penstemon. The most serious insect threat appears to be the pyralid moth. Larvae of a pyralid moth did extensive damage to one population of blowout penstemon in 1990. Adult female pyralid moths deposit their eggs on blowout penstemon plants. After hatching, the larvae burrow into the stems and are active until reaching the pupal stage. These larvae damage or kill blowout penstemon plants by boring into the crown area below the plant's buds.

Stressor: • Disease
Exposure:
Response:
Consequence:
Narrative: Blowout penstemon plants are also quite susceptible to fungal root rots. Plants infected with these fungi wilt, rot, and usually die (USFWS 1992).

Stressor: • Encroachment by Other Plants
Exposure:
Response:
Consequence:
Narrative: The blowout penstemon is well adapted to the rigorous environment of an actively eroding blowout, but it does not grow in close association with most other plants. It generally grows as widely spaced plants in nearly bare sand indicating that these plants may not have the ability to compete with each other or plants of other species for moisture. Its associate in Nebraska, blowout grass, does not use large amounts of soil moisture. Blowout penstemon populations in Nebraska have been known to rapidly decline as members of new species, primarily sand bluestem (Adropogon hallii) and prairie sandreed (Calamovilfa longifolia) increase and begin to use significant amounts of soil moisture following stabilization of the sand habitat (USFWS 1992).

Recovery

Reclassification Criteria:
Blowout penstemon will be considered eligible for reclassification to threatened when: 1. a minimum of 10,000 individuals in at least 5 population groups is established; and 2. the 5 populations have the minimum level of protection that will ensure their continued existence.

Recovery Priority Number: 11C

Delisting Criteria:
Blowout penstemon will be considered eligible for delisting when: 1. a minimum of 15,000 individuals in at least 10 population groups, each with a minimum population of 300 plants is established; and 2. the 10 populations are demonstrated to be at minimum viable population level s.

Recovery Actions:

- 1. Protect and monitor naturally occurring, reintroduced, and introduced populations. 2. Inventory suitable habitat for naturally occurring populations and determine potential reintroduction sites. 3. Conduct research to determine life history, minimum viable population parameters, and management criteria. 4. Establish new populations of blowout penstemon. 5. Establish and implement management plans for each population.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: x Consider revising the recovery plan so that it considers and incorporates the latest information on the species. x Clarify uncertainties regarding the species' taxonomy in Wyoming (USFWS, 2022).

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SPECIES ACCOUNT: *Penstemon penlandii* (Penland beardtongue (aka Kremmling beardtongue))

Species Taxonomic and Listing Information

Listing Status: Endangered; 08/14/1989; Mountain-Prairie Region (R6)

Physical Description

A short plant with linear leaves and several clumped, pubescent stems up to 25 centimeters (10.0 inches) tall. There are 5-15 bright bicolored flowers with blue lobes and a violet throat, 1.2-1.5 centimeters (0.5-0.6 inches) long, per inflorescence; the fruits are small brown capsules. (USFWS, 1992)

Taxonomy

Penstemon penlandii was independently discovered in July 1986 by David Johnson of Western Resource Development Company and John Anderson, then a botanist — with the U.S. Fish and Wildlife Service (Service), on visits to the Osterhout milkvetch site along Troublesome Creek near Sulphur Springs. It was described the same year by Dr. William Weber of the University of Colorado (Weber 1986). A member of the snapdragon family (Scrophulariaceae). (USFWS, 1992)

Historical Range

Endemic to Middle Park near Kremmling in Grand County, Colorado (USFWS, 1992).

Current Range

Near Kremmling in Grand County, Colorado .(USFWS, 1992)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative, sexual: cross-pollination, self-pollination (USFWS, 2016)

Lifespan

Adult: Unknown (USFWS, 2016)

Breeding Season

Adult: June - July (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators, especially Osmia spp. (USFWS, 2016)

Reproduction Narrative

Adult: Blooms in June and July. Kremmling beardtongue has rhizomes and vegetative growth. It is not known how long-lived Penstemon penlandii individuals are. The plant exhibits a mixed mating system: it can produce seed with pollen from the same plant but is significantly more successful with pollen from another plant. Pollen must be moved from plant to plant with the assistance of pollinators. The primary pollinators are native solitary bees, especially those in the genus Osmia (USFWS, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2016)

Habitat Vegetation or Surface Water Classification

Adult: Troublesome Formation shale (USFWS, 2016); sagebrush (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: ~7,500 ft. elevation (USFWS, 1992)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2016)

Habitat Narrative

Adult: The Kremmling beardtongue is only known to occur on white to tan barren shale soil exposures. The plant is locally abundant but highly restricted to sparsely vegetated shales of the Troublesome Formation that are high in selenium. The plant community is dominated by grasses and mixed shrubs (especially sagebrush, rabbitbrush, and bitterbrush) (USFWS, 2016). It inhabits a high elevation sagebrush park at 7,500 feet. Penland beardtongue is only known Pierre Shales and of late Tertiary (Miocene Troublesome Formation) siltstone sediments (USFWS, 1992). It occurs on alkaline clays containing selenium, which is toxic to most plants. Optimum habitat for P. penlandii appears to be in runoff channels, shaded by the deeply cut banks (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Species Trends:

Stable (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2016)

Population Size:

~1.4 million (NatureServe, 2015)

Population Narrative:

There is only one population of the Kremmling beardtongue. It is estimated the species occupies less than 1500 acres (USFWS, 2016). Estimates from Ecotone 2010 surveys are approximately 1.4 million individuals. In 2008, DBG staff set up one temporary macroplot and conducted a point in time count estimate. When compared to visual estimates from the same site in 2005, the population appears stable or increasing (Neale et al. 2008) (NatureServe, 2015).

Threats and Stressors

Stressor: Off-road vehicles (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: The badlands on which Penstemon penlandii occurs are currently vulnerable to degradation from off-road vehicle use because of their fragile soils, steep topography, and arid environment. There are dirt roads running through the badlands which provide easy access for off-road vehicle use. Off-road vehicle damage and mineral exploration have occurred on the area. The resulting modification of the habitat could result in a reduction of the range for Penland beardtongue (USFWS, 1992).

Stressor: Collection (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: CNHP considers all Penstemon species locations as sensitive information because of the risk of collectors targeting populations for use in gardens (NatureServe, 2015).

Recovery

Reclassification Criteria:
The following criteria should ensure the continued existence of the species and the maintenance of its habitat:

1. Land management designations are established and habitat management programs are developed and implemented for all known populations of Penstemon penlandii (USFWS, 1992).

2. The species is protected from detrimental environmental impacts through fulfillment of informal and formal consultation responsibilities under Section 7 and protection regulations under Section 9 of the Endangered Species Act (USFWS, 1992).

3. Factors required to establish and maintain minimum viable populations of the species are identified and minimum viable populations are documented as being maintained (USFWS, 1992).

Delisting Criteria:
Removal from the list of endangered and threatened species (recovery) is not considered feasible because of small natural populations, limited habitat, and persistent nature of potential

threats (USFWS, 1992).

Recovery Actions:

- Inventory any remaining potential habitat: Identifying and surveying potential habitat is important for both species, but especially so for Penstemon penlandii due to its very limited known distribution. The best way to ensure this species long-term viability would be to discover more populations and ensure their protection and management. Most populations of Penstemon oenlandii occur on private lands. The discovery of additional populations of this species on public lands would decrease the species vulnerability and help ensure its long-term viability. Surveys for this species on public lands are a high priority need. (USFWS, 1992)
- Protect existing habitat: Because of the limited amount of habitat, it is important that known habitats be impacted as little as possible. Various strategies are needed for the different threats and landownerships. (USFWS, 1992)
- Protect pollinators Successful reproduction and maintenance of genetic diversity requires sufficient numbers and types of pollinators. (USFWS, 1992)
- Conduct life history/ecology studies In order to understand how to establish and maintain minimum viable populations of each species, additional population biology and ecology studies are necessary. (USFWS, 1992)
- Future actions: The necessity of these actions will be determined by the results of the studies described above. These may include: Management of surface disturbance; Management of plant communities; and Restoration of disturbed habitats. (USFWS, 1992)
- CLARIFIED RECOVERY CRITERIA Population Based Recovery Criteria P-1. Overall population trends for Osterhout milkvetch and Penland beardtongue must be stable or increasing across the current range of each species (as described above) according to the following measures and not reduced from the baseline (see description of baseline above): a) Range-wide populations trends (measured using density (plants/m2JJ must be stable or increasing over a 10-year period as determined by the Bureau of Land Management's monitoring methodology (BLM 2017); and b) Range-wide population trends (measured using density (plants/m2JJ must maintain at least 90 percent confidence that Osterhout milkvetch and Penland beardtongue density estimates are within 10 percent of their estimated true value (BLM 2017). Data collected in years preceding this clarification can be used to measure this criterion. Threats and Management Based Criteria T-1. Land protection covering the habitat of all populations for Osterhout milkvetch and Penland beardtongue and/or statutory and regulatory protections for plants are such that the protections of the Act are no longer needed to compensate for regulatory inadequacies. Current Federal land protection through resource management plans, conservation agreements, recreation management plans, and/or travel management plans must be maintained for all Osterhout milkvetch and Penland beardtongue populations that occur on Federal lands. (USFWS, 2020)

References

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SPECIES ACCOUNT: *Pentachaeta bellidiflora* (White-rayed pentachaeta)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

The white-rayed pentachaeta is a small annual plant in the aster family (Asteraceae) found only in San Mateo County. The plants are 6 to 17 cm (2.3 to 6.6 in) tall and the flower heads consist of 7 to 16 white, strap-shaped petals surrounding 16 to 38 yellow ray flowers. The plants bloom from March to May. The white-rayed pentachaeta is found on serpentine grassland and co-occurs with dwarf plantain (Plantago erecta), purple needlegrass (Nasella pulchra), and coastal tidytips (Layia platyglossa) (Service 2010, p. 3) (USFWS, 2021)

Taxonomy

Pentachueta bellidiflora (white-rayed pentachaeta) was first collected in 1853 to 1854 near Corte Madera by John Milton Bigelow, surgeon and botanist for a railway route exploration (Van Horn 1973). The plant was described as Pentachaeta bellidiflora (Greene 1884). Keck (1958) transferred the entire genusto Chaetopappa. Van Horn (1973) studied Chaetopappa and Pentachaeta and concluded that the two genera are not closely related. Based on differences in floral and vegetative morphology and chromosome number, Van Horn (1973) reinstated the genus Pentachaeta (USFWS, 1998).

Historical Range

See current range/distribution.

Current Range

At the time of listing, Pentachaeta bellidiflora was known from a single large occurrence in the Triangle area which extended east of I-280 into Eastwood Regional Park. Historically, the species was more widespread and was known from at least nine locations in Marin, San Mateo, and Santa Cruz Counties. Most of the occurrences were lost due to urbanization or disturbance from off-road vehicles (CNDDB 2010). The Triangle remains the only known verified occurrence of P. bellidiflora (CNDDB 2010); however, since the time of listing, a small occurrence of P. bellidiflora may have been found on the west side of Upper Crystal Springs Reservoir in San Mateo County (M. Vasey, San Francisco State University, in litt., May 28, 2010). Further surveys need to be done to confirm this occurrence (USFWS, 2010)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 1998)

Breeding Season

Adult: Pentachaeta bellidflora flowers from March to May (Van Horn 1973) and may be visited by the federally threatened bay checkerspot butterfly (Euphydryas editha bayensis) (USFWS, 1998).

Reproduction Narrative

Adult: Pentachaeta bellidflora flowers from March to May (Van Horn 1973) and may be visited by the federally threatened bay checkerspot butterfly (Euphydryas editha bayensis). The butterfly may incidentally pollinate the plant, but the primary pollinators of Pentachaeta bellidflora are unknown (Robison and Morey 1992b). Given that the seeds apparently do not over-winter well, the species may have a limited soil seed bank (Van Horn 1973). Detailed data on the reproductive biology of Pentachaeta bellidflora are not available (USFWS, 1998).

Habitat Type

Adult: Bunchgrass communities (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits bunchgrass communities associated with serpentine soils (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species unique habitat requirements and low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Population Narrative:

Surveys conducted prior to the listing in 1995 showed that the occurrence at the Triangle contained about 1.5 million plants in each of the two years the plant was surveyed in the early 1990's (U.S. Fish and Wildlife Service 1995). The most recent surveys reported to the CNDDB in 2000 noted only that the species numbered in the millions of plants. This population extends to the east side of I-280 on Edgewood Park land; this portion of the population was found to contain 43 plants in 2004 (CNDDB 2010). No abundance information is available for the possible occurrence near Crystal Springs Reservoir (USFWS, 2010).

Threats and Stressors

Stressor: Recreation (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Construction of a trail is no longer proposed on the San Francisco Water Department land within the Triangle site (S. Foree, in litt., May 19, 2010) which alleviates this source of non-native plants as a threat. The SFPUC is proposing to create the Adobe Gulch Grassland Restoration Site near the southwest edge of Crystal Springs Reservoir, immediately adjacent to the possible location of a second occurrence of P. bellidiflora (Winzler and Kelly 2010). The proposed actions within the Restoration Site include enhancing the coastal terrace prairie by shrub removal. Potential habitat for P. bellidiflora may exist within the Restoration Site; however, surveys have not been conducted to determine if the area supports additional plants. Disturbance to the Restoration Site may encourage invasive plants to become established (M. Vasey pers. comm., June 29, 2010) and compete with the Pentachaeta bellidiflora if it exists there (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Endangered Species Act is the primary Federal law that has provided protection for these species since the dates of their listing as endangered in 1985 and 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2010).

Stressor: Non-native plants (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive plant species that are present on the Triangle site are teasel, jubata grass, fennel, harding grass, hoary mustard, bull thistle, and Spanish broom; however, these plants do not directly threaten the Pentachaeta bellidiflora which is located on a hillside that supports fewer weedy plants (S. Foree, in litt., May 21, 2010). Weiss and Luth (2003); however, have conducted research on the effects of nitrogen deposition in a serpentine grassland in the Santa Clara Valley which has bearing on threats to P. bellidiflora. Weiss and Luth found that nitrogen

deposition from automobiles on Interstate 280 were responsible for higher nitrogen levels within 400 meters on the west side of the roadway. Grass cover was higher in these areas. The authors noted that the only known occurrence of P. bellidiflora exists east of the freeway. There is an elevated zone of nitrogen-deposition extending out approximately 100 meters on the east side of the freeway and the species may be at long-term risk from invasions of nitrogen-loving grasses and other weedy plant species. P. bellidiflora is restricted to the thinnest soils in that 100 meter zone; beyond 100 meters, it is one of the dominant plants in the grassland. (S. Weiss in litt, May 25, 2010). Invasions of these nitrogen loving plants into nitrogen-limited grasslands and shrublands appears to be a common response to atmospheric nitrogen deposition (USFWS, 2010).

Stressor: Natural catastrophes (USFWS, 2010)
Exposure:
Response:
Consequence: Extinction
Narrative: Because the species is found at a single site, it is threatened by natural catastrophes that could effect the entire occurrence such as fire, disease, genetic depletion, or drought. These events could increase the risk of genetic changes that decreases the ability of the species to survive (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although the specific effects of climate change on Acanthomintha obovata ssp. duttonii, Cirsium fontinale var. fontinale, and Pentachaeta bellidiflora are unknown, the effects of increased winter flooding and drought conditions in the spring have the potential to adversely affect these species (USFWS, 2010).

Recovery

Reclassification Criteria:
Pentachaeta bellidiflora may be downlisted to threatened status when: 1. A total of five populations are secured and protected from incompatible uses. These include occupied and former known habitat at the Triangle and Edgewood Park and at the new potential occurrence if it is confirmed to be P. bellidiflora along with additional populations and adjacent unoccupied habitat and a 150-meter (500-foot) buffer (USFWS, 2010).

2. A management plan is approved and implemented for recovery areas and includes survival of the species as an objective for all populations and any adjacent areas identified as essential to continued survival of the species (USFWS, 2010).

3. Population monitoring in specified recovery areas shows stable or increasing numbers of plants with evidence of increasing numbers over a 20-year period that includes a normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2010).

4. Seeds stored in at least two Center for Plan Conservation-certified facilities; seed germination and propagation techniques understood (USFWS, 2010).

Delisting Criteria:
Pentachaeta bellidiflora may be delisted when: 1. A total of ten populations are secured and protected from incompatible uses with at least 3 populations in each of Marin, San Mateo, and Santa Cruz Counties (USFWS, 2010).

2. A management plan is approved and implemented for recovery areas and includes survival of the species as an objective for all populations and any adjacent areas identified as essential to continued survival of the species (USFWS, 2010).

3. Population monitoring in specified recovery areas shows no decline in numbers of plants after downlisting with evidence of increasing numbers over a 20-year period that includes a normal precipitation cycle (or longer if suggested by the results of demographic monitoring) (USFWS, 2010)

Recovery Actions:

- Reclassification criteria: This criterion has not been met. No occurrences other than the Triangle site occurrence have been verified. No introductions or reintroductions of the species have taken place. No additional information about the potential new occurrence near Crystal Springs Reservoir is available (USFWS, 2010). Delisting criteria: This criterion has not been met. No occurrences other than the single Triangle site occurrence in San Mateo County have been verified. A second occurrence near the Crystal Springs Reservoir has been reported but must be confirmed. No information is available regarding whether other occurrences which are presumed by CNDDB to be extirpated have been revisited since the time of listing (USFWS, 2010).
- Reclassification criteria: This criterion has partially been met. As noted above in the section on Cirsium fontinale var. fontinale, the San Francisco Public Utilities Commission has developed and implemented the Peninsula Watershed Management Plan (http://sfwater.org/detail.cfm/MC_ID/20/MSC_ID/177/C_ID/2162, accessed May 25, 2010). This plan covers the Lower Crystal Springs Reservoir and the Triangle. The plan addresses rare plants (S. Foree, in litt., May 21, 2010). Policy V5 and V6 of the Plan are as follows: V5. Protect, preserve, and enhance significant botanical resources, including populations of rare, threatened, endangered, and sensitive plant species and their habitat; V6. Encourage and allow investigations of special status plants and communities on the watershed to further the SFPUC's understanding of the watershed's vegetation and its condition. This plan does not specifically identify which areas are essential to the continued survival of the species (USFWS, 2010). Delisting criteria: This criterion has not been completely met. The San Francisco Public Utilities Commission has developed and implemented Peninsula Watershed Management Plan (http://sfwater.org/detail.cfm/MC_ID/20/MSC_ID/177/C_ID/2162, accessed May 25, 2010). This plan covers the Lower Crystal Springs Reservoir and the Triangle. The plan addresses rare plants (S. Foree, in litt., May 21, 2010). Policy V5 and V6 of the Peninsula Watershed Management Plan are as follows: V5. Protect, preserve, and enhance significant botanical resources, including populations of rare, threatened, endangered, and sensitive plant species and their habitat; V6. Encourage and allow investigations of special status plants and communities on the watershed to further the SFPUC's understanding of the watershed's

vegetation and its condition. This plan does not specifically identify which areas are essential to the continued survival of the of the species (USFWS, 2010).

- Reclassification criteria: This criterion has not been met. Monitoring in the late 1980's and early 1990's (CNDDB 2010) has shown numbers of plants at the Triangle were apparently stable; however, no monitoring has been reported since 2000. The portion of the occurrence that is located in Edgewood Park has declined from 100 plants in 1989 to 43 plants in 2004 (CNDDB 2010). No monitoring data is available at the potential Crystal Springs Reservoir site. Monitoring has not been continuous over a 20-year period. Only the Triangle occurrence is known to occur. No introductions or reintroductions have taken place (USFWS, 2010). Delisting criteria: This criterion has not been met. The downlisting criterion has not been met. Only one verified occurrence is known to exist. Monitoring in the late 1980's and early 1990's (CNDDB 2010) has shown numbers of plants were apparently stable; however, no monitoring has been reported since 2000. The portion of the occurrence that is located in Edgewood Park declined from 100 plants in 1989 to 43 plants in 2004 (CNDDB 2010). Monitoring has not been continuous over a 20-year period (USFWS, 2010).
- Reclassification criteria: This criterion has been partially met. Approximately 15,000 seeds were collected from the Triangle occurrence in 2010 by staff from San Francisco Public Utilities Commission and UC Berkeley Botanical Garden. Seed will be sent to U.S.D.A. National Center for Genetic Resource Preservation in Fort Collins, Colorado for germination testing (USFWS, 2010).
- Conduct surveys at occurrences of all three species which have not been visited for five years to determine if habitat remains and whether these areas would be suitable reintroduction sites if the species is no longer present (USFWS, 2010).
- Collect information on habitat preferences for all species in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported the species at historic locations, particularly for Pentachaeta bellidiflora which had a far greater range historically and likely more variability between sites (USFWS, 2010).
- Conduct research on propagation methods for the Cirsium fontinale var. fontinale and Pentachaeta bellidiflora for future outplantings and habitat restoration (USFWS, 2010).
- Conduct research on the relationship between Cirsium fontinale var. fontinale and Deschampsia caespitosa ssp. holciformis (tufted hairgrass). Determine if D. caespitosa ssp. holciformis is critical to outplantings and restoration of C. fontinale var. fontinale occurrences (USFWS, 2010).
- Determine identity and importance of pollinators for Acanthomintha obovata ssp. duttonii and Pentachaeta bellidiflora. (This information has already been collected for Cirsium fontinale var. fontinale). Determine habitat needs of the pollinators and ways to incorporate this information into management and restoration/outplanting plans for the species (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the white-rayed pentachaeta. Some of these recommendations have already been discussed in our previous status review (Service 2010, p. 28): 1. Conduct surveys at known occurrences at least every five

years to determine population trends and habitat changes. 2. Collect information on habitat preferences in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported the species at historic locations, particularly for white-rayed pentachaeta, which had a far greater range historically and likely more variability between sites. 3. Conduct surveys for potential locations in which to establish new populations. The surveys should also confirm that there is only a single population stretching across both the Triangle and Edgewood Park properties, rather than two or more populations separated by a quarter mile or more. 4. Work with partners and landowners to establish new populations. 5. Work with partners to produce and implement management plans specific to white-rayed pentachaeta conservation at each population site. (USFWS, 2021)

References

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SPECIES ACCOUNT: *Pentachaeta lyonii* (Lyon's pentachaeta)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/28/1997; Pacific Southwest (R8)

Physical Description

An annual herb, 6-48 cm tall, with yellow flower heads that bloom in the spring. Each plant may produce 30 or more flower heads. (NatureServe, 2015)

Taxonomy

Pentachaeta lyonii was described by Asa Gray (1886) based on a plant collected by William S. Lyon “near Palos Verdes Mountain” in Los Angeles County. David D. Keck (1958) combined Pentachaeta with Chaetopappa and published the combination Chaetopappa lyonii. This was recognized by Munz and Keck (1959) and Munz (1974). Van Horn (1973) conducted a taxonomic status of Pentachaeta and Chaetopappa and demonstrated that the two genera were distinct in morphological, anatomical features, and breeding systems. This treatment has been followed in current floristic treatments (Raven et a/. 1986, Lane 1993) (USFWS, 1999).

Historical Range

See current range/distribution.

Current Range

Endemic to coastal southern California, where currently known only from eastern Ventura and western Los Angeles Counties, in the Santa Monica Mountains and western Simi Hills (CNDDB 2008 cited in USFWS 2008). Formerly also known from the Palos Verdes Peninsula and Santa Catalina Island, but now believed historical/extirpated from these areas (CNDDB 2008 cited in USFWS 2008). (NatureServe, 2015)

Critical Habitat Designated

Yes; 12/14/2006.

Legal Description

On November 14, 2006, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective 12/14/2006) for Pentachaeta lyonii (Lyon's pentachaeta) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven critical habitat units (CHUs), in California (71 FR 66374-66423).

Critical Habitat Designation

The critical habitat designation for Pentachaeta lyonii includes six CHUs in Ventura, and Los Angeles Counties, California. Approximately 3,396 ac (1,372 ha) fall within the boundaries of the critical habitat designation. The critical habitat units are located in Ventura and Los Angeles Counties, California. Brief descriptions are presented below; detailed coordinates and maps are included in the Final Rule. (USFWS, 2006).

Unit 1: Simi Valley Unit: This unit is located east of Moorpark and west of Simi Valley in Ventura County and consists of 390 ac (157 ha) of private land. This unit is divided into four subunits (subunits 1a, 1b, 1c, and 1d) and mapped from occurrences known at the time of listing. The

subunits are in the same geographic area; they are all within 2.5 mi (4000 m) of each other.

Unit 2: Montclef Ridge Unit: This unit is located along Montclef Ridge, northwest of Newbury Park in Ventura County. It consists of 892 ac (361 ha) of local agency land (Lynmere, Wildwood Park, and Mount Clef Ridge) owned and managed by COSCA and Conejo Recreation and Parks District, and 265 ac (107 ha) of private land. This unit is divided into three subunits (subunits 2a, 2b, and 2c) that occur within the same geographic area, and are mapped from occurrences known at the time of listing and one occurrence identified after listing.

Unit 3: Thousand Oaks Unit: This unit is located in Thousand Oaks near Lake Sherwood in Ventura and Los Angeles Counties. It consists of 671 ac (272 ha) of local agency land (COSCA, Las Virgenes Metropolitan Water District, and Mountain Resources Conservation Authority) and 588 ac (238 ha) of private land. This unit is divided into three subunits (Subunits 3a, 3b, 3c (eastern portion), and 3d (western portion)) mapped from occurrences known at the time of listing and two occurrence identified after listing.

Unit 4. Triunfo Canyon Unit: This unit is located in unincorporated Los Angeles County. It consists of 197 ac (80 ha) of local agency land owned by Mountains Recreation and Conservation Authority, and 9 ac (3 ha) of private land. It is mapped from an occurrence known at the time of listing and includes multiple patches within a large, single population complex.

Unit 5: Mullholland Drive Unit: This unit is located in the Santa Monica Mountains in Los Angeles County and consists of 105 ac (42 ha) of Federal land (Santa Monica Mountains National Recreation Area) and 187 ac (75 ha) of private land. It is divided into 4 subunits (Subunites 5a, 5b, 5c, and 5d) mapped from occurrences known at the time of listing and occurrences identified after listing.

Unit 7: Malibu Lake Unit: This unit is located in the Santa Monica Mountains in Los Angeles County and consists of 58 ac (23 ha) of State land (Malibu Creek State Park) and 34 ac (14 ha) of private land. It is mapped from an occurrence known at the time of listing.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Pentachaeta lyonii critical habitat consists of three components (71 FR 66374-66423):

(i) Clay soils of volcanic origin;

(ii) Exposed soils that exhibit a microbiotic crust, which may inhibit invasion by other plant competitors; and

(iii) A mosaic of bare ground (>10%) patches in an area with less than 60 percent cover.

Special Management Considerations or Protections

Threats that may require special management are specified in the Final Rule for each Critical Habitat Unit: Unit 1. The invasion of annual grasses and nonnative plants that could crowd out P. lyonii, and grazing, edge effects from urban development, road maintenance, and vehicle traffic, which could result in removal or trampling of plants. Unit 2: The invasion by annual

grasses and nonnative plants that could crowd out P. lyonii; recreation, including equestrian activities, foot traffic, and off-road vehicles, which could result in trampling of plants; illegal dumping, urban development, which could result in removal of plants; and edge effects from existing urban development. Unit 3: Edge effects from urban development, removal of plants for urban development or fuel management, invasion by annual grasses and nonnative plants that could crowd out Pentachaeta lyonii, and equestrian and foot traffic that could result in trampling of plants. Unit 4: The invasion by annual grasses and nonnative plants, which could crowd out P. lyonii, fuel management, which could result in removal of plants, and foot traffic, which could result in trampling of plants. Unit 5: The potential for development, which could result in removal of plants; fuel management, which could also result in removal of plants; and invasion by annual grasses and nonnative plants, which could crowd out Pentachaeta lyonii. Unit 7: Recreation activities such as foot traffic, which may result in trampling of plants. (USFWS, 2006)

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015, USFWS, 2006))

Reproduction Narrative

Adult: Pentachaeta lyonii is not capable of self-pollination, but is dependent upon insect pollinators for successful seed production (Fotheringham and Keeley 1998). Pollinators of P. lyonii include digger bees, andrenid bees, and megachilid bees (Braken and Verhoeven 1998; Fotheringham and Keeley 1998). These pollinators are polylectic, meaning that they utilize several plant species within an area (Braken and Verhoeven 1998), and a variety of plants are necessary to sustain pollinator populations. Known pollinators of P. lyonii have the ability to pollinate individual plants up to 1,968 ft (600 m) from the pollen source, suggesting that genetic connectivity occurs between populations that are up to 1,968 ft (600 m) apart from each other. (USFWS, 2006). Seeds have deciduous pappus bristles, suggesting that this species is not often dispersed long distances by wind. However, seeds of species in this family (Asteraceae) are also sometimes transported by small seed-eating mammals and birds (Martin et al.1961 cited in USFWS 2008). This species' seeds likely persist in the soil for several years during extended dry spells (Fotheringham and Keeley 1998 cited in USFWS 2008).; Predominantly outcrossing; SEXUAL; BIOTIC; Hymenoptera (NatureServe, 2015).

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs in saddles between hills, on the tops of small knolls, or in flat areas at the base of slopes. Plants are found within small open, grassy sites that intergrade with fire-adapted chaparral and coastal sage scrub; also on road and trail edges. Occupied sites tend to feature a mosaic of bare ground patches in an area with low overall vegetative cover. Tends to occur on exposed, rocky clay soils of volcanic origin that exhibit a microbiotic crust. Does not compete well with dense annual grasses or shrubs; can apparently persist without disturbance if site conditions (e.g. exposed soils with a microbiotic crust) inhibit the growth of plant competitors,

otherwise periodic disturbance to remove these competitors may be necessary. 85 - 628 m (USFWS 2008). (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Wind/mammals (USFWS, 2006)

Dispersal/Migration Narrative

Adult: produce on the order of 1,000 seeds. The seeds likely persist in the soil for several years during extended dry spells (Fotheringham and Keeley 1998). Plant seeds are frequently dispersed by a variety of vectors, some which result in short-distance dispersal, and others which result in long-distance dispersal (Cain et al. 2000; Nathan and MullerLandau 2000). The presence of deciduous pappus bristles on the seeds indicates that the plant does not exhibit long-distance dispersal by wind, as do many other species in this family, reducing the likelihood of colonization of new areas and contributing to the limited distribution by this method (Keeley and Baer-Keeley 1992; Fotheringham and Keeley 1998). Longdistance dispersal, however, is likely achieved by transport of seeds by wildlife. Seeds from species within the Asteraceae family are known to be transported by small seed-eating mammals, including ground squirrels (Citellus sp.) pocket mice (Perognathus sp.), kangaroo rats (Dipodomys sp.), and birds, including quail (Lophortyx sp.) (Martin et al. 1961). Small mammals facilitate seed dispersal through consumption and elimination of undigested seed and through seed caching (Cain et al. 2000; Sieg 1987) (USFWS, 2006).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:

This species has apparently been extirpated from the southern portion of its historical range (Palos Verdes Peninsula and Santa Catalina Island) (CNDDB 2008 cited in USFWS 2008). Decline of 50-90% (NatureServe, 2015)

Number of Populations:

21 - 80 (NatureServe, 2015)

Population Size:

65,000-70,000 plants (NatureServe, 2015)

Population Narrative:

This species has apparently been extirpated from the southern portion of its historical range (Palos Verdes Peninsula and Santa Catalina Island) (CNDDB 2008 cited in USFWS 2008). Decline of 50-90% Approximately 65,000-70,000 plants as of most recent counts, but this species is an annual known to exhibit large year-to-year fluctuations in population size, so this particular number may not have much meaning in terms of the species' long-term persistence. Annual fluctuations are believed to occur in response to external factors such as rainfall and competition with other plant species (USFWS 2008). Approximately 32 occurrences are believed

extant, with an additional 5 considered historical. At least 3 occurrences have been extirpated. (NatureServe, 2015)

Threats and Stressors

Stressor: Urban Development (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, the primary threats to Pentachaeta lyonii were destruction of habitat from urban development. An indirect threat to the species was the influence of urban development on the surrounding environment, which facilitated the introduction of competitive weeds and altered ecosystem processes. Effects of urban development include habitat fragmentation, which reduces gene flow between sites, reduces insect pollinators, and displaces P. lyonii as a result of changes to the structure and composition of pocket grassland communities (i.e., introduction of competitive weeds, changes in local hydrology, and increased gopher activity) (Alberts et al. 1993, Conservation Biology Institute 2000). Gophers are known to till the soil and can facilitate the growth of annual grasses. One site was extirpated in 1993 after the site was burned and non-native annual grasses and gophers became prevalent at the site (CNDDB 2008) (USFWS, 2008).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Inadequacy of existing regulatory mechanisms was identified in the final listing document as a threat in determining endangered status for Pentachaeta lyonii. The species is listed as endangered under the California Endangered Species Act (CESA). Although CESA prohibits “take” of State-listed plants, this appears to be inadequate to protect against the taking of plants via habitat modification or land use change by landowners. After the California Department of Fish and Game (CDFG) notifies a landowner that a State-listed plant grows on his or her property, CDFG Code only requires that the landowner notify CDFG “at least 10 days in advance of changing the land use to allow salvage of such plant” (chapter 10 sec. 1913). Determinations by local lead agencies under the California Environmental Quality Act (CEQA) have resulted in negative impacts to P. lyonii (62 FR 4172). Because the intent of CEQA is to disclose project impacts, proposed mitigation measures do not necessarily guarantee protection and conservation of sustainable populations of P. lyonii (USFWS, 2008).

Stressor: Fire (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Despite efforts to suppress fires in coastal southern California, the present fire frequency of every 15 years or less, is substantially higher than it was historically, which is thought to be every 50 to 100 years (Keeley 2006). Over a period of 60 years, most of the Santa Monica Mountains burned an average of three to five times, with an average interval of every 12.4 to 20.7 years (Radtke et al. 1982). This current fire frequency may have negatively impacted Pentachaeta lyonii by displacing chaparral and coastal sage scrub communities with annual

invasive grasses that displace P. lyonii. In addition, fire prevention and suppression activities such as spraying fire retardant and discing the soil around urban development remains a threat because it facilitates the growth of annual grasses (USFWS, 2008).

Stressor: Human recreation (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Some light recreation is thought to be compatible and even beneficial to the species. Trails create a zone of compacted soils, and may reduce competition from annual grasses and allow Pentachaeta lyonii to grow. One of the largest populations, with a population of 100,000 plants reported, occurs alongside a popular trail (CNDDB 2008). However, higher intensity uses such as equestrian or vehicle use is a threat to the species. A portion of the population on NPS land was severely reduced after an increase in equestrian use (CNDDB 2008). The remaining portions of the population have been fenced and have shown some signs of recovery (NPS unpublished data 2007) (USFWS, 2008).

Stressor: Stochastic extinction (USFWS, 2008)
Exposure:
Response:
Consequence: Extinction
Narrative: Ten of the 30 known occurrences have greater than 10,000 plants; the remaining populations are small, with several reported at less than 1,000 plants (CNNDB 2008; Appendix A). The small populations are vulnerable to extirpation by demographic, environmental, and genetic stochasticity, and natural catastrophes (Shaffer 1981). Demographic stochasticity is random variability in survival or reproduction among individuals within a population (Shaffer 1981), and could play a role in the extirpation of small populations of Pentachaeta lyonii. Environmental stochasticity refers to annual variation in birth and death rates in response to weather, disease, competition, predation, or other factors external to the population (Shaffer 1981). This could play a role in extirpations of small populations because the species exhibits large annual fluctuations in population size, probably in response to external factors such as rainfall and competition with other plant species. Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations (Arias et al. no date) could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). Natural catastrophes such as fire, landslide, or prolonged drought could result in extirpation of populations (Shaffer 1981). The entire range of P. lyonii occurs within a distance of 24 km (15 mi); therefore, all populations would be expected to experience similar rainfall patterns or could be affected by a single fire (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2005, Intergovernmental Panel on Climate Change (IPCC) 2007). Recently, the potential impacts of climate change on the

flora of California were discussed by Loarie et al. 2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. The Santa Monica Mountains is expected to increase in diversity becoming one of these potential future refugia (Loarie et al. 2008). These increases in species diversity in the refugia, due to climate change, have the potential to result "…in new species mixes, with consequent novel patterns of competition and other biotic interactions…" to the species present (Loarie et al. 2008) with unknown consequences to the species present. We recognize that climate change is an important issue with potential effects to listed species and their habitats. While we lack adequate information to make specific and accurate predictions regarding how climate change, in combination with other factors such as small population size, will affect Pentachaeta lyonii, small ranged species, such as Pentachaeta lyonii, are more vulnerable to extinction due to these changing conditions (Pimm and Raven 2000, Loarie et al. 2008) (USFWS, 2008).

Recovery

Reclassification Criteria:
1. When 10 populations of 10,000 or more plants, from the 30 current sites (see Table 2 of the Recovery Plan), are fully protected and self-sustaining (as demonstrated through monitoring) (USFWS, 1999)

2. When the populations from Reclassification Critieron 1 are managed to control threats such as alien plants (USFWS, 1999)

3. When the populations from Reclassification Criterion 1 are self-sustaining over a minimum of 15 years (or longer, if data suggest large population fluctuations). (USFWS, 1999)

Delisting Criteria:
1. When 20 populations of 10,000 or more plants, from the 30 current sites (see Table 2 of the Recovery Plan), are fully protected and self-sustaining (as demonstrated through monitoring) (USFWS, 1999)

2. When the populations from Delisting Critieron 1 are managed to control threats such as alien plants (USFWS, 1999)

3. When the populations from Delisting Criterion 1 are self-sustaining over a minimum of 15 years (or longer, if data suggest large population fluctuations). (USFWS, 1999)

Recovery Actions:

- Protect and secure populations and habitat on unprotected lands. Habitat for the listed plants must be protected and secured in perpetuity, from identified threats of loss. Methods for securing lands include permanent conservation easements established through land use decisions, in-fee purchase, gifts of easement, or fee interest by property owner (USFWS, 1999).

- Manage and monitor protected areas. The process of evaluating past and current management and making adjustments as needed is termed “adaptive management.” Public and private conservation lands should be adaptively managed to maximize their potential to support listed species and their habitats. (USFWS, 1999)
- Survey historic locations and other potential habitat where species may occur, Surveys of the potential albeit limited, habitat within the species range should be done. Several California Natural Diversity Database occurrence records for the listed species are represented only by observations. Information on population status, threats, and abundance is also needed for these sites. Information gathered from the additional details will be used to provide lead agencies to determine protective land use designation for the listed plant species . Data gathered will assist in determining the range of site characteristics, population vigor, and species viability to help establish minimum population standards for rare plant reserves, and consequently, for recovery. (USFWS, 1999)
- Conduct biological and ecological research to define life history strategies and population dynamics to guide recovery/conservation efforts. A better understanding of the population dynamics and identification of ecological factors that may be affecting those dynamics are needed to develop appropriate management plans to recover the plant species. (USFWS, 1999).
- Develop outreach plans to conserve the species. Outreach is an important component of implementing this recovery plan. This plan should be developed to enhance the public’s understanding of issues related to conservation and recovery of the listed species. Participation from both public and private entities should be encouraged for the establishment of conservation plans for the listed species. (USFWS, 1999)
- Recommendations for Future Actions from 2019 5-Year Review: • Increase monitoring of within and among mainland occurrences for better understanding of population trends. • Monitor the Santa Catalina Island occurrence for better understanding of population numbers, trends, and geographic extents. • Collect additional seed for banking from both mainland and Santa Catalina Island occurrences. • Augment existing occurrences when possible. • Search for additional suitable outplanting locations on protected lands and establish new occurrences. (USFWS, 2019)

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SPECIES ACCOUNT: *Peperomia wheeleri* (Wheeler's peperomia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 1/14/1987

Physical Description

An evergreen, glabrous, erect herb which may reach 1 meter in height. The stems root only at the base and may be up to 1 centimeter in diameter. The opposite leaves are entire, fleshy, elliptic to ellipticobovate, with 3 or 5 main veins ascending from the base. They may be 5 to 7 centimeters long and 2 to 3 centimeters wide with the base tapered to a 1 centimeter petiole. The lower side of the leaf is inconspicuously black punctate. Inflorescenses are spikes, 10 to 16 centimeters long and 5 millimeters in diameter, which are borne solitary and opposite the leaves or at the leaf axils. Flowers are minute, approximately .5 millimeter in diameter. (USFWS, 1990)

Taxonomy

During this review we have received information that Peperomia myrtifolila is frequently misidentified as P. wheeleri. Peperomia myrtifolia is a highly variable taxon distributed throughout the Lesser Antilles and the Virgin Islands (Axelrod 2011). Presently, some species experts agree that P. wheeleri is not a distinctive species from P. myrtifolia because the major difference between the two species is the leaf shape and leaf apex (Axelrod 2011, J. Vélez-Gavilan, UPRM, 2014, pers. comm.). Hence, some authors (e.g., Axelrod 2011) treat P. wheeleri as a synonym of P. myrtifolia. Currently, no genetic studies have been conducted to demonstrate that P. wheeleri is not a valid species. Thus, for the purpose of this review we are treating P. wheeleri as a valid species. This taxonomic issue should be appropriately assessed in the future. When the recovery plan for P. wheeleri was approved in 1990, no common name was recognized for the species. Presently, the name Wheeler's peperomia seems to be widely accepted. This common name has been adopted by the USDA PLANTS database, the Integrate Taxonomic Information System (ITIS) and the IUCN Red List. Therefore, the Service intends to use this common name for this federally listed plant (USFWS, 2014).

Historical Range

See current range/distribution.

Current Range

Known only from Culebra, a small island approximately 27 kilometers to the east of Puerto Rico. The species has not been reported from adjacent small islands or the main island of Puerto Rico (USFWS, 1990)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Biotic (USFWS, 1990)

Breeding Season

Adult: Little is known about natural reproduction, however, individuals growing at Fairchild Tropical Garden (Garden) in Miami, Florida, flowered from June through August in 1989 (USFWS, 1990).

Key Resources Needed for Breeding

Adult: Flowers of Wheeler's peperomia (Peperoinia wheeleri) are bisexual. Pollination may be carried out by insects or wind, although the pollination biology of this species has not been studied. Many individuals have been observed flowering or in fruit and numerous seedlings are scattered throughout the area (Vivaldi and Woodbury 1981, U.S. Fish and Wildlife Service 1987). Little is known about natural reproduction, however, individuals growing at Fairchild Tropical Garden (Garden) in Miami, Florida, flowered from June through August in 1989. Seed collected from this flowering began germination after 34 days; germination rate in this initial trial was less than 10 percent. Branches which have broken off and fallen to the ground in the Garden also root easily where they have fallen on humus (Lippincott pers. comm.). Cuttings root easily and many individuals are currently growing at the Garden (USFWS, 1990).

Other Reproductive Information

Adult: Following Hurricane Hugo's devastating attack on Culebra in 1989, 25 cuttings were collected by the Refuge Manager at Culebra National Wildlife Refuge (NWR) from the Monte Resaca area. These were planted at the Department of Sports and Recreation nursery in Vega Alta, Puerto Rico and rooted quickly. The forest of the Monte Resaca area was defoliated by the hurricane but cover returned quickly, and the Peperomia wheeleri population suffered limited damage (USFWS, 1990).

Habitat Type

Adult: Semi-evergreen forest (USFWS, 1990)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1990)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1990)

Site Fidelity

Adult: High (inferred from USFWS, 1990)

Habitat Narrative

Adult: Peperomia wheeleri, a herbaceous plant, occurs on large granodiorite boulders beneath the semi-evergreen seasonal forest of the Monte Resaca area of Culebra Island (USFWS, 1990)

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2020)

Species Trends:
Increasing (USFWS, 2020)

Number of Populations:
7 (USFWS, 2020)

Population Size:
~ 2,595 (USFWS, 2020)

Population Narrative:
By 2014, Wheeler's peperomia was known from approximately 2,595 individuals in 7 areas in Puerto Rico (USFWS 2014). On the mainland Puerto Rico, the current populations are located at Isabela (El Costillar; C. Pacheco, USFWS, unpubl. data 2007a), Ciales-Florida (Río Encantado Natural Reserve; R. Rodríguez pers. comm. 2013), Arecibo (El Tallonal; Monsegur and ColónMerced, USFWS, unpubl. data 2010), and Guajataca State Forest (Monsegur and Pacheco, USFWS, unpubl. data 2009; and Trejo, unpubl. data 2018). In addition, there are three populations in Culebra Island (Radio tower site, Playa Brava site, Monte Resaca South, C. Pacheco, USFWS, unpubl. data 2007a). These populations are comprised by both natural and planted individuals. Also, an undetermined number of individuals were known from U.S. Virgin Islands, and British Virgin Islands. (USFWS, 2020). When the recovery plan was approved, the Wheeler's peperomia abundance was estimated at several hundred plants on Monte Reseca and almost twenty plants at the Helipad hill, both in Culebra Island (USFWS 1990). In 1995, Santiago-Valentín and Vives-Helyger conducted a survey of the species at El Costillar in Isabela, estimating that population on 50 plants (Santiago-Valentín and Vives-Helyger, 1997). In 2007, Carlos Pacheco conducted a rapid assessment of Wheeler's peperomia in Puerto Rico, estimating its population at 2,466 plants (C. Pacheco, USFWS, unpubl. data, 2007 a,b). Since 2007, the Service has propagated the species in their greenhouses at the Cabo Rojo National Wildlife Refuge and the Culebra National Wildlife Refuge, producing over 200 plants. Presently, the species has been introduced in different localities in Puerto Rico, estimating the population of Wheeler's peperomia at 2,595 individuals in Puerto Rico and Culebra Island (Table 1). Therefore, based on our field observations, and new information available on the species, we believe that the Wheeler's peperomia population trend should be considered as increasing. (USFWS, 2020)

Threats and Stressors

Stressor: Escaped domestic fowl (USFWS, 1990)
Exposure:
Response:
Consequence: Loss of/Damage to plants
Narrative: Populations of Peperomia wheeleri, although protected as part of the Culebra National Wildlife Refuge, continue to face the threat of foraging by escaped domestic fowl (USFWS, 1990).

Stressor: Cattle grazing (USFWS, 1990)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: The possibility of impacts from erosion by cattle passing through the area is listed as a threat to this species (USFWS, 1990).

Stressor: Over collection (USFWS, 1990).
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Collecting has not been documented as a factor in the continued decline of Peperomia wheeleri. However, the number of remaining plants is small enough that taking of the species for any purpose could become a threat in the future, particularly if horticultural interest in the species develops (USFWS, 1990).

Stressor: Deforestation (USFWS, 1990)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Forest cover is essential for healthy plants and continued reproduction. Any disturbance in this area could result in the loss of these plants (USFWS, 1990).

Stressor: Hurricanes (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Due to limited distribution, hurricanes are listed as a threat to this species (USFWS, 2014).

Stressor: Human induced fires (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Due to limited distribution, human induced fires are listed as a threat to this species (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Given the extremely limited geographic distribution of Wheeler's peperomia, it is highly likely that its genetic variability is very low. This would result in a loss of alleles by random genetic drift, which would limit the species' ability to respond to changes in the environment (Honnay and Jacquemyn, 2007). In order to safeguard the remaining genetic diversity, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species. Based on the above, we consider the potential lack of genetic variation as a possible threat to the species (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Changes in climate can have a variety of direct and indirect impacts on species, and can exacerbate the effects of other threats. Rather than assessing "climate change" as a single threat in and of itself, we examine the potential consequences to species and their habitats that arise from changes in environmental conditions associated with various aspects of climate change. Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and adaptive capacity (IPCC 2007; Glick et al. 2011). An expected effect of the climate change is the increase in intensity of hurricanes and tropical storm, followed by extended period of drought (IPPCC 2012). This climate change may alter (modify) the microclimate and the surrounding vegetation around the populations of the Wheeler's peperomia. Hurricane effects followed by extended period of drought may result in changes in soil conditions and microclimate and may allow other plants (native or non-native, herbaceous or woody) adapted to drier conditions to become established (Lugo 2000). Invasive species (e.g. Megathyrsus maximus) may spread and colonized the Wheeler's peperomia habitat, and it could alter fire regimen, microclimate, and nutrient cycling of the habitat that the species depend. Due to its limited distribution and number of natural populations, we consider the cumulative effects by hurricanes, genetic variation, and exotic and invasive species (plants and animals) as detrimental to the Wheeler's peperomia as a whole. The population dynamics of the species is poorly known (e.g., depressed genetic variability and its competitive abilities), there are only few known natural populations, and there is a lack of information to determine what constitutes a viable population. Therefore, we consider the above mentioned threats as high in magnitude because the species has only few known populations; but not imminent because threats like climate change are not likely to occur in near future (USFWS, 2014).

Recovery

Reclassification Criteria:
The existing population is adequately protected. [Note: This includes all known occurrences at the time the plan was written.] (USFWS, 2014).

Two additional populations are established within the Culebra National Wildlife Refuge or on other protected areas on Culebra Island (USFWS, 2014).

Delisting Criteria:
1) Existing populations of P. wheeleri in Culebra Island (2 populations) and Puerto Rico (2 populations) exhibit a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A, C, and E) (USFWS, 2019)

2) Establish or discover two additional populations (as defined in criterion 1) of P. wheeleri on lands protected via conservation mechanism on Culebra Island (Addresses Factors A and E). (USFWS, 2019)

3) Establish two additional poulations P. wheeleri (as defined in criterion 1) on lands protected via a conservatio mechanism on mainland Puerto Rico (Addresses Factors A and E). (USFWS, 2015)

4) Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factors C and E) (USFWS, 2019)

Recovery Actions:

- The first criterion has been partially met. Currently, two of the four known natural populations of Wheeler's peperomia in Puerto Rico are protected as they are located within lands set aside for conservation (Table 1). On Culebra Island, the populations at the Radio tower and Playa Brava are located within the Culebra National Wildlife Refuge (CNWR), land managed by the Service for the conservation of fish and wildlife resources (USFWS 2012). Additionally, the Comprehensive Conservation Plan (CCP) for the Culebra National Wildlife Refuge includes measures for the protection and recovery of the Wheeler's peperomia within this refuge (USFWS 2012). However, the other two natural populations (i.e., El Costillar and Monte Resaca south; Table 1) are not adequately protected because they occur in privately-owned land subjected to urban development and agricultural practices such as cattle and goat grazing. Since 2009, Wheeler's peperomia has been introduced in private and Commonwealth lands managed for conservation (Table 1). These new populations are considered adequately protected because conservation measures have been taken to avoid or minimize threats to the species at each site (USFWS, 2014).
- The second criterion has been partially met. This criterion states that two additional populations of the Wheeler's peperomia should be established within protected areas on Culebra Island. Given that the species has been found in other areas outside Culebra Island, we recommend that this criterion should be reconsidered. Since the recovery plan for this species was approved, two new populations of Wheeler's peperomia have been found in Culebra Island, and another population was discovered at an area known as El Costillar in the municipality of Isabela, in northern Puerto Rico. Additionally, the Wheeler's peperomia has been introduced in three other locations in Puerto Rico (Figure 2). In 2009, the Service and the PRDNER established two populations within the Guajataca Commonwealth Forest, located between the municipalities of Isabela and Quebradillas (Monsegur and Pacheco, USFWS, unpubl. data, 2009). At El Tallonal, a private land in the municipality of Arecibo, the Service established two populations of Wheeler's peperomia in 2010; this property is managed for conservation by the local non-government organization Ciudadanos del Karso (Monsegur and Colón-Merced, USFWS, unpubl. data, 2010). In 2013, the Service and the local Trust Para la Naturaleza planted 40 individuals of Wheeler's peperomia at the Río Encantado Natural Reserve, a private land managed for conservation located between the municipalities of Ciales and Florida (R. Rodríguez, Para la Naturaleza, unpubl. data, 2013). Thus, now there are three populations of this species in the northern karst region of Puerto Rico (USFWS, 2014).
- Conduct genetic studies to determine whether to P. wheelier is a synonym of P. myrtifolia. (USFWS, 2019)
- International coordination is needed for the implementation of protection and management actions in the other Caribbean Islands and to ensure species' viability outside of US jurisdiction (USFWS, 2019)
- Conduct genetic studies to verify if Peperomia wheeleri is a valid species or a synonym of Peperomia myrtifolia (USFWS, 2014).
- Develop measurable objective criteria for delisting the species (USFWS, 2014).
- Conduct studies on the biology and ecology of the Wheeler's peperomia (USFWS, 2014)

- Continue a propagation program for the species and establish new populations in protected areas or increase / augment existing populations (USFWS, 2014).
- Continue working with landowners to enhance existing populations or establish new ones within protected areas that ensure their long-term protection (USFWS, 2014).
- Incorporate the private landowners in habitat conservation programs (e.g., Partners for Fish and Wildlife, Coastal Program, PRDNER-Bosque Auxiliary) (USFWS, 2014).
- Evaluate the abundance and distribution of the species through surveys within traditional and non-traditional sites, using the best available plant survey methodology to determine current population numbers and number of viable populations necessary to protect and stabilize Wheeler's peperomia populations (wild, naturally-reproducing populations large enough to maintain sufficient genetic variation and evolve and respond to natural habitat changes) (USFWS, 2014).
- Appropriate government agencies should continue evaluating and implementing conservation measures to minimize possible adverse effects on natural drainages on Culebra Island (USFWS, 2014).
- Quantify predation pressure on the species and determine if predation is a limiting factor for its recovery (USFWS, 2014)

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SPECIES ACCOUNT: *Phacelia argillacea* (Clay phacelia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1978; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A winter annual, 1-4 dm tall, with deeply lobed leaves. The plants produce clusters of lavender-purple flowers in summer (NatureServe, 2015).

Taxonomy

A member of the waterleaf family. Clay phacelia is very closely related to Phacelia glandulosa Nutt., a west slope Idaho, Wyoming, and Montana native (NatureServe, 2015).

Historical Range

It was initially collected at Pleasant Valley Junction, Wasatch County, Utah, in 1883. It was collected a second time at Clear Creek, Utah County, Utah, in 1894 (USFWS, 1982).

Current Range

It is only found in Utah along the Douglas Creek and Gordon Gulch members of the Green River formation in the Wasatch Mountains in Pleasant Valley (NatureServe, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (NatureServe, 2015), cross-pollination (USFWS, 2013)

Lifespan

Adult: 2 years (USFWS, 2013)

Breeding Season

Adult: May - July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: Late summer or early autumn storms, two rain events per summer, seed bank, insect pollinators (USFWS, 2013)

Reproduction Narrative

Adult: Clay phacelia reproduces sexually. It is unknown whether this species is an obligate selfer, a facultative selfer, or an obligate out-crosser (Harper 1990). Seeds typically germinate in spring and fall, although they sometimes germinate in mid-summer if there is enough available moisture (England 1989). The plant blooms in late July, but non-flowering rosettes have been observed in both June and August (Matheson 1989). England (1989) verifies that advanced

plants have been observed in the spring with early flowering in late May or early June. The pollen vector is unknown; however, a 1988 Bee Biology and Systematics Lab field collection at the Tucker site "yielded the largest series of specimens recorded of a rare species of colletid bee, HYLAEUS GRANULATUS" (Tepedino 1989). Although the very first observed females of this rare bee were among the specimens collected, Harper (1990) surmises that this bee species is far too rare to be the primary pollinator for Clay phacelia. He further speculates that wind, or the more common ground-nesting bees in the area, could prove to be the major pollinators for Clay phacelia. Clay phacelia has the capacity of developing four mature seeds per fruit. In the summer of 1987, England (1989) estimated that as many as 8000 seeds were produced on one adult winter annual. Embryo viability of seed collected in June 1988 was tested by means of a tetrazolium (TZ) test. The TZ equaled 95% or 19 viable seeds out of the 20 tested (Matheson 1989) (NatureServe, 2015). Clay phacelia was formerly considered a winter annual but new data supports the idea that it is instead a true biennial (Meyer 2011b). Germination seems to be triggered by late summer or early autumn storms and two rain events per summer seem to be critical for survival (Meyer 2011a). The species harbors an extended seed bank, and one successful recruitment event every 10-15 years, coupled with high seed output, may be enough for the species survival through time (Meyer 2011a, 2011b). Seeds produced in one year germinate over the course of several years thus ensuring a robust seedbank that can withstand stochastic events. Clay phacelia are likely obligate outcrossers (Smith et al. 1989) that require insect pollinators. The flower is large and showy and is visited by a variety of pollinators, including native sweat and carpenter bee species (USFWS, 2013).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Juniper-pinyon and mountain brush communities (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Cool, subhumid climate (NatureServe, 2015); soil pH 7.7 - 7.9 (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: 6,000 - 7,000 ft. elevation, vegetative cover > 10% (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Scattered (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Clay phacelia occurs on steep slopes in sparse juniper-pinyon and mountain brush communities (Welsh 1987. The general climate for all of the element occurrence sites can, however, be classified as cool and subhumid (England 1989). The majority of plants grow on slopes facing west through southeast. At each site, the plants occur on a xeric, exposed slope of the Green River Formation, somewhere between 6,000 and 7,000 feet elevation (Franklin and Tuhy 1989). The slope at the site which holds the largest number of plants was measured at 70 percent (Armstrong 1990). P. argillacea is dependent upon available, disturbed ground, with

little or no competition (England, 1990). Extant populations of Clay phacelia cover only three to five percent of the slope's surface area in the patches where they occur. Overall vegetative cover is about ten percent in these same areas of critical habitat (England 1989) (NatureServe, 2015). All soils where Clay phacelia occurs are basic, with pH ranging from 7.7- 7.9 for the occupied sites (Armstrong 1992) (USFWS, 2016).

Dispersal/Migration

Dispersal

Adult: Typically low (inferred from NatureServe, 2015)

Dispersal/Migration Narrative

Adult: It is surmised by England (1989) that short distant seed dispersal is achieved primarily by wind, water, and gravity. Rosettes are generally located below or in association with mature adult plants. Some long-distance dispersal may be achieved through grazing and defecation, but the plants are probably grazed prior to seed set (England 1989) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2013)

Number of Populations:

3 (USFWS, 2013)

Population Size:

~340 individuals range-wide (USFWS, 2019)

Population Narrative:

The number of individuals is currently unknown. There are only three known populations of the plant that are occupied. The range of clay phacelia extends along a 7.5 mile (12 kilometer) stretch of Highway 6 in Spanish Fork Canyon in Utah County, Utah. The Service does not have accurate population estimates or trends (USFWS, 2013).; The population size of the Tucker – Clear Creek population is larger now, with 237 individuals documented in 2017, and includes habitat on private and Bureau of Land Management (BLM) lands (Skopec et al. 2018). The Water Hollow – Garner Canyon population contains approximately 100 individuals based on the last partial-population estimate in 2006. At the time of our last 5-Year Review, we did not provide a range-wide total population estimate for clay phacelia (USFWS 2013); we now cautiously estimate there are 340 individuals range-wide. Surveys for the species since our last 5-year review have not documented new occurrences and pilot introduction attempts on U.S. Forest Service (USFS) lands (Tie Fork and Water Hollow – Garner Canyon) were not large enough to maintain the species' presence on Federal lands. Researchers are able to propagate the species from seed, and two propagation efforts are underway to prepare for future introduction efforts on Federal lands. (USFWS, 2019)

Threats and Stressors

Stressor: Small population size

Exposure:
Response:
Consequence:
Narrative: Numerous threats exist for Clay phacelia. Probably the most significant current threat is the species' inherent vulnerability due to small population size and number. In populations with less than 1000 individuals, demographic uncertainties can play a significant role in extinction probability (Shaffer 1987). This may be mitigated by a presumably large soil seed bank. However, the 1987 sheep staging episode significantly impacted the habitat, and the little soil that had accumulated in the area was partly washed away in subsequent thunderstorms. In spite of this, England still suspects a sizeable seed bank (England 1989) (NatureServe, 2015).

Stressor: Habitat modification (NatureServe, 2015; USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Human land-use activities in and near the critical habitats have played the largest role in Clay phacelia's recent dramatic decline. Livestock and sheep have grazed and trampled the plants and their surrounding habitat. The Denver and Rio Grande Western (D&RGW) railroad is adjacent to the Clear Creek site. Construction activities have already modified the neighboring habitat through stabilization of cuts and fills, runoff control, and material storage (Gill et al. 1982). In addition, Highway 6 bisects the Tucker population. Highway maintenance and construction activities such as burning and shoulder stabilization may also impact both potential and existing Clay phacelia and accompanying bee (pollen vector) habitats (NatureServe, 2015).; Within the species' small range, highway construction and maintenance, and transportation and transmission line development are threats that are likely to result in continued habitat loss and fragmentation. There continues to be potential for widening of the Highway 6 corridor into occupied habitat of clay phacelia. The Highway 6 corridor in Spanish Fork Canyon is a designated national energy corridor under section 368 of the Energy Policy Act of 2005. The national energy corridor designation encourages and facilitates the installation of additional transmission lines, and two transmission lines are planned within the species' range (USFWS 2016a and 2016b). Project proponents for two planned transmission lines committed to avoiding and minimizing impacts to clay phacelia through section 7 consultation of the Act, however there are likely to be future transmission line proposals in this area (USFWS, 2019)

Stressor: Grazing (NatureServe, 2015; USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Grazing from endemic ungulates and herbivory from small native herbivores has collectively impacted Clay phacelia. Specific threats include mule deer, elk, and occasional moose that frequent the area of critical habitat in the winter. The exposed south- and west-facing slopes provide a welcome winter home with food and relatively warm areas for bedding down. Rock squirrels have also been sighted nibbling on the herbage (Gill et al. 1982) (NatureServe, 2015).; Herbivory by native and domesticated ungulates is another threat to clay phacelia. Periodic herbivory, largely from mule deer, at the Tucker – Clear Creek population has repeatedly resulted in significant plant losses (Skopec et al. 2018). There are plans by The Nature Conservancy, BLM, USFS, and Weber State University to actively manage the threat of herbivory by installing fences and cages, repairing existing fences, and monitoring wildlife activity at the Tucker – Clear Creek,

Tie Fork, and Water Hollow – Garner Canyon populations. (USFWS, 2019)

Stressor: Competition (NatureServe, 2015; USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Long-term monitoring of exotic and native species which grow in association with Clay phacelia has not been conducted. However, this should be looked at closely, especially in the absence of grazing. Both MARUBIUM VULGARE and CYNOGLOSSUM OFFICINALE could pose significant competition to P. ARGILLACEA (England 1989) (NatureServe, 2015).; Weeds are another threat to clay phacelia. Weed invasion into occupied habitat by houndstongue (Cynoglossum officinale), horehound (Marrubium vulgare), and white top (Lepidium draba) can increase competition for soil moisture and alter the suitability of the habitat for clay phacelia (USFWS 2013). Private, state, Federal and university partners are actively managing weeds in the Tucker – Clear Creek population. We are exploring the use of alternative non-chemical weed control methods and low-residual herbicides in and near occupied habitat. (USFWS, 2019)

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The impacts of global climate change at this time are uncertain, and could either be positive or negative for this species. Overall temperatures may not be a problem, but changes in precipitation and precipitation patterns may alter survivability and retention of a viable seed bank (Meyer 2011a). Because this species is particularly dependent on multiple rains in the summer and fall to produce successful progeny for the year, changes in rainfall patterns have the potential to affect the seed bank and therefore long-term viability of the species (USFWS, 2013).

Stressor: Wildfire (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Wildfire is a potential threat to clay phacelia due to the high frequency of wildfire occurrence in Spanish Fork Canyon. Wildfire has not impacted clay phacelia or its habitat to date; however, the risk and severity of wildfire in occupied habitat may increase with the spread and coverage of weeds from adjacent road and other habitat disturbances. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. To establish a self-sustaining population of 2,000 to 3,000 individuals on 120 acres of protected habitat, and possibly establish at least one new population (USFWS, 2013).

Delisting Criteria:
We are developing objective and measureable delisting recovery criteria for clay phacelia. The delisting criterion identified in the 1982 recovery plan (USFWS 1982) is not objective or measurable: I. Clay phacelia will be delisted when the U.S. Fish and Wildlife Service through collaboration with professional botanists, including the Utah Native Plant Society, is satisfied

that adequate self-sustaining populations have been established. (USFWS, 2019)

Recovery Actions:

- Protect individual specimens and habitat (USFWS, 1982).
- Inventory Green River Formation and surrounding areas (USFWS, 1982).
- Introduce plants into new habitat (USFWS, 1982).
- Conduct a public information program (USFWS, 1982).
- Monitor existing and new populations (USFWS, 1982).
- Continue present efforts to establish new populations on USFS lands (USFWS, 2013).
- Provide funding for ongoing and future research (USFWS, 2013).
- Maintain partnerships with TNC, the USFS, and Red Butte Gardens to continue current research and monitoring projects (USFWS, 2013).
- Protect species from further population and habitat fragmentation from development and maintenance of developed areas (USFWS, 2013).
- Continue to protect species from trampling and habitat degradation from livestock activities (USFWS, 2013).
- Develop and implement an invasive, exotic plant management control plan with appropriate stakeholders (USFWS, 2013).
- Secure remaining occupied habitat under conservation management (USFWS, 2013).
- In conjunction with the Utah Division of Wildlife Resources, develop and implement a wildlife management plan to protect the species from ungulate and lagomorph herbivory (USFWS, 2013).
- Continue to monitor population size of this species through time (USFWS, 2013).
- Monitor seed bank viability, seedling recruitment, and seedling survivorship (USFWS, 2013).
- Document and quantify herbivory pressure from free-ranging herbivores (USFWS, 2013).
- Revisit the sites, creating GPS coordinates for each plant location, and identify areas to survey where the plant may occur (USFWS, 2013).
- Monitor invasive, exotic species distribution and abundance in suitable habitat (USFWS, 2013).
- Complete a population viability analysis (PVA) for this species and reevaluate the number of individuals needed for a healthy population (USFWS, 2013).
- Continue collecting and maintaining a genetically representative ex-situ seed collection for the species (USFWS, 2013).
- Augment introduced sites to ensure genetic representation of the species on Federal lands (USFWS, 2013).
- Study the effects of climate change on this species including how altered precipitation, water volume, availability, and timing of rain events may affect the species (USFWS, 2013).
- Determine the environmental conditions and tolerances necessary for each life stage of the species (USFWS, 2013).
- Determine if and how road and railway traffic volume influences this species, and its community associates such as pollinators (USFWS, 2013).
- Determine the extent to which the plants and their pollinators are being affected by road and railroad maintenance activities (USFWS, 2013).
- Re-examine the genetic diversity of this species in the future to determine if genetic diversity has been maintained or been reduced through time, using samples from multiple years (USFWS, 2013).
- Study the plants' pollinators and the pollinators' habitats (USFWS, 2013).

- Determine the effects of erosion on the species and identify actions that may restore soil conditions (USFWS, 2013).
- Examine conditions surrounding seedling emergence, the dynamics and characteristics of the seed bank including seed dormancy and germination (USFWS, 2013).

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SPECIES ACCOUNT: *Phacelia formosula* (North Park phacelia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/01/1982; Mountain-Prairie Region (R6) (USFWS, 2016). Proposed for delisting.

Physical Description

A biennial herb, 1.5-2.2 dm high, with deeply divided, leaves and bearing violet-purple flowers in a coiled, scorpion tail-like cluster. The species has been observed in flower in July and August, but flowering and fruiting times may be somewhat variable depending on rainfall and other environmental conditions (NatureServe, 2015).

Taxonomy

A member of the waterleaf family (NatureServe, 2015). P. formulosa appears to be most closely related to P. glandulosa (USFWS, 1986).

Historical Range

It was first collected near Walden, Colorado (Jackson County) in 1918 (USFWS, 1986).

Current Range

Currently, North Park Phacelia occurs in 11 disjunct populations (Figure 2). Eight of the 11 populations are in Jackson County, Colorado, and three in the Laramie River valley in northwestern Larimer County, Colorado. In past assessments, based on the best scientific information available at that time, we did not consider the three Laramie River valley occurrences to be North Park Phacelia (FWS 2012, p. 7). However, recent genetic analysis concluded that the three Laramie River valley populations are indeed North Park Phacelia (Riser et al. 2020, entire, in prep). Therefore, our understanding of the current range and distribution of the species has improved since our last 5-year status review with the inclusion of the Laramie River valley populations (Figure 4). The CNHP provided the geographic information system data displayed in Figure 4. The shape of the polygons include a masking technique to hide the precise location of populations occurring on private lands. A data use agreement with CNHP prevents the FWS from displaying the exact location of occupied habitat occurring on private lands. (USFWS, 2020). North Park phacelia is a narrow endemic plant, which occurs in 12 populations in Jackson, Grand, and northwestern Larimer Counties, Colorado, currently occupying approximately 452 acres. (USFWS, 2023)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2012)

Lifespan

Adult: 2 years (USFWS, 2016)

Breeding Season

Adult: July - August (USFWS, 2016)

Key Resources Needed for Breeding

Adult: Bee pollinators (USFWS, 2012)

Reproduction Narrative

Adult: It blooms in July and August and is a biennial surviving for one year as a rosette of leaves before flowering and dying the following year (USFWS, 2016). Phacelia formosula plants can self-pollinate, but are typically pollinated by a variety of bees (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 7,840 to 8,260 ft. elevation (USFWS, 2020)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: North Park Phacelia occurs at elevations of approximately 7,840 to 8,260 feet above sea level (ASL) (2,420 – 2,517 meters ASL) in Jackson County and northwestern Larimer County, Colorado. In Jackson County, the species occurs on specific soil outcrops composed of barren, raw exposures of the sedimentary Coalmont formation, a coal-bearing sandstone substrate susceptible to erosion (Figure 2) (CNHP 2015, p. 1). The Laramie River valley populations occur on barren shale exposures identified as Niobrara Shale outcrops [figure 3] instead of the Coalmont formation. Both areas occupied by North Park Phacelia appear well drained and sparsely vegetated. (USFWS, 2020)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seeds are poorly dispersed (Warren 1990, p. 3) (USFWS, 2012).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

Stable (NatureServe, 2015)

Resiliency:

We describe the resiliency for each of the 11 populations in terms of the habitat, demographic, and climate factors needed by the North Park Phacelia (Service 2021, pp. 22–24). We developed a categorical model to calibrate resiliency based on a range of conditions for two habitat factors (occupied area and ecological setting) and one demographic factor (abundance measured by abundance estimates), and one climate variable (growing season water deficit) (Service 2021, pp. 23–24). We selected these factors based on their importance to resiliency and because we could evaluate them relatively consistently across all 11 populations. We then used a categorical model as a key to evaluate resiliency for each population by systematically evaluating the current condition of each factor. To calculate an overall score for resiliency, we assigned values to the resiliency categories and then calculated an average of the factor ranking (Table 8 in Service 2021, p. 24). Populations in higher resiliency categories are at less risk from potential stochastic events, such as extended drought conditions, than populations in lower resiliency categories (Service 2021, p. 25). Our SSA report provides additional detail regarding the methodology we used to evaluate resiliency for each of the 11 populations (Service 2021, pp. 22–24). (USFWS, 2021)

Representation:

Riser et al. (2020, entire), through genetic analysis, reported the breadth of genetic variability of the species both within and between populations of North Park Phacelia. In addition, Atwood (2010, p. 1–3) concluded that North Park Phacelia in the Laramie River valley show a number of measurable differences in growth forms of flowers, leaves, and seeds from those in North Park. Based on this information, we believe the species displays a relatively high degree of genetic diversity, which may confer some type of adaptability to environmental change. The role of pollinators is unclear since the species can self-pollinate, and we assume that some genetic exchange occurs between populations periodically. We consider ecological representation low as there is little variation in soil type and conditions at population sites. The different soil types between populations in Jackson County and those in the Laramie River valley represent what little ecological variability exists. Our SSA report provides a full account of our evaluation of resiliency, redundancy, and representation for each population, including the assessment of each habitat and demographic factor for each population. Please see the SSA report for our full analysis of current resiliency (Service 2021, pp. 23–29). (USFWS, 2021)

Redundancy:

Like many narrow endemic species, the redundancy of North Park Phacelia is, and has likely always been, relatively low because of its limited geographic range and habitat specificity. However, North Park Phacelia consists of 11 populations, separated by at least 1 mile. Three populations occur approximately 20 mi (30 km) from the other 8 populations, and are separated by the Medicine Bow Mountain Range, which helps spread catastrophic risk over a larger geographic area. We are not aware of any populations that have been lost to the species. Under the current circumstances, redundancy is higher with 11 known populations compared to the 2 known populations at listing (1982). There may be additional undiscovered populations within the range of the species. We believe that redundancy is likely stable under current conditions. (USFWS, 2021)

Number of Populations:

12 (USFWS, 2023)

Population Size:

~23,000 - 26,000 (USFWS, 2023)

Population Narrative:

The long term data population trend is unknown. Although there are no data to indicate a specific trend, the species seems to be stable within its limited available habitat (NatureServe, 2015). Roughly 16,000 individuals are known from six separate populations and the entire species is known only to an area measuring roughly 10 miles in either direction (north to south, east to west) (USFWS, 2016). Currently, North Park Phacelia occurs in 11 disjunct populations (Figure 2). Eight of the 11 populations are in Jackson County, Colorado, and three in the Laramie River valley in northwestern Larimer County, Colorado. In past assessments, based on the best scientific information available at that time, we did not consider the three Laramie River valley occurrences to be North Park Phacelia (FWS 2012, p. 7). However, recent genetic analysis concluded that the three Laramie River valley populations are indeed North Park Phacelia (Riser et al. 2020, entire, in prep). Therefore, our understanding of the current range and distribution of the species has improved since our last 5-year status review with the inclusion of the Laramie River valley populations (Figure 4). The CNHP provided the geographic information system data displayed in Figure 4. The shape of the polygons include a masking technique to hide the precise location of populations occurring on private lands. A data use agreement with CNHP prevents the FWS from displaying the exact location of occupied habitat occurring on private lands. (USFWS, 2020). there are currently 12 populations of North Park phacelia with approximately 23,000 to 26,000 plants (USFWS, 2023).

Threats and Stressors

Stressor: Cattle grazing (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Grazing by cattle is ubiquitous across the range of Phacelia formosula. Cattle trampling and compaction of the soil and trampling of rosettes and mature plants is an ongoing threat because P. formosula, like most small herbaceous plants, can be severely damaged in heavily travelled areas, such as around watering areas and fences and along trails (CNAP 1996, p. 5). A few heavily impacted sites have been documented (CNHP 2010a, pp. 1, 4, 5, 9, 11, 18). Some of the adverse effects from livestock include changes in the timing and availability of pollinator food plants (Kearns and Inouye 1997, pp. 298–299); changes to insect communities (Kearns and Inouye 1997, pp. 298–299; Debano 2006, pp. 2547–2564); damage to ground-nesting pollinators and their nests (Sugden 1985, p. 309); changes in water infiltration due to soil compaction (Jones 2000, Table 1); disturbance to soil microbiotic crusts (Belnap et al. 1999, p. 167; Jones 2000, Table 1); subsequent nonnative invasive plant invasions (Parker et al. 2006, pp. 1459–1461); and soil erosion from hoof action (Jones 2000) (USFWS, 2012).

Stressor: Range improvements (USFWS, 2012)
Exposure:
Response:

Consequence:
Narrative: The recovery plan cites the potential for range improvements, such as vegetation manipulation or spraying and changing water source locations, to affect the species, although no examples were available. The effects of range improvements on occurrences of Phacelia formosula on private lands have not been documented due to lack of access. This is considered a potential threat because future changes (such as altering water sources which forces cattle to congregate in certain areas) could impact the species (USFWS, 2012).

Stressor: Off-road vehicles (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: ORV tracks have been noted at five of the nine occurrences. The Airport occurrence is the most heavily impacted by ORV use. Plants still exist at this occurrence, but its viability is ranked as poor because the habitat is disturbed by ORVs and other general public uses that facilitate the introduction of nonnative invasive plants that can compete with P. formosula (CNHP 2010a, pp. 1-3). As on other BLM lands in western Colorado, ORV use is likely to increase (Colorado Off-Highway Vehicle Coalition 2009, p. 1-2). These activities can destroy more plants and damage habitat for P. formosula. Unpaved access roads on BLM and private land cause habitat fragmentation because they create abrupt transitions in vegetation; are sources of pollutants; and act as filters (allowing some species to cross but not others) and barriers (prohibiting movement) (Spellerberg 1998, pp. 317–333) (USFWS, 2012).

Stressor: Oil and gas development (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: BLM lands in North Park have been leased for oil, gas, and coal development since before the implementation of the ESA (USFWS 1986, p. 6). Three Phacelia formosula occurrences have oil and gas leases that have been issued since 2001. The leases include 144.3 ac (58.4 ha) of occupied habitat for the species. Of these occupied acres, 41.3 ac (16.7 ha) are within 500 meters of wells (Glenne 2011a, pers. comm.) (USFWS, 2012).

Stressor: Residential development (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Development of home sites on ranch land has been cited as a threat to Phacelia formosula (Kram et. al. 2008, p. 4). TNC has secured a conservation agreement for the species that allows a home to be built on a parcel that also has a protected area of plant habitat (Handwerk 2009, pers. comm.). Residential development is a potential threat of low magnitude that is likely to increase as more development occurs in North Park, depending on the economy (USFWS, 2012).

Stressor: Seed predation (USFWS, 2012)
Exposure:
Response:
Consequence:

Narrative: Seed predation by insect larvae was observed in 1980. In 1990, lepidopteran larvae were reportedly destroying half of the seed pods that were inspected. In 1993, many seed pods were destroyed by unidentified insect predation (CNAP 1994, p. 4) (USFWS, 2012).

Stressor: Stochastic events (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The final listing rule and the recovery plan state that any human threats to this species would exacerbate the possibility of small populations going extinct through natural population fluctuations. They also cite lack of species occurrence and environmental data and uninformed land managers, administrators, and landowners as contributing to risk factors. Given current population levels, these factors remain a concern (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change is a potential threat to Phacelia formosula because the species is highly sensitive to changes in precipitation and temperature. Typical future summer monthly temperatures will be as warm as or warmer than the hottest 10% of summers that occurred between 1950 and 1999 (CWCB 2009, p. 1). Phacelia formosula is particularly sensitive to precipitation and temperature during germination, seedling and rosette growth, and especially while developing into flowering adults at the height of summer heat and drought (McCormick and Wu 1999, p. 5). P. formosula also is sensitive to extreme weather events, such as the thunderstorms that are common in North Park which can cause rill and sheet erosion and carry away the P. formosula plants (USFWS, 2012).

Recovery

Reclassification Criteria:
Locate and secure five occurrences of approximately 500 mature flowering individuals each (USFWS, 1986).

Recovery Priority Number: 8

Delisting Criteria:
Ten other areas of suitable habitat are identified and secured with 500 mature flowering individuals each (USFWS, 1986).

Recovery Actions:
- Disseminate information on the known occurrences and potential occurrences of P. formulosa habitat (USFWS, 1986).
- Implement conservation strategies for the perpetuation of the essential habitat of the species (USFWS, 1986).
- Develop strategies to assist in the perpetuation of the essential habitat and the species (USFWS, 1986).

- Initiate scientific research on known and potential habitat and the biology of the species (USFWS, 1986).
- Publicize as appropriate the value of the North Park phacelia and the recovery effort (USFWS, 1986).
- Investigate the advantages of habitat acquisition and/or conservation easements (USFWS, 1986).
- The recovery plan for Phacelia formosula should be revised so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats impacting the species. The recovery plan also should estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting. Finally, the recovery plan should evaluate and map geographic areas essential for the conservation of P. formosula (USFWS, 2012).
- Work with the CRPCI to develop a list of recovery priorities and implement conservation actions (USFWS, 2012).
- Develop conservation agreements and easements with partners such as land trusts, TNC, NRCS, CNAP, and Partners for Fish and Wildlife to protect Phacelia formosula on private lands across the entire range of the species (USFWS, 2012).
- Inventory unsurveyed suitable and potential habitat for Phacelia formosula on public and private lands. Report results to CNHP, BLM, and USFWS. These surveys will provide better information to guide recovery and conservation actions as well as project planning (USFWS, 2012).
- Monitor phenology of the plants and log weather patterns to inform climate change studies (USFWS, 2012).
- Develop and implement a long-term range management monitoring plan to guide grazing management for protection of Phacelia formosula habitat (USFWS, 2012).
- Establish and implement a range-wide trend monitoring protocol (USFWS, 2012).
- Control the location and timing of livestock movement and concentration to minimize impacts to the species (USFWS, 2012).
- Regularly monitor impacts from ORV use. If impacts from ORV use are detected, work with the land manager on reducing those effects (USFWS, 2012).
- BLM plans to expand the existing ACEC and create new ACECs to include contiguous occupied and suitable habitat for the plant and its pollinators. Oil leases have been deferred within the potential ACECs until the new RMP is final (USFWS, 2012).
- Work with the BLM Kremmling Field Office to develop and implement consistent conservation measures in the RMP revision that will avoid and minimize impacts to Phacelia formosula and its habitat from livestock trampling, ORV activities, and energy development (USFWS, 2012).
- Continue ongoing seed collection, germination testing, and long-term storage and preservation of seeds (USFWS, 2012).
- Undertake a study to improve understanding of dormancy characteristics in Phacelia formosula seed banks (USFWS, 2012).
- Conduct a study to identify pollinators and their habitat needs (USFWS, 2012).
- Perform long-term study of local changes in weather patterns and effects on plants (USFWS, 2012).
- Study livestock impacts on plants and habitat (USFWS, 2012).

- Complete the analysis of the genetic relationship between Phacelia formosula and Phacelia scullyi (the population of Phacelia discovered in the Laramie River Valley approximately 20 mi (~30 km) north of known Phacelia formosula populations) (USFWS, 2012).
- Reach out to Jackson County, the town of Walden, the State of Colorado, applicable Federal agencies, and other potential stakeholders with information about the plants, habitat requirements, and known locations in order to proactively engage partners to ensure that projects avoid impacts to Phacelia formosula (USFWS, 2012).
- Educate private landowners about the plant and how they can help protect the species (USFWS, 2012).

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SPECIES ACCOUNT: *Phacelia insularis ssp. insularis* (Island phacelia)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, usually about 1.5 dm tall. Small lavender to violet, bell-shaped flowers bloom in March and April. (NatureServe, 2015)

Taxonomy

The summary and table of the July 31, 1997 notice in the Federal Register (in which the USFWS determines this taxon as endangered) lists the taxon as Phacelia insularis SSP. insularis; in the text the taxon is referred to as a subspecies and as a variety. The treatment the notice appears to follow is Wilken et al. (1993; in Hickman) which treats the taxon as a variety. (NatureServe, 2015)

Historical Range

Endemic to the California Channel Islands and, at the time of listing in 1997, a single population on Santa Rosa Island was the only known population of the species. By the time the recovery plan was published in 2000, island phacelia was known to occur in five localities: the one on Santa Rosa Island at Carrington Point and the four on San Miguel Island (see Santa Rosa Island and San Miguel Island maps, pp. 15-16). Both islands occur on lands managed by Channel Islands National Park (Park). The Santa Rosa Island population occupies about 15 acres (6 hectares (ha)) based on its maximum observed extent in 1998. The San Miguel Island populations range from about 0.02 to 0.86 acres (0.01 to 0.35 ha). These figures are from USGS surveys made in April and May, 1998, when the largest number of plants were observed (McEachern in litt. 2007b). Surveys since 1998 have not seen such extensive numbers of plants in those same areas; however, a seed bank likely still exists (McEachern in litt. 2007b). (USFWS, 2008)

Current Range

This variety occurred only in Santa Rosa and San Miguel Islands, Santa Barbara county, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Currently, little life history information is available for this species. This annual flower blooms from March through April (USFWS, 2000).

Habitat Type

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly

based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Sandy valley and foothill grassland communities, bluffs, dunes, dominated by alien grasses with some scattered native bunchgrasses, shrubs, and herbs; at or near sea level (partly based on Calif. Nat. Diversity Database, May/1998 report). (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

6 EOs (USFWS, 2021)

Population Narrative:

USFWS reports a population of 31 plants from Santa Rosa Island in 1994. No populations have been relocated in San Miguel Island. As of 2001, no populations exist. The California Natural Diversity Database (May/1998) reports four occurrences, none of which have been observed in the last 20 years; but USFWS (1997) reports that Sarah Chaney found one small population in 1994 in Santa Rosa Island. (NatureServe, 2015). Low redundancy, representation and resiliency are inferred based on low population numbers and low number of individuals.

Threats and Stressors

Stressor: Predation (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Some progress has been made toward eliminating non-native animals from Santa Rosa Island since the time of listing. We believe the removal of pigs by 1993, removal of cattle by 1998, and smaller populations of deer and elk since 1998 have reduced browsing pressure on island phacelia. Although habitat conditions on Santa Rosa Island and San Miguel Island show the

effects of long-term grazing, the USGS believes that at the landscape level, conditions are improving (McEachern in litt. 2007b). In fact, browsing by an animal is rarely seen, although predation does occur from mice that are known to harvest the fruits (McEachern in litt. 2007b) (USFWS, 2008).

Stressor: Non-native plants (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasion of habitats by non-native annual grasses, especially ripgut brome, continues to impact the species, particularly germination. Non-native annual grasses and the litter they produce also appear to inhibit successful establishment of phacelia seedlings in field experiments (McEachern in litt. 2007b, Levine et al. 2007) (USFWS, 2008).

Stressor: Small population size (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of genetic variability/extinction
Narrative: At the time of listing, island phacelia was threatened by the risk of stochastic extinction due to small population size and limited distribution (62 FR 40954). The conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, the small size of each population makes it difficult for this species to persist while sustaining the impacts of soil damage and habitat alteration from non-native species. The species remains vulnerable to extirpation due to its small population size, high inter-annual variability in plant numbers, limited distribution, and low survival rate (USFWS, 2008).

Stressor: Climate change (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Island phacelia may be particularly threatened by climate change because its geographic distribution is so narrow and its current range is unlikely to overlap regions that would be climatically favorable in the future (Levine et al. 2007). This is particularly acute for species on islands because they are unable to disperse to more favorable habitat as the environment changes. Because of this, Levine et al. (2007) suggest that the persistence of many rare species depends on how populations respond to climate change in their current locations (USFWS, 2008).

Recovery

Reclassification Criteria:
1. Discover or establish 10 populations per island (San Miguel and Santa Rosa) (USFWS, 2021)

2. Maintain stable populations for a period of 15 years that includes the normal precipitation cycle. (USFWS, 2021)

3. Seed stored in CPC cooperating facilities. (USFWS, 2021)

4. Seed germination and propagation techniques understood. (USFWS, 2021)

5. Successful outplanting techniques developed (USFWS, 2021)

6. Life history research conducted. (USFWS, 2021)

7. Weed management plan developed and implemented. (USFWS, 2021)

8. If declining, determine cause and reverse trend. (USFWS, 2021)

Delisting Criteria:
Discover or establish five additional populations per island (USFWS, 2008).

No decline after downlisting for 10 years (USFWS, 2008).

All potential habitat surveyed. (USFWS, 2021)

Recovery Actions:

- Reclassification Criteria: Although surveys in historical and other suitable habitat have been conducted, additional populations have not been found and no reintroduced populations have been established on Santa Rosa Island. Therefore, this criterion has not been met. We believe this criterion may be possible on San Miguel Island because, although these plants have every specific habitat requirements, there are several places on the island where suitable habitat conditions exist and the plant now occurs (McEachern, in litt. 2007a). However, this criterion is not appropriate with respect to the recovery of the species on Santa Rosa Island because suitable habitats appear to be extremely rare on the island. Suitable habitat may be available on Carrington Point; otherwise, suitable habitat on the island appears to be limited. Therefore, a more realistic goal would be to establish one additional population on Santa Rosa Island. Results of restoration field experiments over time would help establish whether or not the goal of one more population is feasible (McEachern, in litt. 2007a). Delisting Criteria: This criterion has not been met. We believe this criterion may be possible on San Miguel Island where three populations exist now but it is not realistic with respect to the recovery of the species on Santa Rosa Island for the same reasons described in downlisting criterion #1 above (USFWS, 2008).
- Reclassification Criteria: Delisting Criteria: This criterion has not been met. Although we believe the intent of this criterion is appropriate, we think it should be refined to focus on long-term trends, rather than a short-term, absolute decline, once additional information about the life history of the species and the species' response to recovery actions are better understood. Factor B is not relevant to this species. Factor D is relevant but is not addressed in the recovery criteria (USFWS, 2008).
- Reclassification criteria: A precipitation cycle includes periods of drought and wet years, with annual rainfall starting at 100 to 135 percent of average, dropping below 65 percent of average, and returning to at least average (Service 2000). Because the species has not been listed for a minimum of 15 years, this criterion has not been met. We believe this criterion is adequate and appropriate with respect to the recovery of the species (USFWS, 2008).

- The USGS-BRD and NPS should seek additional funding to continue field surveys and monitoring, demographic monitoring, population viability analyses, and further investigations into recovery projects (USFWS, 2008).
- The Service should work cooperatively with NPS and USGS-BRD to refine the generalized downlisting criteria to take into consideration new information. Attaining the recovery objective of securing several populations containing a minimum of 2,000 plants each is unrealistic for this species (USFWS, 2008).
- The Service should work cooperatively with NPS and USGS-BRD to refine delisting criteria to emphasize long-term population growth trends rather than short-term gains or declines (USFWS, 2008).
- The USGS-BRD and NPS should investigate the community-level factors that influence population abundance, distribution, and demographic trends (USFWS, 2008).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue monitoring the Santa Rosa Island occurrence of Phacelia insularis var. insularis and establish regular surveys on both Santa Rosa and San Miguel Islands. 2. Better define suitable germination and growth microhabitat for Phacelia insularis var. insularis, especially in relationship to non-native Bromus diandrus competition and thatch accumulation, and if needed determine how to manage Bromus diandrus. 3. Determine efficient methods to reduce Bromus diandrus thatch without harming Phacelia insularis var. insularis individuals. 4. Control non-native Malva psuedolavatera in the Carrington Point area on Santa Rosa Island. 5. Improve the completeness of coverage of Phacelia insularis var. insularis in conservation seed banks, with more occurrences over more years. (USFWS, 2021)

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SPECIES ACCOUNT: *Phacelia submutica* (DeBeque phacelia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/26/2011; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Annual plant, stems 2-8 cm long, often branched at the base, mostly prostrate, leaves hairy, oblong or egg-shaped, flowers crowded, petals 3.5-4.5 mm long, white or cream colored becoming yellowish with age, stamens not protruding beyond the petals. (NatureServe, 2015)

Taxonomy

Phacelia submutica was first described by Howell based on specimens collected from the town of DeBeque, Mesa County, Colorado, in 1911 and 1912 (Howell 1944, pp. 370– 371Halse (1981, pp. 121, 129, 130) reduced it to varietal status as P. scopulina var. submutica. This has been challenged as incorrect by O'Kane (1987, p. 2), who claimed Halse used inadequate collection materials, and that P. submutica is geographically isolated from P. scopulina (O'Kane 1987, p. 2; 1988, p. 462). Phacelia submutica is recognized at the species rank by current floristic treatments in Weber and Wittmann (1992, p. 98; 2001, p. 203) and by the Director of the Biota of North America Program (Kartesz 2008, pers. comm.). While the Integrated Taxonomic Information System (2001) database cites John Kartesz as the expert source for this species, it is not updated with his currently accepted name for the species: Phacelia submutica (Kartesz 2008, pers. comm.). Phacelia is included in the Hydrophyllaceae (waterleaf family). Recent molecular data suggest that this family should be combined in an expanded Boraginaceae (borage family). There are conflicting views on the configuration of this larger Boraginaceae and the lead author of the family treatment for the upcoming Flora of North America has chosen to retain the Hydrophyllaceae. Therefore, we will retain Phacelia in the Hydrophyllaceae family for this proposal (USFWS, 2010).

Current Range

Phacelia submutica is endemic to Colorado and known only from Garfield and Mesa counties. Estimated range is 356 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences.

Critical Habitat Designated

Yes; 8/13/2012.

Legal Description

On August 13, 2012, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Phacelia submutica (DeBeque phacelia) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four critical habitat units (CHUs), in Colorado (77 FR 48356-48415).

Critical Habitat Designation

The critical habitat designation for Phacelia submutica includes nine CHUs in Garfield and Mesa Counties, Colorado. This species critical habitat encompasses approximately 25,484 acres (ac) (10,313 hectares (ha)) (77 FR 48356-48415).

Unit 1, the Sulphur Gulch Unit, consists of 1,046 ac (423 ha) of federally owned land. The Unit is located approximately 7.7 mi (12.5 km) southwest of the town of DeBeque in Mesa County, Colorado. This Unit is managed by BLM, through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 5,480 to 6,320 ft (1,670 to 1,926 m), appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. All lands within this Unit are leased as grazing allotments, and less than 1 percent is managed as an active pipeline ROW by the BLM. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), domestic and wild ungulate grazing and use, and nonnative invasive species, such as Bromus tectorum.

Unit 2, the Pyramid Rock Unit, is the largest Unit we are designating and consists of 17,321 ac (7,010 ha) of federally and privately owned lands in Mesa and Garfield Counties, Colorado. This Unit is approximately 1.6 mi (2.6 km) west of the town of DeBeque. The eastern boundary borders Roan Creek, and Dry Fork Creek runs through the northern quarter of the Unit. Eighty-nine percent is managed by BLM through the Grand Junction Field Office, and 11 percent is under private ownership. Three percent of this Unit is within the Pyramid Rock Natural Area and Pyramid Rock ACEC that was designated, in part, to protect Phacelia submutica, as discussed in the proposed (75 FR 35739) and final listing rules (76 FR 45054). This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,960 to 6,840 ft (1,512 to 2,085 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Ninety-four percent of this Unit is managed as a grazing allotment on BLM and private lands. Additionally, 11 percent of this Unit is managed as an active pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species including Bromus tectorum and Halogeton glomeratus. The Westwide Energy corridor runs through this Unit. The corridor covers almost 10 percent of this Unit (Service 2011c, p. 9).

Unit 3, the Roan Creek Unit, consists of 54 ac (22 ha) of federally and privately owned lands in Garfield County, Colorado. The Unit is located 3.3 mi (5.4 km) north of the town of DeBeque and for 1.7 mi (2.7 km) along both sides of County Road 299. Ninety-seven percent of this Unit is privately owned. Three percent of this Unit is managed by BLM through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent cover, suitable elevational ranges of 5,320 to 5,420 ft (1,622 to 1,652 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. The entire Unit is within a grazing allotment. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management

will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include recreation (especially OHV use), livestock and wild ungulate grazing and use, nonnative invasive species including Bromus tectorum and Halogeton glomeratus, and a lack of protections on private lands.

Unit 4, the DeBeque Unit, consists of 530 ac (215 ha) of Federal and private lands in Mesa County, Colorado. This Unit is located 0.25 mi (0.4 km) north of DeBeque between Roan Creek Road and Cemetery Road. Seventy-six percent of this Unit is managed by BLM through the Grand Junction Field Office. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 5,180 to 5,400 ft (1,579 to 1,646 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, residential development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species including Bromus tectorum and Halogeton glomeratus. Since 24 percent of the Unit is privately owned and borders the north of the town of DeBeque, this Unit is threatened by potential urban or agricultural development. The Westwide Energy corridor runs through this Unit. The corridor covers almost 66 percent of this Unit (Service 2011c, p. 9).

Unit 5, the Mount Logan Unit, consists of 277 ac (112 ha) of Federal and private lands in Garfield County, Colorado. The Unit is located 2.7 mi (4.4 km) north, northeast of the town of DeBeque, Colorado, and 0.5 mi (0.8 km) west of Interstate 70. Eighty-eight percent of this Unit is managed by BLM through the Grand Junction Field Office. The remainder of this Unit is privately owned. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,960 to 5,575 ft (1,512 to 1,699 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Eighty-eight percent of this Unit is managed as a grazing allotment by BLM, and 53 percent is managed as an active pipeline ROW. An access road runs through the Unit connecting several oil wells and associated infrastructure. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus.

Unit 6, the Ashmead Draw Unit, consists of 1,276 ac (516 ha) of Federal and private lands in Mesa County, Colorado. The Unit is located 1.5 mi (2.5 km) southeast of the town of DeBeque, Colorado, and east of 45.5 Road (DeBeque Cut-off Road). Eighty-seven percent of this Unit is managed by BLM through the Grand Junction Field Office, the remainder is private lands. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (Service 2011e, pp. 1-3). This Unit

currently has all the physical and biological features essential to the conservation of the species including barren clay badlands with less than 20 percent plant/vegetation cover, suitable elevational ranges of 4,940 to 5,808 ft (1,506 to 1,770 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. A network of access roads runs through the Unit. Eighty-eight percent of this Unit is within a BLM grazing allotment, and 84 percent is within the Grand Junction Field Office's designated energy corridor. Thirty percent of the Unit is managed as an active pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus. The Westwide Energy corridor runs through this Unit. The entire Unit is within the Westwide Energy corridor, and 88 percent is within several grazing allotments.

Unit 7, the Baugh Reservoir Unit, consists of 430 ac (174 ha) of Federal and private lands in Mesa County, Colorado. The Unit is located 6 mi (10 km) south of DeBeque, Colorado, near Kimball Mesa and Horse Canyon Road. Thirty-nine percent is managed by BLM through the Grand Junction Field Office, and the remaining 61 percent is on private lands. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (Service 2011e, pp. 5-8). This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,400 to 5,700 ft (1,646 to 1,737 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. An access road runs through the Unit, close to the occurrence of Phacelia submutica. While these lands currently have the physical and biological features essential to the conservation of P. submutica, because of a lack of cohesive management and protections, special management will be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation, livestock and wild ungulate grazing and use, and nonnative invasive species including Bromus tectorum and Halogeton glomeratus. The Westwide Energy corridor runs through this Unit. The entire Unit is within the Westwide Energy corridor and one grazing allotment.

Unit 8, the Horsethief Mountain Unit, consists of 4,209 ac (1,703 ha) of Federal and private lands in Mesa County, Colorado. It is located approximately 3.5 mi (5.6 km) southeast of DeBeque, Colorado, and along the eastern side of Sunnyside Road (V Road). Thirty-four percent is managed by BLM through the Grand Junction Field Office, 29 percent by the White River National Forest, 23 percent by the Grand Mesa Uncompahgre National Forest, and 14 percent is on private lands. This Unit is currently occupied. This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,320 to 6,720 ft (1,622 to 2,048 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, because of a lack of cohesive management and protections, special management will be required to

maintain these features in this Unit. A portion of the site on USFS lands is within a proposed Research Natural Area. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus.

Unit 9, the Anderson Gulch Unit, consists of 341 ac (138 ha) of State and private lands in Mesa County, Colorado. It is located 11 mi (17 km) southeast of DeBeque, Colorado, and 3.5 mi (5.5 km) north of the town of Molina, Colorado. Within the Unit, 56 percent of the lands are managed by CDOW, within the Plateau Creek State Wildlife Area, and 44 percent is private. This Unit is currently occupied. We slightly increased the size of this Unit from our proposed critical habitat designation in our notice of availability (77 FR 18162) to include sites that were revisited and more accurately mapped during the spring of 2011 (CNHP 2012b, spatial data). This Unit currently has all the physical and biological features essential to the conservation of the species, including barren clay badlands with less than 20 percent plant/vegetation cover, a suitable elevational range of 5,860 to 6,040 ft (1,786 to 1,841 m), the appropriate topography, and shrink-swell alkaline clay soils within the Atwell Gulch and Shire members of the Wasatch Formation. Forty-two percent of the Unit is a pending pipeline ROW. While these lands currently have the physical and biological features essential to the conservation of Phacelia submutica, special management may be required to maintain these features in this Unit. Threats to Phacelia submutica and its habitat in this Unit include energy development, recreation (especially from OHV use), livestock and wild ungulate grazing and use, and nonnative invasive species, including Bromus tectorum and Halogeton glomeratus.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Phacelia submutica critical habitat consists of five components (77 FR 48356-48415):

(i) Suitable soils and geology. (A) Atwell Gulch and Shire members of the Wasatch formation. (B) Within these larger formations, small areas (from 10 to 1,000 ft\2\ (1 to 100 m\2\)) on colorful exposures of chocolate to purplish brown, light to dark charcoal gray, and tan clay soils. These small areas are slightly different in texture and color than the similar surrounding soils. Occupied sites are characterized by alkaline (pH range from 7 to 8.9) soils with higher clay content than similar nearby unoccupied soils. (C) Clay soils that shrink and swell dramatically upon drying and wetting and are likely important in the maintenance of the seed bank.

(ii) Topography. Moderately steep slopes, benches, and ridge tops adjacent to valley floors. Occupied slopes range from 2 to 42 degrees with an average of 14 degrees.

(iii) Elevation and climate. (A) Elevations from 4,600 ft (1,400 m) to 7,450 ft (2,275 m). (B) Climatic conditions similar to those around DeBeque, Colorado, including suitable precipitation and temperatures. Annual fluctuations in moisture (and probably temperature) greatly influences the number of Phacelia submutica individuals that grow in a given year and are thus able to set seed and replenish the seed bank.

(iv) Plant community. (A) Small (from 10 to 1,000 ft\2\ (1 to 100 m\2\)) barren areas with less than 20 percent plant cover in the actual barren areas. (B) Presence of appropriate associated species that can include (but are not limited to) the natives Grindelia fastigiata, Eriogonum

gordonii, Monolepis nuttalliana, and Oenothera caespitosa. Some presence, or even domination by, invasive nonnative species, such as Bromus tectorum, may occur, as Phacelia submutica may still be found there. (C) Appropriate plant communities within the greater pinyon-juniper woodlands that include: (1) Clay badlands within the mixed salt desert scrub; or (2) Clay badlands within big sagebrush shrublands.

(v) Maintenance of the seed bank and appropriate disturbance levels. (A) Within suitable soil and geologies (see paragraph (2)(i) of this entry), undisturbed areas where seed banks are left undamaged. (B) Areas with light disturbance when dry and no disturbance when wet.

Special Management Considerations or Protections

The features essential to the conservation of this species (plant community and competitive ability, elevation, topography, soils, climate, reproduction and seed bank, and disturbance regime) may require special management considerations or protection to reduce threats. Specifically, the clay soils on which Phacelia submutica are found are relatively stable when dry but are extremely vulnerable to disturbances when wet. The current range of P. submutica is subject to human-caused modifications from natural gas exploration and production with associated expansion of pipelines, roads, and utilities; development within the Westwide Energy Corridor; increased access to the habitat by OHVs; soil and seed disturbance by livestock and other human-caused disturbances; nonnative invasive species including Bromus tectorum and Halogeton glomeratus (halogeton); and inadequacy of existing regulatory mechanisms (76 FR 45054). Special management considerations or protections are required within critical habitat areas to address these threats. Management activities that could ameliorate these threats include (but are not limited to): Development of regulations and agreements to balance conservation with energy development and minimize its effects in areas where the species resides; the establishment of additional protection areas that provide greater protections for the species; minimization of OHV use; placement of roads and utility lines away from the species and its habitat; minimization of livestock use or other human-caused disturbances that disturb the soil or seeds; and the minimization of habitat fragmentation. These management activities would protect the PCEs for the species by preventing the loss of habitat and individuals, protecting the plant's habitat and soils, and managing for appropriate levels of disturbance. Criteria Used To Identify Critical Habitat As required by section 4(b)(2) of the Act, we used the best scientific data available to designate critical habitat. We reviewed available information pertaining to the habitat requirements of this species. In accordance with the Act and its implementing regulation at 50 CFR 424.12(e), we considered whether designating additional areas-- outside those currently occupied as well as those occupied at the time of listing--are necessary to ensure the conservation of the species. We are designating critical habitat in areas within the geographical area occupied by Ipomopsis polyantha, Penstemon debilis, and Phacelia submutica at the time of listing in 2011. We also are designating specific areas outside the geographical area occupied by I. polyantha and P. debilis at the time of listing because we have determined that such areas are essential for the conservation of the species. All units are designated based on sufficient elements of physical and biological features being present to support Ipomopsis polyantha, Penstemon debilis, and Phacelia submutica life-history processes. Small populations and plant species with limited distributions, like those of Ipomopsis polyantha and Penstemon debilis, are vulnerable to relatively minor environmental disturbances (Given 1994, pp. 66-76; Frankham 2005, pp. 135-136), and are subject to the loss of genetic diversity from genetic drift, the random loss of genes, and inbreeding (Ellstrand and Elam 1993, pp. 217-237; Leimu et al. 2006, pp. 942-952). Plant populations with lowered genetic diversity are more

prone to local extinction (Barrett and Kohn 1991, pp. 4, 28). Smaller plant populations generally have lower genetic diversity, and lower genetic diversity may in turn lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Newman and Pilson 1997, p. 360; Palstra and Ruzzante 2008, pp. 3428-3447). Because of the dangers associated with small populations or limited distributions, the recovery of many rare plant species includes the creation of new sites or reintroductions to ameliorate these effects. Genetic analysis of Ipomopsis polyantha has not been conducted; therefore, we do not understand the genetic diversity of this species. Given the species' limited extent and presence in only two populations, we expect the species may be suffering from low genetic diversity, or could in the future. Genetic research on Penstemon debilis, based on neutral genetic markers, has found that there is more genetic diversity in larger populations than smaller populations, that the northeastern populations are more closely related to one another than to the southwestern populations, that inbreeding is common within each population, and that genetic diversity for the species is low when compared with other species of plants with similar life-history traits (Wolfe 2010, p. 1). The plant is partially clonal, which likely explains the lowered genetic diversity and further reduces the actual population size. Small population sizes with few individuals are a problem for this species, as supported by this research. When designating critical habitat for a species, we consider future recovery efforts and conservation of the species. Realizing that the current occupied habitat is not enough for the conservation and recovery of Ipomopsis polyantha and Penstemon debilis, we worked with species' experts to identify unoccupied habitat essential for the conservation of these two species. The justification for why unoccupied habitat is essential to the conservation of these species and methodology used to identify the best unoccupied areas for consideration for inclusion is described below. Habitat fragmentation can have negative effects on biological populations, especially rare plants, and affect survival and recovery (Aguilar et al. 2006, pp. 968-980; Aguilar et al. 2008, pp. 5177-5188; Potts et al. 2010, pp. 345-352). Fragments are often not of sufficient size to support the natural diversity prevalent in an area, and thus exhibit a decline in biodiversity (Fahrig 2003, pp. 487-515). Fragmentation effects are especially prevalent in systems where multiple generations have elapsed since the fragmentation occurred (Aguilar et al. 2008, p. 5177). Habitat fragmentation has been shown to disrupt plant-pollinator interactions and predator-prey interactions (Steffan-Dewenter and Tscharntke 1999, p. 432-440; Aguilar et al. 2006, pp. 968-980; Eckert et al. 2010, pp. 35-43), alter seed germination percentages (Menges 1991, pp. 158-164), affect recruitment (Santos and Telleria 1997, pp. 181-187; Quesada et al. 2003, pp. 400-406), and result in lowered fruit set (Burd 1994, pp. 83-139; Cunningham 2000, pp. 1149-1152; Eckert et al. 2010, p. 38). In general, habitat fragmentation causes habitat loss, habitat degradation, habitat isolation, changes in species composition, changes in species interactions, increased edge effects, and reduced habitat connectivity (Fahrig 2003, pp. 487-515; Fisher and Lindenmayer 2007, pp. 265-280). These effects are more prevalent in arid ecosystems with low native vegetation cover (Fisher and Lindenmayer 2007, p. 272). Habitat fragments are often functionally smaller than they appear because edge effects (such as increased nonnative invasive species or wind speeds) impact the available habitat within the fragment (Lienert and Fischer 2003, p. 597). Shaffer and Stein (2000) identify a methodology for conserving imperiled species known as the three Rs: Representation, resiliency, and redundancy. Representation, or preserving some of everything, means conserving not just a species but its associated plant communities, pollinators, and pollinator habitats. Resiliency and redundancy ensure there is enough of a species so it can survive into the future. Resiliency means ensuring that the habitat is adequate for a species and its representative components. Redundancy ensures an adequate number of sites and individuals. This methodology has been

widely accepted as a reasonable conservation strategy (Tear et al. 2005, p. 841). We have addressed representation through our PCEs for each species (as discussed above) and by providing habitat for pollinators of Ipomopsis polyantha and Penstemon debilis (as discussed further under ``Ipomopsis polyantha'' below). For Phacelia submutica, we believe that the occupied habitat provides for both resiliency and redundancy and that with conservation of these areas, the species should be conserved and sustained into the future. For I. polyantha, there are only two known populations, both with few or no protections in place (low resiliency). For adequate resiliency, we believe it is necessary for the conservation and recovery of I. polyantha that additional populations with further protections be established. Therefore, we have identified two unoccupied areas as designated CHUs for I. polyantha. For P. debilis, there are only approximately 4,000 known individuals (low redundancy), all within 2 concentrated areas (low resiliency). For adequate redundancy and resiliency, we believe it is necessary for conservation and recovery that additional populations of P. debilis be established. Therefore, we have identified two unoccupied areas as designated CHUs for P. debilis.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated/Asexual (USFWS, 2013)

Lifespan

Adult: One year (USFWS, 2013)

Breeding Season

Adult: DeBeque phacelia plants flower between late April and late June and set seed from midMay through late June (USFWS, 2013).

Reproduction Narrative

Adult: DeBeque phacelia plants flower between late April and late June and set seed from midMay through late June. Preliminary evidence on the pollination biology of the species indicates that insect pollinators are not necessary for reproduction (Langton and Schupp 2012a). Yearly germination is variable depending on precipitation patterns and can fluctuate widely (Burt and Spackman 1995). For example, DeBeque phacelia numbers at Horsethief Mountain fluctuated from 1,700 plants in 1986, to 50 in 1992, up to 1,070 in 2003, and down to only a few from 2006 to 2008 (Colorado Natural Heritage Program (CNHP) 2010) (Figure 1). This strategy of maintaining seed dormancy through unfavorable conditions is common among annual plant species of arid environments (Anderson et al. 2012; Baskin and Baskin 1998). Maintenance of a large seed bank is also vital to the persistence of these species through unpredictable and long periods of drought (Anderson et al. 2012). No information is currently available on the density and longevity of the species' seed bank, nor the environmental conditions required to break seed dormancy, but studies are under way (Langton and Schupp 2012b) (USFWS, 2013).

Habitat Type

Adult: Ridge tops (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Xeric ridge tops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species occurs on steep slopes and ridge-tops on xeric sites in chocolate-brown or gray clay adobe badlands of Western Colorado which often have high shrink-swell potential (large cracks in the soil). The species is adapted to grow only in very early pioneer habitats with sparse vegetation cover (Scheck 1994). The species occurs on Atwell Gulch and Shire Members of Wasatch Formation (O'Kane 1987). Associated species are Grindelia fastigiata, Sarcobatus vermiculatus, Atriplex confertifolia, Eriogonum gordonii, Monolepis nuttalliana, Oenothera caespitosa, Astragalus flavus, Helianthus sp., Lepidium sp., Chenopodium sp., Rumex sp., Cymopterus planosus, Sitanion hystrix, Ceratocephala testiculata, Lactuca serriola, Euphorbia fendleri, Asceplias cryptoceras, Mentzelia sp., Thelypodiopsis sp., Oryzopsis hymenoides, Bromus tectorum, Sphaeralcea coccinea, Gutierrezia sarothrae (O'Kane 1987). Other rare species occurring in the area are Sclerocactus glaucus and Astragalus debequaeus (NatureServe, 2015). High ecologicla integrity of the community and site fidelity as well as low tolerance ranges are based on the species specific haibtat requirements as well as its restricted geographic range.

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Numbers of flowering plants fluctuate, but they do not disperse seeds beyond the existing patches of unique soil that are separated from one another by a few yards or several miles (Ewing 2008b, map) (USFWS, 2010).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

25 (USFWS, 2022)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Vulnerable to changes in habitat conditions, especially surface disturbances such as trampling of soil. An annual species whose population size varies widely from year to year. Because Phacelia submutica is adapted to a very specific geologic substrate and habitat type, a range extension is unlikely. Approximately 35,000-40,000 individuals have been documented within 21 of the 22 occurrences. However, this species is a seed-banking annual with numbers of visible plants varying drastically from year to year. There are 22 principal occurrences documented in the Colorado Natural Heritage Program database. Six of the occurrences have not been observed in over 20 years (as of 2012). The USFS Conservation Assessment documents 40 occurrences (Ladyman 2003). It is likely that this discrepancy in the total number of occurrences is because some of the sites reported by Ladyman are represented in the Heritage database as portions of other occurrences and not reported separately (NatureServe, 2015). Low resileinct, representation and redundancy are based on the low number of known populations, the relatively narrow geographic area this species inhabits and the variability in numbers from year to year. Across its limited range DeBeque phacelia currently has multiple individuals occurring in 25 separate EOs spread across five AUs (Service 2022, pp. 4–5). Redundancy for narrow endemic species is inherently limited; however, DeBeque phacelia plants are distributed broadly across the range of the species in the five defined AUs, providing redundancy throughout its small geographic range, especially given that the only plausible catastrophic event is prolonged extreme drought (Service 2022, p. 33). DeBeque phacelia's broad distribution and multiple moderately resilient AUs contribute to its ability to withstand catastrophic events. Additionally, BLM's ACECs reduce the influence of the stressors of OHV use and oil and gas development in 63 percent of the species' currently occupied range; approximately 359 acres of occupied DeBeque phacelia habitat and nine of the 25 DeBeque phacelia EOs occur within BLM ACECs. A BLM ACEC is a designation that highlights an area where special management attention is needed to protect important historical, cultural, and scenic values, protect fish and wildlife, or protect other natural resources. One of the eight EOs in the South Shale Ridge AU is located in the Pyramid Rock ACEC, which is intended specifically for the preservation of habitat for plant species, including DeBeque phacelia. This area is fenced and closed to livestock use; motorized, mechanized, and equestrian use; and hiking (BLM 2015, p. 31). It is unlikely that any of the ACEC designations will be withdrawn in the foreseeable future (USFWS, 2022).

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Increasing oil and gas development in the Piceance Basin is a significant concern in the recovery of the species. About 95 percent of occupied habitat is on BLM lands leased for energy extraction (Service 2012). Ongoing energy development activities include well pad and road construction, installation of pipelines, and construction of associated buildings, holding tanks, and other facilities. Oil and gas pipelines and well pads are present within thirteen EOs (Service 2012). Several pipelines and pipeline right-of-ways already exist within 20 ft (6 m) of DeBeque phacelia EOs (Lincoln 2008, pers. comm.; Service 2012). Roads used for energy extraction bisect

and cross the edges of eleven EOs (Service 2012) (USFWS, 2013).

Stressor: Utility and Energy Corridors: (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Utility and energy corridors provide pathways for future pipelines and electrical transmission lines. A portion of the designated Westwide Energy Corridor crosses 22,404 ac (9,066.6 ha) of BLM land within the range of DeBeque phacelia (see Figure 3) (Service 2012). Eight of the 20 EOs and 13 percent of critical habitat are within the Westwide Energy Corridor (Service 2012). Continued development of pipeline and transmission lines within the energy corridor is likely to affect DeBeque phacelia and its habitat (USFWS, 2013).

Stressor: Livestock Use and Trampling (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Potential threats related to livestock, deer, and elk use include the direct effects from trampling, and the indirect effects of habitat degradation. Ninety percent of DeBeque phacelia EOs are under management by the BLM as a grazing allotment (Service 2011a). Livestock trampling has occurred or is a threat at 14 EOs (CNHP 2010). Livestock can easily trespass from BLM or private grazing allotments onto USFS property where grazing is not allowed. This has been documented at two occurrences, one obtaining frequent disturbance from its proximity to a pond (Langton 2012). No research or monitoring has been conducted to evaluate the effects of livestock, deer, or elk use on DeBeque phacelia. However, the deleterious effects of livestock on western arid ecosystems are well documented (Milchunas et al. 1992; Jones 2000). Some of the adverse effects from livestock include changes in water infiltration due to soil compaction (Jones 2000, Table 1); changes to the physical and structural properties of soils (Kinlock and Friedel 2002); disturbance to soil microbiotic crusts (Evans and Belnap 1999; Jones 2000); subsequent nonnative invasive plant invasions (Parker et al. 2006); and soil erosion from hoof action (Jones 2000). Effects from livestock grazing to DeBeque phacelia and its habitat are occurring will likely continue (USFWS, 2013)

Stressor: Off-Highway Vehicle Use (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Off-highway-vehicle (OHV) use occurs on lands throughout the range of DeBeque phacelia. OHV recreation has damaged plants and habitat at seven EOs (CNHP 2012). On Federal lands, vehicles stray from designated roads to climb clay barrens for recreational purposes (Johnston 2012; Mayo 2008d). OHV trespass has even been documented within the Pyramid Rock Natural Area and BLM Area of Critical Environmental Concern (ACEC). The ACEC is fenced with post and cable, and an information sign is posted near an access point. The visible effects of OHV recreation within DeBeque phacelia habitat has been seen to persist for several years (Johnston 2012). Surface disturbances from OHV recreation cause accelerated erosion, fugitive dust production, soil compaction, sedimentation, and potentially irreversible changes to soil physical properties and chemistry (Iverson et al. 1981; Pagliali et al. 2003). Additionally, these changes in the soil environment can affect ecosystem function (DeFalco 2009. OHV use is

expected to increase in the region with the construction of additional roadways for energy development and the increasing popularity of OHV recreation. With OHV recreation within the range of the species, direct losses of plants and the seed bank, as well as indirect affects to the species and its habitat will continue to occur (USFWS, 2013).

Stressor: Invasive Nonnative Plants (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The threat from invasive nonnative plant species (weeds) is a growing concern in the recovery of DeBeque phacelia. Weeds have been documented at 15 EOs (CNHP 2012a). Disturbances such as roads, grading, and livestock grazing generally introduce and spread exotic species (Gelbard and Belnap 2003). Weeds invade and alter all types of plant communities, sometimes resulting in nonnative plant monocultures that support little wildlife or native plants (D'Antonio and Vitousek 1992; Olson 1999; Mooney and Cleland 2001). Many experts believe that, following habitat destruction, nonnative invasive plants are the next greatest threat to biodiversity (Randall 1996). Nonnative invasive plants alter different ecosystem attributes including geomorphology, fire regime, hydrology, microclimate, nutrient cycling, and productivity (Dukes and Mooney 2004). Species known to occur within DeBeque phacelia habitat include cheatgrass (Bromus tectorum), bur buttercup (Ranunculus testiculatus), and annual wheatgrass (Eremopyrum triticeum). These weeds are prevalent on public and private lands within the range of the DeBeque phacelia. Recent data suggest that weed cover in DeBeque phacelia sites is related to distance from roads, while the number of flowers was found to be higher at distances away from roads (BioLogic 2011). The control of weeds on public lands, especially around well pads, utility corridors, and roads, may also pose a danger to DeBeque phacelia. For example, herbicide drift from well pad spraying has led to the mortality of Colorado hookless cacti near DeBeque (Perkins 2012, pers. comm.) (USFWS, 2013).

Stressor: Water Reservoirs (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Two water reservoir projects known as Roan Creek and Sulphur Gulch were proposed within potential and occupied habitat of DeBeque phacelia (Bray and Drager 2008, pers. comm.; Grand River Consulting Corporation 2009). The proposals were withdrawn and are not imminent. However, the sites have been identified as potential reservoir locations that could be developed within 20 years if warranted by increased demands for water. Increased demands are likely, depending on the oil shale market, urban development in Colorado, and less (or altered) precipitation due to climate change. If developed, construction and inundation of these reservoirs would permanently destroy DeBeque phacelia plants and habitat within the project areas (USFWS, 2013).

Stressor: The Inadequacy of Existing Regulatory Mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Removal, damage, or destruction of plants on private lands is not prohibited under the Endangered Species Act (Act). We are not aware of any state, county, city, or local laws,

ordinances or zoning that provide for the protection or conservation of DeBeque phacelia or its habitat. Though no state regulations protect rare plants in Colorado, the Colorado Natural Areas Program manages a State Natural Area on BLM land protecting 510.9 ac (206.7 ha) of the species' habitat within the Pyramid Rock population. This agreement between Colorado Natural Areas Program and the BLM can; however, be terminated with a 90-day written notice by either party. Additional habitat on state land includes 7.5 ac (3 ha) of the Anderson Gulch population. This population contains the only "A"- ranked Elemental Occurrence (CNHP 2012a) meaning it has excellent estimated viability/ecological integrity. The majority of this population (90 percent) is within the Piceance Creek State Wildlife Area and is managed by Colorado Parks and Wildlife (USFWS, 2013).

Stressor: Climate Change and Drought (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: According to the Intergovernmental Panel on Climate Change (IPCC), "Warming of the climate system in recent decades is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global sea level" (IPCC 2007). Research indicates that warming is occurring more rapidly in the southwest region of the United States that elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Additionally in the west, the onset of spring has been advancing since the 1970's (Cayan et al. 2001). Annual temperature is predicted to increase approximately 2.2°C (4°F) in the southwest by 2050, with summers warming more than winters (Ray et al. 2008). Effects of climate change include persistent or prolonged drought conditions, changes in the vegetative community including increased invasions by weeds (Everard et al. 2010). Climate change is likely to affect many rare plant species because seed germination, seed dormancy, and persistence of the seed bank are all directly dependent on precipitation and temperature patterns (Levine et al. 2008). However, we do not understand how these changes may affect the long-term persistence of DeBeque phacelia because no information is available on the ecology of the species. Improved localized projections and precipitation models are also needed to better understand the threat of climate change to the species. The potential impacts of climate change will be significant at a global scale and we expect the predicted increased drought conditions to affect the recovery of DeBeque phacelia (USFWS, 2013).

Recovery

Reclassification Criteria:
The preliminary plan lists three basic steps for recovery: 1: Protect and maintain all extant populations (USFWS, 2013).

2. Prevent of minimize habitat disturbing threats (USFWS, 2013).

Develop and implement rangewide monitoring (USFWS, 2013).

Recovery Priority Number: 14C

Recovery Actions:

- Protection of Extant Populations and Habitat: Establish and implement protective measures for all known populations (USFWS, 2013).
- Threats Abatement: Implement protective measures such as fencing, controlled management of livestock use, nonnative species control and additional measures to avoid or minimize impacts to the species and its habitat (USFWS, 2013).
- Threats Abatement: Coordinate with land managers, project proponents, and other partners early in the planning process to limit direct and indirect effects of oil and gas development, grazing, OHV recreation, weeds, and additional threats that arise (USFWS, 2013).
- Threats Abatement: Work with land management agencies and other partners to formally establish land management designations to provide for long-term protection of populations and habitat (USFWS, 2013).
- Threats Abatement: Ensure that additional oil and gas leases avoid or take into consideration occupied and suitable habitat (USFWS, 2013).
- Threats Abatement: Consider installing livestock exclosures for both protection and monitoring purposes (USFWS, 2013).
- Surveys and Monitoring: Complete a comprehensive survey throughout the species' range, including areas designated as "potential habitat". Survey results should provide an accurate population estimate and allow us to identify core population areas so we can more effectively protect the species (USFWS, 2013).
- Surveys and Monitoring: Establish a survey protocol to identify areas of suitable habitat during years in which few above-ground plants are found. This protocol must take into account an evaluation of habitat components that support DeBeque phacelia (USFWS, 2013).
- Surveys and Monitoring: Establish a long-term monitoring plan to document rangewide population demographics and trends, and quantify the affects from threats. An adaptive management approach that uses feedback from implemented, site-specific recovery tasks should be integrated into the plan to inform recovery activities (USFWS, 2013).
- Surveys and Monitoring: Gain permission from landowners to survey for DeBeque phacelia on private lands with potential habitat (USFWS, 2013).
- Research: Continue research into DeBeque phacelia life history and ecology, including pollination biology, seed bank density, seed bank longevity, seed germination ecology, and habitat and soil requirements (USFWS< 2013).
- Research: Study population genetics and demographics (USFWS, 2013).
- Research: Conduct a population viability analysis (USFWS, 2013).
- Research: Conduct investigations that project DeBeque phacelia vulnerability and response to climate change (USFWS, 2013).
- Research: Improve our understanding of livestock and native ungulate grazing impacts (USFWS, 2013).
- Research: Monitor changes in invasive species prevalence and conduct research on impacts to DeBeque phacelia (USFWS, 2013).
- Research: Continue to refine a survey protocol for delineating suitable habitat (USFWS, 2013).
- Research: Continue to analyze the effects of dispersed oil and gas development and roads (USFWS, 2013).
- Seed Banking: Store genetic material in the form of seed in an appropriate repository to provide a back-up supply of genetic stock that represents as much of the available genetic diversity within the species as possible (USFWS, 2013).

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SPECIES ACCOUNT: *Phlox hirsuta* (Yreka phlox)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

Cespitose perennial subshrub from a stout, woody base. Stems stout, to 1.5dm tall. Herbage copiously hirsute with long, jointed hairs. Leaves crowded Blooms April-June. (NatureServe, 2015)

Taxonomy

Elias Nelson (1899) described P. hirsuta based on a collection made by Edward L. Greene in 1876. A complete nomenclatural history can be found in Appendix 1 of the Recovery Plan for Phlox hirsuta (Yreka Phlox) (U.S. Fish and Wildlife Service 2006). No changes in taxonomy have occurred since the time of listing (USFWS, 2007).

Historical Range

Phlox hirsuta is known to occur at five locations, which are referred to as the “China Hill,” “Soap Creek Ridge,” “Cracker Gulch,” “Greenhorn Creek,” and “Jackson Street” occurrences. In addition, the locality information from a single 1930 collection indicates a possible historical location in the vicinity of Etna or in the vicinity of Echo Mill, near Soap Creek Ridge (California Department of Fish and Game 1986; J. Molter in litt. 2001; Appendix 1, prepared by F. Lang in U.S. Fish and Wildlife Service 2006). A P. hirsuta location or occurrence is defined as a group of at least 200 individual plants that is separated from any other P. hirsuta locality by at least 0.40 kilometer (0.25 mile). (USFWS, 2007)

Current Range

In and near the towns of Yreka and Etna in Siskiyou County, northern California (USFWS 1995). Range extent is approximately 34 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dispersal/Migration

Population Information and Trends

Threats and Stressors

Recovery

Reclassification Criteria:

Recovery Priority Number: 2C

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Future actions will focus on securing and permanently protecting four (up to six) Yreka phlox occurrences and ameliorating ongoing threats of invasive weeds. Work has been initiated on each of the actions listed below. • Funding is needed to purchase, or establish conservation easements on, Cracker Gulch, the northern portion of Soap Creek Ridge, and Greenhorn Creek Occurrence properties from willing sellers who have indicated their strong interest in conserving Yreka phlox habitat in perpetuity. • Complete the cooperative agreement with the Siskiyou Land Trust to approach Greenhorn Creek property owners who might wish to establish conservation agreements or easements on several additional scattered properties where Yreka phlox occurs. • Continue to cooperate with the City of Yreka and the County to protect populations from off-road vehicle trespass and invasive non-native weed infestation. • Collect and accession seeds from each Yreka phlox occurrence at the Rae Selling Berry Seed Bank and California Botanic Garden. • Consult, through section 7 of the Endangered Species Act, with the Klamath National Forest on the effects to Yreka phlox of the 2022 McKinney Fire suppression actions, especially with respect to the introduction of non-native invasive weeds on contingency fire lines (USFWS, 2024).

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SPECIES ACCOUNT: *Phlox nivalis ssp. texensis* (Texas trailing phlox)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/1991; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Texas trailing phlox is an evergreen perennial that forms clumps (but seldom mats). The plants are herbaceous or subshruby. Stems tend to spread along the ground surface, and are erect only for the terminal 2—15 centimeters (0.8-5.9 in). Leaves are needlelike to lanceolate, densely packed on the stem (producing an appearance somewhat like a juniper seedling), usually less than 1.5 cm (0.6 inch) long, and more or less glandular pubescent. Older stems have smaller and darker green leaves, and typically lie directly on the ground surface. Young stems produce the flowers, are more or less erect, and have longer, slightly wider, and lighter—green leaves. Inflorescences are 3-12 flowered cymes, terminal on (typically) the tallest stems. The calyx is tubular with five sepals, which are fused for most of their length. The corolla is rotate, with a tube approximately 1.5 centimeters (0.6 inch) long. The five petals, each about 1 centimeter (0.4 inch) long, are pink to magenta in color, and darker near the throat. Petals are reported to be white in some individuals. Pistils have three styles, and the ovule is usually single. Fruits are achene— like, and apparently indehiscent (this character description of the fruit differs from previously published summaries). Flowering occurs from March to May. (USFWS, 1994)

Taxonomy

Texas trailing phlox belongs to the family Polemoniaceae, which includes such plants as sweet William, Jacob's ladder, Texas plume, and phlox. Texas trailing phlox is one of two subspecies recognized in P. nivalis. The nominal subspecies (ssp. nivalis) occurs in pine/oak barrens or scrub on the Coastal Plain or Piedmont, from Alabama to Florida and north to Virginia. Flowers of this subspecies are typically white or pale pink, with plants of forma roseiflora having deep rose or magenta flowers (Fernald 1970). According to Wherry (1955), the major difference between the two subspecies is the presence of minute glandular hairs on texensis, and their absence on nivalis. Currently, the nearest known populations of ssp. nivalis to those of texensis are located more than 1000 kilometers (600 miles) eastward in northern Florida. Wherry included Phlox nivalis in series Subulatae, along with Phlox subulata and Phlox oklahomensis. Both of the latter species have gross morphological features similar to that of P. nivalis, but Bogler (1992) expressed the opinion that, based on Texas specimens, fl. nivalis is most similar to P. oklahomensis. Populations of P. oklahomensis found in Texas are disjunct from the main range of P. oklahomensis (located further north in Oklahoma), lying approximately equidistant between it and range of P. nivalis ssp. texensis. (USFWS, 1994)

Historical Range

Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas. (USFWS, 1994)

Current Range

Endemic to the Pineywoods of the West Gulf Coastal Plain of east Texas. Texas trailing phlox is presently known from only two sites, one each in Tyler and Hardin counties, Texas. (USFWS, 1994; NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) and sexual (outcrossing) (USFWS, 1994)

Breeding Season

Adult: Flowering generally occurs between late March and early April (Ajilvsgi 1979, Poole et al. 2007, U.S. National Park Service (USNPS) 2015), sometimes extending into May depending on precipitation and management (i.e. prescribed burning). (USFWS, 2018)

Other Reproductive Information

Adult: Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. (USFWS, 1994)

Reproduction Narrative

Adult: Flies, bees, and butterflies have been observed at flowers. Based on the plant's floral structure, butterflies are the most likely pollinators. Typically, no more than one seed is produced per flower and, based on limited field observation, fruit set is low. An individual plant may have 3 to 50+ flowers and primarily depending on number of flowers. Its low population numbers are likely due to a combination of anthropogenic factors and a naturally low reproductive rate. (USFWS, 1994); Little is known about the reproduction of the Texas trailing phlox. Their populations are small and consist of a few scattered, inconspicuous individuals (Mahler 1980). This could make asexual reproduction very important for recruitment (Parker and Warnock 1993) but this frequency is unknown. Texas trailing phlox is mostly an outcrossing species pollinated by moths and butterflies (Bogler 1992). However, it is not known whether flowers are obligate or facultative outcrossers (Maxey and Warnock 1996, USFWS 1995). Pollinators include carpenter bees (M. Quinn, pers. comm. 2008), Nessus sphinx moth (Amphion floridensis) (G. Grant, pers. comm. 2017), and Tiger swallowtail butterfly (Papilio glaucus) (G. Grant, pers. comm. 2014). Other bees and butterflies, as well as flies could also serve as pollinators (USFWS 1995, Maxey and Warnock 1996, TPWD 1997). Poole et al. (2000) noted that there is the potential of large terrestrial arthropods to act as pollinators. Also, seed and seedling biology (seed maturation, dormancy, seed viability) are largely unknown for the Texas trailing phlox. We lack information about seed dispersal; however, dehiscence could play a role in local dispersal. (USFWS, 2018)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest/woodland, savanna, shrubland/chaparral, woodland - hardwood (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Texas trailing phlox occurs in southeast Texas in the southern portion of the Pineywoods vegetational area. Within the range of Texas trailing phlox, annual precipitation averages 125 cm (49 in), with no pronounced summer drought. The average frost—free period is 244 days (Bogler 1992), from early March through mid-December (Larkin and Bomar 1983). Elevation ranges from 9 to 75 meters (30-240 feet), and topography is nearly level. This species prefers deep, sandy soils in fire-maintained openings in upland longleaf pine (Pinus palustris) savannahs or post oak-bluejack oak (Quercus stellata-Q. incana) woodlands. Field studies suggest that sandy surface soil, coupled with moisture-bearing clays or sandy-clay soils at depths of 0.5-2 meters (1.6-6.6 feet), provide the best soil structure for Texas trailing phlox. Overstory cover at sites of Texas trailing phlox occurrence typically ranges from 25-75 percent. Understory and shrub cover is less than 25 percent at most plant sites, but ranges up to nearly 100 percent at some. However, the best growth of Texas trailing phlox is seen at the lower percentages of understory and shrub cover. The degree of ground cover associated with optimum growth of Texas trailing phlox appears to be 25-75 percent. Litter depth is generally 3-5 cm (1.2-2.0 in), and coverage is usually 75-100 percent. The most common canopy trees associated with Texas trailing phlox are Pinus palustris, P. elliottii, R. taeda, Ouercus incana, Q. falcata, and Q. stellata and Carva texana. (USFWS, 1994; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Long-term trends indicate a decline of 30 to 70%, whereas short-term trends suggest a relatively stable population (NatureServe, 2015)

Resiliency:

Populations were considered to have high resiliency when they: contained at least 600 individuals, exhibited plant separation less than 2 kilometers (1.24 miles), contained canopy cover between 5-25 percent, limited shrub layer cover to 10-25 percent, maintained litter depths of 3-5 centimeters, and received an annual precipitation rate of 48-60 inches (121.9-152.4 centimeters). Frequent fire exposure (every 1-2 years) serves as a critical component to sustaining healthy individual plants within the longleaf pine ecosystem, as well as other native vegetation associated with the Pineywoods. Using all of these factors, seven extant populations were ranked either low or moderate in current resiliency (USFWS, 2020).

Representation:

We lacked genetic studies specific to Texas trailing phlox examining variability within and among its' populations. Further genetic analysis of Texas trailing phlox could determine to what extent, if any, the impact of range contraction contributes to the loss of the genetic variability. Due to an absence of genetic information informing our measure of representation, we used ecological

diversity as a surrogate for genetic diversity. We assumed no ecological or niche diversity at any of the specific sites therefore, the representation of Texas trailing phlox is extremely low (USFWS, 2020).

Redundancy:

For the Texas trailing phlox, we measured redundancy as an adequate number of resilient populations that provided an exchange of genetic material and foraging opportunities for pollinators. Due to the low or moderate resilience rankings of most populations, the few number of extant populations, and that these populations are distributed throughout a restricted range, we estimated that both connectivity for pollinating species and exchange of genetic material is limited. Therefore, we rank the overall redundancy of Texas trailing phlox as low (USFWS, 2020)

Number of Populations:

7 (USFWS, 2018)

Population Size:

<750 individuals (NatureServe, 2015)

Population Narrative:

Long-term trends indicate a decline of 30 to 70%, whereas short-term trends suggest a relatively stable population. Although its historic range includes Hardin, Polk, and Tyler Counties of Texas, the Texas trailing phlox is presently known from only two sites in southeast Texas. Although nineteen collections of Texas trailing phlox are reported in historical records, these appear to originate from only six definable population systems, however, only two are extant populations. Reintroductions are being attempted in areas where there were historic populations. (NatureServe, 2015); When the species was listed as endangered in 1995, there were only 2 known populations in southeast Texas, one in Hardin County (the type locality) and another from Tyler County. Since then, 17 populations were observed in Hardin, Polk, and Tyler counties, however, these are considered extirpated. The USFWS Recovery Plan (1995) provides a definition of a “population” and a “plant”. Based on this definition, the USFWS recognizes that there are 7 known extant populations in Hardin, Polk, and Tyler counties that include: 1) Sunflower road (Element of Occurrence (EO) 17) and Big Thicket National Preserve (BTNP), Big Sandy Creek reintroduction; 2) Farm-to-Market 1276 right-of-way (EO 21); 3) Campbell Units (EO 22 and 23); 4) The Nature Conservancy, Roy E. Larsen Sandylands Sanctuary (EOs 3, 5, 13); 5) Resource Management Services (EO 9); 6) Hancock Timber (introduced); and 7) BTNP, Turkey Creek reintroduction. Land ownership includes private, public, and state lands. (USFWS, 2018). These extant EO ID’s remain owned and managed by TNC Sanctuary staff. The EO ID was last surveyed for Texas trailing phlox in 2023. Prior to that, the Sanctuary staff conducted a thorough assessment of extant populations in 2019, surveying 68 sites (61 previously recorded and 7 new sites) counting 304 plants (W. Ledbetter, pers. comm. 2019). Dr. C. Edwards and Dr. G. Yatskievych conducted a thorough genetic analysis of the Texas trailing phlox (Edwards 2022, entire) which included sampling from known Sanctuary plants. More information about their research is detailed in the Conservation Measures section of this review. Edwards, Yatskievych, TNC, and the Service visited these EO ID’s between March 30 and April 1, 2021, and found 300+ individual plants (S. Benedict, pers. comm. 2021) at 31 global positioning position (GPS) locations (Strong 2023, redacted site info excel sheet). A site assessment was not completed in 2022; however, in April and May of 2023, TNC staff counted 255 plants across the management

units (USFWS, 2023).

Threats and Stressors

Stressor: Habitat loss (USFWS, 1994)
Exposure:
Response:
Consequence:
Narrative: Habitat loss has been caused by housing development; land—clearing and site preparation for pine plantations and pasture; encroachment of a closed canopy forest onto formerly open forest or savanna due to fire suppression; exposure to herbicides; and activities associated with pipeline, powerline, railroad, and highway construction. (USFWS, 1994)

Stressor: Human activities (USFWS, 1994; NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Factors adversely affecting the habitat of Texas trailing phlox, combined with other potentially adverse activities such as off-road vehicle use, illegal dumping, burning of debris, and commercial take of plants, may continue to restrict the species to critically low population levels. Current threats include continued habitat loss due to canopy closure/encroachment of hardwood trees and soil disturbances associated with human activities. (USFWS, 1994; NatureServe, 2015)

Stressor: Clearcuts (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Much of this taxon's habitat had been clearcut and converted to slash-pine plantations, urbanized, and/or altered by fire suppression. (NatureServe, 2015)

Recovery

Reclassification Criteria:
1. At least 12 self-sustaining populations, distributed across the known geographic range of Hardin, Polk, and Tyler counties, Texas, are established. There should be at least three populations located in each county in order to provide adequate representation. The remaining three populations can be distributed in any fashion among the available habitat across the geographic range. A population will be considered self-sustaining if it reaches and maintains a population number of at least 600 reproductive individual plants. A population is considered a group of plants separated by a distance of at least 2 kilometers (km) (1.2 miles (mi)) from any other Texas trailing phlox plants, as to promote healthy populations of pollinators and the exchange of genetic material. A “plant” is defined as a cluster of Texas trailing phlox stems with no above-ground connection to other groups of stems, and separated by a distance of at least 5 decimeters (dm) (1.6 feet (ft)). Habitat will be of sufficient quality as defined by Maxey and Warnock (1996), that it promotes the success of Texas trailing phlox. The numbers of plants and populations must be verified through adequate monitoring. Populations can include both natural and ex-situ (introduction and reintroduction) efforts. To be considered under this criterion, the habitats of Texas trailing phlox must be managed in a manner that promotes the

continued survival of the subspecies. Management can include, but is not limited to, prescribed burning and/or restoration of longleaf pine habitat. (USFWS, 2019)

2. Sufficient, documented protection measures and management plans have been established for these 12 self-sustaining populations. Long-term, binding agreements that aim to conserve and protect the subspecies, and its habitat, are preferred. Private lands should be a priority focus for these agreements; however, protected areas can and should include lands owned by federal, state, or local government agencies. (USFWS, 2019)

Recovery Priority Number: 3

Delisting Criteria:
1. To secure redundancy of the subspecies into the foreseeable future, we conclude that more populations would be needed for delisting. Therefore, at least 15 populations distributed across the known geographic range of Hardin, Polk, and Tyler counties, Texas, have been established. At least four populations should be located in each of the counties in order to provide representation of the potential genetic and ecological diversity of the subspecies. The remaining three populations can be distributed in any fashion among the available habitat within the range. A population will be considered self-sustaining if it reaches and maintains a population number of at least 600 reproductive individual plants. Ex-situ efforts should be focused within the known geographic range unless habitat suitability mapping proves otherwise. Habitat will be of sufficient quality, as defined by Maxey and Warnock (1996), that it promotes the success of Texas trailing phlox. (USFWS, 2019)

2. Monitoring efforts indicate that the MVP level of 600 reproductive plants at each population has remained stable or has increased over a monitoring time period of 30 years. Monitoring must be routine in order to gauge subspecies' viability. Site-specific management plans should be aligned with landscape scale strategies to attain optimal habitat quality conditions that promotes the Texas trailing phlox. (USFWS, 2019)

Recovery Actions:
- Monitor, protect, and manage existing populations. (USFWS, 1994)
- Locate or establish additional populations of sufficient number to meet downlisting criteria. (USFWS, 1994)
- Obtain biological data necessary to refine downlisting criteria. (USFWS, 1994)
- Characterize suitable habitat of plant and determine the management regime needed to preserve suitable habitat. (USFWS, 1994)
- Determine limiting factors on reproduction. (USFWS, 1994)
- Establish captive populations to protect genetic integrity. (USFWS, 1994)
- 1) Conduct Genetics Investigations: Conduct studies to determine genetic diversity of the Texas trailing phlox. Conduct studies to determine the genetic relatedness between individual plants within a population. Determine relatedness between populations across the species geographic range. Determine the relationship between Texas trailing phlox plants to Phlox oklahomensis, found in Texas, and to Phlox nivalis, found in Louisiana. Use this new genetic information to re-evaluate the criteria used in the Texas trailing phlox Recovery Plan to define a population and an individual plant. (USFWS, 2018)

- 2) Promote Landowner Stewardship and Outreach: Encourage awareness of Texas trailing phlox, its management needs within longleaf pine savanna habitat, and its habitat structure/composition. Develop outreach resources for landowners and land managers. Provide technical support for management, surveys, monitoring, and conservation efforts. Provide financial support for management and/or leverage funds for restoration and recovery efforts. (USFWS, 2018)
- 3) Monitor Extant Populations: Continue to monitor extant populations of Texas trailing phlox to assess species viability, habitat conditions, and management needs. Continue management on sites and acquire long-term conservation easements, where feasible, or conservation agreements. (USFWS, 2018)
- 4) Survey for New Populations: Develop a habitat suitability map to assist in identifying new parcels of land for surveying, restoration, and ex-situ opportunities. Outreach to new landowners and land managers. Conduct surveys of potential Texas trailing phlox habitat, with landowner permission, throughout species' known geographic range. (USFWS, 2018)
- 5) Revisit Historic Populations: Use herbarium records, field data, and expert input to determine and revisit sites presumed to be extirpated. Coordinate with landowners and land managers to access sites. Educate landowners and land managers about the Texas trailing phlox and its habitat. Conduct surveys of suitable areas with permission. Submit data to TPWD's Texas Natural Diversity Database. (USFWS, 2018)
- 6) Actively Manage Habitat: Develop management plans with landowners and land managers with the primary goal of restoring or maintaining longleaf pine savanna habitat for Texas trailing phlox. Investigate plant response to management practices (prescribed burning, mowing, thinning), conducted in various frequency and intensity schemes. (USFWS, 2018)
- 7) Develop Reintroduction Plan: Develop a Controlled Propagation and Reintroduction Plan (per USFWS policy). Limit reintroduction work to the known geographic range of the species (Hardin, Tyler, Polk counties). Coordinate with the Center for Plant Conservation Institutions' guidelines for augmentation procedures. (USFWS, 2018)
- 8) Conduct Essential Life History Studies: Investigate pollinating species of Texas trailing phlox and promote pollinator conservation. Conduct seed biology (seed maturation, fecundity, seedbank) and seedling studies (longevity of plant, mortality). Encourage collaboration, ingenuity, financial support, and technical support between partners and the USFWS to conduct these studies. (USFWS, 2018)
- Conservation measures are not available.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Future actions to aid in the recovery of the Texas trailing phlox should focus on implementation of the following recovery actions: 1.2 Provide immediate protection for existing habitat areas. Most of the extant populations outside of the TNC Sanctuary are declining in abundance and most are on private lands. Long-term mechanisms such as cooperative agreements for conserving and protecting genetically important populations is essential and should be explored with landowners and land managers. 1.3 Contact landowners and land managers of all Texas trailing phlox sites. Changes in landowner/land managers at several of the sites, many of which are privately owned, have occurred. Contact with the new owners at the Tyler County reintroduction site were made in June 2023 and a potential site visit was discussed for fall 2023. Each land steward should be made aware of the ecologic and genetic importance of the Texas trailing phlox. The Service should seek out opportunities to build and strengthen relationships with

new land stewards and continue to work with and foster existing partnerships. 1.4 Work with landowners to develop and implement compatible management for Texas trailing phlox. Assist and/or develop management plans with land stewards with the primary goal of restoring and maintaining longleaf pine savanna habitat for the species. Investigate plant response to management practices (prescribed burning, mowing, thinning), conducted in various frequency and intensity schemes. Encourage collaboration, ingenuity, and financial and technical support between partners and the Service to conduct on the ground management and track the response of these management actions. 1.4.3. Continue to seek landowner assistance with monitoring activities. Continue to actively engage with land stewards at extant sites to monitor and understand conservation needs. Verifying the status of the EO ID records considered to be unverified or historic are a priority. 1.5 Monitor Extant Populations. Continue to monitor extant populations, assessing species' viability, habitat conditions, management needs, and potential threats. 2.1 Search for new populations in suitable East Texas habitat. Develop a habitat suitability map to assist in identifying new parcels of land appropriate for surveying, restoration, and ex-situ opportunities. Using updated habitat suitability mapping and information, the Service should seek out and conduct searches for additional populations of Texas trailing phlox across its range. 3. Implement captive propagation program. Ensure collection of seed and/or plant material from populations where threats remain high, abundance is low, and/or genetic analysis suggested distinctiveness. Work with local Center for Plant Conservation partner to follow collection and storing procedures. 5. Investigate the reproductive biology of Texas trailing phlox including pollination (5.2) seed biology (5.3), and seedling studies (5.5). Conduct essential life history studies, but not limited to the abovementioned topics, should new biological needs arise for the species. Encourage collaboration between the Service, partners, and land stewards to foster ingenuity, financial and technical support to conduct such studies. 6. Investigate the response of Texas trailing phlox to various management techniques and types of disturbance. Assist in the development and implementation of studies aimed at investigating plant response to different types of management, conducted in various seasons, frequency, and intensity. Provide updates to land stewards and partners to better manage the Texas trailing phlox and its habitat throughout the range. Ensure that findings are made available to the public and other potential managers of longleaf pine savanna habitats. 8. Develop Reintroduction Plan. Develop a Controlled Propagation and Reintroduction Plan (per USFWS policy). Limit reintroduction work to the known geographic range of the species (Hardin, Tyler, Polk counties). 9. Implement public education efforts. Encourage awareness of Texas trailing phlox, its management needs within the longleaf pine savanna habitat, and its habitat structure/composition. Develop outreach resources for land stewards. Provide technical support for management, surveys, monitoring, and conservation efforts. Provide financial support for management and/or leverage funds for restoration and recovery efforts (USFWS, 2023).

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SPECIES ACCOUNT: *Phyllanthus saffordii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

Phyllanthus saffordii (NCN), a woody shrub in the Phyllanthaceae family. (USFWS, 2015)

Historical Range

Phyllanthus saffordii (NCN), a woody shrub in the Phyllanthaceae family, is historically known only from the southern part of Guam within the savanna ecosystem. (USFWS, 2015)

Current Range

Currently, P. saffordii is known from 4 scattered occurrences on southern Guam, totaling fewer than 1,400 individuals (Gutierrez 2013, in litt.; Gawel et al. 2013, in litt.). (USFWS, 2015). Guam (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Narrative

Adult: Phyllanthus saffordii (NCN), a woody shrub in the Phyllanthaceae family, is historically known only from the southern part of Guam within the savanna ecosystem (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2015)

Number of Populations:

4 (USFWS, 2015) 4 (USFWS, 2020b)

Population Size:

<1,400 (USFWS, 2015) 1,400 (USFWS, 2020b)

Population Narrative:

Populations of P. saffordii, a single island endemic, are thus decreasing from initial numbers observed on Guam. Currently, P. saffordii is known from 4 scattered occurrences on southern Guam, totaling fewer than 1,400 individuals (Gutierrez 2013, in litt.; Gawel et al. 2013, in litt.). (USFWS, 2015). Phyllanthus saffordii is a small woody short-lived shrub found at the edges of erosion scar and forest vegetation in savanna habitat in southern Guam. It is often found in clusters of up to 20 individuals in one site (Demeulenaere 2020 in litt.). Because there have been no surveys to date focused on distribution and abundance of P. saffordii, the number of populations of P. saffordii is unknown (Demeulenaere 2020 in litt.). There are at least several to many populations and an overall abundance of approximately several thousand individuals (Demeulenaere 2020 in litt.). The populations have no ongoing control of threats and the occupied sites are vulnerable to loss and degradation by nonnative animals (including ungulates, rodents, the brown treesnake, and invertebrates), invasive plants, fire, typhoons, and effects due to climate change. The Guam Plant Extinction Prevention Program has secured 11 Phyllanthus saffordii from Mount Lamlam in their nursery, 262 seeds from Mount Alifan are in storage, and experimental plantings of this species have been conducted at three locations. Six plants were outplanted, two individuals remain alive (GPEPP 2018) (USFWS, 2020)

Threats and Stressors

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Stressor: Urban development (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Other urban development (primarily involving housing development) will further impact the ecosystems that support native species. On Guam, a housing development is proposed for the Sigua highlands, where Phyllanthus saffordii is known to occur (Kelman 2013, in litt.). (USFWS, 2015)

Stressor: Habitat disturbance via development, military training, and urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Development, military training, urbanization (Guam DAWR 2006, p. 69), and the associated destruction or degradation of habitat through loss of forest and savanna areas, disturbance of caves, and dewatering of streams, are serious threats to 13 of the 14 plants including Phyllanthus saffordii. (USFWS, 2015)

Stressor: Alien ungulates (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The presence of alien mammals is considered one of the primary factors underlying the alteration and degradation of native plant communities and habitats on the Mariana Islands. The destruction or degradation of habitat due to nonnative ungulates, including pigs, goats, cattle, water buffalo, and deer, is currently a threat to 17 of the 23 species addressed in this final rule including Phyllanthus saffordii. (USFWS, 2015)

Stressor: Wildfire (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Wildfire is a threat to nine plant species including Phyllanthus saffordii, because individuals of these species occur in the savanna ecosystem or the forest ecosystem adjacent to the savanna ecosystem, on southern Guam (i.e., Cetti Watershed area) and on the Rota Sabana, where fires are common (Grimm 2012, in litt.; Gutierrez 2012, in litt.; Gutierrez 2013, in litt.). (USFWS, 2015)

Stressor: Recreational vehicles (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The savanna areas of Guam are popular for use of recreational vehicles. Damage and destruction caused by these vehicles are a direct threat to the plants Hedyotis megalantha and Phyllanthus saffordii, listed as endangered species in this final rule. (USFWS, 2015)

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:
- Not available.
- Threat and Recovery Potential: Full species with a moderate degree of threat and a high recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine population status and current distribution—Determine the distribution and number of all individuals on each island. Identify priority sites for species conservation. Assess the status and threats to each population to inform prioritization of conservation effort. • Conduct research to clarify life history information and threats to the populations and their habitat—Conduct research to determine the best way to control the brown treesnake, rodents, and invasive invertebrates. Assess development and land

designation and zoning threats to conservation of habitat needed for recovery. • Ungulate monitoring and control—Construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Control ecosystem-altering nonnative invasive plant species and those that compete with P. saffordii at all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction. • Reintroduction and translocation—Augment populations and increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of predation and typhoons, and climate change. • Reduce human distrubance, such as from recreational activities mortality and reduced viability—increase population resiliency by mitigating threats from these human activities. • Fire prevention and control—Implement more effective fuel load control. • Develop regulations and policy essential to recover the species and their habitats—Encourage the development of legislation to ensure protection of the listed species under Commonwealth or Territorial law. Develop and support the implementation of biosecurity plans to prevent the influx of new pests and invasive species into the Territory and inter-island movement of pests and invasive species. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- Current Management Actions: • Surveys and inventories – • The University of Guam's Center for Island Sustainability & Guam Plant Extinction Prevetnion Program surveys for Phyllanthus safordii in savanna habitat (Demeulenaere 2020, in litt.). • Captive propagation for genetic storage and reintroduction • Phyllanthus saffordii was successfully germinated through an aseptic seed germination method by GPEPP. There are 11 individuals from Mount Lamlam currently in the plant nursery, and 262 seeds from Mount Alifan are in storage (GPEPP 2018, entire). Eventually, these individuals could be outplanted in the savanna habitat. • Habitat protection – • A major biosecurity focus within the Mariana Islands is controlling the brown treesnake on Guam. Federal agencies support local capacity. The U.S. Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of InteriorOffice of Insular Affairs (U.S. Geological Survey, USFWS), are developing methods to suppress the snake on the landscape scale (Dorr, et al. 2016, in litt.; Phillips 2014, in litt; BTSTWG 2015, entire; (Siers, et al. 2018, in litt.). • Researchers and students at the University of Guam's Center for Island Sustainability (CIS) conduct biological monitoring in the savanna habitat and are currently exploring optimal restoration methods to restore degraded savanna habitat. The biologists at CIS monitor the watersheds throughout the savanna focusing on sedimentation, erosion, and runoff. There are several graduate student projects focused on savanna ecology and restoration (e.g., seed balls, plant propagation and outplanting) to reduce erosion and runoff. One of these student projects includes Phyllanthus saffordii. These studies are currently underway. • In 2018, public outreach/awareness efforts to protect Phyllanthus saffordii and the savanna habitat were initiated by NOAA Fisheries Pacific Island Regional Office. As part of this effort, NOAA created outreach materials to warn the public about the impacts of erosion on reef ecosystems and to prevent any damage to native savanna species. Cards with pictures and details about P. saffordii and other savanna species are being given to individuals before outplanting efforts in the savanna so extant individuals can be marked and buffers put in place. Although the cards are only currently provided to volunteers as part of outplanting trees, they may be made available to hikers or off-road bikers. • In 2002, a community effort known as the "Humåtak Project" was created to revive the watershed that is affecting Fouha Bay on southern Guam. Sediment traps to control erosion are improving habitat suitability for native plants in the savanna. Swordgrass is very opportunistic and commonly the first plant to colonize an open area

possibly limiting or prohibiting recolonization by Phyllanthus saffordii and other endemic shrubs. • A fire management plan to reduce wildfire potential, protect and enhance natural and cultural resources, integrate applicable permit and reporting requirements and implement ecosystem management goals, sustainable training, and objectives is being drafted (JRM 2019). • Other Natural or Manmade Factors - Recreation – The Guam's Department of Agriculture, Division of Aquatic Wildlife Resources (DWAR) has the authority to enforce laws (5 GCA, Chapter 63, PL-6-85) to protect native flora and fauna. Their Conservation Land areas include Cotal with 552 acres (223 ha) and Bolanos area with 2,830 acres (1145 ha). Cotal is primarily savanna, badlands, and some secondary forests and Bolanos consists of both savanna and forest. The Bolanos Conservation area is dominated by swordgrass and efforts are being made to rehabilitate the area by enforcing public use permits. (USFWS, 2020)

References

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Final Rule. 80 Federal Register 190, October 1, 2015. Pages 59424-59497.

USFWS. 2020b. Recovery outline for 23 Mariana Island Species. Portland, Oregon. 22 pp. + appendices.

USFWS. 2020. Phyllanthus saffordii. 5-Year Review Summary and Evaluation. U.S. Fish and Wildlife Service. Pacific Islands Fish and Wildlife Office Honolulu, Hawaii. 25 pp.

SPECIES ACCOUNT: *Phyllostegia pilosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

A vine (USFWS, 2016).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2016). Newly recognized Hawaiian endemic species of Moloka`i and Maui, formerly treated within Phyllostegia mollis (e.g., Wagner et al., Hawaii, 1990, and Kartesz 1994 and 1999). Recognized as P. haleakalae in Wagner and Herbst's 1999 Supplement, with P. mollis considered endemic to O`ahu only. However, Wagner (1999, Novon 9: 274-275) has subsequently decided that P. pilosa is the correct name for the plants called "P. haliakalae", with the latter name actually applying to the species previously known as P. imminuta (NatureServe, 2015)

Historical Range

Historically known from Molokai. (NatureServe, 2015). The individuals identified as P. pilosa on Molokai, at Kamoku Flats (montane wet ecosystem) and at Mooloa (lowland mesic ecosystem), have not been observed since the early 1900s (TNC 2007; HBMP 2010) (USFWS, 2016).

Current Range

It occurs west of Puu o Kakae on east Maui (USFWS, 2016). Distribution: Maui. Likely extirpated on Molokai (USFWS, 2021)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Phyllostegia pilosa under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eight detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Phyllostegia pilosa includes eight CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime,

and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) Palmeria dolei—Unit 40—Montane Wet (and) Pseudonestor xanthophrys—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. profuga, Phyllostegia hispida, and Pteris lidgatei, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by Adenophorus periens, Cyanea procera, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Melicope reflexa, Phyllostegia mannii, P. pilosa, Platanthera holochila, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant Melicope reflexa, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by Adenophorus periens, Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. procera, C. profuga, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Phyllostegia hispida, P. mannii, P. pilosa, Platanthera holochila, Pteris lidgatei, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical

range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 4 (and) Palmeria dolei—Unit 13—Montane Wet (and) Pseudonestor xanthophrys—Unit 13— Montane Wet This area consists of 180 ac (73 ha) of State land and 1,653 ac (669 ha) of federally owned land (Haleakala National Park), in Kaapahu Valley on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Clermontia samuelii, Cyanea copelandii ssp. haleakalaensis, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. maritae, Cyrtandra ferripilosa, and Huperzia mannii. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 4 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, Cyanea duvalliorum, C. glabra, C. mceldowneyi, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Melicope balloui, M. ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) Palmeria dolei—Unit 41—Montane Wet (and) Pseudonestor xanthophrys—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by Adenophorus periens, Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. procera, C. profuga, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Melicope reflexa, Phyllostegia hispida, P. mannii, P. pilosa, Platanthera holochila, Pteris lidgatei, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 2 (and) Palmeria dolei—Unit 11—Montane Wet (and) Pseudonestor xanthophrys—Unit 11— Montane Wet This area consists of 4,075 ac (1,649 ha) of State land, 9,633 ac (3,898 ha) of privately owned land, and 875 ac (354 ha) of federally owned land (Haleakala National Park), from Haiku Uka to Puukaukanu and upper Waihoi Valley, on the

northern and northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Bidens campylotheca ssp. pentamera, Clermontia samuelii, Cyanea copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. mceldowneyi, Geranium hanaense, G. multiflorum, and Wikstroemia villosa, and by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 2 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, Cyanea glabra, C. maritae, Cyrtandra ferripilosa, Diplazium molokaiense, Huperzia mannii, Melicope balloui, M. ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, and Schiedea jacobii, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 3 (and) Palmeria dolei—Unit 12—Montane Wet (and) Pseudonestor xanthophrys—Unit 12— Montane Wet This area consists of 2,228 ac (902 ha) of federally owned land (Haleakala National Park) in Kipahulu Valley, on the northeastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units are occupied by the plants Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, Cyanea copelandii ssp. haleakalaensis, C. hamatiflora ssp. hamatiflora, C. maritae, and Melicope ovalis, and by the forest bird, kiwikiu (Pseudonestor xanthophrys). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 3 is not known to be occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Clermontia oblongifolia ssp. mauiensis, C. samuelii, Cyanea duvalliorum, C. glabra, C. horrida, C. kunthiana, C. mceldowneyi, Cyrtandra ferripilosa, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Huperzia mannii, Melicope balloui, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, or by the forest bird, the akohekohe (Palmeria dolei), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Wet—Unit 5 (and) Palmeria dolei—Unit 14—Montane Wet (and) Pseudonestor xanthophrys—Unit 14— Montane Wet This area consists of 222 ac (90 ha) of State land, and 165 ac (67 ha) of federally owned land (Haleakala National Park), near Kaumakani on the eastern slopes of east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units area occupied by the plant

Bidens campylotheca ssp. pentamera. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 5 is not currently occupied by the plants Adenophorus periens, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. waihoiensis, Clermontia oblongifolia ssp. mauiensis, C. samuelii, Cyanea copelandii ssp. haleakalaensis, C. duvalliorum, C. glabra, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. maritae, C. mceldowneyi, Cyrtandra ferripilosa, Diplazium molokaiense, Geranium hanaense, G. multiflorum, Huperzia mannii, Melicope balloui, M. ovalis, Peperomia subpetiolata, Phyllostegia bracteata, P. haliakalae, P. mannii, P. pilosa, Platanthera holochila, Schiedea jacobii, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Phyllostegia pilosa critical habitat consists of two components. Lowland mesic (Molokai) and Montane wet (east Maui and Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp.

lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to

further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (inferred from USFWS, 2016). Short (USFWS, 2021)

Reproduction Narrative

Adult: It is a short-lived perennial (USFWS, 2016).

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: Montane wet and lowland mesic forest (USFWS, 2012; NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: < 3,300 - 6,500 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: It occurs in the lowland mesic ecosystem (grasslands, shrublands, and forests, generally below 3,300 ft. (1,000 m) elevation), and montane wet ecosystem (grasslands, shrublands, forests, and bogs) found at elevations between 3,300 and 6,500 ft. elevation) (USFWS, 2012). Habitat is characterized as forest (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

2 (USFWS, 2016). Unknown (USFWS, 2023)

Population Size:

7 (USFWS, 2016). Unknown (USFWS, 2023)

Population Narrative:

There are two occurrences totaling seven individuals (USFWS, 2016). There are no known individuals of Phyllostegia pilosa remaining in the wild. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that, before the split into different species, P. mollis (including P. pilosa) is highly vulnerable to the effects of climate change. Most of the reintroduced populations are provided some protection from ungulates within exclosures. Genetic representation is complete. Collection, propagation, and reintroduction are ongoing. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs and goats), nonnative plants, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (pigs, goats, and slugs) is considered an ongoing threat to Phyllostegia pilosa throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)
Exposure:
Response:

Consequence:
Narrative: Phyllostegia pilosa faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). The seven known individuals of Phyllostegia pilosa are not protected from direct predation by feral pigs and goats on Maui. This species has not been observed on Molokai for over 100 years (USFWS, 2013).

Recovery

Reclassification Criteria:
Number of populations and individuals needed for each plant species to meet Preventing Extinction Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 50. (USFWS, 2023) Number of populations and individuals needed for each plant species to meet the Interim Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 300. (USFWS, 2023) Number of population and individuals needed for downlisting based on population and life history characteristics: Number of Populations: 5. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Priority Number: 5

Delisting Criteria:
Number of populations and individuals needed for delisting based on population and life history characteristics: Number of Populations: 10. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Actions:
- Not available - this species does not have a recovery plan.
- Not available

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to search suitable habitat for individuals of Phyllostegia pilosa in recent and historical locations. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with P. pilosa at all populations. • Predation and herbivory by rats and slugs—Implement effective control measures for rats and slugs at all populations. • Captive propagation for genetic storage and reintroduction—Collect seeds and other propagative materials for storage and begin propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Augment populations and increase numbers of populations and individuals in suitable habitat to reduce the impacts of predation and climate change. • Population biology research—Research the effects of nonnative insects and develop and implement control methods if necessary. Research the possible causes of lack of natural recruitment. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and monitoring—PEPP monitors and surveys for individuals of Phyllostegia pilosa on east Maui (Oppenheimer 2019, pers. comm.). • Ungulate control— o The

East Maui Watershed Partnership (EMWP) works in coordination with landowners to protect and monitor the native ecosystems of east Maui (http://eastmauiwatershed.org/explorethe-watershed/management/, accessed 28 JAN 2020). The partnership addresses ungulate removal and exclosure construction (over 11 kilometers (7 miles) of fencing). Most of the reintroduced populations of P. pilosa are fenced. o The Nature Conservancy's Waikamoi Preserve encompasses (2,117 hectares, 5,230 acres) along the northern boundary of Haleakala National Park on east Maui (TNCH 2011, p. 4). Ungulate control is the focus of the Waikamoi resource management program, utilizing a combination of fencing, hunting, and snaring (TNCH 2011, pp. 13–14). Individuals of P. pilosa that occur within the preserve are provided protection by these conservation activities. o The Plant Extinction Prevention Program (PEPP) constructs and maintains fencing and conducts nonnative plant control at wild and reintroduced populations of P. pilosa on east Maui (PEPP 2015). • Nonnative plant control— o The EMWP has also initiated nonnative plant control planning and implementation in areas where P. pilosa occurs (http://eastmauiwatershed.org/explore-thewatershed/management/, accessed 28 JAN 2020). o The Plant Extinction Prevention Program (PEPP) constructs and maintains fencing and conducts nonnative plant control at wild and reintroduced populations of P. pilosa on east Maui (PEPP 2015). o The TNCH conducts nonnative plant control (prioritized target species: Hedychium gardnerianum, Fraxinus uhdei (tropical ash), Pinus spp. (pine), Cortaderia jubata (pampas grass), and Ulex europeaus (gorse) within Waikamoi Preserve (TNCH 2011, p. 19). • Captive propagation for genetic storage and reintroduction— o The Lyon Arboretum Micropropagation Laboratory reports 341 explants in storage representing five individuals from the population at Makawao-Olinda (Lyon Arboretum 2019). The Lyon Arboretum Seed Conservation Laboratory reports 17,355 seeds collected from 11 individuals representing the population at Makawao-Olinda with 17,201 of those in storage (Lyon Arboretum 2019). o Haleakala National Park (HNP) reports 70 seeds in storage representing one individual at Waikamoi Preserve (HNP 2016). o The National Tropical Botanical Garden (NTBG) reports 142 seeds in storage (collected in 2013) representing at least one individual at Waikamoi (NTBG 2019). o The Olinda Rare Plant Facility (ORPF) reports four potted plants in storage representing one individual from Waikamoi, six potted plants representing one individual from Makawao-Olinda, and 38 potted plants representing two individuals from Makawao-Olinda intended for outplanting at Makawao (ORPF 2019). • Reintroduction and translocation—PEPP has planted approximately 164 plants at four sites, most of which are in the Makawao-Olinda area (the three other sites are Waikamoi, Haipua'ena, and Honomanu); however, no natural recruitment has been observed (PEPP 2013, 2014, 2015, 2016, 2017, 2019). (USFWS, 2020)

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Proposed Rule. 77 Federal Register 112. June 11, 2012. Pages 34464 - 34775

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SPECIES ACCOUNT: *Physaria douglasii ssp. tuplashensis* (White Bluffs bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 05/23/2013; Pacific Region (R1) (USFWS, 2016)

Physical Description

White Bluffs bladderpod is a low growing, herbaceous, perennial plant with a sturdy tap root and a dense rosette of broad gray-green pubescent leaves (WDNR 2010). The subspecies produces showy yellow flowers (USFWS, 2013a).

Taxonomy

Although specimens of this taxon were originally collected from a population in 1883, the plant material was in poor condition, no definitive identification could be made, and the plant was not recognized as a species at that time. The population was rediscovered in 1994, and was described and published as a species, Lesquerella tuplashensis, by Rollins et al. (1996, pp. 319–322). Based on molecular, morphological, phenological, reproductive, and ecological data, the conclusions in AlShehbaz and O'Kane (2002, p. 322) and Caplow et al. (2006, pp. 8–10) combining the genera Lesquerella and Physaria and reducing the species Lesquerella tuplashensis to Physaria douglasii subsp. tuplashensis, provide the most consistent and compelling information available to date (USFWS, 2013a).

Historical Range

In 1996, White Bluffs bladderpod was only known from a single population that occurred along the upper edge of the White Bluffs of the Columbia River in Franklin County, Washington (USFWS, 2013a). It is endemic to a small band about 17 km long by about 10 meters wide (NatureServe, 2015).

Current Range

White Bluffs bladderpod is still known only from the single population that occurs along the upper edge of the White Bluffs of the Columbia River, Franklin County, Washington (USFWS, 2013a). Extensive searches of suitable substrate elsewhere in Washington have been conducted but no other plants have been found (USFWS, 2004; NatureServe, 2015). – In the late 1990s the subspecies was described as occupying a narrow area 17 to 20-km long on the slopes and top of the White Bluffs. When the listing rule was revised, it was determined that the occupied area had likely shrunk due to threats and habitat changes in the southern part of the range (USFWS 2013b, p. 76998). The recent and current range of White Bluffs bladderpod is uncertain because there has not been a complete survey since 1997, only the northern part of the distribution is monitored. The northern part continues to be occupied but the status of the southern part is unknown. However, Refuges' outplanting efforts from 2013 to 2015 have resulted in at least a temporary range expansion within the Monument. As of 2020, the plants in the outplanting area were still successfully reproducing. The establishment of a self-sustaining population there could be essential to the continuation of the subspecies should there be catastrophic landslides where the main population occurs. (USFWS, 2020)

Critical Habitat Designated

Yes; 4/23/2013.

Legal Description

On April 23, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Physaria douglasii ssp. tuplashensis (White Bluffs bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (78 FR 76995-77005; 78 FR 24008-24032).

Critical Habitat Designation

The critical habitat designation for Physaria douglasii ssp. tuplashensis includes one CHU in Franklin County, Washington. This species critical habitat encompasses approximately 2,033.4 acres (ac) (822.9 hectares (ha)) (78 FR 76995-77005; 78 FR 24008-24032).

White Bluffs bladderpod is only known from a single population that occurs in a narrow band approximately 10 m (33 ft) wide by 17 km (10.6 mi) long, at the upper edge of the White Bluffs of the Hanford Reach. The subspecies only occurs at the upper surface areas of a near-vertical exposure of paleosol (ancient, buried soil whose composition may reflect a climate significantly different from the climate now prevalent in an area). This surface material overlies several hundred feet of easily eroded sediments of the Ringold Geologic Formation, a sedimentary formation made up of soft Pleistocene lacustrine deposits of clay, gravel, sand, and silt (Newcomb 1958, p. 328). The upper part of the Ringold Formation is a heavily calcified and silicified cap layer that exists to a depth of at least 4.6 m (15 ft). This layer is geologically referred to as ‘‘caliche,’’ although it lacks the nitrate constituents found in true caliche. The caliche-like layer is a resistant caprock underlying a 275–305 m (900–1,000 ft) plateau extending north and east from the White Bluffs (Newcomb 1958, p. 330). The entire population of White Bluffs bladderpod is down-slope of irrigated agricultural land, and is being impacted to differing degrees by landslides induced by water-seepage (see Factor A). The potential for landslide is greatest in the southern portion of the subspecies’ distribution where irrigated lands are closer to, or directly adjacent to, the bluffs (Lindsey 1997, p. 12). In addition, field investigations have determined that Lesquerella (now Physaria) plants can be outcompeted by nonnative, weedy plant species associated with irrigation projects and other disturbance (TNC 1998, p. 5). Therefore, based on the information above, we identify the weathered cliffs at approximately 210–275 m (700–900 ft) above sea level of the White Bluffs of the Ringold Formation exposed by natural erosion as a physical and biological feature essential to the conservation for White Bluffs bladderpod. The habitat includes the adjacent cliff breaks, moderate to gentle slopes (<100 percent slope) to the toe of slope, and flat or gently sloping cliff tops with exposed alkaline paleosols. This habitat is stable with a minimal amount of landslide occurrence. This critical habitat unit was mapped using Universal Transverse Mercator, Zone 11, North American Datum 1983 (UTM NAD 83) coordinates. These coordinates establish the vertices of the unit boundaries. The map in this entry, as modified by any accompanying regulatory text, establish the boundaries of the critical habitat designation. The coordinates or plot points or both on which the map is based are available to the public at the field office internet site (http:// www.fws.gov/wafwo/HanfordPlants/ FLFCH.html), http:// www.regulations.gov at Docket No. FWS–R1–ES–2013–0012, and at the Service’s Washington Fish and Wildlife Office. You may obtain field office location information by contacting one of the Service regional offices, the addresses of which are listed at 50 CFR 2.2.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Physaria douglasii ssp. tuplashensis critical habitat consists of five components (78 FR 76995-77005; 78 FR 24008-24032):

(i) Weathered alkaline paleosols and mixed soils overlying the Ringold Formation. These soils occur within and around the exposed caliche-like cap deposits associated with the White Bluffs of the Ringold Formation, which contain a high percentage of calcium carbonate. These features occur between 210–275 m (700–900 ft) in elevation.

(ii) Sparsely vegetated habitat (less than 10–15 percent total cover), containing low amounts of nonnative or invasive plant species (less than 1 percent cover).

(iii) The presence of insect pollinator species.

(iv) The presence of native shrub steppe habitat within the effective pollinator distance (300 m (approximately 980 ft)).

(v) The presence of stable bluff formations with minimal landslide occurrence.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and that may require special management considerations or protection. All areas designated as critical habitat as described below may require some level of management to address the current and future threats to the physical and biological features essential to the conservation of Umtanum desert buckwheat. In all of the described units, special management may be required to ensure that the habitat is able to provide for the biological needs of the species. Further studies leading to an enhancement or reintroduction plan may be necessary to increase population size and prepare for recovery postwildfire. More research is needed to determine habitats most suitable for expansion of the current population. In summary, special management considerations or protections should address activities that would be most likely to result in the loss of Umtanum desert buckwheat plants or the disturbance, compaction, or other negative impacts to the species' habitat. These activities could include, but are not limited to, recreational activities and associated infrastructure, off-road vehicle activity, dispersed recreation, wildfire, and wildfire suppression activities. Special management considerations or protection will conserve the primary constituent elements for the species. Management activities that could ameliorate these threats include, but are not limited to, the fire management plan that has been completed for the Hanford installation (DOE 2011, p. 93) and recently revised to incorporate more detailed management objectives and standards. Though not intended to specifically address Umtanum desert buckwheat, implementation of this plan will contribute to the protection of the primary constituent elements (and physical or biological features) by: (1) Using a map of ''sensitive resources'' on the site during implementation, including the location of Umtanum desert buckwheat habitat; (2) requiring a biologist to assist the command staff in protecting these environments during wildfire suppression efforts; and (3) restricting public access to the entire Umtanum desert buckwheat site, including the pollinator use area. Public access without security clearance is currently prohibited at the Umtanum desert buckwheat site, reducing the risk of trampling or crushing the plants by ORV use. Special management to protect the designated critical habitat areas and the

features essential to the conservation of Umtanum desert buckwheat from the effects of the current wildfire regime may include preventing or restricting the establishment of invasive, nonnative plant species, post-wildfire restoration with native plant species, and reducing the likelihood of wildfires affecting the population and nearby plant community components. These actions may be achieved by detailed fire management planning by the DOE, including rapid response and mutual support agreements between the DOE, the Monument, the U.S. Department of the Army, Bureau of Land Management, and the Washington Department of Fish and Wildlife for wildfire control. These agreements should contain sufficient detail to identify actions by all partners necessary to protect habitat for Umtanum desert buckwheat from fire escaping from other ownerships.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2013a)

Lifespan

Adult: 4 - 5 years (USFWS, 2013a)

Breeding Season

Adult: May - July (USFWS, 2013a)

Reproduction Narrative

Adult: In a presentation of preliminary life history studies, Dunwiddie et al. (2002, p. 7) reported that most individuals reach reproductive condition in their first or second year, most adult plants flower every year, and the lifespan of this short-lived subspecies is probably 4 to 5 years. Flowers are produced in May, June, and July (USFWS, 2013a).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Cliff, shrubland/chaparral (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: 900 - 1,000 ft. elevation (USFWS, 2013a)

Environmental Specificity

Adult: Very narrow (NatureServe, 2015)

Habitat Narrative

Adult: Found on a dry, barren, vertical exposure of caliche (a hard, highly alkaline, highly calcalcareous substrate) capping a bluff (Hallock 2002; Washington Natural Heritage 2002). The environmental specificity is very narrow; it is known only from one extensive rock formation (the White Bluffs of the Columbia River), where the plants occur in a highly alkaline caliche-type cemented paleosol that caps several hundred feet of easily eroded alkaline lacustrine sediments

(USFWS, 2004). Terrestrial habitat is characterized as cliff or shrubland/chaparral (NatureServe, 2015). The uppermost part of the Ringold Formation is a heavily calcified and silicified cap layer to a depth of at least 4.6 m (15 ft.). This layer is commonly called ‘‘caliche’’ although in this case, it lacks the nitrate constituents found in true caliche. The ‘‘caliche’’ layer is a resistant caprock underlying the approximately 274–304 m (900–1,000 ft.) elevation (above sea level) plateau extending north and east from the White Bluffs (Newcomb 1958, p. 330) (USFWS, 2013a).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Number of Populations:

1 (USFWS, 2020)

Population Size:

2,529 to 58,472 (USFWS, 2020)

Population Narrative:

The White Bluffs bladderpod population continues to fluctuate greatly among years, with an overall trend of consistently going up and down over time. The monitored portion of the population has ranged from an estimated 2,529 to 58,472 flowering plants since 2013. The size of the entire White Bluffs bladderpod population is uncertain because monitoring occurs only along permanent transects in an area totaling 3.7-km long in the northern part of the subspecies’ range. A population viability analysis has not been done and therefore a minimum viable population size has not been estimated. It was suggested that there should be at least 10,500 reproductive individuals in the monitored portion for the population to be considered viable (Caplow 2003, p. 3-3) but as recently as 2015 and 2016 this threshold was not met. Therefore, small population size may continue to be a threat. (USFWS, 2020)

Threats and Stressors

Stressor: Irrigation (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: About one-third of the population is located near or adjacent to irrigated land, where excess groundwater seepage has triggered mass-slope failures (landslides) in the past that obliterate the narrow blufftop soil band in which these plants are found; Lesquerella tuplashensis has not been found in areas disturbed by these landslides (USFWS 2004). Recent incorporation of the area into a national monument/national wildlife refuge may increase capabilities to mitigate this threat somewhat; however, irrigation-dependent farming continues in the area (NatureServe, 2015).

Stressor: Pesticide use (NatureServe, 2015)
Exposure:

Response:
Consequence:
Narrative: Pollinators may be affected by use of agricultural pesticides nearby (USFWS, 2004; NatureServe, 2015).

Stressor: Invasive species (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Yellow star thistle (Centaurea solstitialis), a highly invasive exotic weed, has been documented in the vicinity (USFWS 2003 & 2004). A seed-predator insect has also been noted in recent years (USFWS, 2004), but it is not known if this is a natural phenomenon or an exotic species introduction (NatureServe, 2015). Cheatgrass is an introduced annual grass that is widely distributed in the western United States, and has been documented in the White Bluffs bladderpod population. Cheatgrass can outcompete native plants for water and nutrients in the early spring, since it is actively growing when native plants are initiating growth. It also completes its reproductive process and becomes senescent before most native plants (Pellant 1996, p. 1–2) (USFWS, 2013b).

Stressor: Off-road vehicles (NatureServe, 2015)
Exposure:
Response:
Consequence:
Narrative: Off-road vehicles, including mountain bikes, have increased disturbance and erosion, and destroyed individual plants (F. Caplow, pers. comm. cited in USFWS 2003 & 2004) (NatureServe, 2015).

Stressor: Fire (USFWS, 2013b)
Exposure:
Response:
Consequence:
Narrative: Fire is considered to be a threat to White Bluffs bladderpod, although the decline in population numbers after the 2007 fire indicated the population estimate was still within the known range of variability. Fire events tend to be large and unpredictable in the Hanford Reach (see Table 3) and can potentially affect large numbers of plants and significant areas of pollinator habitat. In addition, wildfire also impacts pollinator communities by directly causing mortality, altering habitat, and reducing native plant species diversity (USFWS, 2013b).

Stressor: Predation (USFWS, 2013b)
Exposure:
Response:
Consequence:
Narrative: Since 1996, some predation by larval insects on developing fruits of White Bluffs bladderpod has been observed. Larvae of a species of Cecidomyiid fly have been observed infesting and destroying flowering buds, and an unidentified insect species has been documented boring small holes into young seed capsules and feeding on developing ovules. However, the overall effect of these insect species on the plants or population is not known (TNC 1998, p. 5). Although insect predation may be a potential threat to White Bluffs bladderpod, more thorough

investigations are necessary to determine its significance to seed production (USFWS, 2013b).

Stressor: Utility lines (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Since the listing rule, one highly localized and largely temporary potential threat emerged. A 115 kilovolt electrical transmission line (Benton-Othello) crosses the White Bluffs in an area where the subspecies occurs. The line, owned by Avista Utilities (hereafter, Avista), was rebuilt from 2019-2020. Direct (e.g., uprooting plants, crushing plants) and indirect (e.g., increased likelihood of fire or non-native plants) impacts to bladderpod were expected (U.S. Department of Energy 2019, p. 44). Within the subspecies' critical habitat, the estimated disturbance was 0.02 ac permanently and 2.37 ac temporarily. The actual disturbance was less than estimated. Construction techniques were altered to reduce impacts in critical habitat; for example, spoil that would normally be placed in the right-of-way was instead hauled away (U.S. Department of Energy 2019, p. 13). Avista developed a site-specific restoration plan that specifies how damage to the habitat and vegetation will be avoided, minimized, and mitigated (U.S. Department of Energy 2019, p. 16). The Service reviewed a draft of the plan. Revegetation will begin in late 2020 and continue into 2021, with weed control to occur for several years. All disturbed areas not needed for future operation and maintenance of the line will be revegetated with native species (USFWS 2018a, pp. 4-5). Avista will monitor these areas for 5 years to ensure success criteria have been met; if not met, additional restoration and monitoring will occur (U.S. Department of Energy 2019, p. 16). (USFWS, 2020)

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Recovery Priority Number: 6C

Delisting Criteria:
1) Discover or establish at least one additional population of White Bluffs bladderpod within the Monument or, if possible, on nearby protected lands. These populations will be capable of adapting to changing environmental conditions and be of sufficient size and distribution to withstand stochastic events, such that extinction is highly unlikely (USFWS, 2022).

2) Manage and improve sufficient habitat to support populations wherever they occur (USFWS, 2022).

Recovery Actions:
- 1. Monitor population status, trend, and distribution (USFWS, 2022).
- 2. Conduct scientific research to improve understanding of the subspecies' life history, autecology, and limiting factors (USFWS, 2022).
- 3. Protect, conserve, and enhance habitat (reduce or eliminate Factor A threats) (USFWS, 2022).
- 4. Determine the minimum viable population size for White Bluffs bladderpod and the number and distribution of populations needed for long-term viability (USFWS, 2022).

- 5. If needed, increase population size and distribution (reduce or eliminate Factor E threats) (USFWS, 2022).
- 6. Promote outreach and cooperation with partners and stakeholders (USFWS, 2022).

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SPECIES ACCOUNT: *Physaria filiformis* (Missouri bladderpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/08/1987; Great Lakes-Big Rivers Region (R3) (USFWS, 2015)

Physical Description

The Missouri bladderpod is a winter annual, up to 2.5 dm tall, which produces yellow flowers which are especially showy against the plant's silvery stems and foliage. The plants flower, set seed, and die in early spring; the seeds germinate in autumn and overwinter as rosettes. (NatureServe, 2015)

Taxonomy

Previously known as Lesquerella filiformis (USFWS, 2008)

Historical Range

In addition to its current range, the bladderpod is believed to be extirpated in Jasper and Lawrence counties, Missouri. (USFWS, 1987)

Current Range

The Missouri bladderpod currently occurs in four counties in Missouri and five counties in Arkansas and the species is distributed on limestone glades in Southwest Missouri, dolomite glades in northern Arkansas (a report for Missouri on a dolomitic glade has not been confirmed, George Yatskievych, pers. comm. Aug. 11, 2014), and shale glades in the Ouachita Mountains in central Arkansas (Witsell, 2008). (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; self-incompatible (USFWS, 2015)

Lifespan

Adult: Less than one year (USFWS, 1988)

Dependency on Other Individuals or Species

Adult: Numerous insect species as pollinators (USFWS, 2015)

Reproduction Narrative

Adult: The Missouri bladderpod is a winter annual, germinating in the fall and overwintering in the form of basal rosettes. Plants send up flowering stems in late April and flower, fruit and senesce by the end of June. Seeds lie dormant on the limestone glades through the summer and germinate in the fall, starting the life cycle over again. There is considerable variation in these life history details from year to year. (USFWS, 1988) This bladderpod is an obligate outcrosser,

being dependent upon several species of pollinators for pollination and fruit set. No less than 38 species of insects in four orders, visited Missouri bladderpod plants (Edens-Meier et al., 2011). (USFWS, 2015)

Habitat Type

Adult: Unglaciated prairie areas (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Limestone and dolomitic glades or grazed pastures (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Limestone, dolomitic, or shale substrate (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist on specific soils (inferred from USFWS, 2015)

Site Fidelity

Adult: High (USFWS, 2015)

Habitat Narrative

Adult: The Missouri bladderpod is most commonly found in open limestone glades, barrens, and outcrops within unglaciated prairie areas. It occasionally occurs in dolomitic glades, and is known from one site on a shale substrate. It is often associated with grazed pastures. Cedar invasion of glade sites is common. (NatureServe, 2015; USFWS, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 1988)

Dispersal/Migration Narrative

Adult: Seeds are mainly dispersed by falling from dried capsules although some dispersal occurs by seeds being washed downhill by rainwater runoff. (USFWS, 1988)

Population Information and Trends

Population Trends:

Increasing (USFWS, 2015). Unknown. Inferred from information (USFWS, 2020)

Species Trends:

Increasing (USFWS, 2015). Unknown. Inferred from information (USFWS, 2020)

Population Growth Rate:

Increasing, but annually variable (USFWS, 2015)

Number of Populations:

76 (USFWS, 2015)

Population Size:

10,000 to >1,000,000 individuals (NatureServe, 2015)

Adaptability:

Somewhat compatible with residential development and grazing. (NatureServe, 2015)

Population Narrative:

When listed, the Missouri bladderpod was not yet known from Arkansas and there were only 11 known populations in Missouri (USFWS, 2003). As of 2015, the species is known from 66 sites in four counties in Missouri and 10 sites in five counties in Arkansas (USFWS, 2003); Rhonda Rimer, pers. comm. Mar.10, 2014, Jan. 14, 2015; Cindy Osborne, pers. comm., Aug. 13, 2014). While the total number of populations now far exceeds the number when listed, an assessment as to whether or not they are self-sustaining is problematic because populations of Physaria filiformis can vary widely from year to year depending on different climatic and edaphic factors and in response to various management practices. For example, Young (2013) monitored populations of Physaria filiformis over a 25-year period on the largest bladderpod site on the Wilson Creek National Battlefield in Missouri and demonstrated that plants fluctuated from a few thousand in 1990, to 261,000+ in 1991, to a few thousand in 1992, to zero in 1993 and 1994, and then rebounded to highs of between 30,000+ and 137,000+ in 1995, and between 42,000+ and 114,000+ in 2011. Similar results have been noted in other areas (USFWS, 2003). While some of the currently known bladderpod sites exceed one-half acre in size, many are much smaller and the distributions of some populations are limited due to the availability of suitable glade habitat. (USFWS, 2015). While populations on managed glades are stable or increasing, data suggest that populations that receive no management are declining. During 2015 and 2016 surveys, Edwards et al. (2019, p. 18) found that P. filiformis was absent or only represented by a single individual in 11 of 25 populations surveyed, and many of these populations showed further decline in 2017. A review of 19 glades surveyed by MDC between 2006 and 2019 demonstrated that seven glades (37%) have stable populations, four have declining populations (21%), and eight are presumed extirpated (42%) (Rhonda Rimer, MDC, Nov. 12, 2019, Dec. 18, 2019, pers. comm.). More than half of Missouri sites have not been surveyed since 2005 and their status is unknown (USFWS, 2020). We received survey data and monitoring reports from MDC and ANHC with updated information regarding the species' status and current threats in the time since we conducted the last 5-year review. Three new sites have been documented since the last review. Results of these efforts indicate that managed populations in Missouri and Arkansas are stable and that unmanaged populations may be declining rapidly. No new threats have been documented since the last 5-year review. As described above, the recovery criteria outlined in the recovery plan has not been met. Eleven of 30 self-sustaining populations occur on public land; however, four of these occur in the Ouachita Mountains and may be reclassified as a different species in the future. Fourteen populations either occur on protected land or privately owned land but are being managed by a conservation agency. The exclusion of populations in the Ouachita Mountains would reduce the number of protected populations range-wide from 14 to 10. (USFWS, 2020)

Threats and Stressors

Stressor: Human disturbance and collection (USFWS, 1987)
Exposure:
Response:
Consequence:
Narrative: The low number of individual plants make the species vulnerable to collecting and other human disturbance. Two of the populations are within the Wilson's Creek National Battlefield, where a system of interpretive trails extends through the sites. These populations receive some disturbance from the more than 124,000 annual visitors to the Battlefield site, but Morgan (1983) concluded that disturbance may help maintain the Lesquerella filiformis populations. In addition, wildflower collectors may reduce populations in more accessible sites. As Steyermark (1963) pointed out, this plant with handsome yellow flowers makes a desirable addition to rock gardens and may be vulnerable to overcollecting. (USFWS, 1987)

Stressor: Lack of management research (USFWS, 1987)
Exposure:
Response:
Consequence:
Narrative: Research is needed to determine proper management techniques for maintenance of the species, especially at disturbed sites. (USFWS, 1987) Consistent glade management maintains suitable habitat for P. filiformis and is considered vital to the survival and recovery of populations in Arkansas and Missouri. Removal of Eastern red cedar (Juniperus virginiana), prescribed fire, and control of exotic species allow for the persistence and expansion of populations. Many privately owned glades in Missouri are not being managed to promote the persistence of this plant species, and surveys indicate generally low numbers of P. filiformis. With a few exceptions, glades on private lands are over-shaded by encroaching Eastern red cedar, intensively grazed, densely covered by grasses and forbs, and not managed with fire (Christine Edwards, MOBOT, Nov. 12, 2019, pers. comm.). Although restoration efforts increase abundance of P. filiformis, implementation of those efforts on privately-owned glades is challenging (Rhonda Rimer, MDC, November 12, 2019, pers. comm.). Similar to Missouri, glade habitat in Arkansas has become degraded at several locations due to lack of management. (USFWS, 2020)

Stressor: Right-of-way maintenance (USFWS, 1987)
Exposure:
Response:
Consequence:
Narrative: Three populations of Lesquerella filiformis occur in Dade County within Missouri highway rights-of-way. Two of these populations extend onto private land. Because of yearly right-of-way treatments, there is a threat of destruction to these populations. Cooperation with the State Department of Highways and Transportation is necessary in order to provide these sites additional protection from accidental mowing or chemical treatment. (USFWS, 1987)

Stressor: Seed destruction (USFWS, 1987)
Exposure:
Response:
Consequence:
Narrative: Seed predation by insects and fungal infection of developing capsules have been reported by Morgan (1983). It is not known whether the ensuing loss of reproductive capacity constitutes a significant threat to the species. (USFWS, 1987)

Stressor: Competition from native and exotic plants (USFWS, 2003; 2015)
Exposure:
Response:
Consequence:
Narrative: Shortly after listing, the Service (1988) documented the presence of exotic plant species, such as Bromus tectorum (a cheat grass), in bladderpod habitat as a significant threat, and this was further supported by observations by Hickey (1988, 2000) and Thomas (1996, 1998). (USFWS, 2003) Witsell (2008) and Eulinger and Skinner (2007) noted that encroachment by Eastern red cedar onto glades causes habitat degradation and this threat will need to be continually monitored. (USFWS, 2015)

Stressor: Development (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: Hickey (1988, 2000) and Thomas (1996) identified development, especially land-use changes resulting from urban expansion, as a major threat to the species. (USFWS, 2003)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Climate change may lead to increased frequency and duration of droughts (Rind et al., 1990; Seager et al., 2007; Rahel and Olden, 2008). Climate warming may increase the virulence of nonnative parasites and increased drought conditions may favor the establishment and spread of nonnative species (Rahel and Olden 2008). Extended droughts and an increase in soil and air temperatures could negatively impact seed set, germination, and overall fitness of Physaria filiformis. (USFWS, 2015)

Recovery

Reclassification Criteria:
The bladderpod has already been reclassified from endangered to threatened based on discovery of new populations and reduced threats to large existing populations. (USFWS, 2003)

Delisting Criteria:
The Missouri bladderpod may be considered for delisting when there are thirty scattered, self-sustaining populations of Lesquerella filiformis that are maintained and protected. Fifteen of the thirty populations must be in secure ownership, occupy a minimum of one-half acre of habitat each, and show self-sustaining populations for at least seven years. (USFWS, 1988)

Recovery Actions:
- Existing populations need to be protected and managed. (USFWS, 1988)
- Suitable habitat needs to be surveyed for new populations. (USFWS, 1988)
- Populations need continuing monitoring; autecological and management research is needed on the species. (USFWS, 1988)

- Management programs need to be developed and then initiated on protected sites. (USFWS, 1988)
- New populations need to be established on public land. (USFWS, 1988)
- Programs need to be developed to enhance public awareness and support for conservation of the species. (USFWS, 1988)
- The establishment of measurable recovery criteria that address threats to the species should be developed and implemented before possible delisting is recommended. (USFWS, 2015)
- A revision of the 1998 Missouri Bladderpod Recovery Plan is needed to develop measurable delisting criteria that reflect remaining threats to the species and to incorporate new information that has been obtained in the last 26 years. Development of such a plan should be done in cooperation with the appropriate experts and stakeholders in Missouri and Arkansas. (USFWS, 2015)
- Missouri bladderpod numbers and the results of ongoing conservation efforts need to be regularly monitored to assess recovery and ongoing management efforts. It may be appropriate to identify priority populations in Missouri and Arkansas for monitoring. Monitoring efforts should include populations that occur on the three different substrate types. (USFWS, 2015)
- Studies need to be initiated on the potential impacts of climate change on the Missouri bladderpod and its habitat. The species could be impacted from droughts and accompanying problems associated with climate change; further research is warranted. (USFWS, 2015)
- Physaria filiformis would benefit from additional genetic studies that evaluate genetic diversity across the range of the species, especially given the now known large geographic gaps between populations in southwest Missouri and scattered populations in Arkansas and the occurrence on three different soil substrates. (USFWS, 2015)
- Outreach efforts need to be made to private landowners in Missouri and Arkansas regarding best management practices that will maintain, and where necessary restore bladderpod habitat. (USFWS, 2015)
- Ongoing survey efforts should continue to search for new populations, especially in Arkansas. (USFWS, 2015)
- Viable sites should be protected and properly managed in all the outlying clusters within the species' range. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The Service provides the following recommendations: 1. Revise the recovery plan to include measurable delisting criteria that appropriately reflect remaining threats to the species and new information that has been obtained in the last 31 years. The plan should define "self-sustaining" and identify how often populations should be monitored within a 7-year period to meet that definition. Development of such a plan should be done in cooperation with the appropriate experts and conservation partners in Missouri and Arkansas. 2. Monitor populations and use results to assess efficacy to further recovery efforts. Recovery criteria cannot be met unless ≥30 populations are monitored. 3. Assess the status of populations in Missouri that have not been surveyed since 2010. Examine what proportion of unmanaged, extant populations in Missouri are threatened by overgrazing, encroaching Eastern red cedar and invasive grass and forb species, as well as changing land use practices that may result in extirpation of populations. 4. Implement a simple, standardized survey to count or estimate the number of plants present in Missouri and Arkansas populations. 5. Conduct outreach efforts with private landowners

in Missouri and Arkansas regarding best management practices to maintain, and where necessary, restore habitat for Missouri bladderpod. 6. Collect data to evaluate whether or not application of herbicide spraying to populations along rights of way and roadways in Arkansas negatively affect P. filiformis. 7. Implement management practices such as prescribed burning and removing Eastern red cedar and non-native plant species within glades. Develop and implement additional management plans in Missouri and Arkansas to maintain habitat on private and public lands to further recovery efforts for this plant species. 8. Protect and manage more of the populations that occur on privately owned land through an appropriate combination of financial incentives, acquisition, easements, and logistical support. 9. Continue to protect and manage at least one population within each distinct genetic group and two populations from the genetically distinct group that occur in Sharp and Izard Counties, Arkansas. 10. Conduct a morphological study to determine if populations located in the Ouachita Mountain in Arkansas are a different species. (USFWS, 2020)

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USFWS. 2020. 5-YEAR REVIEW Missouri bladderpod (Physaria filiformis). 7 pp + appendices.

SPECIES ACCOUNT: *Physaria globosa* (Short's bladderpod)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 8/1/2014

Physical Description

An erect, short-lived perennial (or biennial) herb with slender, leafy stems that spread from the base and are 3-5 dm tall, giving vigorous plants a bushy appearance. Leaves are densely hairy, grayish-green. Flowers are bright yellow to yellow-orange, cross-shaped, borne in elongated clusters of up to 50 flowers. Fruits are globe-shaped (NatureServe, 2015).

Taxonomy

A member of the mustard family (Brassicaceae), Short's bladderpod was first described as Vesicaria globosa by Desvaux (1814, p. 184). Because of several distinctive characters, Watson (1888, pp. 249-250) proposed that the American species of the genus Vesicaria be placed in the genus Lesquerella. This treatment was recognized as valid, until Al-Shehbaz and O'Kane (2002, entire) united most of the genus Lesquerella with the genus Physaria. Within the genus Physaria, and earlier treatments of Lesquerella, P. globosa has long been recognized as a geographically and evolutionarily distinct taxon (USFWS, 2017a).

Current Range

The species has a disjunct distribution, with populations known from Posey County, Indiana; Bourbon, Clark, Fayette, Franklin, Jessamine, Madison, Mercer, Nelson, Powell, Scott and Woodford Counties, Kentucky; and Cheatham, Davidson, Dickson, Jackson, Maury, Montgomery, Smith, Trousdale, and Williamson Counties, Tennessee (USFWS, 2017a).

Critical Habitat Designated

Yes; 8/26/2014.

Legal Description

On August 26, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Physaria globosa (Short's bladderpod) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 20 critical habitat units (CHUs), in Indiana, Kentucky and Tennessee (79 FR 50990-51039).

Critical Habitat Designation

The critical habitat designation for Physaria globosa includes 20 CHUs in Posey County, Indiana; Clark, Franklin, and Woodford Counties, Kentucky; and Cheatham, Davidson, Dickson, Jackson, Montgomery, Smith, and Trousdale Counties, Tennessee. This species critical habitat encompasses approximately 925.5 acres (ac) (373 hectares (ha)) (79 FR 50990-51039).

Unit 1: Kings and Queens Bluff: Unit 1 consists of 7.6 ha (18.9 ac) of private land, but the U.S. Army Corps of Engineers (Corps of Engineers) holds flood easements on approximately 40 percent of this land. This unit is located in Montgomery County, Tennessee, on a bluff on the right descending bank of the Cumberland River within the city limits of Clarksville, approximately 0.16 km (0.10 mi) south of the intersection of State Route 12 (Ashland City Road) and Queens Bluff Way. Beginning approximately 0.28 km (0.18 mi) south of the easternmost intersection of

Ashland City Road (U.S.–41a Bypass) and Queens Bluff Road, this unit parallels the Cumberland River in a downstream direction for approximately 1.7 km (1.1 mi). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading and competition due to encroachment of native and invasive, nonnative plants.

Unit 2: Lock B Road: Unit 2 consists of 10.1 ha (25.0 ac) of privately owned land, but the Corps of Engineers holds flood easements on approximately 3 percent of this land. This unit is located in Montgomery County, Tennessee, approximately 6.9 km (4.3 mi) south of the city limits of Clarksville, on a hillside that lies to the east and west of Lock B Road North, beginning approximately 0.8 km (0.5 mi) south of its junction with Gholson Road and continuing south for approximately 0.4 km (0.25 mi), at which point Lock B Road North veers to the southwest. From this point, this unit continues south for approximately 1.0 km (0.6 mi) along the hillside that is east of Lock B Road North. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to potential right-of-way construction or maintenance using herbicides or mechanized equipment along Lock B Road North or the Illinois Central Railroad, both of which traverse portions of the unit, and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 3: Jarrel Ridge Road: Unit 3 consists of 5.2 ha (12.8 ac) of privately owned lands, but the Corps of Engineers holds flood easements on approximately 8 percent of this land. This unit is located in Montgomery County, Tennessee, approximately 10 km south of the city limit of Clarksville, on a hillside that lies west and north of the southern terminus of Jarrel Ridge Road. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment along Jarrel Ridge Road at the unit boundary or the Illinois Central Railroad, which traverses the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 4: Cheatham Lake: Unit 4 consists of 27.3 ha (67.5 ac) of privately owned, local government, and Federal lands. This unit is located in Cheatham County, Tennessee, approximately 9.0 km (5.6 mi) westnorthwest of the city limits of the town of Ashland City, on a series of hillsides that begins approximately 0.8 km (0.5 mi) northeast of the junction of Beech Grove Road and Cheatham Dam Road and arcs in a southeasterly direction for approximately 2.2 km (1.4 mi). Here, the unit crosses Cheatham Dam Road, and continues for approximately 2.2 km in a southeasterly arc to its eastern boundary on the right descending bank of the Cumberland River, approximately 0.18 km (0.11 mi) south of Kimbrough Road. The land within this unit is approximately 70 percent privately owned, 12 percent owned by Ashland City, and 18 percent owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or

mechanized equipment along the Illinois Central Railroad, which traverses the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 5: Harpeth River: Unit 5 consists of 25.5 ha (63.1 ac) of privately owned and federal land in Cheatham County, Tennessee. This unit is located approximately 5 km (3.1 mi) west of the city limits of the town of Ashland City, on the west slope of a hillside and associated bluffs that begin on the point of land formed by the confluence of Cumberland and Harpeth rivers and extend upstream along the right descending bank of the Harpeth River, reaching the unit's southernmost boundary approximately 0.6 km (0.4 mi) east of SR–49, where it crosses the Harpeth River. The land within this unit is approximately 32 percent privately owned, and 68 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 6: Montgomery Bell Bridge: Unit 6 consists of 11.2 ha (27.7 ac) of privately owned and federal land in Cheatham and Dickson Counties, Tennessee. This unit is located approximately 5.5 km (3.4 mi) west of the city limits of the town of Ashland City, on a hillside and bluffs on the left descending bank of the Harpeth River that begin approximately 0.4 km (0.27 mi) east of the Montgomery Bell Bridge, where SR–49 crosses the river and bisects the unit, and parallels the river in an upstream direction for approximately 1.8 km (1.1 mi). The land within this unit is approximately 19 percent privately owned, and 81 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 7: Nashville and Western Railroad: Unit 7 consists of 30.5 ha (75.3 ac) of privately owned, local government, and Federal land in Cheatham County, Tennessee. This unit is located along the southwest city limit of the town of Ashland City, on hillsides and bluffs that begin approximately 0.26 km (0.16 mi) east of the confluence of Marrowbone Creek and the Cumberland River and extend upstream on the right descending bank of the Cumberland River for approximately 2.3 km (1.4 mi). Here, the unit continues in a southeasterly direction for approximately 0.9 km (0.5 mi) from the point where the river veers away from the hillside and bluffs. The land within this unit is approximately 68 percent privately owned, 27 percent owned by the Cheatham County Rail Association, and 5 percent owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment along the Nashville and Western Railroad, which traverses the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 8: River Trace: Unit 8 consists of 42.8 ha (105.7 ac) of privately owned land, with the exception of the River Trace road rightof-way. The Corps of Engineers holds flood easements on approximately 13 percent of the lands within the unit. This unit is located in Davidson and Cheatham Counties, Tennessee, on hillsides and bluffs approximately 0.9 km (0.6 mi) southeast of the city limit of the town of Ashland City, beginning at the western extent of River Trace and extending along both sides of this road in a southeasterly direction for a distance of approximately 2.3 km (1.4 mi). Here, the unit leaves River Trace and continues along the hillside and bluffs on the right descending bank of the Cumberland River in an upstream direction for approximately 2.1 km (1.3 mi). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment along River Trace or the Nashville and Western Railroad, both of which traverse the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 9: Old Hickory Lake: Unit 9 consists of 4.8 ha (11.9 ac) of privately owned and Federal lands in Trousdale County, Tennessee. This unit is located approximately 3.5 km (2.2 mi) west of the southern city limits of the town of Hartsville and 0.5 km (0.3 mi) south of Oldham Road, on a hillside and bluffs on the right descending bank of the Cumberland River. Beginning approximately 0.4 km (0.25 mi) downstream of the mouth of Second Creek, this unit parallels the Cumberland River in a downstream direction for approximately 0.7 km (0.4 mi). The land within this unit is approximately 40 percent privately owned, and 60 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 10: Coleman-Winston Bridge: Unit 10 consists of 7.4 ha (18.2 ac) of privately owned and Federal lands in Trousdale County, Tennessee. The unit is located at the southern city limit of the town of Hartsville, on a hillside and bluffs overlooking the Cumberland River. Beginning on the right descending bank approximately 0.5 km (0.3 mi) east of SR–141, which bisects the unit where it crosses the Cumberland River at the ColemanWinston Bridge, this unit parallels the river in a downstream direction for approximately 1.1 km (0.7 mi). The land within this unit is approximately 55 percent privately owned, and 45 percent is owned by the Corps of Engineers. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment along SR–141, which bisects the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 11: Cordell Hull Reservoir: Unit 11 consists of 12.3 ha (34.2 ac) of Federal lands in Smith County, Tennessee. This unit is located approximately 4.3 km (2.7 mi) north of the city limits of

the town of Carthage, on hillsides and bluffs on the right descending bank of the Cumberland River. Beginning approximately 2.0 km (1.25 mi) upstream of the Cordell Hull Dam, this unit parallels the river in an upstream direction for approximately 0.6 km (0.4 mi), where it crosses a 0.3- km (0.2-mi) expanse of open water, and then continues paralleling the river for a distance of 1.2 km (0.7 mi). All of the land within this unit is owned by the Corps of Engineers, and the open water is not included in the area of the unit reported above. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 12: Funns Branch: Unit 12 consists of 20.8 ha (51.3 ac) of Federal lands in Jackson County, Tennessee. This unit is located approximately 12.1 km (7.5 mi) southwest of the city limits of the town of Gainesboro, on hillsides and bluffs on the right descending bank of the Cumberland River. Beginning approximately 0.4 km (0.2) mi upstream of the mouth of Funns Branch, this unit parallels the river in an upstream direction for approximately 1.0 km (0.65 mi) where it crosses a 0.3-km (0.2-mi) expanse of open water, and then continues paralleling the river for a distance of approximately 1.0 km (0.64 mi). All of the land within this unit is owned by the Corps of Engineers, and the open water is not included in the area of the unit reported above. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 13: Wartrace Creek: Unit 13 consists of 37.5 ha (92.6 ac) of Federal lands in Jackson County, Tennessee. This unit is located approximately 7.7 km (4.8 mi) west of the city limits of the town of Gainesboro, on hillsides and bluffs on the right descending bank of the Cumberland River. Beginning at the mouth of Indian Creek, this unit parallels the river in a downstream direction for approximately 1.6 km (1.0 mi), where it crosses the mouth of Wartrace Creek, and then continues paralleling the river for a distance of 2.5 km (1.5 mi). All of the land within this unit is owned by the Corps of Engineers, and areas of open water are not included in the area of the unit reported above. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 14: Camp Pleasant Branch: Unit 14 consists of 17.4 ha (42.9 ac) of privately owned lands in Franklin County, Kentucky. This unit is located approximately 8.3 km (5.8 mi) north of the city limits of Frankfort, on hillsides near Camp Pleasant Branch, a tributary to Elkhorn Creek. Beginning approximately 0.29 km (0.18 mi) west of the intersection of Indian Gap Road and Camp Pleasant Road, the unit begins in a hollow north of Indian Gap Road and extends to the east and north along hillsides above the right descending bank of Camp Pleasant Branch for approximately 0.75 km (0.5 mi) to the intersection of Camp Pleasant Road and Gregory Woods Road. Here the unit crosses Gregory Woods Road and extends north for a distance of

approximately 0.58 km (0.36 mi), encompassing the hillside to the east of the road. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment along Indian Gap Road, Camp Pleasant Road, or Gregory Woods Road, which are adjacent to the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 15: Kentucky River: This unit consists of 93.1 ha (230.0 ac) of privately owned and State land in Franklin County, Kentucky. This unit begins within the northwestern city limit of Frankfort, on a hillside that parallels U.S.–421 on its east side from approximately 0.21 km (0.13 mi) southeast of its junction with Clifty Drive to approximately 0.23 km (0.15 mi) northwest of its junction with U.S.– 127. Here the unit follows the topography of the hillside as it turns away from the road to the east, leaving the city limits, and then arcs to the northeast, before abruptly turning back in a westerly direction. From this point, the hillside and this unit extend in a westerly direction for approximately 0.7 km (0.4 mi) and then parallel the Kentucky River in a downstream direction in an arc approximately 5.3 km (3.3 mi) in length on its left descending bank, encompassing hillsides in two hollows that extend from the river to the west. Approximately 90 percent of the land in this unit is privately owned, and the Commonwealth of Kentucky owns approximately 10 percent, which is part of a State nature preserve. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to erosion or prolonged inundation due to water level manipulation; changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment along U.S.–421, where it parallels the unit; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 16: Owenton Road: Unit 16 consists of 2.8 ha (7.0 acres) of privately owned and City of Frankfort municipal park lands in Franklin County, Kentucky. The unit is located approximately 0.1 km (0.08 mi) north of the city limits of Frankfort on a hill that is adjacent to and west of U.S.–127 (Owenton Road), approximately 0.6 km (0.4 mi) north of the intersection of U.S.–127 and U.S.–421. The land within this unit is approximately 46 percent privately owned, and 54 percent is owned by the City of Frankfort. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment on U.S.–127; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 17: Little Benson Creek: Unit 17 consists of 9.4 ha (23.3 ac) of privately owned lands in Franklin County, Kentucky, located within the city limits of Frankfort. Beginning approximately 1.1 km (0.7 mi) south of the intersection of Mills Lane and Ninevah Road, this unit lies on a hillside on the east side of Ninevah Road and extends to the south for approximately 0.5 km (0.3 mi), where it crosses Ninevah Road and follows a hillside that parallels Ninevah Road for approximately 1.0 km (0.65 mi) on its west side. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which

could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment on Ninevah Road; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 18: Boone Creek: Unit 18 consists of 5.0 ha (12.4 ac) of privately owned lands in Clark County, Kentucky. This unit is located approximately 13.2 km (8.2 mi) southwest of the city limits of Winchester, and begins adjacent to Grimes Mill Road approximately 0.17 km north of the Fayette and Clark County line. From here, the unit extends on a hillside to the east for a distance of approximately 0.21 km (0.13 mi), where the unit and hillside then parallel a bend in Boone Creek on its left descending bank for a distance of approximately 0.68 km (0.42 mi). The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats related to changes in land use, including residential or commercial construction, which could cause removal of forest vegetation or soils or soil loss due to erosion; potential rightof-way construction or maintenance using herbicides or mechanized equipment on Grimes Road; and shading or competition due to encroachment of native and invasive, nonnative plants.

Unit 19: Delaney Ferry Road: Unit 19 consists of 0.6 ha (1.4 ac) of privately owned lands in Woodford County, Kentucky. This unit is located approximately 7.8 km (4.8 mi) south of the city of Versailles. Beginning approximately 2.1 km (1.3 mi) east of the intersection of Troy Pike and Delaney Ferry Road, this unit extends approximately 0.08 km (0.05 mi) northeast along Delaney Ferry Road, where the unit boundary turns to the northwest for approximately 0.08 km (0.05 mi). From this northeast corner of the unit, the boundary extends to the southwest approximately 0.05 km (0.03 mi), where it turns to the southeast, paralleling a driveway for 0.05 km (0.03 mi) before turning to the southwest for approximately 0.03 km (0.02 mi). From this point the unit boundary turns to the southeast for approximately 0.05 km (0.03 mi), returning to the starting point. The features essential to the conservation of the species in this unit may require special management considerations or protection to address threats of shading or competition due to encroachment of native and invasive, nonnative plants. The current landowner manages encroaching vegetation to prevent shading and competition where Short’s bladderpod occurs within the unit.

Unit 20: Bonebank Road: Unit 20 consists of 1.7 ha (4.3 ac) of lands in Posey County, Indiana, which are owned by the Indiana Department of Natural Resources. This unit is located approximately 13 km (8.1 mi) southwest of the city limits of Mt. Vernon, beginning at the intersection of Graddy Road and Bonebank Road and paralleling Bonebank Road on its west side for a distance 0.73 km (0.45 mi) north of the intersection. The surface geology at this site—Quaternary glacial outwash—and soils are markedly different from other sites on calcareous geology throughout the rest of the species’ range. However, this site supports an occurrence that has numbered in the hundreds to more than a thousand individuals in the past, and the PCE of forest vegetation with canopy openings (PCE 3) is present at the road edge. The feature essential to the conservation of the species in this unit may require special management considerations or protection to address threats of shading or competition due to encroachment of native and invasive, nonnative plants.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Physaria globosa critical habitat consists of four

components (79 FR 50990-51039):

(i) Bedrock formations and outcrops of calcareous limestone, sometimes with interbedded shale or siltstone, in close proximity to the mainstem or tributaries of the Kentucky and Cumberland rivers. These outcrop sites or areas of suitable bedrock geology should be located on steeply sloped hillsides or bluffs, typically on south- to west-facing aspects.

(ii) Shallow or rocky, well-drained soils formed from the weathering of underlying calcareous bedrock formations, which are undisturbed or subjected to minimal disturbance, so as to retain habitat for ground-nesting pollinators and potential for maintenance of a soil seed bank.

(iii) Forest communities with low levels of canopy closure or openings in the canopy to provide adequate sunlight for individual and population growth. Invasive, nonnative plants must be absent or present in sufficiently low numbers not to inhibit growth or reproduction of Short's bladderpod.

Special Management Considerations or Protections

The features essential to the conservation of Short's bladderpod may require special management considerations or protection to reduce the following threats: (1) Actions that would directly result in removal of soils or indirectly cause their loss due to increased rates of erosion; (2) building, paving, or grazing of livestock within or upslope of Short's bladderpod sites that alters water movement or causes soil erosion that results in sediment deposition in suitable habitat; (3) blasting or removal of hard rock and soil substrates; (4) dumping of trash and debris; (5) prolonged inundation of sites due to manipulation of regulated waters for flood control or other purposes; (6) indiscriminate maintenance of transportation rights-of-way, including grading, mowing, or herbicide application; and (8) shading and competition due to forest canopy closure and encroachment of invasive, nonnative plants. Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in or upslope of Short's bladderpod sites when planning for location of commercial or residential development; maintenance, construction, or expansion of utility and transportation infrastructure; and access for livestock; (2) removing trash and debris that are dumped onto or upslope of Short's bladderpod sites; (3) locating suitable habitat, determining presence or absence of Short's bladderpod, and protecting or restoring as many sites or complexes of sites as possible; (4) evaluating the effects of flow regulation on Short's bladderpod occurrences within the fluctuation zone of regulated river reaches and adjusting management to avoid or minimize prolonged periods of inundation; (5) reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat; (5) providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat; (6) managing, including reducing, canopy cover and competition from native and invasive, nonnative plants to maintain an intact native forest community with canopy openings or low levels of canopy closure.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-compatibility and self-incompatibility (USFWS, 2017a).

Breeding Season

Adult: Typically flowers and produces seed during the months of March through June. Timing of seed germination is not currently known, but it is possible that seeds could germinate in the fall and form rosettes over winter, germinate in spring when conditions become favorable, or exhibit either phenology depending upon the dormancy status of individual seeds and variation in seasonal climatic conditions (USFWS, 2017a).

Key Resources Needed for Breeding

Adult: Pollinators are likely native ground nesting bees and flies (USFWS, 2017a).

Reproduction Narrative

Adult: This species likely is self-incompatible, and nearly 50 percent of extant occurrences are threatened with adverse effects associated with small populations including loss of genetic variation, inbreeding depression, and reduced availability of compatible mates. Short's bladderpod is a biennial or perennial that typically flowers and produces seed during the months of March through June. Based on observations of an apparent biennial life history in at least some populations, the generation length is considered to be two years – i.e., the time between seed germination and next generation recruitment into the population would be a minimum of two years. Timing of seed germination is not currently known, but it is possible that seeds could germinate in the fall and form rosettes over winter, germinate in spring when conditions become favorable, or exhibit either phenology depending upon the dormancy status of individual seeds and variation in seasonal climatic conditions. Fitness of Short's bladderpod individuals is dependent on appropriate temperature, soil moisture and nutrients, and light regimes for seed germination; growth of seedling, juveniles, and adults; and reproduction. Availability of mate-compatible genotypes and abundance of pollinators are critical factors for production of viable seed (USFWS, 2017a). For this reason, it is essential that habitat for pollinators be conserved in close proximity to known occurrences to increase the likelihood of pollen exchange among compatible mates. Where possible, habitat patches should be protected that would reduce fragmentation between multiple occurrences among which pollinator dispersal could facilitate gene flow. Two species of dipterans (flies; Nemotelus bruesii, Toxomerus geminatus) and four species of hymenopterans (bees; Lasioglossum illinoense, L. versatus, Halictus ligatus, Augochlorella striata), from the family Halictidae, were determined to be effective pollinators for Short's bladderpod. Available data indicate that four species of hymenoptera (Pickering 2009) and T. geminatus (Hilty 2015) are generalist foragers. Sites where the species occurs should not be subjected to activities that would remove the soil seed bank. Moderate soil disturbance, however, could promote germination from the seed bank in locations where overstory shading and competition from herbaceous and shrub species have caused population declines (USFWS, 2014, USFWS, 2017a). The majority of floral foragers observed visiting Physaria filiformis (Missouri bladderpod) were true bees representing five families, with greater than 50 percent from the family Halictidae. The families Apidae and Andrenidae also were common among bee pollinators of this species, the most dependable and frequent of which were ground-nesters. (USFWS, 2020a). Seed-dispersal of Short's bladderpod has not been studied, though Shea (1993, p. 21) suggested that the seeds might be dispersed by gravity and wind. The small seeds (1.0-1.8 millimeter (mm)) (~0.4 in) of Short's bladderpod (Rollins and Shaw 1973, p. 167) exhibit no morphological adaptations to facilitate widespread dispersal by wind or any other means, thus wind dispersal would only act to disperse the seeds very short distances (~1-2 m (~3.6-7.2 ft)) from the maternal plant. Limited dispersal distance

has been demonstrated for other Physaria species, such as P. ludoviciana, for which Grant et al. (2012, p. 68) found highly significant reductions in the abundance of seeds in the seedbank 1-2 m (3.6-7.2 ft) from the mother plant relative to abundance directly adjacent to the mother plant. Cabin et al. (2000, p. 296) and Elberling (2000, p. 89) observed similarly short dispersal distances for P. fendleri and P. arctica, respectively. Although individual seeds are likely only dispersed very short distances by wind, longer distance dispersal could potentially occur if an entire fruiting raceme or branch of a plant were to break off and be transported by wind before seed pods dehisced (Thacker, pers. comm., May 2015). This hypothetical tumble-weed-like means of wind dispersal may occur infrequently, if at all, but could disperse seeds upslope on rising air currents, acting to periodically counter downslope dispersal of seeds by gravity and surface flow. It also is possible that Short's bladderpod is associated with historical travel routes of ungulates, which could have provided an alternative mechanism for dispersal of seeds upslope and over longer distances via soil stuck to hooves (Littlefield, pers. comm, November 20, 2017). (USFWS, 2020a)

Habitat Type

Adult: Short's bladderpod typically grows on steep, rocky, wooded slopes and talus (sloping mass of rock fragments below a bluff or ledge) areas. It also occurs along tops, bases, and ledges of bluffs and infrequently on sites with little topographic relief. The species usually is found in these habitats on south- to southwest-facing steep heels or bluffs adjacent to the Cumberland River within the Highland Rim and Central Basin Sections of the Interior Low Plateaus Province . The most stable and vigorous occurrences are found in sites with relatively open overstory canopy (USFWS, 2017a).

Habitat Vegetation or Surface Water Classification

Adult: Populations can include vegetation associated with both xeric and mesic conditions (USFWS, 2017a).

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dry, open limestone ledges on river bluffs, talus of lower bluff slopes, and shale at cliff bases. These are usually south- to west-facing rocky slopes, and the tops, ledges, or bases of steep cliffs, often along major waterways, such as the Cumberland River (Pyne et al. 1995). Also on thin, calcareous soils in cedar glades. The plants should be sought on dry limestone rocks or open rock ledges. The species has also colonized artificial surfaces, especially roadcuts, downhill from natural or semi-natural bluffs (NatureServe, 2015). Short's bladderpod populations are most robust in sites where light availability is high due to low levels of shading from midstory and overstory vegetation (USFWS, 2017a).

Dispersal/Migration

Dispersal

Adult: There is a lack of evident mechanisms for long-distance dispersal for Short's bladderpod but flowing water is needed for dispersal within watershed (USFWS, 2017a).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2014)

Resiliency:

The historical and current distributions of Short's bladderpod are characterized primarily by populations of low resiliency, owing to small population sizes and presence of threats to the species, its habitat, or both. The vulnerability of small populations is borne out by the turnover in occurrences of the species between 1992 and present day, resulting in the loss of at least 8 occurrences during that time period. With regard to the species' overall resilience, these losses have been potentially offset by the discovery of additional, albeit small, populations in Tennessee since 1992 (USFWS, 2017a).

Representation:

We used trends in number of physiographic sections, states, and counties occupied by the species as measures of representation. The species representation has changed between 1992 and 2016 only with respect to the counties where it occurs. In both years, the species occurred in three states and four sections of physiographic provinces. The species representation has increased in terms of numbers of counties occupied, from 10 in 1992, to 13 in 2016; despite extirpation from two counties during that time span. In Kentucky, the species is no longer extant in Bourbon or Scott counties, but is now present in Madison and Woodford counties. In Tennessee, the species was discovered in Dickson and Jackson counties after 1992' (USFWS, 2017a).

Redundancy:

We evaluated redundancy of Short's bladderpod by examining trends in total number of occurrences and number of occurrences with ≥100 individuals per physiographic section, state, and county. The one Indiana occurrence, located in the Shawnee Hills section, has decreased in number from an estimated hundreds-to-thousands of plants in 1992 to 18 plants that were observed in 2017. As of 1992, there were 13 Short's bladderpod occurrences in Kentucky (and the Bluegrass section), with 10 of those occurrences in Franklin County alone. Only two occurrences consisting of at least 100 individuals were known from Kentucky, one each in Bourbon and Franklin counties. There are now 11 occurrences in Kentucky, with the greatest concentration still in Franklin County, albeit reduced from 10 to 7 occurrences. There are now three occurrences where recent data indicate that at least 100 individuals are present, all in Franklin. The Bourbon County occurrence, where 118 Short's bladderpod were present in 1992, and a smaller occurrence in Scott County have been extirpated. In Tennessee, there were eight occurrences located in the Highland Rim section and three in the Nashville Basin as of 1992. There was only one Tennessee County with more than three occurrences in 1992. Three occurrences in the Highland Rim section and one in the Nashville Basin consisted of at least 100 individuals. Today there are 14 occurrences located in the Highland Rim section and 5 in the Nashville Basin. Cheatham County still has the greatest number of occurrences, up to five from

the three that were known in 1992. There are four occurrences with at least 100 individuals in the Highland Rim section and one in the Nashville Basin' (USFWS, 2017a).

Number of Populations:

33 (USFWS, 2021)

Population Size:

1 - 1,000 individuals (USFWS, 2017a)

Minimum Viable Population Size:

Unknown (USFWS 2017a)

Population Narrative:

Population numbers of this seed-banking mustard vary substantially from year to year, with maintenance of seed-bank diversity dependent on significant reproduction in at least some years. Shading from overtopping trees or invasive shrubs can deplete populations as well. Many sites are on roadsides, where they are no longer within natural ecosystems (USFWS, 2004). Species has a distjunct distribution where historically is was known from 55 occurrences, and as of 2016 there were 10 extant occurrences in Kentucky, 20 in Tennessee, and 1 in Posey County, Indiana, for a total of 31 extant occurrences range-wide (INHDC 2017, KNHP 2017, TNHID 2016). One of these (Tennessee EO 22) was not found when last visited, in 2013, and flood damage was observed at the site, but it is considered extant until such time as it is declared extirpated in the TNHID. Extant occurrences in Kentucky are distributed among Clark (1), Franklin (7), Madison (1), and Woodford (1) Counties, and in Tennessee among Cheatham (5), Davidson (3), Dickson (1), Jackson (3), Montgomery (3), Smith (2), and Trousdale (2) Counties. One Tennessee occurrence straddles the county line between Cheatham and Davidson Counties. This is an increase of 5 occurrences as compared to the 26 extant occurrences reported in the proposed listing rule for the species (78 FR 47111-47113; August 2, 2013). The rediscovery of Kentucky EO 10 in 2013 also adds Madison County to the species' current range. Of these occurrences, only 8 have greater than 100 individuals (USFWS, 2017a). The remaining populations are in many cases small, isolated, and have limited potential for recolonization should they be extirpated (USFWS, 2017b). Short's bladderpod was listed as endangered in 2014, when there were 26 extant populations of the species known to exist. The most significant threats to the species at the time of listing were the present or threatened destruction, modification, or curtailment of its habitat and range (Listing Factor A) and the often adverse effects associated with small population size, including potential for reduced genetic variation, low numbers of compatible mates, increased likelihood of inbreeding depression, and reduced resilience to recover from acute demographic effects of other threats to the species and its habitat (Listing Factor E). While the number of known extant populations has increased to 33, as of 2020, habitat at 29 of these populations is adversely affected by one or more threats discussed above under Listing Factor A. Additionally, most populations are small in size, with many having declined in abundance since the species was listed. (USFWS, 2021)

Threats and Stressors

Stressor: Soil Loss (USFWS, 2014)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: The features essential to the conservation of Short's bladderpod may require special management considerations or protection to reduce the following threats: (1) Actions that would directly result in removal of soils or indirectly cause their loss due to increased rates of erosion (USFWS, 2014).

Stressor: Development/grazing (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: (2) Building, paving, or grazing of livestock within or upslope of Short's bladderpod sites that alters water movement or causes soil erosion that results in sediment deposition in suitable habitat (USFWS, 2014).

Stressor: hard rock mining (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 3) Blasting or removal of hard rock and soil substrates (USFWS, 2014).

Stressor: Trash dumping (USFWS, 2014)
Exposure:
Response:
Consequence: Habitat degradation
Narrative: (4) Dumping of trash and debris (USFWS, 2014).

Stressor: Prolonged inundation (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individual plants
Narrative: (5) Prolonged inundation of sites due to manipulation of regulated waters for flood control or other purposes (USFWS, 2014).

Stressor: Right-of way maintenance (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: (6) Indiscriminate maintenance of transportation rights-of-way, including grading, mowing, or herbicide application

Stressor: Invasive/non-native plants (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: (8) Shading and competition due to forest canopy closure and encroachment of invasive, nonnative plants (USFWS, 2014).

Recovery

Delisting Criteria:
Agreements have been reached with key stakeholders to conserve, restore, and manage habitat to provide ecological conditions, as described in the Species Status Assessment for Short's bladderpod (SSA), that promote growth of individuals and support resilient populations (USFWS, 2017b).

Monitoring demonstrates stable or increasing population growth rates or an average population size for at least 25 populations that is equal to or above the minimum viable size. Populations are protected by a conservation mechanism. A minimum of 6 of these populations must be located in the Kentucky River watershed and 15 populations in the Cumberland River watershed, in addition to the population in the Wabash River watershed, in order to ensure adequate regional representation and intra-regional redundancy of resilient populations (USFWS, 2017b).

In lieu of satisfying criteria 1 and 2, the species could be considered for delisting if 50 resilient occurrences (as described in the SSA) are distributed among the physiographic regions where the species occurs (USFWS, 2017b).

Estimated Cost to Delist: The cost to recover and ultimately delist Short's Bladderpod is estimated to be $3,029,000. Some costs are not determinable at this time, and therefore the total cost of recovery may be higher than this estimate. Date of Delisting: If all actions are fully funded and implemented as outlined, including full cooperation of all partners needed to achieve recovery, we anticipate that recovery criteria for delisting could be met by 2063. (USFWS, 2020)

Recovery Actions:
- Work with the Corps to develop and implement a conservation strategy for Short's bladderpod on lands that the Corps owns or controls (USFWS, 2017b). Includes: develop and implement an adaptive management framework to manage populations on Corps managed lands and implement annual monitoring of populations on Corps managed lands (USFWS, 2017c). Estimated Cost. $475,000. Priority 1. (USFWS, 2020)
- Develop and implement management agreements with departments of transportation, local highway departments, railroad authorities, and utility companies to ensure protection of populations near rights-of-way (USFWS, 2017b). Includes: determine which populations are potentially impacted by right-of-way maintenance, assess potential impacts of rights-of-way maintenance on specific Short's bladderpod occurrences, and work with right-of-way stakeholders to develop and implement management agreements (USFWS, 2017c). Estimated Cost. $314,000. Priority 2. (USFWS, 2020)
- Work with state agencies and private landowners in Kentucky, Tennessee, and Indiana to obtain protection for populations on privately owned lands and to develop and implement adaptive management strategies for protected sites (USFWS, 2017b). Estimated Cost. $900,000. Priority 2. (USFWS, 2020)
- Establish standardized methods for monitoring of populations and habitat conditions, and initiate regular stage-specific monitoring at occurrences range-wide (USFWS, 2017b). Includes: develop a standardized rangewide population monitoring protocol and initiate regular stage-specific monitoring at occurrences range-wide (USFWS, 2017c). Estimated Cost. $475,000. Priority 1. (USFWS, 2020)

- Conduct research that enhances knowledge of Short's Bladderpod to facilitate the development of scientifically sound management plans and models for conducting population viability analyses (USFWS, 2017b). Includes: conduct research to identify ecological conditions needed for germination, establishment, and reproduction of Short's bladderpod; conduct research to examine life history, seed bank longevity, breeding system, pollination, and dispersal for Short's bladderpod; determine germination and propagation requirements of Short's bladderpod; determine genetic diversity within populations and the genetic structure and distance between range-wide populations; determine the tolerance of Short's bladderpod to prolonged drought and inundation; and incorporate results from monitoring and research projects into development of models for estimating minimum viable size and demographic structure of populations and for evaluating extinction risk under various management scenarios (USFWS, 2017c). Estimated Cost. $550,000. Priority 1. (USFWS, 2020)
- Facilitate and support surveys to identify new populations (USFWS, 2017b). Includes: develop a geospatial database to determine priority areas for surveys and conduct surveys to identify additional populations of Short's bladderpod (USFWS, 2017c). Estimated Cost. $360,000. Priority 1. (USFWS, 2020)
- Increase the representation and genetic diversity of ex situ collections of Short's bladderpod in seedbanks to ensure the breadth of species diversity is conserved (USFWS, 2017b). Estimated Cost. $90,000. Priority 2. (USFWS, 2020)
- Augment protected populations that are unable to grow in response to habitat management due to low population size, or introduce populations into suitable, but unoccupied, managed habitat on conservation lands (USFWS, 2017b). Estimated Cost. $30,000. Priority 2. (USFWS, 2020)
- Continue to coordinate with Federal, State, County and City agencies to promote plant recovery and find innovative ways to increase public awareness of the need to protect this species and its habitats (USFWS, 2017b). Includes: develop a Short's bladderpod working group (USFWS, 2017c). Estimated Cost. $200,000. Priority 3. (USFWS, 2020)
- Management activities that could ameliorate these threats include, but are not limited to: (1) Avoiding areas located in or upslope of Short's bladderpod sites when planning for location of commercial or residential development; maintenance, construction, or expansion of utility and transportation infrastructure; and access for livestock (USFWS, 2014). Estimated Cost. $110,000. Priority 3. (USFWS, 2020)
- (2) Removing trash and debris that are dumped onto or upslope of Short's bladderpod sites (USFWS, 2014).
- (3) Locating suitable habitat, determining presence or absence of Short's bladderpod, and protecting or restoring as many sites or complexes of sites as possible (USFWS, 2014).
- (4) Evaluating the effects of flow regulation on Short's bladderpod occurrences within the fluctuation zone of regulated river reaches and adjusting management to avoid or minimize prolonged periods of inundation (USFWS, 2014).
- (5) Reaching out to all landowners, including private, State, and Federal landowners, to raise awareness of the plant and its habitat (USFWS, 2014).
- (6) Providing technical or financial assistance to landowners to help in the design and implementation of management actions that protect the plant and its habitat (USFWS, 2014).
- (7) Managing, including reducing, canopy cover and competition from native and invasive, nonnative plants to maintain an intact native forest community with canopy openings or low

levels of canopy closure (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 4.1 Publish final Recovery Plan and Recovery Implementation Strategy for Short's bladderpod. 4.2 Establish and hold regular meetings of a recovery working group for Short's bladderpod to disseminate information about recovery efforts and coordinate on planning and carrying out recovery actions for the species (Action 9 in Draft Recovery Plan). 4.3 In cooperation with state conservation agencies and others, engage right-of-way managers to develop cooperative agreements providing guidance and establishing commitments for managing habitats in and adjacent to transportation and utility rights-of-way to benefit Short's bladderpod (Action 2 in Draft Recovery Plan). 4.4 Coordinate with State conservation agencies and others to develop a standardized rangewide protocol for monitoring populations and habitat conditions and conduct monitoring at regular intervals (Action 4 in Draft Recovery Plan). 4.5 Work with the Corps to develop and implement a conservation strategy for Short's bladderpod on lands that the Corps owns or controls (Action 1 in Draft Recovery Plan). In addition, encourage the Corps to inform landowners of the presence of Short's bladderpod on privately owned parcels where the Corps holds flood easements and engage those landowners in participating in recovery efforts for the species. (USFWS, 2021)
- Since 1991, the number of extant Short's bladderpod populations has increased from 25 to 33. In 1992, 18 of the populations consisted of less than 100 individuals, whereas this is true for 28 of the currently extant populations. One or more threats, including right-of-way maintenance, overstory shading, invasive species, and small population size affect most populations. The historical and current distributions of Short's bladderpod are characterized primarily by populations of low resiliency, owing to small population sizes and presence of threats to the species, its habitat, or both. The vulnerability of small populations is borne out by the turnover in occurrences of the species between 1992 and present day, resulting in the loss of at least 8 occurrences during that time period. With regard to the species' overall resilience, the discovery of additional, albeit small, populations in Tennessee since 1992 have potentially offset these losses. (USFWS, 2020a)

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Endangered and Threatened Wildlife and Plants

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SPECIES ACCOUNT: *Physaria obcordata* (Dudley Bluffs twinpod)

Species Taxonomic and Listing Information

Listing Status: Threatened; 02/06/1990; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb with flowering stems, 1.2-1.8 dm tall, arising from a tuft of silvery, erect, basal leaves. Flowers are yellow and bloom in May and June. This species is recognized by its dense, silvery covering of dish-shaped hairs which completely encrust its stems, leaves, and heart-shaped fruits. (NatureServe, 2015)

Current Range

Endemic to Colorado; known from Rio Blanco County only along the Piceance and Yellow Creek drainages and at Clamity Ridge. Estimated range is 574 square kilometers, calculated in GIS by drawing a minimum convex polygon around the known occurrences.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2008)

Breeding Season

Adult: Flowers are yellow and bloom in May and June (NatureServe, 2015).

Reproduction Narrative

Adult: Flowers are yellow and bloom in May and June (NatureServe, 2015). These species rely exclusively on insect pollination (USFWS, 2008).

Habitat Type

Adult: Shale (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (natureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species is found in white oil-shale, Parachute Creek Member of the Green River Formation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Unknown. There is insufficient data to characterize long-term trends. Unknown (NatureServe, 2015)

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

10,000 - 100,000 individuals (NatureServe, 2015)

Population Narrative:

Population trends are unknown. There is insufficient data to characterize long-term trends. Unknown Total estimated sum of individuals from the 10 documented occurrences is 34,400. There are 10 principal occurrences documented in the Colorado Natural Heritage Program database. All of the occurrences are in a restricted geographic area. Several occurrences are within approximately 1-2 km of one another, but have not been combined due to data complexity. (NatureServe, 2015). Low resiliency and moderate redundancy and representation are based on the relatively narrow geographic range this species is known to inhabitat and the overall number of known populations and individuals.

Threats and Stressors

Stressor: Oil and Gas Development (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: While not discussed in the recovery plan, ongoing oil and gas development is currently the primary threat to the bladderpod and the twinpod. Natural gas production is prolific from formations located stratigraphically below the oil shale. Four of the top 35 natural gas fields in the United States are located in the southern Piceance Basin (BLM 2007). This threat also is projected to increase significantly on the lands managed by the BLM-WRFO. Numerous projects are currently being planned and implemented to expand existing development and the

associated infrastructure within the range of both plants. Along some pipeline routes, there is no room for additional pipelines without impacting occupied plant habitat (USFWS, 2008).

Stressor: Oil Shale Development (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The potential for oil shale development in the Piceance Basin was identified as the primary threat to both species in the 1993 recovery plan. In 2008, the threat is imminent (USFWS, 2008).

Stressor: Energy Corridors (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The potential designation of energy corridors is likely to impact energy development throughout the western United States, including commercial oil shale and tar sands development, because the location of energy corridors may facilitate development by removing administrative and planning barriers for potential pipelines, electric transmission lines, and associated infrastructure (BLM 2007) (USFWS, 2008).

Stressor: Summary of Energy Development (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Oil and gas development presents an imminent threat to the entire range of both species. BLM has managed to avoid oil and gas impacts on the species in most of the range, but further development in some areas may not be possible without disturbing suitable habitat for the species. The potential impacts from oil shale development depend on the alternative selected and the amount and distribution of leased areas. Potential impacts could be severe. New energy corridor designations may facilitate a larger volume of oil and gas activity and threats to the species, depending on the routes. As a listed species, consultation through Section 7 should minimize impacts. In the absence of the ESA's protections, we believe substantial threats would threaten both species range-wide (USFWS, 2008).

Stressor: Trampling (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: information on cattle and wild horse trampling of plants shows only localized damage to plants in a few occurrences. The effect on plant numbers cannot be distinguished from population fluctuations during drought years (USFWS, 2008).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Protection of habitat for both species depends on BLM management regulations. In the past year, BLM has worked with the Service to develop and apply more comprehensive conservation measures and larger avoidance buffers for oil and gas development. To date, all Section 7 consultations for the plants have resulted in findings of not likely to adversely affect. Increasing pressure on BLM to approve applications for more intensive oil and gas development is likely to result in formal consultations and more disturbance to potential if not occupied habitat. In the absence of the ESA's protections, we believe the situation would be considerably worse (USFWS, 2008).

Stressor: Secondary Impacts of Energy Development (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Air pollution from diesel truck exhaust and from proposed coal-fired power plants for oil shale production could be a potential impact. Development of each new gas well requires between 375 and 1,375 round trips by large trucks to deliver materials, supplies and equipment, depending on the depth and location of the well. Operating wells require 0.25 truck trips per day (Kuhn 2006). Possible effects on the plants have not been predicted. Likewise, dust from heavy use of nearby roads may impede growth of the plants; information on likely impacts is not available. Conservation measures that are being implemented by BLM include dust abatement using water on roads, instead of magnesium chloride that could damage plants. Overspray from a produced-water evaporation pond on private land has reached an adjacent BLM plant occurrence; effects on the plants have yet to be determined. Accidental release of produced water from gas wells has been observed to kill sagebrush and associated vegetation near a few well pads. These species rely exclusively on insect pollination. As described above in section 2.3.1.1, Tepedino (1996) estimates that foraging bees may fly 4.8 km (3 mi) to obtain nesting materials. Increasing ground disturbance in the vicinity of occupied plant habitat may be curtailing nesting resources for ground nesting bee pollinators. Increasing vehicle traffic may cause mortality of pollinators. Available information regarding these potential threats is not sufficient to show that larger buffer areas would benefit the pollinators (USFWS, 2008).

Stressor: Climate Change (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Changes in the global climate system during the 21st century are very likely to be larger than those observed during the 20th century (IPCC 2007). For the next two decades, a warming of about 0.2°C per decade is projected (IPCC 2007). Afterwards, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6 to 4.0°C with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). It is very likely that hot extremes, heat waves, and heavy precipitation will increase in frequency (IPCC 2007). There also is high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Milly et al. (2005) project a 10 to 30 percent decrease in precipitation in mid-latitude western North America by the year 2050 based on an ensemble of 12 climate models. Drought years result in a loss of plants. When occurrences also are impacted

by other factors during drought years, they may require several years to recover. Dislodging of plants while monitoring during drought years has been cited as a factor in population decline at two ACEC sites (BLM-WRFO 1989; BLM-WRFO 2002b). Climate change may exacerbate the frequency and intensity of droughts in this area (USFWS, 2008).

Recovery

Reclassification Criteria:
Protect and/or enhance all known occurrences of L. congesta/P. congesta (bladderpod) and P. obcordata (twinpod) on public and private lands. Establish land management designations, and develop and implement habitat management programs (USFWS, 2008).

Protect both species from impacts via consultation under Section 7 and protection under Section 9 of the Endangered Species Act (ESA) (USFWS, 2008)

Minimum viable populations are defined and documented as being maintained for both species (USFWS, 2008).

Delisting Criteria:
1. At least seven key conservation areas for bladderpod and eleven key conservation areas for twinpod are protected (Factors A, C, D, and E). A key conservation area includes all occupied habitat within an occurrence and the surrounding area of potential impact. The area of potential impact is the area where indirect effects may impact plants. For bladderpod and twinpod, we consider this to be the area within 1,970 ft (600 m) of occupied habitat. i. Protection of these sites means that the sites are owned or managed by an individual, agency, or organization that identifies conservation of bladderpod or twinpod as a management objective of the site, and that regulatory mechanisms or other conservation plans or programs reduce or ameliorate threats associated with habitat loss and degradation. ii. Long-term habitat protections are in place to protect key conservation areas from identified threats to the species and manage for surface disturbing activities. Habitat protection can be achieved via long-term management agreements, conservation agreements, or memoranda of understanding in accordance with landowner and agency authorities (Factor D). (USFWS, 2020)

2. Habitat within key conservation areas possesses all of the following qualities (Factors A, C, and E): i. Habitat is of the quality and quantity necessary to support a stable and selfsupporting occurrence of bladderpod or twinpod. In key conservation areas where both species are present, the area may be considered a key conservation area for both species, given that the habitat of the area is of the quality and quantity necessary to support stable and self-supporting occurrences of both bladderpod and twinpod. Unless a PVA or other science provides a more detailed definition of habitat quality, necessary habitat quality will be assumed if the occurrence has been stable in that habitat for ten years, as per criterion 3. ii. Adjacent habitat is available with conditions sufficient to support pollinating insects. iii. Habitat conditions at each key conservation area are stable or improving after 10 years of monitoring. (USFWS, 2020)

3. At least seven occurrences of bladderpod and eleven occurrences of twinpod within key conservation areas are stable and self-sustaining. To be deemed stable and selfsustaining, an occurrence must demonstrate a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive 10-year period and contain at least 4,824 plants at the end of the 10-

year period. Plant abundance may fluctuate within individual sites and from year to year, but the defined occurrences should have a stable or increasing growth rate from year one to year ten. The ten-year period may start retroactively (Factors A, C, D, and E). (USFWS, 2020)

4. All populations of bladderpod and twinpod are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004). The ex-situ seed collection should contain existing levels of genetic diversity (representation) of bladderpod and twinpod across the ranges of the species and should take place over a 10-year period (Factor E). (USFWS, 2020)

5. Criteria 1 through 4 have been realized and demonstrated effective via monitoring efforts (Factors A, C, D, and E). (USFWS, 2020)

Recovery Actions:

- Inventory Remaining Potential Habitat - Additional survey work has expanded the known distribution and abundance data for these species. Since 1993, bladderpod has been documented at two new occurrences on about 180 to 187 hectares (ha) (446 to 462 acres (ac)) (CNHP 2006b). During this same period, twinpod has been documented at five new occurrences on about 16 ha (40 ac) (CNHP 2006b, 2008). Most of the potential habitat on BLM land has been surveyed. Most of the potential habitat on private lands (primarily owned by energy companies) still needs to be surveyed. Establish Land Management Designations on Federal Land - Four Areas of Critical Environmental Concern (ACECs) were designated to protect the plants including about 177 ha (438 ac) (CNHP 2006a; BLM-CO 2004), or about 64 percent of known occupied habitat for both species on BLM land. Estimated occupied habitat on BLM land not protected by ACECs is 101 ha (250 ac) (CNHP 2006b), or 36 percent of known occupied habitat for both species on BLM land. Permanent protective land management designations are necessary on all, or nearly all, occupied BLM land in order to fully achieve recovery. Protect Habitat on Private and State Land – Ownership of one bladderpod occurrence at Duck Creek was transferred from State Division of Wildlife to a private energy company. A permanent conservation management and monitoring plan Memorandum of Agreement for the plants was attached to the land exchange. Similar agreements are needed for occurrences on other private parcels. Create Habitat Management Plans - Habitat management plans have not been developed for either species. Apply No Surface Occupancy Stipulations on Federal Land - No Surface Occupancy stipulations are applied to the four ACECs and to all known and potential habitat under BLM jurisdiction for endangered, threatened, and candidate plant species. Exceptions are allowed if surveys show there would be no direct impact or effects to the plants. Under this policy, developments including pipelines, roads and well pads have been approved by BLM within all four ACECs. In some cases, ground disturbance occurs within 30 meters (m) (98 feet (ft)) of plant habitat. No monitoring results are available to measure the effects of these actions on the plants. BLM is currently working with the Service to determine appropriate buffer distances to protect the plants and their habitat from direct and indirect effects of oil and gas development activities. The Service currently recommends a 200-m (656-ft) buffer to avoid adverse effects to plants and habitat for these listed plants. Implementation of buffers is an ongoing effort for BLM and the Service. Review Mining Claims – The Service has not reviewed plot records to determine the extant of historic mining claims, if any. Future claims require a plan of development and environmental analysis for mining. Current land management designations close all known and potential habitat to surface mineral materials

development. Establish Off-highway Vehicle Designations – Within the ACECs, motorized vehicle travel is limited to designated roads and trails (BLM-WRFO 1997). The maps show about 26 segments of road that remain open within the ACECs, and about 19 that are closed. Off-highway vehicles on BLM land not in ACECs are limited to existing routes in areas with potential habitat for the plants. Additional fencing, signage, enforcement and education is needed to ensure compliance with existing road closures. Transfer Privately Owned Occurrences to BLM - Exchanges of private land into BLM management as recommended in the Recovery Plan have not occurred. Shell Oil acquired land in an exchange with the Colorado Division of Wildlife (CDOW) that includes approximately 28 ha (70 ac) of occupied bladderpod habitat adjacent to the Duck Creek ACEC and Natural Area. CDOW consulted with the Service and the Colorado Natural Areas Program to develop a Memorandum of Agreement that will protect the plant habitat acquired by Shell (CDOW 2007). The Memorandum of Agreement provided the basis for concurrence by the Service that the land exchange was not likely to adversely affect the species (USFWS, 2008).

- Process Project Clearances - BLM has ongoing informal Section 7 consultations with the Service regarding multiple gas pipelines, seismic survey projects, a large oil and gas Piceance Development Plan that covers an area including two of the ACECs, and five Oil Shale Research Development and Demonstration projects. The Service also is reviewing proposed oil shale lease areas described in the Draft Oil Shale and Tar Sands Resource Management Plan (RMP) Amendments Programmatic Environmental Impact Statement (BLM 2007). CDOW has informally consulted with the Service to avoid impacts to plant habitat on several projects involving gas pipelines, processing facilities and land exchanges. While Section 7 consultations are not considered recovery actions, they are the primary tool for implementing conservation measures to avoid or minimize disturbance of the habitat for both species (USFWS, 2008).
- Conduct Soil Analyses, Life History Analyses and Monitoring - Detailed descriptions of the Thirteenmile Creek Tongue, the Parachute Creek Member, and the Garden Gulch Member of the Green River Formation are available, but the lack of finely mapped geology is still a limiting factor in modeling suitable habitat (Decker et al. 2006). Resources have not been available to conduct life history analyses. A minimum viable population analysis has not been performed. Because the habitat is limited and imminent threats encompass the entire range of both species (see five factor analysis, section 2.3.2, below), we are assuming that most, if not, all suitable habitat and occurrences are essential to the survival of the species. BLM has conducted sporadic monitoring on the ACEC occurrences of both species from 1985 to 2007. The Colorado Natural Areas Program and BLM have been monitoring the bladderpod at two locations on the Duck Creek ACEC and Colorado Natural Area for 10 years (Rickey and Kurzel 2007). One site for each species has been monitored on the Dudley Bluffs ACEC (Kurzel 2006). Results are described below in section 2.3.1.2 (USFWS, 2008).
- Publish a technical correction in the Federal Register noting the change in taxonomy from Lesquerella congesta to Physaria congesta, and correcting 50 CFR 17.12 (USFWS, 2008).
- Revise the recovery plan for both species so that it reflects the best scientific and commercial information available. The revised recovery plan should include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. Recovery criteria should address all threats meaningfully impacting the species. The recovery plan should also estimate the time required and the cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2008).

- Designate critical habitat for both species. “Critical habitat” is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation. This could be done concurrently, in a single rule, with other neighboring plant species (USFWS, 2008).
- Recommend at least a 200 m (656 ft) buffer between occupied or suitable habitat and ground disturbance or other activities that may affect the plants or their habitat (USFWS, 2008).
- Develop and implement consistent conservation measures in the WRFO RMP revision that will avoid and minimize impacts from all development, ORV, and grazing activities. Include protection for all occupied and suitable habitat in the conservation measures. Expand existing ACECs to include contiguous occupied and suitable habitat for the plants and their pollinators. Designate the Yellow Creek occurrence as an ACEC as was proposed in the recovery plan, plus contiguous occupied and suitable habitat (USFWS, 2008).
- Inventory remaining potential habitat on public and private lands. Report results to CNHP, BLM, and the Service (USFWS, 2008).
- Map all potential habitat, occupied habitat, and areas of existing and proposed leases, applications to drill, and development activities in GIS format (USFWS, 2008).
- Develop and implement permanent conservation agreements for occurrences on private lands (USFWS, 2008).
- Monitor the effects of development activities located within 200 m (656 ft) of plant occurrences on plants, pollinators, and habitat. Change buffers as determined by monitoring results (USFWS, 2008).
- Conduct annual status evaluations including estimates of mean density and population sizes at all Element Occurrences for the duration of intense energy activities within the range of both species (USFWS, 2008).
- Research the function of pollinators in the life history needs of the species, determine the habitat requirements of key pollinators, and adjust energy development best management practices accordingly (USFWS, 2008).
- 1 Protect, enhance, and maintain existing bladderpodand twinpod populations and habitat (USFWS, 2020a)
- 2. Maintain propagule bank, including long-term seed storage for bladderpod and twinpod. (USFWS, 2020a)
- 3. Conduct research to aid in the recovery of bladderpod and twinpod. (USFWS, 2020a)
- 4. Develop and implement a post-delisting monitoring plan. (USFWS, 2020a)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Publish a technical correction in the Federal Register noting the change in taxonomy from Lesquerella congesta to Physaria congesta, and correcting 50 CFR 17.12. • Inventory remaining potential habitat on public and private lands. Report results to CNHP, BLM, and the Service. • Identify key conservation areas for both species. • Develop and implement permanent conservation agreements for occurrences on private lands. • Conduct annual status evaluations including estimates of mean density and population sizes at all key conservation areas. For more information about recommended future actions, refer to the 2019 recovery plan and implementation schedule (USFWS 2019a-b). (USFWS, 2020)

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SPECIES ACCOUNT: *Pilosocereus robinii* (Key tree cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/20/1984; Southeast Region (R4)

Physical Description

The Key tree-cactus is a large, tree-like cactus with erect columnar stems, reaching 10 m in height. At maturity, the plants are either much-branched (in variation robinii), or remaining few-branched (in variation deeringii). The stems of the tree-cactus are cylindrical, green, succulent, and 2 to 4 inches thick, with nine to 15 prominent ribs. Areoles bear 15 to 30 acicular spines that are up to 0.78 inches long and are thickly pubescent when young. Flowers are solitary in the Upper areoles, nocturnal, and 2.0 to 2.3 inches long. The outer perianth segments of the flowers are green, with tips pointed (in variation robinii) or rounded (in variation deeringii). The inner perianth segments of the flowers are white. The style is slightly exserted (in variation robinii) or included (in variation deeringii). The fruit of the Key tree cactus is globose, depressed, and 1.4 to 1.6 inches in diameter. The coat of this fruit is thin, leathery, bright red, and splits open at maturity. The seeds are small, hard, shiny black, and set in a soft, white pulp (Benson 1982, Britton and Rose 1937, Small 1931). (USFWS, 1999)

Taxonomy

The taxonomy of Pilosocereus in the Keys has been historically confusing and is not yet clearly resolved. Most recently both P. robinii and P. bahamensis have been grouped into the more widespread species Pilosocereus polygonus (Lem.) Byles & G.D.Rowley (Zappi 1994, Anderson 2001). Botanists who are familiar with the Key tree-cactus have not adopted this taxonomy, and P. polygonus is not recognized by the Integrated Taxonomic Information System (ITIS) (ITIS 2010a). The Flora of North America (1993) also states that this treatment is not supported by existing data. The ITIS accepts Pilosocereus robinii (Lem.) Byles & Rowley as a valid taxon. Two varieties are recognized, P. robinii var. deeringii (Small) Kartesz & Gandhi and P. robinii var. robinii (Lem.) Byles & Rowley (ITIS 2010b). The taxonomic position of Pilosocereus populations in Cuba is uncertain (Adams and Lima 1994). The Service will defer any decision to adopt the revised taxonomic scheme until the ongoing difficulties with classification in this group of taxa are settled. (USFWS, 2010)

Historical Range

The historical range of Key tree-cactus included the entire expanse of the Florida Keys, from Key West to Key Largo (Adams and Lima 1994), encompassing an area of about 80 miles (128 kilometers [km]) east to west, and 30 miles (48 km) north to south. (USFWS, 2010)

Current Range

The Florida Keys in Florida, an area 40 miles (114 km) east to west, and 15 miles (24 km) north to south. Records exist for populations on Key West, Boca Chica Key, Big Pine Key, Long Key, Lower Matecumbe Key, Upper Matecumbe Key, Windley Key, and Key Largo. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: The Key tree-cactus can flower year-round, but July, August, and September are peak flowering periods.

Reproduction Narrative

Adult: Long distance dispersal and establishment of new tree-cactus populations is dependent upon the production of seed. However, reproduction within a single population (a clump) is mostly, if not entirely, vegetative. This reproductive strategy (formation of clonal clumps from rooted wind-thrown branches) also accounts, in part, for the clumped distribution of the species (Adams and Lima 1994). Pollination agents are unknown, but may include sphingid moths (Adams and Lima 1994). Seed dispersal by birds (Cardinalis cardinalis, for example) is indicated for this species (Austin 1980). The effective dispersers would be those fruit-eating birds, which favor openings in the woods. The Key tree-cactus can flower year-round, but July, August, and September are peak flowering periods. Mature flowers develop in about 12-14 days, and many flowers may occur simultaneously on a single pseudocephalium (Adams and Lima 1994). Seed dispersal, based on one observation, occurs in August (Austin 1980; Avery [no date]).

Habitat Type

Adult: Tropical hardwood hammocks

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: The Key tree-cactus grows in a narrow range of plant associations, which include tropical hardwood hammocks and a thorn-scrub association known locally as a “cactus hammock.” The major requirements for successful growth of Key tree-cactus are an open canopy and freedom from frequent floods or frequent fires. Hardwood hammocks inhabited by the species are typically in an early stage of succession following disturbance (Avery [no date], Small 1917, 1921). Dominant tree species include Bumelia salicifolia, Bursera simaruba, Coccoloba diversifolia, Ficus aurea, Krugiodendron ferreum, Metopium toxiferum, and Piscidia piscipula. The Lower story of the canopy typically contains small trees of the dominant species and plants of Amyris elemifera, Ateramnus lucidus, Bumelia celastrina, Capparis flexuosa, Eugenia foetida, Guapira discolor, Pithecellobium guadelupense, Randia aculeata, and Zanthoxylum fagara (Austin 1980, Weiner [no date]). These hardwood hammocks are upland communities which are flooded only rarely (during major storms) and are mesic in character (Weiner [no date]). The thorn-scrub, “cactus hammock” association occurs at relatively low elevations in the Keys and is prone to more flooding. Consequently, the canopy of this vegetative community is lower and more open than hardwood hammocks. Conocarpus erectus and Ximenia americana are the most typical dominant tree species (Weiner [no date]). Cereus gracilis, Cereus pentagonus, and Opuntia dillenii are common associates of Key tree-cactus in these habitats. Key tree-cactus exists on high sites within cactus hammocks that are rarely flooded. These sites support the hardwood hammock species listed above, but they are rarely extensive enough to allow typical development of hardwood hammocks. The hardwood hammocks and cactus hammocks where the Key tree-cactus grows are all on coral rock. Key tree-cactus grows well on well-drained

upland sites with little or no soil development. Mineral soil is, if present at all, a very thin (less than 0.4 inches) layer of rock rubble, calcareous sands or calcareous marl (Austin 1980). A layer of leaf litter one to two cm thick is typically present (Austin 1980). Deeper accumulations of soil may be found in pockets and crevices in the rock. These soils are classified as Histosols (Soil Conservation Service 1975). They are placed in the "catch-all" Rockland groups (Jones 1948). There is no detailed work on soil types in the Keys due to their small area, agricultural insignificance, and lack of well-developed soils. Hammocks on Key West and Boca Chica Key, where Key tree-cactus grew in the past, were developed on oolitic limestone. Soil conditions at these sites were not recorded, but were probably similar to those listed above. Key tree-cactus exists in small, isolated patches or clumps. The patches may consist of a single plant, or a group of plants may cover an area of tens of square meters (Austin 1980, Small 1917). When many plants occur in a clump, most, if not all, of the separate stems likely represent vegetative offshoots of one or a few founders. Vegetative reproduction is common because of old stems being knocked to the ground.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing

Number of Populations:

10 8 Natural and 2 introduced (USFWS, 2019)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

As of 2018, eight (8) natural and two (2) introduced populations are extant on six (6) islands of the Florida Keys. Extant wild populations are located on Big Pine Key, Long Key, Lower Matecumbe Key, and Upper Matecumbe Key (Adams and Lima 1994, FNAI 2009, Maschinski et al. 2009, Service 1999). Reintroduction efforts since 2010 have returned the species to Key Largo and Windley Key. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: The historic decline of Key tree-cactus was directly linked to the clearing of hardwood hammocks for development (Service 1999). Habitat destruction from development continues to occur and development pressure remains high; however, habitat loss currently occurs at substantially lower rates than in earlier periods (e.g., 1970s to 1990s). Clearing of hammocks for development is currently a threat to one population which remains unprotected on private land. Six of seven Key tree-cactus populations are protected from habitat loss to development. Four are protected on public conservation lands and two are protected by covenant or easement on

private property. Development continues to fragment the remaining habitat, restricting gene flow between populations, and limiting the potential for expansion or shift in the species range in response to environmental changes. (USFWS, 2010)

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes
Exposure:
Response:
Consequence:
Narrative: The threat of overutilization for commercial or recreational purposes was identified at the time of original listing in 1984 (49 FR 29234). Key treecactus is an attractive species with high horticultural value as landscape ornamentals. Cacti are regarded as one of the groups of plants that are most vulnerable to illegal collection due to their popularity with collectors worldwide (Anderson 2001). Laws prohibit the removal of cacti from State and Federal protected areas, but enforcement is difficult due to insufficient resources and the the remoteness of the plants. There is recent evidence that the illegal trade in rare cacti includes Key tree-cactus. For example, a potted Key tree-cactus was sold across state lines on a well-known auction website in 2006 (Ebay 2006). The buyer subsequently surrendered this plant to Service law enforcement. Key tree-cactus is vulnerable to unlawful exploitation and collection and removal of plants from any of the protected areas for commercial or recreational reasons would be detrimental to the species. All sites with Key tree-cactus should be monitored for possible illegal collection activities

Stressor: Disease or predation
Exposure:
Response:
Consequence:
Narrative: There is no data to suggest that disease is the primary cause of the recent declines in Key tree-cactus populations. Tissue samples from several dying cacti were sent for analysis on more than one occasion. Results by Tropical Research & Education Center (TREC) of University of Florida – Institute of Food & Agricultural Sciences (UF-IFAS) (Aaron Palmateer; UF-IFAS, TREC Pathology Lab, Homestead) and Tim Schubert, Florida Department of Agriculture and Consumer Services [FDACS], Pathology, Gainesville) in January and April 2005, respectively reported no primary pathogens. A second test was conducted by TREC in 2008 and again, no primary pathogens were detected (P. Hughes, unpubl. data 2006, Goodman et al. 2008). Goodman et al. 2008 reported that a single cactus showed symptoms of basal rot that included 'black goo' leaking from the affected area. These are typical signs of bacterial necrosis in cacti. These bacteria are known to infect other large columnar cacti such as Saguaro (Carnegiea gigantea). Since this symptom has only been observed in one individual Key tree-cactus, evidence is insufficient to connect this observation to the range-wide decline phenomenon. Goodman et al. (2008) observed that the surface of the soil just below the leaf litter at one site was entirely made up of frass from the introduced yellowbanded millipede (Anadenobolus monilicornis). While this organism is not known to be damaging to plants, they suggested that the predominance of frass could modify the soil structure or chemistry and possibly have an effect on plants. The native ant species, Crematogaster ashmeadi and Solenopsis abdita were observed removing the pulp and seeds from still-attached fruits and carrying them to ground level. In addition, the pulp and seeds of split fruits that had fallen were similarly removed by these two ant species (Adams and Lima 1994). There is no evidence suggesting seed predation by ants is a threat to Key tree-cactus. Ants may actually aid in seed dispersal. Hennessy and Habeck (1994) reported 'feeding damage' on plants in NKDR. Observed damage included complete girdling of

woody trunks, uprooting, and chewing of stems. Maschinski et al. (2008) documented damage to cactus trunks at NKDR in which the fleshy tissue was removed down to the woody core of the plant. Damage occurred within 1.0 m of the ground and often on the exposed side of the plant that are more easily accessible to deer. Key deer are believed to damage Key tree-cactus through herbivory and antler polishing (Maschinski et al. 2008). Damage caused by herbivory or antler polishing by Key deer may weaken plants, making them more vulnerable to other stressors. (USFWS, 2010)

Stressor: Inadequacy of existing regulatory mechanisms:
Exposure:
Response:
Consequence:
Narrative: Key tree-cactus is listed as endangered by the State of Florida on the Regulated Plant Index (Florida Department of Agriculture and Consumer Services Rule 5B-40). This law regulates the taking, transport, and sale of listed plants. It does not prohibit private property owners from destroying populations of listed plants on their property nor require landowners to manage habitats to maintain populations. Existing Federal and State regulations prohibit the removal or destruction of listed plant species on public lands. However, such regulations afford no protection to listed plants on private lands. The ESA only protects populations from disturbances on Federal lands or when a 'Federal nexus' is involved for other lands, meaning any action that is authorized (e.g. permitted), funded or carried out by a Federal agency. In addition, State regulations are less stringent than Federal regulations toward land management practices that may adversely affect populations of listed plants on private land. Monroe County has adopted a point system of evaluation for building permit applications. Building permit applicants are required to replace listed plants and native vegetation removed from the construction site elsewhere on the property. Monroe County requires mitigation for impacts to rare plant species, including Key tree-cactus. If Key tree-cactus is found on a property to be developed, the property owner would be required to pay a mitigation fee to the County prior to development. Clearing is limited to 10 to 30 percent in high quality habitat. A conservation easement may then be placed on the remaining native habitat. These protections are limited, and populations can be still destroyed by private landowners. As such, existing regulatory mechanisms are adequate to protect Key tree-cactus, with exception of the single remaining unprotected population on private land. (USFWS, 2010)

Stressor: Hurricanes
Exposure:
Response:
Consequence:
Narrative: Hurricanes have the potential to adversely affect tree-cactus populations. High winds can bring surrounding vegetation crashing down on top of individual cacti, injuring or killing them. However, hurricanes also open hammock canopies, allowing light to penetrate, thus providing conditions that may be favorable to cactus regeneration. Hurricane Georges made landfall on Big Pine Key in October 1998 and caused severe damage to the tree-cactus population on the NKDR. Maschinski et al. (2008) provides accounts by several individuals describing dramatic impacts to the lower Keys hammocks after Hurricane Georges. Many of the larger cacti were directly damaged by high winds or injured by airborne debris. A range of models suggest that due to global warming, future tropical cyclones (typhoons and hurricanes) will likely become more intense, with larger peak wind speeds and more heavy precipitation associated with

ongoing increases of tropical sea-surface temperatures (IPCC 2007). The long-term impacts of hurricanes on tree-cactus are difficult to predict, but because the number of locations where Key tree-cactus occurs has been reduced, the potential threat of hurricanes is significant. (USFWS, 2010)

Stressor: Storm Surges
Exposure:
Response:
Consequence:
Narrative: Hurricanes also cause storm surges, which inundate Key tree-cactus habitat with seawater. Maschinski et al. (2008) provides a local residents account which confirms that the area of NKDR where the cactus occurs was completely inundated during the storm surge produced by Hurricane Wilma in 2005. In a hammock where a Key tree-cactus population has decreased by about 90 percent, a past storm surge is evidenced by 'wrack line' of debris at that site (Maschinski et al. 2008). Storm surges during tropical storms and hurricanes have inundated areas where Key tree-cactus occurs on Big Pine and Long Keys (Maschinski et al. 2008). Storm surges can modify habitat by increasing soil salinity. Data suggest that high soil salinity may be the cause of the recent decline phenomenon in Key tree-cactus populations (Maschinski et al. 2009). The cause of the high salt levels is suspected to be salts deposited by storm surge events, from saltwater intrusion of groundwater, or both. Storm surges temporarily inundate large areas with seawater, which then drains off and percolates through the soil, leading to increased soil salinity. (USFWS, 2010)

Stressor: Sea Level Rise (SLR)
Exposure:
Response:
Consequence:
Narrative: The projected global average sea level in 2100 will be 0.18 to 0.59 m higher than the average reported from 1980 to 1999 (IPCC 2007). SLR predictions do not take into account the full contribution of melting ice sheets, because existing data are inadequate to quantify these inputs. As a result, the predictions may underestimate SLR (IPCC 2007). SLR is the largest climate-driven challenge to refuges and other lands in the sub-tropical ecoregion of southern Florida (CCSP 2008). According to CCSP (2008), much of lowlying, coastal south Florida "will be underwater or inundated with salt water in the coming century". SLR is expected to exacerbate inundation, storm surge, erosion and other coastal hazards. Small islands, low-lying coastal areas and coastal systems such as mangroves and salt marshes are identified as areas that will be especially affected. While habitat may be only partially inundated by 2100, it is likely that under any scenario, soil salinity will continue to increase, either by pulses as with successive storm surges, or incrementally due to saltwater intrusion. The Service anticipates that these processes will act separately or synergistically to cause ongoing mortality pulses of Key tree-cactus and eventually result in the conversion of their existing coastal hammock to transitional habitats and then tidal areas dominated by mangroves. (USFWS, 2010)

Recovery

Reclassification Criteria:
1. When further loss, fragmentation, or degradation of suitable, occupied habitat has been prevented (USFWS, 1999)

2. When native and non-native nuisance species have been reduced by 80 percent (USFWS, 1999)

3. When all suitable, occupied habitat on priority acquisition lists is protected either through land acquisition or cooperative agreements (USFWS, 1999)

4. When potential habitat on protected lands is restored or rehabilitated for the Key tree-cactus (USFWS, 1999)

5. When stable populations of the Key tree-cactus are distributed on secure sites within its historic range (including two on Upper Matecumbe, one on Lower Matecumbe, three on Long Key and two on Big Pine Key) (USFWS, 1999)

6. When three, additional, stable populations have been established on Windley Key, Boca Chica Key, and Key West. These populations will be considered demographically stable when they exhibit sexual reproduction and have a rate of increase equal to or greater than 0.0 as a 3-year running average for 6 years. (USFWS, 1999)

Delisting Criteria:
The Key tree-cactus will be considered for delisting when: 1. At least 20 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. 2. Populations (as defined in criterion 1) occur in tropical hardwood hammock habitat and are distributed across the historical range of the species. (Factor A) 3. Populations (as defined in criterion 1) must be protected via a conservation mechanism and/or managed such that enough suitable habitat is present for the species to remain viable for the foreseeable future. (Factors A, D, and E) (USFWS, 2019)

Recovery Actions:
- Conduct surveys to determine the distribution and status of P. robinii. Known P. robinii populations occur in coastal hammocks on Upper Matecumbe Key, Lower Matecumbe Key, Long Key, and Big Pine Key (Adams and Lima 1994), but other populations may exist. Survey historic range and determine distribution and status of P. robinii. Conduct surveys on private lands first since these are most likely to be vulnerable to disturbance. (USFWS, 1999)
- Protect and enhance existing populations. The remaining population sites must be protected as the first step toward recovery. These sites are currently the only ones which will offer assurance of supporting the species. Plant stocks for expansion of the population must come from the remaining specimens. (USFWS, 1999)
- Conduct research on the biology of P. robinii. Study the reproductive biology of P. robinii. Conduct genetic studies to document genetic variation within and between populations. Determine population size and viability of all populations. Study the response of P. robinii to habitat management treatments. Characterize the habitat and identify suitable sites for experimental outplantings. (USFWS, 1999)
- Monitor P. robinii populations. Annual monitoring is the primary means to determine whether management practices are effective and what changes are needed. Inventories should detect changes in health, abundance, distribution, and threats. (USFWS, 1999)
- Increase public awareness and instill stewardship. Develop informational materials and host public workshops to increase awareness about P. robinii and instill a sense of stewardship

for the protection of this endangered species. Conduct outreach efforts on national wildlife refuge properties and the State Recreation Area, through the Monroe County school system, and through press releases to emphasize the importance of the plant community, the conservation ethic, and Federal and State regulations and laws, including penalties for collection and vandalism. (USFWS, 1999)

- Establish reclassification and delisting criteria. Develop measurable reclassification criteria based on the factors that would produce a stable or increasing population, including total population size, number of subpopulations, habitat condition and availability, and level of threats. Evaluate and monitor P. robinii's status in relation to reclassification criteria. Refine recovery goals. It is necessary to establish a realistic recovery objective for the species based on its biological characteristics. Recovery objectives should be re-evaluated and revised as necessary. Determine additional actions necessary to achieve the recovery objective. These actions must include legal protection, research, habitat protection, and other management strategies necessary to achieve recovery. (USFWS, 1999)
- Habitat-level Recovery Actions. Conserve existing habitats. Acquire habitat. Acquire and protect occupied habitat within historic range. Acquire the plant's suitable unoccupied sites that contain habitat associations important to P. robinii. Protect and manage P. robinii on private and public lands. Restore areas to suitable habitat. Conduct research on habitat-level ecological processes. Monitor the status of P. robinii habitat. Increase public awareness of P. robinii habitat and instill stewardship. (USFWS, 1999)
- Continue to acquire privately owned parcels when there are willing sellers. (USFWS, 2010)
- Experiment with plant enclosures at NKDR to prevent potential damage to the plants by Key deer. (USFWS, 2010)
- Continue to monitor mature individuals for flowering/fruiting and collect seed if found. (USFWS, 2010)
- Continue and increase monitoring for signs of disease. (USFWS, 2010)
- Attempt to increase seed set through hand pollination in selected plants to equalize representation in stock available for reintroduction projects. (USFWS, 2010)
- Maintain an aggressive program to salvage representative samples from dying cacti.(USFWS, 2010)
- Continue to monitor extant populations to confirm whether the rapidly declining populations have truly stabilized after 2007. (USFWS, 2010)
- Initiate genetic assessments to determine the genetic structure of the species at a range of spatial scales (clusters, populations, and species). Include the P. bahamensis population on Key Largo, and Pilosocereus in Cuba to determine the identity of these populations and relationship to P. robinii. (USFWS, 2010)
- Expand ex situ collections via cuttings from earlier collections and from seeds. Complete studies of soil to further test hypothesis that soil salinity is the main cause of the population decline. (USFWS, 2010)
- Conduct a greenhouse experiment to determine the range of salinity tolerance of Key tree-cactus. (USFWS, 2010)
- Determine the importance of specific elements and conditions that contribute to increased soil salinity – saltwater intrusion, storm surges, elevation, and drainage patterns. (USFWS, 2010)
- Continue to monitor soil salinity at all sites to provide early detection of rising salinity or evidence of declining salinity. (USFWS, 2010)
- Expand the scoring and evaluation of potential reintroduction sites. (USFWS, 2010)

- Develop an Emergency Response Plan for hurricanes and storm surges. (USFWS, 2010)
- Provide the Village of Islamorada ongoing technical support regarding cactus and site management in the newly acquired parcel. (USFWS, 2010)
- Reintroduce cactus in multiple, well dispersed sites, including those with raised elevation in the Lower Keys (e.g., NKDR; Key West Tropical Forest and Botanical Garden), and representing a range of percent canopy cover. (USFWS, 2010)

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SPECIES ACCOUNT: *Pinguicula ionantha* (Godfrey's butterwort)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/11/1993; Southeast Region (R4)

Physical Description

Pinguicula ionantha has a rosette of fleshy, oblong, bright green leaves that are rounded at their tips, with only the edges rolled upward. The rosette is about 15 cm (6 in) across. The upper surfaces of the leaves are covered with short glandular hairs that capture insects. The flowers are on leafless stalks (scapes) about 10-15 cm (4-6 in) tail. When a flower is fully open, its corolla is about 2 cm (almost 1 in) across. The five corolla lobes are pale violet to white. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. The corolla has a spur 4-5 mm (0.2 in) long that is yellow to olive (Godfrey and Stripling 1961, Godfrey and Wooten 1981). (USFWS, 1994)

Taxonomy

Pinguicula ionantha Godfrey (Godfrey's butterwort or violet-flowered butterwort) is a member of the bladderwort family (Lentibulariaceae), a small family of carnivorous plants closely related to the snapdragon family (Scrophulariaceae) (USFWS, 1994). Pinguicula L., the second most diverse genus of the carnivorous Lentibulariaceae, is monophyletic and composed of about 85 to 100 species native to Europe, North America, Asia, and South and Central Americas (Cieslax et al. 2005, Degtjareva et al. 2006). Six species can be found in Florida, of which P. ionantha Godfrey is endemic (Gluch 2005). All Florida species belong to the section or subgenus Isoloba (Fleischmann 2021, Cieslax et al. 2005, Gluch 2005). We are not aware of any changes to the taxonomy of this entity, and it is still considered valid by the Service and the scientific community (USFWS, 2023).

Historical Range

See current range/distribution.

Current Range

Endemic to the central panhandle region of Florida with reported occurrences in Bay, Calhoun, Franklin, Gulf, Liberty, and Wakulla counties (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Pinguicula L., the second most diverse genus of the carnivorous Lentibulariace is monophyletic and composed of about 85 to 100 species native to Europe, North America, Asia, South and Central America, and southern Mexico (Cieslax et al. 2005, Degtjareva et al. 2006). Members of this genus use sticky, glandular leaves to trap and digest insects (USFWS, 2009). It is unclear what benefit the plant derives from this carnivory.

Breeding Season

Adult: The flowers rise from late February to April according to temperatures (USFWS, 2009).

Reproduction Narrative

Adult: Pinguicola ionantha has a rosette of fleshy, bright green-yellow leaves of up to 15 cm across that can be characterized by upward rolled leaf edged. The plants stay in rosette form all year. The flowers rise from late February to April according to temperatures. The flowers, borne on stalks of about 10 to15 cm in height, are about two centimeters across and possess five pale violet to white petals all of same shape corolla. The throat of the corolla and the corolla tube are deeper violet with dark violet veins. A yellow to olive spur 4 to 5 mm long is present on the corolla and the palate is yellow with a purple base and covered with yellow hairs (Godfrey and Stripling 1961, Godfrey and Wooten 1981) (USFWS, 2009). SEXUAL; ABIOTIC; Wind; (NatureServe, 2015)

Habitat Type

Adult: Bos/long leaf pine savannas (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred form NatureServe, 2015)

Site Fidelity

Adult: High (inferred form NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits open, acidic soils of seepage bogs on gentle slopes, deep quagmire bogs, ditches, and depressions in grassy pine flatwoods and grassy savannas, often occurring in shallow standing water. "Pinguicula ionantha occurs in herb bog habitats embedded in longleaf pine savannas. Specifically, it is found between a lower elevation habitat dominated by pond cypress (Taxodium ascendens) overstory and a slightly higher elevation pine flatwoods dominated by an overstory of longleaf pine (Pinus palustris) (USFWS 2009) (NatureServe, 2015). High ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the species specific habitat needs.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends

Population Trends:

Unknown (USFWS, 2018)

Species Trends:

Unknown (USFWS, 2018)

Population Growth Rate:

It is estimated that between 85 and 98% of herb bog/savanna habitats have been lost (Folkerts 1982 cited by Kesler et al. 2008). Decline of >70% (NatureServe, 2015)

Number of Populations:

~66. (approximately 54 occurrences on public lands and an additional 12 on private lands) (USFWS, 2023).

Population Size:

2500 - 100,000 individuals (NatureServe, 2015)

Additional Population-level Information:

Previously, 83 historical sites were documented between 1956 and 2009 (FNAI 2008). Based on information provided by FNAI (2017) and FWCC (2018) and recent surveys, the number of sites has increased to 92; technically representing 66 EOs. About 10,558 plants were present at 21of the 23 EOs revisited in 2015 (Molano-Flores et al. 2014). A total of 52 sites were visited in 2006, 2008, and 2009 surveys: 33 sites were revisited by Kesler and Trusty (2008) during April 2006, and 19 sites were visited by Negrón-Ortiz during 2008 and 2009 surveys. Plants were present at 24 (46%) of these sites. Searches did not locate plants at 22 (42%) of the previously recorded sites. Additionally, high water or a dense woody midstory prevented access to six previously recorded sites in Gulf and Franklin counties (Kesler and Trusty 2008, Negrón-Ortiz, 2008 surveys). This species appears to be increasing in number of populations on public lands. However, overall trends in both abundance of individuals within each population and the total number of populations through the species range remain unknown. (USFWS, 2018)

Population Narrative:

Current survey information indicates an increase in the number of populations. Survey information shows 22 (33%) of the 66 EOs appear to be extirpated due to development and/or habitat modification. However, since surveys were conducted irregularly and based on either presence/absence and/or qualitative visual estimate (Jenkins et al. 2007); with most sites visited only once; and the actual counts of plants rarely provided, a comprehensive population survey is needed in order to better assess the current status of this species. Studies have demonstrated variation among the number of plants necessary for a population to survive risks of extinction (Given 1994, Matthies et al. 2004, Menges 1990). Matthies et al. (2004) study of 379 populations of eight threatened plant species in northern Germany demonstrated that very small populations face a considerable risk of extinction, while the risk for populations with more than 1000 individuals was very small. Because most of the P. ionantha populations have less than 1000 individuals, any impact to existing populations (specifically sites outside the ANF) could cause extirpation of these populations. Furthermore, the relatively low level of genetic diversity associated with this species is a concern as it may impair fitness and evolutionary adaptability in a changing environment (Zaya et. al 2016). (USFWS, 2018). Godfrey's butterwort is a carnivorous plant presently located in six Florida panhandle counties. The species' populations primarily found on Apalachicola National Forest and Tate's Hell State Forest. There are approximately 54 occurrences on public lands and an additional 12 on private lands. Most of the P. ionantha populations have less than 1000 individuals, therefore any impact to existing populations (specifically sites outside the Apalachicola National Forest) could cause loss of these

populations (USFWS, 2023).

Threats and Stressors

Stressor: Logging and Pulpwood Production (USFWS, 2018)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Privately owned forests managed (clearcutting, mechanical site preparation, and bedding) for commercial timber production, is a primary threat to P. ionantha habitat. An active paper mill located in Panama City (Bay County) receives timber from thousands of acres of pine plantation. The commercial timber industry in North Florida became well established in the 1850's (FNAI 2005). It started in Franklin County in the 1870's and continued to be a prominent industry until the mid-1990's (Howell and Hartsell 1995). The Timberland Company had close to a million acres in timber production in the eastern region of the Panhandle and they plan to continue to commercially harvest and replant off-site pine species. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. In 2013, the Timberland Company sold more than 380,000 acres of its land to AgReserves, Inc.. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. Within Gulf County, AgReserves, Inc. has repurposed timberlands into pasture lands for cattle (A. North, FDEP, 2/6/2018, pers. comm.). (USFWS, 2018)

Stressor: Coastal real estate and road development (USFWS, 2018)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urban development continues to threaten Godfrey's butterwort. The Timberland Company is one of the largest private landowners in Florida, and one of the largest real estate operating companies in the Southeast. The Company develops both residential and commercial properties along roadways and near or within business districts in the region. More than a third of Florida's land is projected to be developed by 2070 along with a grow of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Many P. ionantha locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable habitat; widening may convert native habitat to managed road side; and culvert modification may change drainage patterns, which may change seasonal hydrology. Evidence suggests past road improvements have resulted in localized extirpation of Godfrey's butterwort in ANF (Kesler and Trusty 2008). Therefore, because they contribute to habitat loss, road widening and new roads continue to pose a threat to the species. (USFWS, 2018)

Stressor: Fire suppression (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Suppression of fire during the growing season continues to threaten the pineland and savanna's flora, as fire is an important factor in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly

develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent, low intensity prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., < 3 yr interval, are needed to maintain optimal habitat for P. ionantha populations (Kesler et al. 2008). At present, the Apalachicola National Forest utilizes a 3- to 5-yr interval burn rotation (2-4 yr burn rotation at the burn units with P. ionantha, J. Drake, USFS, 02/21/2018, pers. comm.); Box-R WMA and SJBSBP utilize 2- to 3-yr interval; and Lathrop Bayou applies prescribed fire on a 2- to 7-yr interval. Thus, fire suppression continues to threaten to P. ionantha habitat and population numbers. Lack of fire, and subsequent growth of shrubs (particularly encroachment of Cyrilla racemiflora L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008, Kesler et al. 2008). Declining fire frequency reduces P. ionantha abundance in areas where it was previously observed in large quantities (FNAI 2008). Emergence of this species is prolific within one year of the fire event (Kesler and Trusty 2008). (USFWS, 2018)

Stressor: Over collection (USFWS, 2018)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: This factor is a threat, but the magnitude has been reduced. Butterworts are widely cultivated, grown and sold by plant enthusiasts and nurseries. Pinguicula ionantha was overcollected in the 1970s (58 FR 37440). Many thousands of plants propagated by tissue culture were sold without permits, but the plant is no longer commercially available in large quantities (D'Amato, California carnivores). In order to implement conservation measures and regulations, the Service granted a permit (TE061005-1) to the International Carnivorous Plant Society (ICPS) in 2003, which allows the society to sell seeds of endangered and threatened carnivorous plants only within the USA. Some restrictions apply to this permit (see http://www.carnivorousplants.org/conservation/policies); in addition, an annual report is required stipulating their selling activities. Collecting guidelines for live plants and seeds were developed by the ICPS: 1) they do not recommend collecting live plants unless it is for scientific purposes such as herbaria, the species has never been introduced to cultivation, or because a variant (a taxon exhibiting slight differences in form); 2) they will not accept field collected seed of listed plants, only seeds from cultivated plants will be accepted if they are donated in accordance with all relevant laws. The Nurseries Stock Restrictions manual summarizes the entry status of regulated plant material capable of or intended for propagation (USDA 2010). (USFWS, 2018)

Stressor: Hurricanes (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Saltwater inundation from storm surges caused by hurricanes represents a threat. Kesler and Trusty (2008) monitored one population in Franklin County, which was flooded during Hurricane Francis in 2004. In 2005, they observed that the plant number declined from about 100 to two individuals. (USFWS, 2018)

Stressor: Sea Level Rise (USFWS, 2018)
Exposure:

Response:
Consequence:
Narrative: Sea level rise (SLR) as a result of climate change is a growing concern for much of Florida's coastline and the endemic species that occur there because about 10% of Florida is less than 1 meter above current sea level. Being endemic to Florida, Godfrey's butterwort is threatened by climate change. Using the NOAA Sea Level Rise and Coastal Flooding Impacts Viewer (https://coast.noaa.gov/slr/), the projections indicated potential impacts to six known P. ionantha EOs (Bay Co.: 1 EO; Franklin Co.: 5 EOs) by intrusion of saltwater beginning at one foot SLR. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Section 7(b)(4) and 7(b)(2) of the Endangered Species Act (Act) generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of Federally listed threatened and endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulations or in the course of any violation of a State criminal trespass law. Seeds of both threatened and endangered species found on Federal land are regulated under the Act. However, the seeds of threatened species are not regulated if they come from cultivated plants (7 CFR 319.37.2, USDA 2008). Since P. ionantha is a threatened species, growers can obtain and sell seeds from other growers. Several populations of P. ionantha occur on private timberland and ROWs. While the Act requires Federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. The Act does not provide for protection of plants on private lands as long as the activity is permissible under state/local laws. The State requires permission of private landowners for collecting of State-listed plants from their property. Pinguicula ionantha is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). Bay County Comprehensive plan, under chapter 6, provides restrictions, constraints and requirements to protect and preserve designated habitat conservation areas for rare, threatened, or endangered species, and wetlands (http://baycountyfl.gov/276/Planning-Zoning). Calhoun, Gulf, Franklin, and Liberty Counties do not have such regulations. Highway ROW maintenance activities are not always reviewed for threatened and endangered species impact. However, if there is an activity (e.g., construction, mowing, or maintenance projects) affecting protected species, then the Service can recommend consultation to the FDOT under section 7 of the Act. The FDOT routinely consults with the Service on all major road construction activities. (USFWS, 2018)

Recovery

Reclassification Criteria:
Not relevant. (USFWS, 1994)

Delisting Criteria:
1. When 15 populations are adequately protected and managed throughout its historic range. Existing public land (mainly the Apalachicola National Forest) does not suffice for recovery). (USFWS, 1994)

Recovery Actions:
- Manage ROW Continue fostering conservation practices for utility and highway Right-of-Ways with the Forest Service, FDOT, and USFWS; a ROW Best Management Practices plan should be developed and implemented. (USFWS, 2018)
- Develop a stand-alone plan for managing listed plants at the Apalachicola National Forest and THSF, and integrate it to their Management Plan. (USFWS, 2018)
- Conduct a long-term study using 15 populations distributed throughout the species' historical range for 10 years to determine whether the observed declines in abundance reflect acceptable stochasticity or if they are indicative of dangerously declining populations. This study could use the sites from Kesler and Trusty (2008) study, and will address the delisting criterion. (USFWS, 2018)
- Since habitat loss and degradation are leading causes of endangerment for P. ionantha, designating habitat that is critical for survival and recovery is recommended. (USFWS, 2018)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the species' status. (USFWS, 2018)
- Conduct surveys/inventories on potentially new sites. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought, and identify sites for reintroductions such as areas that will not be affected by SLR and future development (USFWS, 2018)
- Establish (or continue) frequent growing-season fire regimes (i.e., 2-3 yr interval) on selected areas such as Apalachicola National Forest, SJBSBP, THSF, and Tyndall AFB to maintain optimal conditions of P. ionantha populations. Re-visit sites shortly after a burn event, and mark and count individual plants. Populations tend to be more evident after a fire event. (USFWS, 2018)
- Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. (USFWS, 2018)
- Investigate if there is a soil seed bank persistence of P. ionantha seeds throughout the species geographic range. (USFWS, 2018)
- Conduct population biology studies at Apalachicola National Forest. Compare the demographic performance of P. ionantha in pinelands and road habitats. Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in or near roadside populations of SR 65 and pinelands. (USFWS, 2018)
- The recovery plan should be updated to define objective measurable criteria and better address the five listing factors.(USFWS, 2018)
- 1. Manage ROW
- 2. Since habitat loss and degradation are leading causes of endangerment for P. ionantha, designating habitat that is critical for survival and recovery is recommended (USFWS, 2009).

- 3. Evaluate the current species status (USFWS, 2009).
- 4. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites (USFWS, 2009).
- 5. Establish frequent growing-season fire regimes (i.e. 2-3 yr interval) on selected areas such as Tate's Hell State Forest, St. Joseph State Buffer Preserve, and ANF to maintain optimal conditions of P. ionantha populations. Re-visit sites shortly after burn event and mark individual plants. Populations tend to be more evident after a fire event (USFWS, 2009).
- 6. Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. Studies on the viability of dry-stored seeds, the timing of the germination, and whether a persistent seed bank is present should be addressed (USFWS, 2009).
- 7. Conduct population studies at ANF (USFWS, 2009).
- 8. Conduct systematic studies to examine the current taxonomic classification (USFWS, 2009).
- 9. Conduct pollination studies (USFWS, 2009).
- 10. The recovery plan should be updated to define objective measurable criteria and better address the five listing factors (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES 1. Address the delisting criterion, 'adequately protect and manage 15 populations distributed throughout the species' historical range for 10 years'. This study could use the sites from Kesler and Trusty (2008) established plots. a. Continue the long-term monitoring ANF, Tyndall, and LB sites, and set up plots in SJSBP and THSF. b. As sea levels rise, seawater intrusion increases in duration, frequency, and spatial extent. To assess the effect of salinity on P. ionantha, sites where intrusion of salt water occurs should be considered for long-term monitoring. 2. Conduct surveys/inventories on potentially new sites. a. Calhoun and Wakulla counties. Historically, P. ionantha was documented in Wakulla and Calhoun. Therefore, surveys are strongly recommended in these counties within the habitat types or vegetation communities associated with the species. b. This action can include the use of aerials and species distribution modeling methods to initially determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. 3. Manage ROW Continue fostering conservation practices for utility and highway ROWs with the Forest Service, FDOT, and USFWS; a ROW Best Management Practices plan should be developed and implemented. 4. Develop a stand-alone plan for managing listed plants at the ANF and THSF, and integrate it to their Management Plan. 5. Since habitat loss and degradation are leading causes of endangerment for P. ionantha, designating habitat that is critical for survival and recovery is recommended. 6. Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the species' status. 7. Establish (or continue) frequent growing-season fire regimes (i.e., <4 yr interval) on selected areas such as ANF, SJBSBP, THSF, and Tyndall to maintain optimal conditions of P. ionantha populations. Re-visit sites shortly after a burn event, and mark and count individual plants. Populations tend to be more evident after a fire event. 8. Garden propagation and reintroduction. An ex-situ plant collection should be actively pursued and implemented with a botanical garden. In February 2016, 238 plants were removed from the F-22 Munitions Storage Complex on Tyndall AFB prior to new bunker construction and relocated to a wet prairie at Tyndall

AFB. Post-transplanting monitoring is ongoing since 2017. 9. Investigate if there is a soil seed bank persistence of P. ionantha seeds throughout the species geographic range. The following studies were inconclusive; therefore, better observations are needed to clarify the type of seed bank present in this species. A few points from these studies: • The lack of a persistent seed bank was suggested by Kesler et al. (2008), as they observed a 430-day delay in the population growth response of P. ionantha to dormant season fires. • Molano-Flores et al. (2014) found the emergence of two Pinguicula seedlings from soil collections, but identification to species was not possible because seedlings did not reach the flowering stage during the study. • Molano-Flores et al. (2021) subsequent seed germination and seed bank studies on multiple populations of P. ionantha, P. lutea, and P. planifolia suggest: o transplanting seedlings is not recommended unless moisture and humidity are retained, and root disturbance is minimized. o sprouted seeds of P. ionantha with emerging cotyledon, previously soaked in gibberellic acid solution and rinsed with distilled water, were transplanted to a soilless mixture but did not survive o 6 months post-collection seeds kept in cold storage for about 5 months have high potential for germination o viability potential of seeds in the seed burial trail was at least 2 months (that was the duration of their study) 10. Conduct population biology studies at ANF Survey for seedling recruitment and survival of tagged individuals (plant height and reproduction) for a period of 3-5 years in or near roadside populations of SR 65 and pinelands (USFWS, 2023).

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SPECIES ACCOUNT: *Pityopsis ruthii* (Ruth's golden aster)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 7/18/1985

Physical Description

A perennial herb, 1-3 dm tall. The stems are leafy with grass-like leaves. Bright yellow flower heads bloom in late summer and fall (NatureServe, 2015).

Taxonomy

Past taxonomic treatments of Ruth's golden aster, and golden asters in general, have involved frequent shifting of species among genera. Small (1897) described the species as Chrysopsis ruthii but subsequently transferred it to the genus Pityopsis (Small 1933), a genus characterized as those golden asters with graminiform (grass-like) leaves. This concept was rejected by Fernald (1942) who described the recognition of Pityopsis as "hardly worthwhile" and retained the species in Chrysopsis. Later, Shinners (1951) included Chrysopsis in his concept of the genus Heterotheca. His treatment generally was accepted by Harms (1969), who published the combination Heterotheca ruthii, and by Bowers (1972b) and Cronquist (1980). Dress (1953), in his study of the eastern Chrysopsis, continued to follow Small's 1933 nomenclature (except in the case of the Pityopsis graminifolia complex). Semple (1977), Semple et al. (1980), and Semple and Bowers (1985) reaffirmed Heterotheca, Chryopsis, and Pityopsis as distinct genera. Semple's work is widely accepted, and Ruth's golden aster will be referred to here as Pityopsis ruthii (Small) Small. It is instructive to note that no student of the genus has questioned the validity of the species, only the proper generic designation (USFWS, 1990).

Historical Range

See current range/distribution.

Current Range

Known only to occur along short reaches of the Ocoee and Hiwassee River, Polk County, Tennessee (USFWS, 2018).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Reproduction in natural populations is attributed to stem regeneration or tillering of the subaerial root-rhizome crown (Wofford and Smith 1980). This agrees with White (1977), who stated that the chief method of reproduction is by existing rhizomes. White observed no seedlings in the field and concluded that P. ruthii has difficulty becoming established on the phyllite boulders. His comparison of plants from the Hiwassee River population with those grown for his greenhouse studies showed an average of 50 achenes and 58 achenes per flowering head, respectively. Typically, 18 percent of those achenes from the wild population

were filled (i.e., viable) compared to 19 percent from the greenhouse populations. Although White (1977) presented no figures on percentage germination of the filled achenes he sowed during his greenhouse study, he indicated that 62 percent of the P. ruthii seedlings resulting from the 960 filled achenes sown survived their first 3 weeks. It is suggested that a combination of wind and nonselective foraging by insects could account for the low percentage of filled achenes (Wofford and Smith 1980). No studies of pollinators or of pollination in P. ruthii have been performed. However, in the field, Bowers (1972a) noted several kinds of bees visiting the flowers of various members of the section Pityopsis (including P. ruthii), and in the greenhouse he observed occasional visits by flies to the flowers of the same species. He determined that members of the section Pityopsis are obligate outcrossers and that self-fertilization and apomixis seldom, if ever, occur. He also concluded that wind is of little importance in pollination. White (1977), while collecting soil samples in the field, observed numerous ant colonies sharing the same crevices with P. ruthii. He suggested there may be a relationship between the presence of the ants and the establishment of P. ruthii but made no further investigation of this potential relationship. Production of low numbers of viable seeds could easily contribute to difficulties in the establishment of new plants. Ineffective dispersal methods also could be a contributing factor. While Wofford and Smith (1980) stated that "age class determinations indicate only mature individuals are present," there was evidence that regeneration from seeds is occurring. In an ongoing study of P. ruthii, Collins and Gunn (1986) observed one subpopulation on the Hiwassee River comprising 1,149 individual plants. Relative to other subpopulations measured in 1986 and 1987, a greater preponderance of those plants were small and single-stemmed and were not located near enough other larger plants to have come from rhizomes. The same subpopulation was measured the next year (Collins and Gunn 1987), and 307 fewer individuals were found, perhaps the victims of stress from severe drought. Apparently many of the absent individuals were the small, single-stemmed plants recorded the prior year. It is possible that many of those plants were young seedlings, not yet vigorous enough to withstand the extreme conditions at the time. Furthermore, a great many more individuals not producing flowering heads were seen than were found by Wofford and Smith (1980). The extent and significance of predation upon P. ruthii are not known. White (1977) observed predation by the larvae of three moth species on plants in the greenhouse. In the field, Collins and Gunn (1986) also have observed insect larvae apparently feeding on the achenes in the maturing heads of some plants (USFWS, 1990).

Habitat Type

Adult: The species is restricted to outcrops of phyllite (rarely greywacke) within 5.7 km (3.5 mi) and 4.6 km (2.9 mi) reaches of the Hiwassee and Ocoee Rivers, respectively (USFWS, 2018).

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits soil-filled cracks in phyllite boulders along river banks and in rivers, within 5.7 km (3.5 mi) and 4.6 km (2.9 mi) reaches of the Hiwassee and Ocoee Rivers, respectively (USFWS, 2018). Shade intolerant but adapted to annual high water flows; requires periodic flooding and scouring to remove competing vegetation (NatureServe, 2015). High ecological integrity of the community and site fidelity along with low tolerance ranges are noted based on the species specific habitat requirements and the relatively low number of populations (NatureServe, 2015).

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 1990)

Dispersal

Adult: Low (inferred from USFWS, 1990)

Dispersal/Migration Narrative

Adult: No study of fruit dispersal has been made, but the pappus is disposed to dissemination by wind. According to Wofford and Smith (1980), dispersal also is achieved by water. They regarded effective dispersal as rare, based on the paucity of observations of seedlings in nature, but provided no supportive data (USFWS, 1990). Low mobility and dispersal are inferred based on rare effective dispersal of the species.

Population Information and Trends

Population Trends:

Stable to decreasing (USFWS, 2018)

Species Trends:

Decreasing (USFWS, 2018)

Number of Populations:

2 (USFWS, 2023)

Population Size:

~100,000 total individuals (USFWS, 2023)

Population Narrative:

As of 2017, the population from the Ocoee River was relatively stable from 2011 through 2017 ranging from a low of 1,140 during 2011 to a high of 1,299 individuals in 2015. As of 2017, there were 1,232 individuals, an overall increase of 82 individuals (7.2 percent) compared to the baseline census in 2011. Data collection on the Hiwassee River has occurred at a total of 57 sites, but only 27 sites have been counted annually. These 27 sites account for more than 90 percent of all plants counted in each year from 2011 through 2017, thus are representative of trends for the population on this river. Data from the Hiwassee demonstrate that a period of increase occurred from 2011 through 2014, followed by decreases through 2017. Using data from the 27 sites counted annually, as of 2017 there has been a decrease of 1,676 individuals (17.6 percent) compared to the 2011 baseline and a decrease of 4,125 individuals (34.5 percent)

since 2014, when the population peaked (USFWS, 2018). A study from 2013 showed moderate genetic diversity in three populations sampled and a study from 2018 determined that gene flow levels among populations within each river were sufficient to reduce risk of divergence due to genetic drift. The species is restricted to two populations located along short reaches of the Hiwassee and Ocoee rivers, in Polk County, Tennessee. Available data indicate that the Ocoee River population has increased by approximately 20 percent since 2011, to a total of 1,388 individuals in 2022. While it is the larger of the two populations, the species abundance in the Hiwassee River population has decreased by approximately 10 percent since 2011, to a total of 8,968 individuals in 2022 (USFWS, 2023).

Threats and Stressors

Stressor: Encroachment of competing vegetation (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: There are concerns about the loss of habitat in the Hiwassee drainage to encroachment of competing herbaceous and woody vegetation. A Biological Assessment prepared by TVA (2002) discussed the threat posed to the Hiwassee population by vegetation encroachment onto the phyllite boulders due to altered flows in the river below Apalachia Dam since its construction in 1943. They identified this threat as the cause for the observed decline of P. ruthii since monitoring began in 1986. Several lines of evidence support this conclusion, including the general declining trend in the Hiwassee population since monitoring began, the finding of Thomson and Schwarz (2006) that all Hiwassee populations suffered mean negative growth rates except for one plot from which vegetation had been removed in the past, and Cruzan's (2000) observation that vegetative cover in the Hiwassee floodplain has increased approximately 50 percent since the late 1940s (USFWS, 2012). Continued ecroachment and habitat reduction contributes to decreases in P. ruthii in some sites. As abundance decreases, pollinator attraction could decrease, potentially creating a negative feedback loop reducing reproductive output and contributing to further declines (USFWS, 2018).

Stressor: Altered flow regimes (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Altered flow regimes (due to the Apalchia dam) and encroachment of competing vegetation into suitable habitat in the Hiwassee drainage remain the greatest active threats for P. ruthii. Because the process of vegetation encroachment has occurred over a period of several decades, riparian communities have become established on the phyllite boulders to the extent that periodic high flows alone would not be enough to remove this threat and restore P. ruthii habitat (USFWS, 2012). Maintenance work in 2015-2016 on the Apalachia powerhouse and switchyard caused elevated flows for 132 days in the Hiwassee River where P. ruthii occurs and a decline in this population was observed. Drought conditions also occurred during part of 2016, which could also account for the decline in the observed Ocoee River population (USFWS, 2018).

Stressor: Recreation (USFWS, 2012)
Exposure:
Response:

Consequence: Loss of individual plants
Narrative: The development of a whitewater recreation facility on the Ocoee River and hosting of whitewater events during the 1996 Olympics elevated concerns about recreation-related impacts to P. ruthii, both from whitewater paddlers and spectators. The USFS-CNF recommended corrective measures to reduce recreation-related impacts at two sites (Doublesuck and Tablesaw) where they were found to be greatest (Herrig and Wyrick 1996). The threat of trampling by spectators at the Tablesaw site was reduced by the extension of a guardrail on the nearby highway, eliminating parking access in close vicinity to this population. However, no billboard or kiosk has been constructed at the access point for paddlers upstream of Doublesuck, to inform paddlers of the presence of P. ruthii and biologically sensitive areas near particular whitewater features (USFWS, 2012). No adverse effects from whitewater recreationists or observers have been reported since 2015 (USFWS, 2018).

Stressor: Road construction (USFWS, 2018)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Tennessee Department of Transportation is currently analyzing transportation alternatives for Corridor K, which passes through the Ocoee River Gorge and based on a preliminary map of targeted spot improvements, some of the road construction would occur along US HWY 64 where it parallels sites on the Ocoee River that P. ruthii occupies. A Section 7 consultation has not been completed and therefore the potential for adverse effects to P. ruthii that could result from implementing the Targeted Approach have not been analyzed (USFWS, 2018).

Stressor: Disease or predation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Five potential invertebrate herbivores have been observed on P. ruthii in situ and ex situ plants and can damage flower buds and developing seeds (USFWS, 2018).

Stressor: Hybridization (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The potential for hybridization to occur between Heterotheca ruthii (=P. ruthii) and H. graminifolia (=P. graminifolia var. latifolia) was first documented by Bowers (1972), in a cross that produced only two seeds, one of which germinated and died within a week. Moore et al. (2016) report that P.A. Wadl (unpublished data) produced viable offspring from controlled crosses between these species. Recent evidence (Boggess 2013, Hatmaker et al. 2018, P. Wadl 2018, pers. comm.) indicates that wild hybrids may be formed where these two species co-occur. Hybridization could present a threat to reproductive output and genetic variation (USFWS, 2018).

Stressor: Climate change (USFWS, 2018)
Exposure:
Response:
Consequence:

Narrative: Using NatureServe's Climate Change Vulnerability Index (CCVI) to assess P. ruthii's predicted exposure to climate change, the species was ranged as highly to extremely vulnerable indicating that abundance and/or range extent or are either likely to decrease significantly (highly vulnerable), or extremely likely to substantially decrease or disappear (extremely vulnerable), by 2050 (Young et al., 2015)(USFWS, 2018). Drought experienced in 2016 and 2017 contributed to declines of this species and very likely reduced seedling establishment given that seedling emergence has been observed to occur beginning in November (USFWS, 2018).

Recovery

Delisting Criteria:
The Ocoee River population, under the criteria described in or to be established by implementation of Task 7, is deemed recovered and the rate of natural succession on the phyllite boulders on the Hiwassee River is determined to not be detrimental to the survival of P. ruthii (USFWS, 1990).

The Hiwassee River population, under the criteria described in or to be established by implementation of Task 6, is deemed recovered and Tasks 7.2, 7.3, 7.4, and 7.6 are accomplished for the Ocoee River population.

Pityopsis ruthii shall be considered recovered when the full set of recovery goals (Tasks 6 and 7) for each population is fulfilled (USFWS, 1990).

Recovery Actions:
- 1. Maintain formal agreements among the appropriate concerned agencies on the preservation of Pityopsis ruthii.
- 2. Maintain permanent plots.
- 3. Determine what is necessary for effective and successful achene dispersal. seed germination, and seedling establishment. 3.1 Study achene dispersal. 3.2 Determine life history. seed germination, and seedling establishment requirements. 3.3 Determine the role of interspecific and intraspecific competition.
- 4. Determine what constitutes suitable habitat.
- 5. Search for Pityopsis ruthii on other rivers.
- 6. Determine and implement for the Hiwassee River population the management necessary for long-term reproduction, maintenance, and vigor. 6.1 Determine and compare Past and present stream flow regimes. 6.2 Determine the nature and role of natural succession on the phyllite boulders. 6.3 Determine whether or not the population is self-sustaining. 6.4 Establish P. ruthii on unoccupied suitable habitat. 6.5 Establish a cultivated population of plants descended from the Hiwassee River population and provide for long-term seed storage. 6.6 Determine feasibility and/or necessity of water releases and hand-clearing of phyllite boulders (USFWS, 1990).
- 7. Determine and implement for the Ocoee River population the management necessary for long-term reproduction, maintenance, and vigor. 7.1 Study the relationship of the river to P. ruthii. 7.2 Determine impacts of river recreational users and implement required management actions. 7.3 Ensure that highway construction will not damage or destroy plants or suitable habitat. 7.4 Determine whether the population is self-sustaining. 7.5 Establish P. ruthii on unoccupied suitable habitat. 7.6 Establish a cultivated population of

plants descended from the Ocoee River population and provide for long-term seed storage (USFWS, 1990).

- 8. Variability in population trends among sites in the Hiwassee River suggests that demographic monitoring of selected sites would be useful in understanding which life history stages are most affected by threats to the species and its habitat. Demographic monitoring will be necessary for evaluating effectiveness of any future efforts to reintroduce the species into suitable unoccupied habitat (USFWS, 2018).
- 9. Future restoration projects should explore effects of planting season and importance of mycorrhizal associations on establishment, survival, growth, and reproduction of introduced plants. Additionally, if restoration into suitable habitat is to be successful, multiple outplantings over time likely will be necessary at any given site (USFWS, 2018).
- 10. For each mapped location on the Hiwassee River, record data on apparent vulnerability to vegetation encroachment, including observations on substrate composition (e.g., bedrock, boulder, cobble, gravel, degree of sediment deposition), landform and aspect. Use these data to map risk of local extinction and assess whether and where management is needed to control vegetation encroachment (USFWS, 2018).
- 11. Incorporate observations on presence and relative abundance of Pityopsis graminifolia var. latifolia at monitoring sites, to document locations where potential threat of hybridization is greatest (USFWS, 2018).
- 12. Coordinate with TDOT to avoid potential adverse effects to P. ruthii from road construction activities on US HWY 64 (USFWS, 2018).
- The primary actions needed to move P. ruthii towards a status at which downlisting or delisting could be considered, include: 1. Determining effective methods for controlling vegetation encroachment and restoring degraded habitat in the Hiwassee drainage (USFWS, 2012).
- 2. Implementing a vegetation control and habitat restoration program to restore suitable habitat conditions across the occupied range in the Hiwassee drainage. For long-term prevention of repeated vegetation encroachment, altering flows to provide sufficient frequency and duration of scouring of phyllite boulders will likely be necessary (USFWS, 2012).
- 3. Analyzing and comparing contemporary flow regimes (i.e., since 1943) on the Hiwassee River to pre-impoundment flow regimes (USFWS, 2012).
- 4. Conducting future surveys of P. ruthii populations in the Hiwassee drainage in order to assess (1) the degree to which suitable habitat for the species declines due to vegetation encroachment and (2) whether the species' linear distribution along the Hiwassee River changes over time (USFWS, 2012).
- 5. Developing effective reintroduction methods for establishing P. ruthii in suitable habitat, in order to fulfill recovery tasks 6.4 and 7.5 (USFWS, 2012).
- 6. Ensuring that recommendations for controlling whitewater recreation-related threats to the Ocoee population are implemented (USFWS, 2012).
- 7. Continuing long-term monitoring effort that has been implemented by TVA, USFS-CNF, and TDEC (USFWS, 2012).
- 8. Continuing annual meetings of the RCWG to coordinate recovery efforts (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities In the absence of river flows sufficient to regulate vegetation encroachment in many sites where Pityopsis ruthii occurs along the Hiwassee

River, it could be necessary to develop effective approaches for mechanical or chemical control to prevent the species' displacement from some sites where this threat of encroaching vegetation is most aggressive. It would likely be infeasible to conduct such intensive management at the scale of the entire occupied reach, owing to the remoteness of the area and other environmental considerations (e.g., presence of endangered mussel species and designated critical habitat in this reach of the Hiwassee River). A management plan identifying the areas under the greatest threat and that guides incremental habitat restoration over a period of several years, however, may need to be developed in order to advance recovery of the species at a biologically meaningful scale. Additionally, flow prescriptions could be developed to regulate vegetation encroachment and enhance P. ruthii habitat, as discussed below. Monitoring and Research Activities The 2012 and 2018 5-year status reviews for Pityopsis ruthii discussed at length how a better understanding of artificially regulated river flows in the Hiwassee River and their influence on P. ruthii population growth could inform the development and implementation of more ecologically compatible flow prescriptions. The presumed importance of river flows that inundate occupied P. ruthii habitats at a frequency sufficient to regulate encroachment of competing herbaceous and woody vegetation are discussed in the species recovery plan, which calls for an analysis of contemporary and historical flow regimes to understand how flow alterations have contributed to changes in riparian vegetation conditions and availability of suitable sites for P. ruthii. Hydrological reference conditions for the Hiwassee River, however, are unavailable prior to the closing of Apalachia Dam. An alternative approach for understanding how flows interact with vegetation and suitable sites for P. ruthii would be to adapt a methodology used for assessing effects of river flows on another species in the family Asteraceae, beautiful Barbara's buttons (Marshallia pulchra) (Tracey and Simmerman 2021). These methods could be adapted to investigate relationships between discharge, depth and duration of inundation, and response of P. ruthii and the associated vegetation community to compare these dynamics for the Hiwassee River to the Ocoee River, where conditions have supported population increase for more than a decade of monitoring. With a better understanding of the relationship between river flows, habitat inundation, and P. ruthii population responses in both river systems, it might be possible to prescribe a flow regime that would support population growth in the Hiwassee River population. A collaborative effort leveraging the authorities and resources of multiple partners, such as the U.S. Fish and Wildlife Service, Tennessee Valley Authority (TVA), American Whitewater Association, US Forest Service, and Tennessee State Parks, could potentially take on such an investigation to advance the status of the species (USFWS, 2023).

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SPECIES ACCOUNT: *Plagiobothrys hirtus* (rough popcornflower)

Species Taxonomic and Listing Information

Commonly-used Acronym: Plhi

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Rough popcornflower plants are between 7 centimeters (cm) (2.75 inches [in]) to 60 cm (23.6 in) tall, with narrow, simple hairy-margined bright-green leaves along hairy stems. The non-fragrant flowers consist of five fused petals, are trumpet-shaped, mostly white with yellow centers, and positioned in a hairy calyx. The flowers are helicoid in development and occur on paired coiled inflorescences. Each flower produces four tan to black-colored, one-seeded nutlets, which loosely adhere to the receptacle, until they drop. These nutlets will germinate readily (Amsberry and Meinke 2002, p. 24). However, due to fruit abortion or lack of pollination, flowers with fewer than four nutlets are often observed. As in most members of the Boraginaceae family, anthers are included and epipetalous (having stamens attached to the inner corolla surfaces. Rough popcornflower can be either an annual or a short-lived perennial. Rough popcornflower exhibits two distinct growth forms in the northern and southern portions of its range in Douglas County. In the northern part of its range near Yoncalla, the plants are more robust, slightly taller, and predominantly perennial (Figure 1). Here rough popcornflower has the ability to produce adventitious roots that easily establish in the moist soil of their wetland habitats. In the southern part of the range, 25.8 kilometers [km] (16 miles [mi]) south of the Yoncalla population, from the general area of Sutherlin to Wilbur, the population include annual plants, often in clusters, with a few sporadic perennial plants. The rough popcornflower and fragrant popcornflower (P. figuratus) are found in similar wetland habitat in northern Douglas County. Both are members of the subgenus Allocarya (Peck 1961, p. 66), and are quite similar in appearance. Rough popcornflower differs from fragrant popcornflower in that the entire plant is larger and has less fragrant flowers, hairier stems and fruits, more robust stems, and blooms several weeks later. The larger rough popcornflower plants grow with more arched stems as well. A stout, hairy (on the upper part of the stems) annual, 3-6 dm tall, with long, narrow leaves and white flowers. Blooms primarily from mid to late June. (NatureServe, 2015)

Taxonomy

Allocarya hirta Greene was the original scientific name applied to the species in 1888. Since then, the species has undergone a number of taxonomic re-arrangements, including Allocarya scouleri var. hirta, Allocarya calycosa, and Plagiobothrys scouleri var. hirtus. Since the 1961 edition of Plants of Oregon, it has remained Plagiobothrys hirtus (Peck 1961, p. 661), and this classification is recognized as valid by the U.S. Department of Agriculture Plants Database (U.S. Department of Agriculture 2018, website) and the Integrated Taxonomic Information System (Integrated Taxonomic Information System 2019, website).

Historical Range

Rough popcornflower is found only in northern Douglas County, Oregon, occurring at low elevations (100 and 230 meters (m) [328 to 755 feet [ft]) within the Umpqua River basin, distributed in the Elk Creek, Umpqua River, and Lower North Umpqua River watersheds.

Current Range

Rough popcornflower has been documented at 23 populations historically; 18 are extant and 5 are extirpated. Five of the known populations occur on private land and lack monitoring access. Despite this, the species is estimated to have greater than 883,154 mature, reproductive individuals across its range. Of the 18 extant populations, 1 is very large (700,000 plants), 10 are relatively large (5,000-70,000 plants), 4 are medium (1,000-4,999 plants), and 3 are small (less than 1,000 plants). While smaller populations, in general, are more vulnerable to extirpation from stochastic events and genetic drift than larger populations (Szczecińska et al. 2016, p. 17; Ma et al. 2013, p. 805), the majority of rough popcornflower populations support more than 5,000 individuals and we believe are less susceptible to stochastic events and genetic issues.

Critical Habitat Designated

No;

Legal Description

NA

Life History

Food/Nutrient Resources

Competition

Adult: Competes with both invasive and native plants

Food/Nutrient Narrative

Adult: water availabilty is dependent on annual weather patterns and heavy clay soils

Reproductive Strategy

Adult: r strategy, species relies on outcrossing but can self if necessary

Reproduction Narrative

Adult: Popcornflower can be a perennial, growing to 70 cm tall (27.5 inches), with dozens of flowering stems and hundreds of flowers, or can be a diminutive annual with only a few flowers (Amsberry and Meinke 2001). At Popcorn Swale Preserve, rough popcornflower generally reaches peak growth and flowering by mid-June. By July 1, many plants have dropped seed and are senescing. By July 15, rough popcornflower generally appears gray-brown and crispy although a rare flower or two may be found low to the ground in moister, shaded areas. Although most plants are dormant by mid-July, perhaps around 1% of individuals may still be green and actively growing and flowering. Rough popcornflower, like most borages, can potentially produce four nutlets per flower. In most sites, copious numbers of mature seeds were observed from mid-June through early September, but plants in a few wetter habitats delayed seed maturation until the beginning of August. The number of seeds produced by individual plants is largely controlled by the number of flowers produced, and correspondingly, large plants produce more flowers (USFWS, 2016). Pollination biology of rough popcornflower is not well documented but we are not currently considering lack of pollination or seed production a stressor, but are more concerned with connectivity and habitat quality since pollination is dependent of habitat corridors of an adequate variety of native and non-native plants (habitat quality). We know that the typical high seed set indicates that pollination is highly successful

since the flowers are visited by a diverse group of generalist pollinators, and that pollination is not currently a limiting factor for this species. Connectivity and habitat quality is essential to ensure that genetic exchange is taking place within and among populations by these pollinators (U.S. Fish and Wildlife Service 2003, p. 54). (USFWS, 2021b)

Habitat Type

Adult: River valley wetlands (USFWS, 2016)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2016)

Environmental Specificity

Adult: Very narrow to narrow. (Natureserve, 2015)

Habitat Narrative

Adult: Rough popcornflower is a plant closely associated with seasonally wet, relatively level, open habitats in Douglas County formed from poor draining clay-loam soils, concentrated in the Sutherlin Creek basin in Oregon. These wet habitats are unique to the Sutherlin area and correspond to a particular type of soil series known as Conser silty clay-loam. The majority of rough popcornflower populations largely correspond to Conser soils, which is a poorly draining silty clay-loam series soil. To a lesser extent, the species occurs on clay or loam soils including Bashaw clay, Brand silty clay loam, Curtin clay, Dixonville silty clay loam, Nonpareil loam, Oakland clay-loam, Packard silty loam, Philomath-Dixonville complex, Sibold clay, and Waldo silty clay loam soil types. Rough popcornflower habitat corresponds to emergent wetlands within seasonally wet meadows or prairie, seasonally-ponding mudflats, and Oregon ash (Fraxinus latifolia) swale openings dominated by native wetland-associated herbs and graminoids in valley lowlands where the ground is moist well into the summer season. The species appears to be adapted to early seral succession habitat so it does not often occur under dense shade. Native perennial plant species commonly associated with rough popcornflower habitat include Oregon ash, dense sedge (Carex densa), green-sheathed sedge (C. feta), one-sided sedge (C. unilateralis), spreading rush (Juncus patens), pointed rush (J. oxymeris), common rush (J. effusus), tufted hairgrass (Deschampsia cespitosa), great white camas (Camassia leichtlinii), rush-leaved coyote thistle (Eryngium petiolatum), Willamette gumweed (Grindelia integrifolia), and western mannagrass (Glyceria occidentalis). Native annuals commonly associated with rough popcornflower include American sloughgrass (Beckmannia syzigachne), skullcap speedwell (Veronica scutellata), Cascade calicoflower (Downingia yina), and Douglas meadowfoam (Limnanthes douglasii). Common invasive plant associates in rough popcornflower habitat include trees (e.g. European pear [Pyrus communis]); shrubs (e.g. Armenian blackberry [Rubus armeniacus] and English hawthorn [Crataegus monogyna]); herbaceous plants (e,g. meadow knapweed [Centaurea moncktonii], teasel [Dipsacus fullonum], Canada thistle [Cirsium arvense], pennyroyal [Mentha pulegium], and curly dock [Rumex crispus]); and graminoids (e.g. reed canarygrass [Phalaris arundinacea] and tall fescue [Schedonorus arundinaceous]). Pennyroyal and tall fescue are nearly always present in or around rough popcornflower habitat. Rough popcornflower appears to be a species that requires early seral habitat and is not associated with habitat under dense tree or shrub canopies. Grazing helps to control invasive and native plant competitors and provides a measure of disturbance that maintains the preferable more-early seral and open habitat conditions for rough popcornflower. Flooding, fire, and native ungulate grazing, also likely

played a large role in the development and maintenance of habitat for the plant (U.S. Fish and Wildlife Service 2000, p. 3867). When such natural disturbance events are lacking, active management is necessary to control competing vegetation and maintain requisite conditions for this plant to compete with naturally occurring and non-native plant species. An increase in abundance of Oregon ash or spreading rush can result in a loss of rough popcornflower habitat without mowing, grazing, or fire to restore habitat suitability (USFWS 2021).

Dispersal/Migration

Population Information and Trends

Population Trends:

Has increased from 8 populations at the time of listing to 18 populations. (USFWS 2021).

Resiliency:

We assessed habitat conditions for rough popcornflower in terms of habitat area, population size, habitat quality, connectivity, management, protection, reproduction, abundance of insect pollinators, and rainfall. Of the 18 total rough popcornflower populations, 11 had a higher probability of persistence, 3 had a moderate probability of persistence, and 4 had a low expected persistence over the next 30 years. (USFWS 2021)

Representation:

An abundance of insect pollinators and habitat connectivity leads to genetic diversity by the process of cross-pollination between patches within a population. There is a need to maintain the genetic variation between populations as their potential genetic and life history attributes may buffer the species to adapt to environmental changes over time. At this time, we do not know the degree of genetic variation among rough popcornflower populations and whether connectivity and active genetic exchange is occurring across populations and within patches or within populations. Most rough popcornflower populations are not isolated from one another by over 2.0 km (1.24 miles) and it is assumed that gene flow occurs among the majority of the population. (USFWS 2021)

Redundancy:

Rough popcornflower requires multiple resilient populations distributed throughout its range to provide for redundancy. The more populations, and the wider the distribution of those populations, the more redundancy the species will exhibit. Redundancy reduces the risk that a large portion of the species' range will be negatively affected by a catastrophic natural or anthropogenic event at a given point in time. (USFWS 2021)

Population Growth Rate:

From 7,000 individuals at the time of listing has increased to a total population estimate of over 883,154 individuals. (USFWS 2021).

Number of Populations:

18 are extant and 5 are extirpated. (USFWS 2021)

Population Size:

883,154 individuals (USFWS 2021)

Minimum Viable Population Size:

Although a minimum viable population hasn't been determined, based on studies by Lande (1995) and Lynch et al. (1995) we have recommended the recovery level population size for rough popcornflower as 5,000 plants per population. This figure is based on the authors' suggestion that in most cases, 5,000 individuals in a population, is necessary to maintain above normal levels of potentially adaptive genetic variability under a balance between mutation and random genetic drift. Without a Population Viability Analysis (PVA) to indicate what an optimal abundance level should be, using our best professional judgement, we consider a population with over 5,000 mature plants to be in high condition, over 1,000 plants to be in medium condition, and under 200 plants to be in low condition.

Adaptability:

We have no documentation of rough popcornflower's adaptability. Maintaining representation in the form of genetic or ecological diversity will provide rough popcornflower the capacity to adapt to future environmental changes.

Population Narrative:

Rough popcornflower has been documented at 23 populations historically; 18 are extant and 5 are extirpated. All known populations (naturally occurring and reintroductions) occur in Douglas County, OR. Five of the known populations occur on private land and lack monitoring access. Despite this, the species is estimated to have greater than 883,154 mature, reproductive individuals across its range. Of the 18 extant populations, 1 is very large (700,000 plants), 10 are relatively large (5,000-70,000 plants), 4 are medium (1,000-4,999 plants), and 3 are small (less than 1,000 plants). The majority of rough popcornflower populations support more than 5,000 individuals and we believe are less susceptible to stochastic events and genetic issues. Through extensive surveys and augmentation and introduction efforts, the 7,000 individuals within 8 populations known at the time of listing has increased to 18 populations, with a total population estimate of over 883,154 individuals. The bulk of this estimate includes a single extensive rough popcornflower population south of Sutherlin, which has not been adequately censused but may have as many as 700,000 individuals.

Threats and Stressors

Stressor: Competition (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Stressors to rough popcornflower habitat include encroachment by Oregon ash and European pear, Armenian blackberry and English hawthorn, pennyroyal, teasel, Canada thistle, curly dock, spreading rush and reed canarygrass), which compete for moisture, light, and space. Pennyroyal is nearly always present in rough popcornflower habitat and is an ever-present competitor. (USFWS, 2021, p. 17).

Stressor: Development (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Development was described as a serious stressor to rough popcornflower. In addition, habitat can become degraded by both channelization (e.g. ditching) and filling of wetland habitat.(USFWS,2021, p. 17)

Stressor: Agriculture (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The species appears to be adapted to early seral succession habitat and cannot compete with later successional vegetation such as Oregon ash, rushes, and tall fescue for light, moisture, and space. Stressors to rough popcornflower habitat include encroachment by Oregon ash and European pear, Armenian blackberry and English hawthorn, pennyroyal, teasel, Canada thistle, curly dock, spreading rush and reed canarygrass), which compete for moisture, light, and space. Pennyroyal is nearly always present in rough popcornflower habitat and is an ever-present competitor.

Stressor: Fire suppression (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire suppression resulting in encroaching native oaks and ash trees that shade popcornflower and reduced gene flow due to habitat fragmentation are considered to be other threat factors (USFWS 2010).

Stressor: Urban and Rural Development (USFWS, 2021b)
Exposure:
Response:
Consequence:
Narrative: Urban and Rural Development. The final listing decision (U.S. Fish and Wildlife Service 2010, p. 3869) described how rough popcornflower populations had become fragmented due to draining and filling of wetlands from properties being developed, primarily in the city of Sutherlin area. For example, between 1995 and 2002, four rough popcornflower populations were either heavily impacted or lost due to urban development, mostly prior to the species' listing. Currently, we consider urban development in the general vicinity of Sutherlin (within and just beyond the Urban Growth Boundary) as a threat to four populations (Hawthorne, Southside Swale, Sutherlin East, and Stearns Lane). However, 11 of the 18 populations (151,195 of 883,154 total plants) throughout the species' range are under Federal, State, municipal, or land trust protections providing for the long-term persistence of these populations. At other privately owned populations on rural pasturelands (Horsepasture 2, Nonpareil), long-term persistence has been documented for over 30 years. Additionally, developers, State and Federal wetland regulators, and city and county governments are doing an increasingly better job of recognizing rough popcornflower habitat and avoiding and minimizing (or mitigating) development impacts. Because the majority of the population is protected and the species is benefitting from increased awareness, the threat posed by development has been significantly diminished. Nine rough popcornflower populations occur on Federal, State and Municipal owned lands, where management of the species is directed by species-specific management plans and regulations (Table 2). Rough popcornflower is distributed across properties with a mix of ownership (Table 2) and land use practices. These land use practices on privately owned land may or may not be

consistent with rough popcornflower conservation. For example, while some landowners mow rough popcornflower during its growing period, seed with non-native pasture grass, and use selective herbicides to promote hay or agricultural crops (i.e., practices that can be detrimental to the species), other landowners are interested in conserving the species, mow, and graze when competition with invasive non-native species is problematic for the species. As discussed above in the Habitat section, some forms of land use practice can be beneficial to the species. The fact that lands are held in private ownership in and of itself does not constitute a threat to the species. In fact, three of the largest rough popcornflower populations occur on private lands where the property is not specifically managed to benefit the species (Table 2). Of the 18 extant rough popcornflower populations, 4 with greater than 5,000 individuals occur partially or wholly on private lands which are grazed beneficially for the species. At the time of listing, only five populations of rough popcornflower were protected from detrimental land-use activities. Since listing, significant progress has been made in protecting and managing sites supporting rough popcornflower. Because 12 of the 18 of the populations are now considered protected or on adequately managed land, the threat from development activities is no longer as severe. (USFWS, 2021b)

Stressor: SMALL POPULATION SIZE (USFWS, 2021b)
Exposure:
Response:
Consequence:
Narrative: The final listing rule (U.S. Fish and Wildlife Service 2000, pp. 3869-3870) described the distribution of the rough popcornflower as 17 small patches (approximating 7,000 plants) which were threatened by natural (i.e., flood) and / or anthropogenic (e.g., herbicide treatment) events. At the time, the species' small population size was considered a threat because a single natural or man-made event could have the potential to extirpate a small rough popcornflower patch. Although small populations occur that are still vulnerable to extirpation, there are now multiple, large populations of rough popcornflower occurring in patches larger than those at the time of listing, providing added resilience to the species. In addition, at the time of listing there were concerns that a small, isolated population might not be able to sustain adequate genetic variation, or that reproduction may be impaired (see Fertilization, below). There was also a concern that a lack of connectivity between isolated patches and populations would limit pollinator-mediated gene flow. Since then, these concerns have since been alleviated to a significant extent. At the time of listing, the limited number of individuals and populations was considered a threat. Today, eight of the 18 populations are dispersed over a much larger area (over 500 m2 [5382 ft2]) than in the past and are likely large enough to withstand a single random natural or anthropogenic event. However, the Hawthorne, Stearns Lane, and Ford's Pond populations are located in small discrete areas and are vulnerable. Even so, these small populations are broadly distributed and the likelihood of large-scale event affecting them collectively is unlikely. Overall, while this species' relatively small population is still of some concern, it is much less vulnerable than when it was listed. (USFWS, 2021b)

Stressor: HERBIVORY (USFWS, 2021b)
Exposure:
Response:
Consequence:
Narrative: Herbivory by Columbian white-tailed deer (Odocoileus virginianus leucuruswas), black-tailed deer (Odocoileus hemionus columbianus), assorted rodents, and livestock, particularly

sheep, has occasionally been documented and could be a threat to rough popcornflower (U.S. Fish and Wildlife Service 2000, p. 3871). Densities of white-tailed and black-tailed deer are high in much of the Sutherlin Creek area and generally overlap with the distribution of rough popcornflower. Deer herbivory was evident following introduction of rough popcornflower to a wetland mitigation site (U.S. Fish and Wildlife Service 2020, p. 2) and some evidence of sheep herbivory has been documented (U.S. Fish and Wildlife Service 2000, p. 3871). Despite the densities of deer, herbivory does not appear to be causing widespread damage to most rough popcornflower populations. (USFWS, 2021b)

Stressor: INVASIVE PLANT ENCROACHMENT (USFWS, 2021b)
Exposure:
Response:
Consequence:
Narrative: Non-native invasive plants are a primary threat to the establishment of rough popcornflower due to their encroachment of habitat and elimination of bare-ground, which popcornflower seeds require to germinate. Invasive pennyroyal is present at many rough popcornflower sites and controlling this species requires constant effort and is a management priority at the NBHMA, TNC Popcorn Swale Preserve, and Red Rock Park populations. Similarly, teasel and Canada thistle control requires constant effort at the NBHMA, Yoncalla South and the TNC Popcorn Swale Preserve populations. Reed canary grass covered over 70 percent of the Red Rock Park rough popcornflower site for several years and required three years of repeated manual weeding efforts and herbicide treatments to reduce this invasive plant to manageable levels. As discussed above, rough popcornflower is conservation reliant in that some form of active management is necessary to maintain habitat in an early-successional condition. For example, prescribed fire, mowing, manual weeding, and herbicide treatment may be required to help maintain many of the rough popcornflower populations into the future (U.S. Fish and Wildlife Service 2010, p. 27). This is exemplified by the active management practices and population response at multiple locations (see Appendices 2 and 3). Invasive plants appears to be less of a concern on private lands because livestock grazing controls invasive plant growth (citation). Strategic grazing by livestock, in terms of seasonal grazing periods and intensity, when closely monitored, can benefit rough popcornflower populations by reducing plant competition and creating open ground that facilitates seed germination and enables population expansion (U.S. Fish and Wildlife Service 2020, p. 2). Competition with invasive plants is an ongoing threat to rough popcornflower. However, investments in weed control and lessons learned in how to combat invasive species has resulted in flourishing populations. A continued commitment will be needed to maintain these populations (see Appendices 3 and 4). While invasive plants remain a threat to rough popcornflower, this threat can be successfully managed. (USFWS, 2021b)

Stressor: FIRE (USFWS, 2021b)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, fire was considered a necessary natural event key to the formation and maintenance of rough popcornflower habitat (U.S. Fish and Wildlife Service 2000, p. 3867). In late September 2003, an accidental fire occurred at the Soggy Bottoms meadow within the BLM's NBHMA and burned across the introduced rough popcornflower population. The intensity of the fire was moderate but did not sterilize the soil's organic layers. Following the burn, staff noted that individual rough popcornflower plants were much larger, robust, and the

population increased from 1,193 plants in July 2003 to 1,869 plants in July 2004. However, by 2009 the population had been reduced to 15 individuals. The BLM and the Service attributed the rapid population decline to factors other than the burn, including changes in water flow and increased erosion due to stream channelization at the site that affected the hydrology of the site. While the effects of fire in rough popcornflower habitat restoration are still unknown (U.S. Fish and Wildlife Service 2010, p. 27), the fire at North Bank/Soggy Bottoms suggest that low to moderate intensity fire can have short-term beneficial effects to the species. (USFWS, 2021b)

Stressor: CLIMATE CHANGE (USFWS, 2021b)
Exposure:
Response:
Consequence:
Narrative: The likely impacts of climate change on rough popcornflower's ecological processes are closely connected to availability of water. Due to their shallow and ephemeral nature, wet swales in southwestern Oregon are particularly sensitive to increases in evaporation or reductions in rainfall. Strong climate variability is likely to persist in the Pacific Northwest, owing in part to the year-to-year and decade-to-decade climate variability associated with the Pacific Ocean (May et al. 2019, p. 1039). Periods of prolonged drought are projected to intersperse with years featuring heavy rainfall driven by powerful atmospheric rivers and strong El Niño winters (May et al. 2019. p. 1039). Even modest increases in warming could result in more runoff in winter and less in spring and summer, more winter flooding, and drier summer soils, thereby altering the seasonality and duration of wetland hydration (Field et al. 2017, p. 18). Climate change is expected to lead to increased variability in precipitation and to an increased loss of soil moisture due to evaporation and transpiration (Field et al. 2017, p. 18), which may exacerbate effects due to drought. Drought-mediated decreases in water depth and inundation periods could increase the frequency at which wetlands dry before rough popcornflower has completed their flowering and fruiting stages. Climate change could also cause temperatures to exceed those suitable for growth of the species (U.S. Fish and Wildlife Service 2010, p. 28). The expected negative effects of climate change on rough popcornflower include heavier winter rains and limited spring moisture, which would result in decreased fruit production. (USFWS, 2021b)

Stressor: Herbicide use
Exposure:
Response:
Consequence:
Narrative: The species is likely affected by common herbicides. We have no knowledge the species is affected by Malathion or other general contaminants.

Recovery

Reclassification Criteria:
Criterion 1. At least 9 reserves, containing a minimum of 5,000 plants each, are protected and managed to assure their long-term survival. A reserve may be composed of one or more patches of rough popcornflower located within 1 km (0.6 mi) of each other. Criterion 2. A minimum of 500 m2 (5,382 ft2) is occupied by the rough popcornflower within each reserve. Occupied habitat should be determined by using a GPS device to delineate patches of plant, with the GPS data then uploaded into a GIS program to calculate total area. The maximum allowable location error is +/- 3 m (9.8 ft). For patches too small to be delineated accurately, a

GPS point location should be recorded along with a measurement of the occupied area. Criterion 3. A minimum of nine reserves, each meeting the requirements in Downlisting Criteria 1 and 2, are distributed with at least one reserve each in the Calapooya Creek and Yoncalla Creek recovery units, and a minimum of five reserves in the Sutherlin Creek recovery unit. The remaining two required reserves may be located within any of the natural recovery units, or elsewhere within the Lower North Umpqua River (1710030111), Calapooya Creek 6 (1710030301), and Elk Creek (1710030303) Hydrologic Unit Code 10 watersheds containing the recovery units. Criterion 4. Over a 5-year period with a minimum of 3 individual years of monitoring, demographic data indicate that at least seven of the nine reserves have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.

Recovery Priority Number: 8C

Delisting Criteria:
Criterion 1. At least 9 reserves will have established management plans or conservation agreements that include requirements for periodic monitoring and habitat maintenance. Habitat maintenance must prioritize the removal of woody vegetation and non-native invasive plants. Criterion 2. Seed accessions need to be collected from all 9 reserves and submitted for long-term storage at a local seed bank repository, with a minimum of 15,000 seeds per reserve stored for use in future augmentations or to re-establish each source population should one ever be extirpated. Criterion 3. Over a 10-year period with a minimum of 7 years of monitoring, demographic data indicate that populations in at least seven of the 9 recovery reserves have average population numbers that are stable or increasing, without decreasing trends lasting more than 2 years.

Recovery Actions:

- Recovery Measures for Popcornflower: Evaluate the status of all existing populations. Conduct surveys to search for new populations. Rough popcornflower populations will have reserve status if protected and meet recovery criteria of 5,000 plants. Currently we consider 12 of 18 populations protected. Protect habitat to be included in reserves Provide educational opportunities for landowners/managers/general public Use of existing authorities and applicable regulations Evaluate techniques to reduce competition Evaluate techniques to reduce impacts of woody succession Implement control measures: Implement appropriate management to reduce competition and control woody plant succession Collect seeds from extant sites Produce and establish transplants Monitor existing populations Identify ecologically appropriate habitat Protect population introduction sites Produce and establish transplants Manage populations to promote viability Monitor new populations to determine viability Rank populations. Collect and bank seeds Evaluate population genetic diversity Evaluate pollinator availability Provide outreach services for reserve owners and the general public Evaluate the status of Plagiobothrys hirtus Inventories for new and known populations of popcornflower were conducted throughout the species range in 2005 and 2014 by ODA (K. Amsberry, Oregon Department of Agriculture, pers. comm. 2014). Documentation of the distribution and abundance of popcornflower began in 1995 and has continued annually at most sites in most years; the exceptions are 2001 for BLM populations and 2008 to 2011 for TNC populations (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Recommendations: • Recommend downlisting to threatened. • In cooperation with partners, continue to manage rough popcornflower, utilizing best management practices for this conservation-reliant species. • Enhance protection for, and augment, existing populations in the Calapooya Recovery Unit by ensuring protection through formal conservation agreements, management plans or publicly established reserves for the Nonpareil and other populations in this Recovery Unit. • Reintroduce rough popcornflower into suitable habitat, particularly in locations that will contribute to meeting recovery criteria. • Continue to pursue protected/reserve status of wetland and wet-swale habitat conditions benefitting rough popcornflower. (USFWS, 2021a)
- Vegetation Control Mowing is a management tool utilized in rough popcornflower habitat to control competing native plant species and invasive species as well as to prepare for outplanting efforts. The Red Rock Park, Wilbur Mitigation Site, the Southside Swale, and the ODOT Yoncalla South populations are regularly mowed and rough popcornflower populations have expanded. A late summer and fall mowing at Red Rock Park was instrumental in combatting pennyroyal growth throughout much of the site and resulted in the largest ever plant count at this location (U.S. Fish and Wildlife Service 2020, p. 2) (Table 2). The Service funds mowing at the Southside Swale and the TNC Popcorn Swale Preserve to control native graminoids, non-native grass, and pennyroyal. In the last 15 years, the Service funded various non-native invasive plant and native vegetation management at four rough popcornflower populations (Southside Swale, Red Rock Park, TNC Popcorn Swale Preserve, and Orenco Ponds). The initial results were promising for the four sites, which saw increased population numbers. Non-native and native tree thinning conducted in 2004, at the TNC Popcorn Swale Preserve resulted in the highest number of rough popcornflower plants recorded for the preserve (three years post-treatment). Unfortunately, over time and without further vegetation management, the native and non-native plants (spreading rush and pennyroyal) responded more aggressively than rough popcornflower and encroached on much of the habitat formerly occupied by the plant, leading to an overall population decline. The population is slowly rebounding and TNC has plans to mow the property annually, with the expectation that plants will spread into previously occupied habitat. There is no planning to utilize grazing or prescribed burns for vegetation control at this time. Fencing Fencing can protect populations from anthropogenic disturbance. The Sutherlin Red Rock Park rough popcornflower population was regularly affected by horse trampling and used horse bedding was tossed into the wetland area supporting rough popcornflower. The plants were often smothered while competing with aggressive grass and pennyroyal. Since the area was enclosed with fencing and signed with information about rough popcornflower, the plants are no longer subject to trampling and no longer smothered with the bedding and thus are able to grow in denser patches, compete better with the grass and pennyroyal, and occupy more space than prior to fencing. Introductions and Augmentation In 1998, before the species was listed, rough popcornflower plants were introduced to three locations on BLM managed lands. Two of the populations were successful and are still extant. Rough popcornflower was also introduced to the Orenco Ponds mitigation site in 2011 on a parcel owned by Douglas County and at a privately held mitigation site in 2001 (ODOT Wilbur Mitigation Site). Rough popcornflower was also successfully augmented at the Douglas SWCD property, the ODOT Wilbur Mitigation Site, and a second ODOT mitigation site (Del Rio Mitigation Site). In 2016, a new population was introduced to the NBHMA (Soggy Bottoms Sister) and is a recovery level population (i.e., greater than 5,000 plants) (J. Brown, pers. comm. 2020). Stakeholder workshops Five stakeholder meetings occurred between 2004 and 2016, at which population and species needs, recovery targets, and habitat conservation were discussed. At the most recent meeting, the agencies and landowners indicated that the species was making significant progress in recovery. Conservation Agreements Collaboration among stakeholders plays an important role in species management. For example, a Management

Plan between the Service, City of Sutherlin, ODA, and Douglas SWCD was finalized to protect and maintain the populations on Sutherlin and Douglas SWCD properties in 2007. For information specific to each reserve and other populations of rough popcornflower, see Appendices 2 and 3.

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SPECIES ACCOUNT: *Plagiobothrys strictus* (Calistoga allocarya)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, 1-4 dm tall. White flowers appear March-April in a slender, curved inflorescence. (NatureServe, 2015)

Historical Range

Historically, three populations of Plagiobothrys strictus were documented within a 3-kilometer (2-mile) radius of Calistoga, Napa County, California. Prior to listing one population had been extirpated due to urbanization and agricultural land conversion (California Native Plant Society 2008a). (USFWS, 2010)

Current Range

The range extent covers a small area in Napa County, near Calistoga. The total range is only about 14 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Plagiobothrys strictus is an annual herb in the Boraginaceae (borage family) (USFWS, 2010).

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits geyser- and hot spring-fed vernal pools and swales in meadows at 90-160 m elevation. Soils are clay or gravelly-clay loams. These pools contain high concentrations of boron and sulfates - substances that are toxic to most plants. Associated species include the rare Napa blue grass (Poa napensis). (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:
Decreasing (NatureServe, 2015)

Population Growth Rate:
Decline of 30-50% (NatureServe, 2015)

Number of Populations:
1 (USFWS, 2023)

Population Size:
297,963 plants (USFWS, 2023)

Adaptability:
Highly vulnerable due to annual habit and location in wetlands. (NatureServe, 2015)

Population Narrative:
Highly vulnerable due to annual habit and location in wetlands. Decline of 30-50% .Population size of this annual fluctuates from year to year. In some good years, as many as 6000 plants were reported. There are only 2 extant EO's ;there is a third, historical EO. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and individuals. Historically, there were only three known populations of both the Calistoga allocarya and the Napa bluegrass. The three populations of Calistoga allocarya were documented within a 3- kilometer (2-mile) radius of the city of Calistoga in Napa County, California; however, prior to listing one of the populations was extirpated due to urbanization and agricultural land conversion (Service 1997, pp. 55792, 55799). At the time of listing and our 2010 status review, there were two extant occurrences of Calistoga allocarya: one within a property that contains Myrtledale Hot Springs (hereafter referred to as the hot spring property) and the other on a property where the former Calistoga glider airport is located (hereafter referred to as the airport property) (Service 1997, p. 55792; Service 2010, p. 4). The combined area of the two remaining populations is less than 80 square meters (900 square feet) (CNPS 1990 as cited in Service 1997, p. 55792). The three historical occurrences of Napa bluegrass were also entirely within Napa County: two were on the hot spring property and the third was on the airport property (Service 2010, p. 4). Prior to listing, one of the Napa bluegrass populations on the hot spring property was extirpated (Department 1989, p. 2), and at the time of listing, two populations of Napa bluegrass, one at the hot spring property and one at the airport property, remained (Service 1997, p. 55799). The total area occupied by Napa bluegrass was estimated to be slightly greater than 100 square meters (1,100 square feet). In 1994, near the time of listing, the population of Calistoga allocarya at the airport property had approximately 5,000 plants within 180 square meters (2,000 square feet) (J. Ruygt 1996 as cited

in Service 2010, p. 5). Surveys carried out prior to the last status review in 2009 estimated the airport property population size at between 3,310 and 5,000 individual plants (Service 2010, p. 6). Since the 2010 status review, the population of Calistoga allocarya at the airport property has been surveyed annually from 2013–2022, except for 2020 due to Covid restrictions (WyrickBrownworth et al. 2021, p. 3) (see specific counts in Table 1, below). The number of plants counted during these annual surveys is heavily influenced by the survey methods. Surveys consisting of weekly walk-throughs of the property from early spring to early summer (January – May) are preferable as identification of individuals is difficult later in the summer when the plants have already senesced and lost their flowerheads. In 2019, the total population for Calistoga allocarya equated to 297,963 plants within the airport property (Wyrick-Brownworth et al. 2021, p. 6). (USFWS, 2023).

Threats and Stressors

Stressor: Commerical/Residential Development (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The two Plagiobothrys strictus and Poa napensis populations exist on private land and could be developed. The airport property will be required by the City of Calistoga to be evaluated under the California Environmental Quality Act for the environmental effects to these species, and the evaluation reviewed by the California Department of Fish and Game, if and when any development should ever be proposed. According to the City of Calistoga Zoning Map, one property is zoned as Rural-residential and the former airport property is zoned Commercialairport (City of Calistoga 2003). Given that both species' population sizes are very small and restricted to two locations, development of these parcels could lead to the extinction of both species. The occurrences of the two species on the second private parcel (Myrtledale Hot Springs) in the City of Calistoga had been proposed for a new hospital (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: the California and Federal Endangered Species Acts are the primary State and Federal laws, respectively, that provide protection for this species since its listing as endangered in 1997. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2010).

Stressor: Human activities (USFWS, 201)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Poa napensis individuals within the Myrtledale Hot Springs population could be lost to trampling should the number of hikers increase to the hot spring, the paved road is widened, or the property owner decides to alter the landscape causing the alteration of hydrology. Because the most recent observation of six Poa napensis individuals was in 2007 and conducted from

outside the property boundary (Occurrence #1, CNDDB 2009b), the risk of human activities may be even greater since a more accurate count of individuals does not exist currently. The former Calistoga airport parcel could be mowed or its hydrology could be altered presenting unknown magnitude of risk to the populations of either species since neither population has been thoroughly surveyed since 1996 (P. napensis Occurrence #3 and Plagiobothrys strictus Occurrence #3, CNDDB 2009a) (USFWS, 2010).

Stressor: Restricted Habitat, Range, and Few Numbers of Populations (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of geneitc variability/extinction
Narrative: Species in natural habitats face threats both from deterministic facts such as habitat loss, overexploitation, pollution, introduced species, and stochastic events associated with small population size. Such events may be of a demographic genetic or environmental nature, including catastrophes (World Conservation Monitoring Centre 1992). The estimated population size for Plagiobothrys strictus was over 5,000 individuals in 1994 (Occurrence # 3, CNDDB 2009a) and six plants in 2007 as observed from the edge of the second property boundary for Poa napensis (Occurrence #1, CNDDB 2009b). Both species' populations could be susceptible to extirpation from random events due to their restricted range. Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations (Menges 1991; Ellstrand and Elam 1993)

Stressor: Invasive plant species (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition from invasive plant species poses a potential threat to both species. Exotic and/or invasive, weedy plant species reduce native plant diversity and diminish the habitat suitability for native species; this is particularly the case in sensitive habitats (G. Cooley, California Department of Fish and Game, pers. comm. 2008). The consistent pattern of heavy growth of nonnative grasses when not controlled by grazing or other management can 'smother' native plants, resulting in the subsequent crowding out, outcompeting, or overshadowing of native annuals. A common consequence of such heavy annual grass growth is development of thatch, which adds to the strong smothering effect by inhibiting annuals' germination and growth (Weiss et al. 2007) (USFWS, 2010).

Stressor: Climate Change and Drought (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these modeling results, Plagiobothrys strictus and Poa napensis plants could be unable to shift their range because of their isolated, small populations, whose growth depend upon particular

hydrological regimes, and the limited available, suitable habitat surrounding the two private parcels (USFWS, 2010).

Recovery

Reclassification Criteria:
Recovery Priority Number: 5C

Recovery Actions:

- No final recovery plan has been completed for these species (USFWS, 2010).
- Work with the landowners, the California Department of Fish and Game, the City of Calistoga, and California Native Plant Society to ensure the protection of all known populations of Plagiobothrys strictus and Poa napensis (USFWS, 2010).
- Work with the landowners, the California Department of Fish and Game, the City of Calistoga, and California Native Plant Society to ameliorate or eliminate any threats to Plagiobothrys strictus and Poa napensis from hydrological changes and from competition from nonnative plants (USFWS, 2010).
- Collect seeds from both species from both parcel sites and store them in Center for Plant Conservation certified botanic gardens to guard against extirpation of populations from chance catastrophic events (USFWS, 2010).
- Follow conservation measures and policies as stated in the 2007 Napa County General Plan Update (USFWS, 2010).
- Follow conservation measures and policies as stated in the 2003 City of Calistoga General Plan for sensitive plant species (USFWS, 2010).
- Conduct a population assessment for each species and continue monitoring over the next 5 years (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Calistoga allocarya and Napa bluegrass. Some of these recommendations were discussed in the last status review (Service 2010, p. 16) and remain valid. 1. Partner with private landowners, the California Department of Fish and Wildlife, the City of Calistoga, and the California Native Plant Society to ensure protection of all known populations of Calistoga allocarya and Napa bluegrass. 2. Work with the California Department of Fish and Wildlife, the City of Calistoga, and the California Native Plant Society to ameliorate or eliminate any threats to Calistoga allocarya and Napa bluegrass from hydrological changes and competition from invasive plants. 3. Collect seeds from both populations of both species and store them in Center for Plant Conservation certified botanic gardens to guard against extirpation from chance catastrophic events. 4. Follow policy CON-17 and associated conservation measures as stated in the Napa County General Plan to “Preserve and protect native grasslands, serpentine grasslands, mixed serpentine chaparral, and other sensitive biotic communities and habitats of limited distribution” (Napa County Department of Conservation, Development, and Planning 2009, p. CON-28). 5. Follow policies P1.1-3 and P1.1-4 and associated actions as stated in the Open Space and Conservation Element (Updated 2012) of the City of Calistoga General Plan to continue “efforts to identify and map biological resources on the gliderport property [airport property], which provides an important and unique habitat area within the city limits” and “explore the possibility of designating parcels as Natural Resource Preservation

Areas in areas of the city known to contain sensitive and unique species, in order to protect these resources" (City of Calistoga 2012, p. OSC-23). 6. Conduct a population assessment for each species and continue monitoring annually (USFWS, 2023)

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SPECIES ACCOUNT: *Pleodendron macranthum* (Chupacallos)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 11/25/1994

Physical Description

A small to medium size aromatic evergreen tree reaching 10 meters (33 feet) in height, 20 centimeters (8 inches) in diameter with brownish twigs that are slender and hairless. Leaves are alternate, simple, leathery, entire, measuring 8.5 - 12.5 centimeters (3.5 - 5.0 inches) long and 4.5 - 5.0 centimeters (1.7 - 2 inches) wide. The blades are elliptic with the upper surface dark shiny green and the mid-vein sunken. The lower surface is pale green with a prominent mid-vein and with fine, parallel side veins. The leafstalks are about 7 millimeters (.25 inches) long and canal-shaped (Vivaldi etal. 1981). The solitary flowers, whitish in color and bisexual, are axillary and are subtended by a long flower stalk 2.5 centimeters (1 inch) long. The flowers are 2 centimeters (.8 inches) wide with 3 sepals, 12 petals and many united stamens. The cup-shaped calyx is persistent in the fruit. The aromatic purplish black fruit measures 2 centimeters (.8 inches) in diameter and contains many rounded, shiny brownish black seeds. The wood is described as nearly white, hard, and heavy (Little et al. 1974) (USFWS, 1998).

Taxonomy

There are no recent taxonomic or nomenclatural changes for P. macranthum, which was originally described as Cinnamodendron macranthum. Its closest relative, P. ekmanii, is a very rare tree from Haiti (Little et al., 1974) whose present status is unknown. The other member of the Canellaceae family in Puerto Rico is Canella winterana, a dry forest species (USFWS, 2014).

Historical Range

See current range/distribution.

Current Range

Known from the Caribbean National Forest and the Rio Abajo Commonwealth Forest, which are administered by the USDA Forest Service and the Department of Natural and Environmental Resources (USFWS, 1998). The populations at El Yunque National Forest (EYNF) consisted of nine trees at the Jimenez Ward and two separated trees at Mameyes II Ward in Rio Grande. However, none of these populations were located during the latest surveys conducted by University of Puerto Rico at Mayagiiez personnel in March 2011. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Plethodendron macranthum has been collected with flowers in February, April-June, and with fruits in June-August (Little et al. 1974) (USFWS, 1998).

Reproduction Narrative

Adult: Very little is known about the reproductive biology of Pieodendron macranthum and Eugenia haematocarpa due to their extremely low population numbers and isolated locations. Plethodendron macranthum has been collected with flowers in February, April-June, and with fruits in June-August (Little et al. 1974). This species is known to reproduce successfully on the forest; specimens with fruit have been encountered in July (USDA Forest Service 1993) (USFWS, 1998).

Habitat Type

Adult: Forest (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1998)

Site Fidelity

Adult: High (inferred from USFWS, 1998)

Habitat Narrative

Adult: Plethodendron macranthum is known to exist in the subtropical wet (tabonuco forest type) and the subtropical lower montane wet (palo colorado forest type) forest life zones (USFWS, 1998). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Population Information and Trends

Number of Populations:

6 natural populations (USFWS, 2022)

Population Size:

~24 natural individuals 55 outplanted (USFWS, 2022)

Population Narrative:

Overall, the majority of the known individuals of Chupacallos are planted trees. There are 97 known individuals in the wild, and 70 percent have been planted (Table 1). Of the 21 naturally occurring individuals, none have been observed during the last decade. The 97 individuals occur in 10 populations, 6 of which are experimental populations consisting of planted individuals (USFWS, 2014). Low representation, resiliency and redundancy are inferred based on the low number of populations and individuals as well as the specific habitat needs of the species. In the 2014 5-year status review, we reported 30 individuals of chupacallos planted by PRDNER at Guavate in the Carite Commonwealth Forest (CCF), but the is no updated information about their current status. Therefore, based on the best available information, the current estimated number of plants of chupacallos is 24 individuals in 6 natural localities, and 55 planted

individuals distributed in 6 locations (USFWS, 2022)

Threats and Stressors

Stressor: Deforestation (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails maintenance, and shelter construction were identified as threats to both Chupacallos and Uvillo. Based on the available information, the core of the known populations of Chupacallos and Uvillo occurs within the boundaries of Federal, State, or other protected areas. Within these areas, there is no direct evidence of populations or individuals being affected by forest management practices. Therefore, USFWS no longer considers forest management practices a threat to Chupacallos or Uvillo. However, the largest known population of Uvillo lies within Las Robledas along a ridge that marks the boundary of several private properties and some clusters of individuals lie within neighboring properties that are not managed by the PRCT. Boundary management practices (clearing and fencing) may affect individuals along these areas. Similarly, land clearing for agricultural purposes and urban development may affect the small populations of Uvillo within private properties at the Sierra de Cayey, including the private properties adjacent to Las Robledas. Undetected populations of Chupacallos and Uvillo might be affected by deforestation for urban development on the periphery of El Yunque National Forest. In the northern Karst 13 region, suitable habitat for these species may be affected by rock quarries, particularly in the Quebradillas and Isabela area. The present or threatened destruction, modification, or curtailment of the species habitat or range remains a threat to Chupacallos and Uvillo. However, since the majority of the known populations lie within properties managed for conservation and there is no direct evidence of populations being affected by habitat destruction or modification, we consider this threat to be low in magnitude and non-imminent (USFWS, 2014).

Stressor: Storms (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Hurricanes and landslides are listed as a threat to this species (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes, exposure to those changes, and the adaptive capacity of the species (Glick et al. 2011). Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of Chupacallos and Uvillo may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Climate change may also compromise natural recruitment by affecting the survival of seedlings. Despite the low number of populations and individuals (particularly for

Chupacallos), at this time the USFWS considers hurricanes, landslides and climate change a moderate and non-imminent threat to both species. Climate change is occurring gradually and the frequency of severe hurricanes is low (USFWS, 2014).

Stressor: Decreased genetic variation (USFWS, 2014)
Exposure:
Response:
Consequence: Lack of genetic variability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007), and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and low number of known natural populations of Chupacallos, it is likely that their genetic variability is low. As previously indicated, all reported populations consist of less than 10 individuals, and in some cases they are represented by a single individual. Despite the reports of new populations of Uvillo, this species may be affected by genetic depression due to the low number of individuals in some populations, as it is evident that the species was severely affected by former habitat fragmentation due primarily to extensive deforestation for agriculture. However, the wide distribution and geographical isolation of the species, from the eastern to the northwestern side of the Island (i.e., El Yunque National Forest, Sierra de Cayey, and Guajataca Commonwealth Forest), with different environmental conditions, suggests that the species may show high interpopulation genetic variability. In order to safeguard the remaining genetic diversity, the origin and survival of reintroduced individuals needs to be monitored as well as their development into mature individuals. The protection and monitoring of known adult individuals should be considered a high priority for the conservation of Chupacallos and Uvillo. Based on the above, we consider the lack of genetic variation is a high and imminent threat to Chupacallos, and a low and non-imminent threat for Uvillo (USFWS, 2014).

Stressor: Lack of natural recruitment (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of genetic variability
Narrative: Without natural recruitment or successful augmentation from captive propagated individuals, populations (natural and reintroduced) of Chupacallos are likely to become extirpated as older individuals naturally die. Despite future efforts to enhance natural populations by planting seedlings and saplings, it is unknown if planted individuals will develop into mature plants capable of reproducing. Therefore, we consider the lack of natural recruitment a high and imminent threat to Chupacallos (USFWS, 2014).

Recovery

Reclassification Criteria:
The two species will be considered for down listing when the following criteria are met: 1. An agreement between the USFWS and the USFS concerning the protection of Chupacallos and Uvillo within the Caribbean National Forest property has been prepared and implemented (USFWS, 2014).

2. An agreement between the USFWS and the PRDNER concerning the protection of these two species in Commonwealth Forests, specifically Río Abajo, for Chupacallos, has been prepared and implemented (USFWS, 2014).

3. New populations (the number of which will be determined by appropriate scientific studies) capable of self-perpetuation have been established within protected areas (USFWS, 2014).

Recovery Priority Number: 8

Delisting Criteria:
1. Three (3) natural populations of uvillo and two (2) populations of chupacallos exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).

2. Establish or discover two (2) new populations of uvillo and seven (7) new populations of chupacallos within the historic range of the species that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and populations extending onto private lands are protected through a conservation mechanism (addresses Factors A and E). (USFWS, 2019).

3. Threat reduction and management activities (e.g., trail maintenance) have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A). (USFWS, 2019).

Recovery Actions:
- Criterion 1 has been partially initiated. There is no formal agreement between the USFS and USFWS for the implementation of a management plan to protect Chupacallos and Uvillo. Nonetheless, under Section 7 of the Endangered Species Act (ESA), Federal agencies are mandated to carry out programs for the conservation of endangered species. Under the ESA, it must be ensured that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of an endangered species. The USFS and USFWS have developed a good communication relationship, and USFS always consults with USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. Further coordination is needed for the long term monitoring of natural populations and propagation of Chupacallos and Uvillo (USFWS, 2014)
- Criterion 2 has been partially met. The Río Abajo Commonwealth Forest has an approved management plan that recognizes the presence of Chupacallos within the forest. Furthermore, PRDNER has listed Chupacallos as endangered, and as part of their list of critical elements. Species on the list of critical elements receive special consideration when evaluating development actions within suitable habitat. However, there is no formal agreement in place between USFWS and the PRDNER to protect Chupacallos populations within the Río Abajo Commonwealth Forest. Further coordination is needed 6 for the long term monitoring of natural populations and the propagation of Chupacallos. Because the species is not monitored on the forest, adverse impacts to the populations could be occurring due to forest management practices (e.g., opening of new trails and research projects) (USFWS, 2014).

- Criterion 3 has been initiated. Several natural populations of Uvillo have been reported since the species was listed in 1994. The Puerto Rico Conservation Trust (PRCT) has conducted an exhaustive evaluation of two recently discovered population in the municipality of Cayey in two properties known as Las Robledas, and Sotomayor del Toro and have consulted with the USFWS about adequate management practices for these populations. USFWS biologists visited the population at Las Robledas and it seems to be healthy and may set the standards to establish further viable populations within these areas (Las Robledas and Sotomayor del Toro) and other Commonwealth protected areas. Furthermore, a germination experiment with Uvillo is being conducted by the PRCT in their greenhouse at Río Piedras, which is expected to improve our knowledge on the propagation of this species (USFWS, 2014). Despite the lack of available information about the natural populations of Chupacallos, this species was successfully propagated by Dr. Eugenio Santiago (professor at UPRRP). The material produced in this effort has been used to establish a new experimental population of Chupacallos in an area adjacent to the aviary of the Puerto Rican parrot at El Yunque National Forest. However, more information on the reproductive biology and ecology of this species is needed in order to establish what constitute a viable population. Thus, further research and monitoring of planted individuals of Chupacallos is needed (USFWS, 2014).
- Refined recovery action for 2019: Monitoring should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., natural recruitment, lack of pollinators or seed dispersers). This recovery action should be coordinated with Puerto Rico Department of Natural and Environmental Resources and United States Forest Service and be included within Task 121,212,323, 324: Monitor all known populations, Assess periodicity of flower production and pollination activity, Assess seed viability and Evaluate seedling establishment and growth of the approved recovery plan. (USFWS, 2019).
- 1. Studies should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., lack of pollinators or seed dispersers) (USFWS, 2014).
- 2. All known populations should be marked and monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine any possible adverse effects on the populations (USFWS, 2014).
- 3. The previous ex situ conservation efforts (individuals reintroduced to the wild) should be monitored and further similar efforts should be undertaken to enhance the status of both species (USFWS, 2014).
- 4. The USFS and USFWS should develop a comprehensive survey program to inventory areas with potential habitat. This program should include training to field biologists of both agencies so these personnel is able to recognize listed species on the field (USFWS, 2014).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed material should be developed and implemented to avoid altering the natural recruitment of the species. Enhancement of natural populations should be considered particularly for Chupacallos. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2014).
- 6. The recovery plan should be revised to establish measurable down listing and delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist these species (USFWS, 2014),

- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations in order to develop a plan to preserve the species genetic variability (USFWS, 2014).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. Studies should be conducted on both species' phenology and reproductive biology to address other limiting factors affecting these species (e.g., pollinators and seed dispersers). 2. Previous and ongoing planting efforts (individuals reintroduced into the wild) should be monitored, and further similar efforts should be undertaken to enhance the status of both species. 3. The U.S. Forest Service and the Service should develop a comprehensive survey and monitoring program to inventory known localities and potential habitat. This effort should provide continuity to the surveys and methodology implemented by PRDNER (2016). Populations should be monitored on a regular basis, and additional visits should be made after hurricanes or other major disturbances to determine adverse effects on the populations. 4. A propagation plan that considers the species populations genetics (geographic distribution) and habitat, should be developed for both species. A protocol to collect seed material should be developed and implemented to avoid altering the natural recruitment of the species. Enhancement of natural populations should be considered, particularly for chupacallos. 5. Studies should be conducted to determine the patterns of genetic variation within and among populations to develop a plan to preserve the species genetic variability (USFWS, 2022).

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SPECIES ACCOUNT: *Pogogyne abramsii* (San Diego mesa-mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An aromatic annual herb, 1-3 dm tall, covered dense, curved hairs. Flowers (April-June) are lavender, 11-14 mm long. (NatureServe, 2015)

Taxonomy

There has been some debate whether Pogogyne abramsii is taxonomically distinct from Pogogyne nudiuscula. Abrams (195 1) recognized this species but considered it possibly not distinct from Pogogyne nudiuscula. Current work (Jokerst 1993; McMillan unpublished data 1995) supports taxonomic distinction. Not only do the two species differ in the calyx pubescence (hairiness) and bract morphology, but also in the number of flowers per stem node. All of the current Pogogyne populations north of Mission Valley and south of Del Mar Mesa are still considered to be Pogogyne abramsii. The populations from the central (San Diego) mesas were probably Pogogyne abramsii, but with such limited herbaria records, this question will probably never be fully resolved (USFWS, 1998).

Historical Range

Historically, outside of Pogogyne abramsii's current range, it is thought to have occurred around Linda Vista, the vicinity of Balboa Park, Normal Heights, and the area surrounding San Diego State University (USFWS 1998a, p. 12; Zedler et al. 1979), however some confusion has existed regarding P. abramsii's historical range due to misidentified herbarium specimens (identified as Pogogyne nudiuscula) and vague references regarding collection sites. (USFWS, 2010)

Current Range

California endemic. San Diego Co., mesas from San Diego to Miramar. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015)

Breeding Season

Adult: May and June (USFWS, 2010)

Reproduction Narrative

Adult: The family is primarily bee pollinated (Proctor & Yeo, 1973, p. 219).; (NatureServe, 2015). Pogogyne abramsii usually blooms in May and June when water is absent from the vernal pool (Munz 1974, p. 531). The plants produce fruit, dry out, and senesce in the hot, dry summer

months. Pollination of P. abramsii was described by Schiller et al. (2000, p. 392) by monitoring insect visitors to individual plants on Del Mar Mesa. They found the Eurasian honey bee (Apis mellifera) and two anthophorid bees (Exomalopsis nitens and E. torticornis) to be the most common and likely pollinators of P. abramsii. They also documented that P. abramsii is selffertile but has greater seed set when cross-pollinated (Schiller et al. 2000, p. 393) (USFWS, 2010).

Habitat Type

Adult: Vernal pool (NatureServe,2015)

Environmental Specificity

Adult: Narrow/specialist

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits vernal pools on coastal terraces (mesas) at 100-200 m elevation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Zedler and Black (1992, p. 4) found that Pogogyne abramsii seeds germinated and grew from pellets of brush rabbits and Audubon's cottontail rabbits (Sylvilagus bachmani and S. auduboni), which were collected from vernal pools on Del Mar Mesa and Miramar Mesa. They postulated that rabbit movement may be a potential mechanism for dispersal and genetic mixing of vernal pool obligate species. In addition P. abramsii seeds float, which may result in limited dispersal opportunities when pools interconnect or lakes fill their basins in years of greater than average precipitation (Scheidlinger 1981, p. 54) (USFWS, 2010).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2010)

Number of Populations:

43 extant/presumed extant (USFWS, 2023)

Population Narrative:

About 36 populations believed extant (NatureServe, 2015). USFWS (2010) indicates that the species population levels are decreasing. Low resiliency, representation and redundancy are inferred based on the low number of known populations and decreasing population trends. Based on current updates from 2010, there are 43 distinct Pogogyne abramsii locations still potentially occupied (Figure 1, Table 1), of which 36 are extant and 7 are presumed extant. There are 25 Pogogyne abramsii locations that are considered extirpated or possibly extirpated, of which 22 are extirpated and 3 are possibly extirpated. A total of 22 locations have been extirpated since listing (3 occurrences that were historically occupied were considered extirpated prior to listing) and several past occurrences from the 2010 5-year review have been split into new, more specific occurrences. Vernal pool restoration sites MV-22 and Del Mar Mesa – Zamudio represent new occurrences for the species that did not exist during the 2010 5-year review. It is also possible that P. abramsii occurs at other locations that have not been surveyed or detected. We have new information about the status of Pogogyne abramsii locations from local monitoring efforts, which occur annually at several sites. The City of San Diego monitors several vernal pool complexes including Carroll Canyon (D5-8), Del Mar Mesa (H1-10, 13-15, 18-26), Greystone Torrey Highlands (H39), Lopez Ridge (B7-8), and Montgomery Field (N5-6) as described in the VPHCP and associated the Vernal Pool Monitoring and Management Plan. Biologists record occupancy at occurrences, percent cover, and provide notes at multiple locations (City of San Diego 2021, pp. 1-3). The occurrence table (Table 1) has been updated to reflect the current status of P. abramsii locations resulting from these monitoring efforts. In summary, the species is extant or presumed extant at 43 locations and a total of 25 locations are considered extirpated or possibly extirpated. Overall, the species distribution remains restricted to southern San Diego County as described in our 2010 5-year status review, and this information does not alter our understanding of the distribution of Pogogyne abramsii (USFWS, 2023).

Threats and Stressors

Stressor: Road widening (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Since listing, road projects have continued to impact Pogogyne abramsii occurrences. Though future work on Highway 163, Highway 52, Interstate 15, or Miramar Road could impact P. abramsii habitat, we don't currently consider road widening projects a direct threat. Camino Del Sur is being extended through vernal pool habitat in Del Mar Mesa (EO 38, H18-23) and while no direct impacts from the road are expected to impact P. abramsii, indirect impacts such as edge effects are possible (S. Wynn, 2010, pers. obs.). Edge effects to P. abramsii are evident as a result of road widening projects, creating outer bands of habitat distant from the center but immediately proximal to a different type of habitat, thus providing a different species composition and abundance divergent from the interior of the habitat (Forman and Gordon 1986, p. 108). These edges may allow P. abramsii to be in closer proximity to disturbed areas, which may facilitate the incursion of invasive, nonnative plants. Edge effects degrade extant interior habitat and create an island of the protected habitat/reserve through isolation and decrease the effective size and serviceability of a conservation area (Diamond and May 1976, pp. 228–252). Characteristics of habitat islands include less resistant habitat, more disturbed habitat, areas more susceptible to invasive species, areas with native species less resistant to disturbance, and higher seed immigration (Meyers and Bazely 2003, pp. 34-50). Further development of the

roads mentioned above and surrounding areas would exacerbate these impacts (USFWS, 2010).

Stressor: Urban Development (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Since listing, many Pogogyne abramsii occurrences impacted by approved development have been restored, partially restored (may include reshaping the basin, transplantation of inoculum containing P. abramsii seeds), or pools have been created to mitigate unavoidable losses (Appendix 1). These mitigation efforts are designed to help offset impacts from development of vernal pool habitat and are required under the MSCP; however, the long-term viability of such efforts remains unclear (Black and Zedler 1998). While restructured and inoculated pools (which represents the most intensive of restoration treatments) present a much more "natural" appearance than disturbed pools, the degree to which these pools resembles the original pools is unknown (Black and Zedler 1998, p. 197). Black and Zedler (1998, p. 205) also state that "there is no assurance of success, and restored pools, unless restored from only minor disturbance, do not have the same historic and scientific interest as undisturbed pools." Successful restoration must include long-term maintenance and monitoring to ensure that the P. abramsii and other vernal pool species persist. Development continues to threaten Pogogyne abramsii, and will not, in the foreseeable future, be reduced as a threat until sufficient private land supporting vernal pools has been conserved or purchased for reserves (USFWS, 2010).

Stressor: Off-Highway Vehicles (OHVs) (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: OHV use remains a threat to at least eight EOs including (11 vernal pool complexes), and is a predominant threat on Del Mar Mesa (Appendix 1). Installation and maintenance of fencing and signage are needed to help protect P. abramsii habitat from the impact of OHV users (USFWS, 2010).

Stressor: Military Activities (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals/loss of habitat
Narrative: Provisions under the Integrated Natural Resources Management Plan (INRMP) guide conservation and management of Pogogyne abramsii habitat on MCAS Miramar (see Factor D for further discussion). The military must maintain the flexibility to adapt the defense mission to political and technological developments (Department of Defense Instruction 4715.3 para. F.1. i(4)). For this reason, vernal pool sites on military lands are not considered fully protected, though threats to P. abramsii habitat are ameliorated under the INRMP. As of July 2010, no training activities or military maneuvers are planned that are expected to negatively impact P. abramsii in the near future (Kassebaum pers. comm. 2010); however military activities are considered a potential threat to all extant occurrences found on MCAS Miramar in the event that unforeseen circumstances necessitate changes in vernal pool management (USFWS, 2010).

Stressor: Alteration of Hydrology (USFWS, 2010)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Although altered hydrology continues to impact this species at six EOs (six vernal pool complexes), the Service has been successful in ensuring implementation of measures to reduce this threat through section 7 consultations. For example, the use of best management practices reduces the amount of runoff entering vernal pool watersheds, and restoration projects are designed to minimize water draining off impervious surfaces into vernal pool watersheds. However, the specific impact runoff has on Pogogyne abramsii is unknown because site specific monitoring has not been conducted. Preserved pools should be monitored for these runoff impacts to identify remediation where feasible and prevent further damage to vernal pool systems (USFWS, 2010).

Stressor: Illegal Dumping (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Illegal dumping was identified as a threat at listing and continues to impact Pogogyne abramsii habitat at Carroll Canyon (EO 27), Del Mar Mesa - Deer Canyon (EO 38, 41; H 17), and Rose Canyon (EO 1) (Appendix 1). Additionally, pool complexes in Murphy Canyon (EO 3) have served as dump sites for domestic refuse in the past (Black and Zedler 1998, p. 203). Trash and other materials can decrease the amount of space available to vernal pool species, disturb the soils, and release toxic substances and pollutants which may make vernal pools inhospitable to P. abramsii. Fencing and monitoring may decrease the impact of this threat on protected lands, however illegal dumping and deterrence on private lands are difficult to control making this a continuing threat to P. abramsii (USFWS, 2010).

Stressor: Nonnative Plants (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Development and other threats that disturb vernal pool habitat allow certain invasive nonnative plants, such as those discussed above, to invade and replace Pogogyne abramsii. Invasive nonnatives pose the biggest threat to P. abramsii and other vernal pool obligates on MCAS Miramar (Kassebaum pers. comm. 2010), specifically, invasive grasses and bromes (e.g Agrostis spp. and Bromus spp.) which outcompete P. abramsii at the drier edges of vernal pools. Therefore, we consider invasive nonnative plants to be a continuing threat to P. abramsii (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, the Act provides the greatest regulatory protection to Pogogyne abramsii. Habitat conservation plans, and the related conservation actions arising from the Act have contributed to short and long term conservation of P. abramsii. The INRMP at MCAS Miramar has created policy mechanisms and partnerships that have restored and conserved vernal pool habitat. Additional potential protection provided by other Federal, State, and local laws and ordinances is discretionary, incomplete, subject to funding availability and changing

missions, and largely dependent on the federally listed status of P. abramsii. As a result, regulatory mechanisms provided by other Federal, State, and local laws and ordinances do not independently or collectively provide adequate regulatory protection to P. abramsii (USFWS, 2010).

Stressor: Human Access and Disturbance (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Separation of Pogogyne abramsii occurrences through habitat loss and fragmentation is often accompanied by effects associated with human access or disturbance associated with adjacent development. These include trampling, OHV-activity, pedestrian introduction of nonnatives, and trash dumping. This can directly impact P. abramsii by crushing, shading, or releasing toxic substances that harm individual plants. Human access and disturbance has been identified as a threat to seven EOs containing nine vernal pool complexes. Trampling by pedestrians and OHVs may damage or kill plants. Pool complex C28 (EO 36) on Mira Mesa was extirpated partly as a result of human access and disturbance, more specifically OHV damage and trampling (City of San Diego 2004). Pool complex H 39 (Greystone Highlands, EO 41) on Del Mar Mesa is vulnerable to human trampling from adults and children trespassing from the nearby residential development (City of San Diego, 2006, p. 34). Protective fencing is used in many conserved occurrence areas to protect vernal pool complexes (Appendix 1). Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still threaten Pogogyne abramsii. Occurrences on private, non-conserved lands remain vulnerable to this threat (USFWS, 2010).

Stressor: Drought and Climate Change (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of haibtat
Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including Pogogyne abramsii) or sites at this time. Although we cannot predict the exact effects of climate change on P. abramsii, it is likely that it will exacerbate identified threats and may introduce new additional threats. A changing climate with spatial and temporal shifting of temperature and precipitation may cause this species specific adaptations to climate to work against its survival. A changing climate may also provide advantages to other native and nonnative plant species. Sharing information between scientists, land managers, and decision makers will increase our ability to address these threats. Increasing the success with which we address current threats to P. abramsii will increase our success of handling the uncertain effects of future climate change (USFWS, 2010).

Stressor: Small Population Size (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of genetic variability/extinction
Narrative: The restricted range and small population of Pogogyne abramsii pose a threat as it increases the possibility that urban development or other activities near remnant pool ecosystems could destroy a significant portion of the species' remaining population and habitat

(USFWS 1993, p. 41390). Pogogyne abramsii is distributed on approximately 19.2 ac (7.8 ha) of vernal pool habitat on MCAS Miramar, and approximately 0.8 ac (0.3 ha) outside the boundary of MCAS Miramar (U.S Marine Corp 2006, p. 5-4; City of San Diego 2004, p. 11). Stochastic events outside the natural range of frequency and severity, such as floods, fires, contamination, or drought, can substantially reduce or eliminate species, such as P. abramsii with a restricted range and small population, and increase the likelihood of extinction (Lande 1993, p. 912). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3-30; Menges 1991, pp. 58 – 61). Allee (1931, pp. 17- 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi – 216). Stephens et al. (1999, pp. 185 -190), Dennis (2002, pp. 389 - 401) and Courchamp et al. (2008, pp. vi – 216) suggest that the Allee effect is a density-dependent event that is inversely related to population size. The isolated vernal pool complex on Los Pensaquitos Canyon (EO 54, complex B5-8) and on Mira Mesa (EO 36, complex B11) are all that remain in both of these areas making P. abramsii susceptible to random events here (USFWS, 2010).

Stressor: Fire control (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire control has been identified as a potential threat to Pogogyne abramsii at two of the 28 extant EOs (four vernal pool complexes) listed in Appendix 1. The ecological effects of fire exclusion in the habitat of southern California has not been specifically detailed for vernal pool habitat, however the processes and structure of fire ecology is comparable to other ecosystems (Keane et al. 2002, pp. 3–11; D'Antonio and Vitousek 1992, pp. 63 - 87). Fire exclusion may affect the natural regulation of succession via selecting and regenerating plants. Species that are adapted to light fire (such as P. abramsii during the dry season) are replaced by species that are able to out compete for growing resources in the absence of fire (Keane et al. 2002, pp. 3 - 11). While complete fire exclusion may result in Pogogyne abramsii being outcompeted for space, the alternative may pose an equal threat as fires at critical times can eliminate populations of P. abramsii by killing individual plants, overheating soil to create hydrophobic conditions, or intense heat which kills or eliminates the seed bank (Agee 1993, pp. 1–493; Keane et al. 2002, pp. 3–11; Keeley 2001, pp. 81–94; Arno and Fiedler 2005, pp. 7-38). The severity of fires may be exacerbated by a greater fuel load provided by nonnatives (Bauder 1996, p. 3), and a higher density of established native upland species that have not been disturbed by fires in the past (MALGBC 2007, p. 7). Fire suppression has been identified as a threat at Del Mar Mesa which could act as a staging ground for fire control activities if a fire began (City of San Diego 2006, pp. 37, 42). Currently a burn study is being conducted on MCAS Miramar to determine how fire impacts vernal pool species. Initial observations show that there is no difference between species composition between burned and unburned vernal pools (Kassebaum pers. comm. 2010) (USFWS, 2010).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
"Existing vernal pools and their associated watersheds…should be secured from further loss and degradation. Habitat functions and species viability… must be ensured… Maintaining habitat function and species viability (as determined by prescribed research tasks)" (USFWS, 2010)

The existing vernal pools and their associated watersheds contained within the complexes…are secured in a configuration that maintains habitat function and species viability (as determined by recommended research); (USFWS, 2010)

Secured vernal pools are enhanced or restored such that population levels of existing species are stabilized or increased; (USFWS, 2010)

Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification. Monitoring should continue for a period of at least 10 years following reclassification to ensure population stability" (USFWS 1998a, p. iv-vi). (USFWS, 2010)

Recovery Priority Number: 8C

Delisting Criteria:
In the interest of ensuring these criteria are clearly articulated, we are amending the following clarification to the existing recovery plan. This amendment does not represent a revision of the delisting criteria, it simply provides more specific terminology. Delisting for the species covered by the 1998 recovery plan may be considered when the downlisting criteria have been met and: 1. All 74 geographic areas and associated vernal pool complexes as identified in Appendices F and G of the 1998 Recovery Plan under each of the specific management areas are protected and managed to ensure long-term viability. 2. The U.S. Fish and Wildlife Service must determine that the following factors are no longer present, or continue to adversely affect, Eryngium aristulatum var. parishii, Pogogyne abramsii, Pogogyne nudiuscula, Orcuttia californica, and the Riverside and San Diego fairy shrimp: (1) the present or threatened destruction, modification, or curtailment of their habitat range; (2) over utilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural and manmade factors affecting their continued existence (50 CFR 424.11). 3. Population trends for all seven taxa continue to be stable or increasing for 10 consecutive years after threats have been sufficiently ameliorated or managed (completion of delisting criterion 2) prior to consideration for delisting. (USFWS, 2019)

Recovery Actions:
- "Conduct surveys and research essential to the conservation of these species; (USFWS, 2010)
- Secure the existing vernal pools and their associated watersheds; (USFWS, 2010)
- Where necessary reestablish vernal pool habitat to the historical structure; (USFWS, 2010)
- Manage and monitor habitat and listed species"(USFWS 1998a, p. vi). (USFWS, 2010)
- Support continued conservation, management and monitoring of Pogogyne abramsii habitat to include acquisition of occupied sites (USFWS, 2010)

- Develop a coordinated interagency invasive species prevention and eradication program for all vernal pool habitat where Pogogyne abramsii is extant (USFWS, 2010).
- Identify the conditions and areas necessary to support all of the necessary biotic interactions (e.g. pollination, seed dispersal, population movement) for Pogogyne abramsii (USFWS, 2010).
- Monitor restored/enhanced habitat to determine their suitability and impact in furtherance of recovery of Pogogyne abramsii (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below are to be initiated over the next 5 years. Successful implementation of these actions will reduce threats and provide a better understanding of Pogogyne abramsii population health and habitat requirements. We recognize that conservation of this taxon will require cooperation and coordination with partners to minimize impacts from current threats and aid future restoration efforts. The recommended actions listed below include actions from the previous 5-year review and new actions that are relevant to the conservation of P. abramsii. Work with partners to identify opportunities for conservation or preservation of Pogogyne abramsii occurrences on private lands. Support land acquisition to meet Habitat Conservation Plan goals. Work with local, State, and Federal partners to identify and leverage funding (i.e., section 6) to acquire P. abramsii habitat. 1. Adaptively manage Pogogyne abramsii occurrences to maintain, enhance, or restore habitat and reduce threats. a. Manage nonnative species in vernal pool habitat. b. Coordinate with partners to develop a nonnative species prevention and eradication program for all vernal pool habitat where P. abramsii is extant. c. Ensure the correct species pallet from a nearby source is being selected for areas during restoration projects inside and outside of the known range for P. abramsii. 2. Monitor occurrences (evaluate habitat quality, and threats) and assess management effectiveness. a. Conserve Pogogyne abramsii seed in an off-site seed bank. b. Monitor restored/enhanced habitat to determine their suitability and impact in furtherance of recovery of Pogogyne abramsii. c. Identify the conditions and areas necessary to support all the necessary biotic interactions (e.g., pollination, seed dispersal, population movement) for Pogogyne abramsii. 3. Formalize Pogogyne abramsii monitoring on MCAS Miramar consistent with the methodology used in the City of San Diego Vernal Pool HCP so that data can be analyzed across the range of the species. 4. Help locate funding to support nonnative plant removal activities within vulnerable vernal pool groups where Pogogyne abramsii occurs (i.e., MCAS Miramar) (USFWS, 2023).

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SPECIES ACCOUNT: *Pogogyne nudiuscula* (Otay mesa-mint)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A small aromatic annual to 3 dm tall. Leaves are dark green, opposite, ovate to oblong and hairless. There are both axillary flowers and flowers at the top of the plant. The flowers are two-lipped, lavender and 11-14mm long. The fruit consists of small nutlets. Blooming is May-July. (NatureServe, 2015)

Taxonomy

Pogogyne nudiuscula is an annual herb in the mint family (Lamiaceae). As was mentioned in the description for Pogogyne abramsii, Howell (1931) considered all Pogogyne populations on Otay Mesa to be Pogogyne nudiuscula. Many of the older herbarium specimens that might be from the central mesas are labeled as Pogogyne nudiuscula, but are likely Pogogyne abramsii. Howell considered Pogogyne nudiuscula to be diagnosable from Pogogyne abramsii by having a glabrous (smooth) calyx and bract with a different morphology. This distinction is supported by current work (Jokerst 1993; McMillan unpublished data 1995), and the species is also diagnosable by usually having at least six flowers per node on the stem (USFWS, 1998).

Historical Range

Historically P. nudiuscula was found beyond Otay Mesa and occurred at 10 locations in southern San Diego County (Appendix 1). Herbarium records indicate that P. nudiuscula historically occurred further north near University Heights, Balboa Park, and Mission Valley (CNDDB 2010, Element Occurrence (EOs) 4, 9, and 10, respectively). Also, P. nudiuscula occurred in Mexico at the eastern edge of the city of Tijuana; however, it was believed to be extirpated from its Mexican locations prior to listing (Bauder and McMillan 1998, p. 65; USFWS 1993, p. 41385). Currently, P. nudiuscula is found at three locations on Otay Mesa: Otay Mesa West, Otay Mesa East, and Otay Mesa Northeast (Appendix 1). (USFWS, 2010)

Current Range

San Diego County, California; adjacent Baja California, Mexico. The range extent covers approximately 370 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015)

Reproduction Narrative

Adult: The family is primarily bee pollinated (Proctor & Yeo, 1973, p. 219).; (NatureServe, 2015). There is little documented information regarding pollination and seed dispersal mechanisms of P. nudiuscula. Observations in the field suggest that native syrphid flies (Syrphidae) and bee flies (Bombyliidae) are the most common pollinators (S. McMillan, EDAW pers. comm. 2010). Eurasian honeybees (Apidae) have also been seen pollinating P. nudiuscula (McMillan, pers. comm. 2010). Research on the similar species Pogogyne abramsii show that it is self-fertile but has greater seed set when cross-pollinated (Schiller et al. 2000, p. 393); further research is necessary to determine if this is the case for P. nudiuscula (USFWS, 2010).

Habitat Type

Adult: Vernal pools (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist

Habitat Narrative

Adult: Vernal pools (Smith & Berg, 1988). Moist flats in chaparral and coastal sage scrub (Munz, 1959). (NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Zedler and Black (1992, p. 4) found that Pogogyne abramsii seeds germinated and grew from pellets of brush rabbits (Sylvilagus bachmani) and Audubon's cottontail rabbits (S. auduboni) that were collected from vernal pools on Del Mar Mesa and Miramar Mesa. Zedler and Black (1992, p. 2) postulated that rabbit movement may be a potential vector for seed dispersal and genetic mixing of vernal pool obligate species including P. abramsii. They concluded that rabbit dispersal explains the "anamolous occurrence of vernal pool plants in newly excavated artificial pools (1992, p. 8)." Additionally, P. abramsii seeds float, which may result in limited dispersal opportunities when pools interconnect or lakes fill their basins in years of greater than average precipitation (Scheidlinger 1981, p. 54). It is possible that these dispersal mechanisms also apply to P. nudiuscula; however, data do not exist to support this assumption (USFWS, 2010).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

17 known and 2 questionable (USFWS, 2021)

Population Size:

1000 - 2500 individuals (NatureServe, 2015)

Population Narrative:

This wetland annual endemic is highly vulnerable. The long term trend is one of very rapid decline. Decline of >90% Population numbers for this annual are mostly unknown. CNDDB records only record a total of 1700 plants from all currenly known vernal pools. This is likely wildly off from reality. Of 9 EOs, at least five may be extirpated, and all but a few are severely threatened. (NatureServe, 2015). Based on current updates, there are 24 Pogogyne nudiuscula locations (Figure 2, Table 1): 17 are extant, 2 are presumed extant, 3 are historically extirpated, and 2 have questionable identification. (USFWS, 2021)

Threats and Stressors

Stressor: Urban development (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Planned and ongoing development projects throughout Pogogyne nudiuscula's range were described as a primary threat in the listing rule (USFWS 1993, p. 41387). Urban development may result in: (1) the loss or damage of vernal pools by filling, grading, discing, leveling, and other activities; and (2) destruction of watersheds and the hydrology that support vernal pools; (3) isolation of vernal pools; (4) fragmentation of vernal pool systems. Destruction of watersheds and disruption of hydrological systems can create further impacts by creating barriers to dispersal, such that pollination and reproductive output may be inhibited (Schiller et al. 2000, p. 395). Potential means of seed dispersal (e.g., rabbits, floating seeds) (Zedler and Black 1992, p. 2) may also be impacted. Whenever development impacts vernal pools in a complex, some degree of fragmentation occurs within and among complexes. Because P. nudiuscula has specific habitat requirements (e.g., soil type, water depth), habitat degradation and alteration likely result in population decline (USFWS, 2010).

Stressor: Road projects (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Road projects are a type of development that pose a threat to Pogogyne nudiuscula habitat at Otay Mesa West, Otay Mesa South, and Otay Mesa Northeast (Appendix 1). First, the listing rule identified State Route 125 construction on Otay Mesa as a project that could impact P. nudiuscula habitat. This project was completed and directly impacted vernal pool basins on the Otay Mesa Northeast occurrence (i.e., J29–30); however, vernal pools containing P. nudiuscula were avoided in one pool and seeds were collected and used to reestablish populations within their mitigation site which encompass J29–30 (Wynn, pers. obs. 2010). Second, the construction associated with Interstate 905 and Otay Mesa Road (J14) did not directly impact P. nudiuscula; however, indirect impacts in the future in the form of edge effects (see below) are possible. Third, State Route 11 (associated with a new U.S./Mexico border crossing) is planned southeast of State Route 125 on Otay Mesa. Though habitat is present, P. nudiuscula was not detected and Caltrans anticipates future potential edge effects to vernal pools if they are discovered in the area (USDOT and Caltrans 2008, p. 3.20-11–3.20-15). Edge effects to Pogogyne nudiuscula are evident as a result of road widening projects, creating outer bands of habitat distant from the center but immediately proximal to a different type of habitat, thus providing a different species composition and abundance divergent from the interior of the habitat (Forman and Gordon

1986, p. 108). These edges may allow P. nudiuscula to be in closer proximity to disturbed areas, which may facilitate the incursion of invasive, nonnative plants that can outcompete P. nudiuscula for space (see also Factor E discussion). Edge effects degrade extant interior habitat and create an island of the protected habitat/reserve through isolation and decrease the effective size and serviceability of a conservation area (Diamond and May 1976, pp. 228–252). Characteristics of habitat islands include less resistant habitat, more disturbed habitat, areas more susceptible to invasive species, areas with native species less resistant to disturbance, and higher seed immigration (Meyers and Bazely 2003, pp. 34-50). Further development of the roads mentioned above and surrounding areas would exacerbate these impacts (USFWS, 2010).

Stressor: Alteration of watershed (Hydrology) (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although altered hydrology continues to be a threat to the species, the Service has been successful in ensuring implementation of measures to reduce this threat through section 7 consultations. For example, best management practices reduce the amount of runoff entering vernal pool watersheds, and restoration projects are designed to minimize water draining off impervious surfaces into vernal pool watersheds. However, the specific impact runoff has on Pogogyne nudiuscula is unknown because site specific monitoring has not been conducted. Preserved pools should be monitored for these runoff impacts to identify remediation where feasible and prevent further damage to vernal pool systems (USFWS, 2010).

Stressor: Compaction of erosion of soil (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Recent studies suggest that trampling associated with limited livestock grazing in the watershed may benefit some vernal pool species by increasing the inundation period of the pools through reduction of vegetation (particularly nonnative grass) in the watershed and compaction of the soil, which reduces infiltration (Marty 2005, p. 1630). Grazing may also increase the duration of vernal pool inundation by altering soil properties and modifying the rate of evapotranspiration from plants, thus counteracting the potential decrease in precipitation brought about by climate change to some degree (Pyke and Marty 2005, p. 1623). However, it is unknown if Pogogyne nudiuscula or vernal pool habitat in San Diego County benefit from low levels of trampling (USFWS, 2010)

Stressor: Off-Highway Vehicles (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Since listing, OHV continues to threaten Pogogyne nudiuscula, especially from recreational and Border Patrol activities (see Appendix 1). Installation and maintenance of fencing and signage are needed to help protect P. nudiuscula habitat from these impacts (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Since listing in 1993, the Act is the primary law that provides protection for Pogogyne nudiuscula on Federal lands or in instances where there is a Federal nexus. Nearly all occurrences of P. nudiuscula are conserved under the San Diego's MSCP; however, coverage for this species and six other vernal pool species was removed from the City of San Diego Subarea Plan in April 2010. The Service accepted the City's relinquishment of coverage for vernal pool species; thus, P. nudiuscula is no longer a covered species under the subarea plan. However, the City of San Diego is currently working with the Service to revise and improve the management plan for P. nudiuscula under the MSCP. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. However, once a revised subarea plan is completed that provides coverage for P. nudiuscula, the Act will likely provide the most effective protection for the species (USFWS, 2010).

Stressor: Competition with invasive, nonnative plants (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Depending upon conditions, certain invasive, nonnative plants (such as the grasses discussed above) may replace Pogogyne nudiuscula. Therefore, we consider invasive, nonnative plants to be a continuing rangewide threat to all extant occurrences of P. nudiuscula (USFWS, 2010).

Stressor: Human access and disturbance effects (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Protective fencing is used in several conserved areas to protect vernal pool complexes and has been successful in significantly decreasing the impact of trampling and OHV use in the J29–30 vernal pool complex at Otay Mesa Northeast and J2 N/W/S vernal pool complex at Otay Mesa West (City of San Diego 1997, p. 299, 316). Though implementing this protective measure has lessened the impacts of human access and disturbance, such effects still threaten Pogogyne nudiuscula occurrences. The J32 complex in the Otay Mesa West occurrence may be the most severely impacted by trampling due to foot traffic by immigrants, transients, Border Patrol, and OHV use (City of San Diego 1997, p. 236). Fencing was installed and stolen (City of San Diego 1997, p. 236) indicating that monitoring is critical in reducing the impacts of human access and disturbance (USFWS, 2010).

Stressor: Fire and fire suppression activity (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire and fire suppression have been identified as a current potential threat at three of the four occurrences (vernal pool complexes J2, J2 N/W/S, J28, J14, and J29–30), with the exception of the Otay Mesa East occurrence. These areas may serve as a staging area in the event of a fire if defensible structures are developed in the vicinity (City of San Diego 1997) (USFWS, 2011).

Stressor: Drought and climate change (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species, including Pogogyne nudiuscula or sites at this time. However, it is likely that impacts from existing threats could increase and new threats may arise. Sharing information between scientists, land managers, and decision makers will increase our ability to address and manage these threats (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)
Exposure:
Response:
Consequence: Lack of geneitc variability/extinction
Narrative: Since listing, Pogogyne nudiuscula's range has decreased and there have been no new occurrences of the species. Therefore, restricted range and small population size continue to threaten P. nudiuscula at all of its occurrences (USFWS, 2010).

Recovery

Delisting Criteria:
All the existing vernal pools and their watersheds identified in Appendix F and G of the Recovery Plan should be secured from further loss and degradation in a configuration that maintains habitat function and viability (as determined by prescribed research tasks) (USFWS, 2010).

Secured vernal pools must be enhanced or restored such that population levels of existing species are stabilized or increased (USFWS, 2010.

Population trends must be shown to be stable or increasing for a minimum of 10 consecutive years prior to consideration for reclassification (USFWS, 2010).

In the interest of ensuring these criteria are clearly articulated, we are amending the following clarification to the existing recovery plan. This amendment does not represent a revision of the delisting criteria, it simply provides more specific terminology. Delisting for the species covered by the 1998 recovery plan may be considered when the downlisting criteria have been met and: 1. All 74 geographic areas and associated vernal pool complexes as identified in Appendices F and G of the 1998 Recovery Plan under each of the specific management areas are protected and managed to ensure long-term viability. 2. The U.S. Fish and Wildlife Service must determine that the following factors are no longer present, or continue to adversely affect, Eryngium aristulatum var. parishii, Pogogyne abramsii, Pogogyne nudiuscula, Orcuttia californica, and the Riverside and San Diego fairy shrimp: (1) the present or threatened destruction, modification, or curtailment of their habitat range; (2) over utilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) the inadequacy of existing regulatory mechanisms; and (5) other natural and manmade factors affecting their continued existence (50 CFR 424.11). 3. Population trends for all seven taxa continue to be stable or increasing for 10 consecutive years after threats have been sufficiently ameliorated or managed (completion of

delisting criterion 2) prior to consideration for delisting. (USFWS, 2019)

Recovery Actions:

- This recovery criterion does not explicitly address any of the threat factors identified in the five factor analysis in the listing rule or in the above discussion. Moreover, achievement of this criterion as written is complicated by the fact that some pool basins within the complexes identified in Appendices F and G have been developed or preserved in accordance with provisions of regional HCPs since the completion of the Recovery Plan. However, working toward the goals in this criterion will reduce the threats discussed above under Factors A and E. Securing vernal pool complexes physically, legally, and ecologically would reduce threats posed by development (e.g., habitat loss and alterations of hydrology) and discussed under Factor A and E above. As discussed in Factor A, all of the extant occurrences of Pogogyne nudiuscula, are partially or completely conserved and those that are only partial conserved have been mitigated in another area of suitable habitat (Appendix 1). These protections generally extend to direct loss and not necessarily indirect loss of habitat through degradation. These lands are under conservation easements or protected in perpetuity, conserved through mitigation, or have some sort of protection from development (Appendix 1). Pools within these areas meet the criterion in the Recovery Plan as "secured legally" from further habitat loss. In the Recovery Plan, Appendix F lists the vernal pool occurrences that are necessary to stabilize the proposed and listed vernal pool species (USFWS 1998, p. F1). Appendix G of the Recovery Plan lists vernal pool occurrences identified as necessary to secure in order to reclassify the proposed and listed vernal pool species (USFWS 1998, p. G1). Appendix G broadly lists complex J (undescribed) and J–3 and J–22. Pogogyne nudiuscula is found throughout the J complex and portions of this complex have been conserved partially or fully and other areas have been extirpated and mitigated. Although some of these occurrences are considered secure from development, they are not all guaranteed monitoring or maintenance in perpetuity. Although it is not possible to specifically identify every complex in Appendices F and G of the Recovery Plan, development and impacts on complexes listed in Appendices F and G that contain P. nudiuscula should be avoided. Additionally, the Service is working towards conserving these complexes (USFWS, 2010.
- This criterion does not directly address any of the threats discussed above in the five-factor analysis. Rather, it uses a measure of stability that is not easily assessed for Pogogyne nudiuscula. As discussed in the abundance section of this 5-year review, the population numbers for P. nudiuscula are not easily measured. Because methods of measurement are not standardized and P. nudiuscula does not germinate every year, population abundance is not a good indicator for the species. However, restoration and management do provide a measure of protection against threats to the species. Additionally, the CFWO issues biological opinions associated with consultations under section 7 of the Act for Pogogyne nudiuscula. These opinions detail avoidance and minimization measures to prevent jeopardizing the species' continued existence and can include restoration of P. nudiuscula habitat. Many of these opinions lead to successful restoration and protected populations of P. nudiuscula. Some pools are being restored and therefore meet the outlined goals of Criterion 3 in the Recovery Plan (USFWS, 2010).
- This criterion does not directly address any threats outlined in the five-factor analysis. In order to stabilize or increase the population, threats would have to be reduced. Reducing the threats discussed above in Factors A and E would help us provide the conditions needed to work toward the goal in this criterion, but vernal pool habitat has been reduced by

human-induced conversion (Bauder and McMillan 1998, p. 66). As yet, however, it is difficult to assess the abundance of Pogogyne nudiuscula in the absence of standardized sampling methods and population trends for vernal pool annuals are often difficult to detect. Therefore, we are unable to address this criterion (USFWS, 2010).

- Support continued conservation, management, and monitoring of vernal pool habitat that supports Pogogyne nudiuscula, including monitoring of restored/enhanced habitat to determine if vernal pool restoration projects continue to be viable through time (e.g., artificial clay layer remains stable and supports adequate ponding) (USFWS, 2010).
- Work with the Otay Mesa Water District to address inundation of pools in J26 from the Otay Mesa water pump. Implement measures to ensure that water does not flow over the road and into the pools (USFWS, 2010).
- Conduct research to determine life history traits most vulnerable to threats discussed in the five factor analysis (USFWS, 2010).
- Develop a dynamic, threats based, species-specific recovery plan based on analysis of current knowledge of the species (USFWS, 2010).
- Establish a seed bank for Pogogyne nudiuscula according to Center for Plant Conservation guidelines (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed below were identified in the 2010 status review (USFWS 2010, p. 29). The actions were intended to reduce threats to Pogogyne nudiuscula and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of P. nudiuscula will require cooperation and coordination with partners to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. We continue to believe the actions described in 2010 are relevant to the conservation of P. nudiuscula. 1. Support continued conservation and management of vernal pool habitat that supports Pogogyne nudiuscula, with emphasis on complexes that are not currently conserved and those within the Stockpen soil association. 2. Develop and implement a long-term monitoring program to describe population trends to better understand the resiliency of the different vernal pool complexes, including monitoring of restored and enhanced habitat to determine if vernal pool restoration projects continue to be viable through time (e.g., artificial clay layer remains stable and supports adequate ponding). 3. Identify a new conservation easement holder and land manager for the J26 complex. 4. Conduct research to determine life history traits most vulnerable to threats discussed in the five-factor analysis. 5. Develop a dynamic, threats based, species-specific recovery plan based on analysis of current knowledge of the species. (USFWS, 2021)

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SPECIES ACCOUNT: *Polygala lewtonii* (Lewton's polygala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1993; Southeast Region (R4) (USFWS, 2015)

Physical Description

Polygala lewtonii is a relatively short-lived (5 to 10 year) perennial herb. Each plant produces one to several annual stems, which are spreading, upward-curving or erect, and are often branched. The leaves are small, sessile, rather succulent, broader toward the tip, and are borne upright, tending to overlap along the stem, like shingles. The normally opening flowers are in erect, loosely flowered racemes about 1.5 cm (Wunderlin et al. 1981) or 3.3 cm (Weekley 1996) long. The flowers are about 0.5 cm long and bright pink (Wunderlin et al. 1981) or purplish-red (Ward and Godfrey 1979). Two of the five sepals are enlarged and wing-like, between which the largest of the three petals forms a keel that ends in a tuft of finger-like projections (Ward and Godfrey 1979). The plant also produces two types of small, cleistogamous (non-sexual) flowers (L. Miller, Ocala NF, personal communication 1996,Weekley 1996). This species is closely related to the widespread P. polygama, which forms larger clumps and has a longer root, narrower leaves, and differently shaped wing sepals. It also has short branches that hug the ground, bearing inconspicuous self-pollinating flowers. (USFWS, 1999)

Taxonomy

This small herb was first collected near Frostproof, Florida by F. L. Lewton in 1894, and was named by J.K. Small (1898). The status of P. lewtonii as a distinct species was affirmed by Blake (1924) and James (1957). There have been no other taxonomic treatments of this species. (USFWS, 1999)

Historical Range

See current range.

Current Range

Lewton’s polygala occurs in sandhill (high pine) vegetation and Florida scrub of the Lake Wales and Mount Dora ridges in Highlands, Polk, Osceola, Orange, Lake, and Marion Counties of central Florida. (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollination/self-fertilization

Lifespan

Adult: relatively short-lived (5-10 year) (USFWS, 2019)

Other Reproductive Information

Adult: Lewton's polygala is amphicarpic, producing flowers and fruits above and below ground at different times (Menges and Weekley 2002). Lewton's polygala is one of only a few dozen amphicarpic angiosperms known worldwide. Amphicarpy is viewed as an adaptation for reproduction in uncertain habitats, for example, producing seeds underground where they have better chances of surviving fire (Cheplick and Quinn 1982) and are protected from herbivory (Menges and Weekley 2003). While self-fertilization occurs in Lewton's polygala, it appears to be a less-reliable mechanism for seed production than insect pollination. (USFWS, 2019)

Reproduction Narrative

Adult: Confusion has existed about whether P. lewtonii has cleistogamous flowers (James 1957, Wunderlin et al. 1981, Ward and Godfrey 1979, FWS 1996). More recently, Weekley (1996) and Miller (Ocala NF, personal communication 1996) confirmed the presence of two types of cleistogamous flowers. The first are solitary flowers in the axils of the lower leaves and the second are few-flowered racemes on underground rhizomes that are usually 5 to 15 cm long (Weekley 1996). Polygala lewtonii blooms from February to May with chasmogamous flowers dominating from February to April. Chasmogamous flowers have an average of four to six racemes per plant, though one extreme individual had 30 racemes (Weekley 1996). Each raceme has 20 to 25 flowers 85 to 100 percent of these set fruit. This high percentage of fruit set suggests that flowers self-pollinate when insect pollinators are not present. (USFWS, 1999).

Habitat Type

Adult: high pine and turkey oak barrens and transitional areas (USFWS, 1999)

Environmental Specificity

Adult: Narrow (USFWS, 1999)

Habitat Narrative

Adult: Polygala lewtonii is not strictly a scrub species and is found in widely scattered populations that frequently occur in transitional habitats between high pine and turkey oak barrens. P. lewtonii also occurs in both habitats (Wunderlin et al. 1981, Christman 1988). P. lewtonii depends on fire to maintain its habitat. It is found in sunny openings and often colonizes disturbed sites, such as roadsides and fire lanes. P. lewtonii's preference for transitional habitats between high pine and turkey oak barrens suggests a preference for a burn frequency that is less frequent than high pine, but more frequent than turkey oak barrens. (USFWS, 1999)

Dispersal/Migration

Population Information and Trends

Number of Populations:

32 known occurrences (USFWS, 2021)

Population Narrative:

Lewton's polygala is a perennial herb occurring in sandhill and scrub communities on the Lake Wales and Mount Dora Ridges in central Florida. Currently, there are an estimated 32 extant populations, though most are of unknown status due to lack of recent surveys, and 19 known or

possibly extirpated populations (Table 1). Of the 32 extant populations, only 1 is stable to increasing, 6 are stable, 2 are declining, and 23 have an unknown status (Table 1). Although demographic and abundance data have been collected at 6 populations for approximately 20 years (Rosner-Katz 2020; Menges et al. 2021; Noland 2021), information on natural recruitment and age distribution is lacking for almost all populations, and trends cannot be determined. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:

Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of P. lewtonii, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the seral stages of high pine and xeric oak scrub to sup port P. lewtonii (USFWS, 1999)

4. When monitoring programs demonstrate that these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Delisting Criteria:
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub or sand hill habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:
- Determine current distribution and status of P. lewtonii. This species' distribution is somewhat questionable since individuals are easily overlooked. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)

- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, has become isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species, more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of P. lewtonii. (USFWS, 1999)
- Provide public information about P. lewtonii. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about P. lewtonii. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. lewtonii and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS A detailed discussion of recovery actions and criteria are presented in the Recovery Plan and amendment (Service 1999 and 2019, respectively). During this status review new and/or targeted potential recovery activities were identified and are included below. Recovery Activities • Conduct habitat restoration efforts at possibly extirpated sites on managed lands since Lewton's polygala has a persistent soil seed bank and can reappear after fire/restoration. Lewton's polygala 5-Year Review • Work with State, Federal, and non-profit partners to ensure adequate fire management is achieved at sites that support Lewton's polygala. • Work with private landowners to acquire or conserve extant populations and restore sandhill and scrub habitat on these sites. • Strengthen ex situ conservation measures, including ensuring representation of Lewton's polygala at the National Center for Genetic Resources Preservation in Fort Collins, Colorado. Monitoring/Research Activities • Determine the condition of populations on private land whose status is currently unknown. • Expand level 3 (demographic) monitoring to more populations, such as ONF, Tiger Creek Preserve, and Bok Tower Gardens Pine Ridge Preserve, (as recommended by Menges et al. 2019) to determine trends and produce a population viability analysis. • Develop a standard methodology for monitoring Lewton's polygala on conservation lands. • Initiate large-scale level 1 (distribution) and 2 (population size/condition) monitoring of Lewton's polygala throughout the geographic range, including sites across a spectrum of time-since-fire and management regimes. • Compare germination rates of aboveground to belowground seeds and investigate the limitations to germination of aboveground seeds. • Determine the status of pollinator populations. (USFWS, 2021)

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SPECIES ACCOUNT: *Polygala smallii* (Tiny polygala)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/19/1985; Southeast Region (R4)

Physical Description

Tiny polygala is an erect short-lived herbaceous species. Most plants germinate and die within one year. It forms a rosette and grows no more than 8 cm tall (Kennedy 1998). It has one to four, short, usually unbranched stems, and a well-developed, scented taproot. Its leaves are oblanceolate to lanceolate, from 1.5 to 5 cm long and 0.2 to 1.4 cm broad and occur in a basal rosette. The inflorescence is a cylindric raceme from 0.4 to 7 cm long and 0.5 to 1.8 cm thick and usually surpassed by the basal leaves (Kennedy 1998) The flowers have both functional stamens and pistils (perfect) and are not radially symmetrical (zygomorphic). The calyx has five sepals. The lateral pair is decurrent, large and petaloid. The corolla is a greenish-yellow color with three petals. The fruit is a thin-walled, two-celled capsule that splits down the center of the compartment. The seed is 1.2 to 1.4 mm long, with sparse rather short, stiff, appressed hairs (strigose). It also has a pair of aril-like outgrowths about half the length of the capsule (Gann and Bradley 1995, Smith and Ward 1976). (USFWS, 1999)

Taxonomy

J.K. Small first described tiny polygala as Polygala arenicola (Small 1905; type specimen at New York Botanical Garden, Small #1276). The specific epithet was later found to be invalid due to its prior use in 1903 by Gurke in describing another species of Polygala from southeast Africa (Smith and Ward 1976). In 1933, Small revived the segregate genus Pilostaxis Raf., and renamed tiny polygala Pilostaxis arenicola (Small) Small. The genus Pilostaxis has since fallen out of use, but represents the series Decurrentes, a natural group of seven species of Polygala found only in the southeastern U.S. (Smith and Ward 1976). Long and Lakela (1971) considered tiny polygala to be conspecific with Polygala nana (Michx.) DC., a species widely distributed in the southeastern U.S., but in 1976, Smith and Ward defended the specific status of tiny polygala, recognizing distinct characters of the seeds, lateral sepals, flower color, and leaves, and proposed Polygala smallii Smith and Ward as a nomen novum. Synonyms: Polygala arenicola Small, non Gurke; Pilostaxis arenicola (Small) Small; Polygala nana auct., non (Michx.) DC. (USFWS, 1999)

Historical Range

See Current Range. The historic distribution of tiny polygala to the north is uncertain; it possibly ranged as far north as central Brevard County, Florida. (USFWS, 1999)

Current Range

This species is known to occur on the Atlantic Coastal Ridge of southeast Florida, in Miami-Dade, Palm Beach, St. Lucie, and Martin Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: ~ 180 days

Other Reproductive Information

Adult: Pollination in tiny polygala has not been observed in 2.5 years of monitoring (Kennedy 1998), or in 3 years of monthly life history monitoring (DERM 1994). Zomlefer (1991) reports that self-pollination may occur in species of Polygala which have a tuft of hairs on the sterile apical lobe of the stigma. These hairs catch pollen when the anthers dehisce, and, as the flower develops, these hairs may touch the receptive lobes of the stigma, transferring pollen. Tiny polygala has these hairs (Smith and Ward 1976) and may be selfpollinating. (USFWS, 1999)

Reproduction Narrative

Adult: Tiny polygala seedlings can be observed from late October through April, but are most typically seen from December to February (DERM 1996). Populations in Miami-Dade County appear to have two germination periods, a short one in June and a longer one between September and January (Kennedy 1998). Thus, seedlings can be germinating for 6 months out of the year, resulting in plants maturing at different times of the year, and overlapping generations within years. In populations, flowers appear throughour the year with a peak during summer. Also, seeds are produced year-round. Approximately one year following appearance of seedlings, plants show a marked reduction in condition, apparently allocating resources to flowering instead of growth or self-maintenance. By July, approximately 18 months after the first seedlings are observed, remaining plants senesce and die (DERM 1994). (USFWS, 1999)

Habitat Type

Adult: pine rockland, scrub, high pine, and open coastal spoil (USFWS, 1999)

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial

Environmental Specificity

Adult: Narrow (inferred from USFWS, 1999)

Habitat Narrative

Adult: Tiny polygala occurs in four distinct habitats with similar characteristics: pine rockland, scrub, high pine, and open coastal spoil (Gann and Bradley 1995). All of these habitats are pyrogenic-extremely dry and prone to periodic natural fire. Pine rocklands historically burned every 2 to 15 years (Snyder et al. 1991). Sand pine scrub and sandhill burn less frequently, possibly every 10 to 50 years. (USFWS, 1999)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Tiny polygala seeds have paired, fleshy outgrowths, a typical adaptation to ant dispersal. ostermeijer (1989) reports that a similar species Polygala vulgaris L. is a specialist in ant dispersal. Also, ants have been observed carrying tiny polygala seeds to their nests on several occasions in Miami-Dade County (K. Bradley, Institute for Regional Conservation, personal

communication 1996). The seeds have a bilobed aril attached to the caruncle. This bilobed aril was suggested by some to be an elaisome, a structure that contains lipids that are attractive to ants. Kennedy (1998) reports observing ants going into the flowers and removing and transporting seeds by the arils. After applying Sudan IV stain to the arils, she determined that they do not contain lipids; rather the arils appear to be hollow sacs. It is unclear why the ants are moving the seeds. (USFWS, 1999)

Additional Life History Information

Adult: Polygala smallii seeds are able to float in water for extended periods (over three weeks) (Kennedy 1998). The hairs on the seed coat appear to provide most of the buoyancy by trapping air. Since many of the sites where tiny polygala occurs are riparian or riverine and the seeds are buoyant, water may be the primary means of dispersal. After Hurricane Andrew, tiny polygala was found growing in areas where the soil was turned over or disturbed (ie. around uprooted fallen trees). A response to soil turnover may indicate a good seed bank. The seed banks probably occur in more habitat types than previously thought. (USFWS< 1999)

Population Information and Trends

Number of Populations:

6 (USFWS, 2021)

Population Narrative:

Polygala smallii is extant on a total of nine sites in Miami-Dade, Palm Beach, St. Lucie, and Martin Counties, with the highest density of sites located in southern Miami-Dade County (Wendelberger and Frances 2004; Woodmansee et al. 2007; Maschinski, pers. comm. 2010; Florida Natural Areas Inventory [FNAI] 2010a; Lange, pers. comm. 2017; Possley, pers. comm. 2017a). Clusters of sites are separated by an average of 38 miles (61 km). Eight of nine known occurrences are on publicly owned lands, and all the sites are currently being managed for conservation of P. smallii. The species is known to have been extirpated from at least five historical locations, including three in Miami-Dade County and single populations in Broward and St. Lucie Counties. Five sites are known from Miami-Dade County. These include the publicly owned Zoo Miami and adjacent U.S. Coast Guard (USCG) property, both located within the 2,100-acre Richmond pinelands (Lange, pers. comm. 2017; Possley, pers. comm. 2017). Possley pers. comm. (2017a) indicates the P. smallii population size within Zoo Miami has fluctuated from 13 to over 1,000 individuals in the past decade. The USCG site contains the largest population, which was estimated at over 10,000 plants during a 2008 survey (Lange, pers. comm. 2017; Possley, pers. comm. 2017a); no recent estimates are available for the species at this site. The three remaining P. smallii sites within Miami-Dade County each retain populations of ten individuals or less (Lange, pers. comm. 2017; Possley, pers. comm. 2017a). In Palm Beach County, the P. smallii abundance at two known locations fluctuates dramatically from year to year (Woodmansee et al. 2007). At Jupiter Ridge Natural Area, P. smallii abundance has fluctuated from 86 (2005) to 8 (2017) (Buck, pers. comm. 2017). The Limestone Creek Natural Area population has ranged from 3 to 60 since being discovered in 2002, with 5 encountered during 2017 (Woodmansee et al. 2007; Shearer, pers. comm. 2017). In southern Martin County, P. smallii is known to occur in Jonathan Dickinson State Park (JDSP). Surveys of the site have recorded between 6 and 64 individuals (Woodmansee et al. 2007; FNAI 2010a). Woodmansee et al. (2007) indicated that while the species appears to be in decline at JDSP, it is expected that plant numbers will increase in the long run, provided fires are administered. In St.

Lucie County, a small population (14 plants) of P. smallii occurs at the privately owned Lynn University (Woodmansee et al. 2007). (USFWS, 2019). Tiny polygala is currently known to occur in small populations located on tracts of suitable pine rockland and scrub habitat, mostly within publicly owned lands. Its limited distribution renders tiny polygala vulnerable to random natural or human-induced effects, including fire suppression and invasive exotic species. The most recent surveys for the species indicate that plants remain on ten sites within six populations (Table 1; Woodmansee et al. 2007; FNAI 2019; Black Finch 2020; Possley 2020; Rogers 2020; Rossmanith 2020; Shearer 2020; Law 2021). The majority of known tiny polygala populations occur on publicly owned lands that are managed for conservation. The one remaining population on private lands is managed for conservation under an HCP (Coral Reef Commons in the Richmond Pineland Complex; Service 2017). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat loss and fragmentation
Exposure:
Response:
Consequence:
Narrative: The pine rockland community of south Florida is critically imperiled globally (FNAI 2010b). In Miami-Dade County, development and agriculture have reduced pine rockland habitat by 90 percent. Continued habitat loss (Factor A) and fragmentation threaten the existence of this species, and less than 1 percent of the original acreage of pine rockland habitat remains outside of Everglades National Park (Herndon 1998). Populations on private sites remain threatened with destruction or habitat modification due to improper or lack of management (Factors A and E). (USFWS, 2019)

Stressor: Indequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: Currently, regulatory mechanisms (Factor D) provide limited protections for this species. The Florida Department of Agriculture and Consumer Services designated these species as endangered under Chapter 5B-40, Florida Administrative Code. This law regulates the taking, transport, and sale of listed plants. This law does not prohibit private property owners from destroying listed plants, nor does it require them to manage habitats to maintain populations. The Natural Forest Communities (NFC) program was established by Miami-Dade County to encourage but not require private landowners to protect forested lands by making it necessary to apply for a permit with the County prior to working in designated NFCs (i.e., pinelands, hammocks). (USFWS, 2019)

Stressor: Inadequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire suppression continues to affect Amorpha crenulata(Factor E). Historically, frequent (approximately twice per decade), lightning-induced fires were a vital component in maintaining native vegetation and ecosystem functioning within south Florida pine rocklands. A period of just 10 years without fire may result in a marked decrease in the number of herbaceous

species due to the effects of shading and litter accumulation (FNAI 2010b). The majority of extant populations of this species is affected by some degree of inadequate fire management, with the primary threat being shading by hardwoods (Bradley and Gann 1999; Bradley and Gann 2005). (USFWS, 2019)

Stressor: Nonnative invasive plants
Exposure:
Response:
Consequence:
Narrative: Invasion by exotic plant species continue to affect Amorpha crenulata (Factor E). Nonnative invasive plants compete with native plants for space, light, water, and nutrients, and make habitat conditions unsuitable for this species, which prefers open conditions (Factor E). Bradley and Gann (1999) indicated that the control of nonnative plants is one of the most important conservation actions for the pine rockland species and a critical part of habitat maintenance. Nonnative plants have significantly affected pine rocklands and negatively impacted all occurrences of this species to some degree (Bradley and Gann 1999; Bradley 2006; Bradley and Saha 2009; Bradley and van der Heiden 2013). (USFWS, 2019)

Recovery

Reclassification Criteria:
Not developed (USFWS, 1999; USFWS, 2010)

Delisting Criteria:
1. Existing natural populations achieve and maintain a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

2. A network of 6 new populations are either discovered or reintroduced that exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (addresses Factors A and E) (USFWS, 2019)

3. All populations (criteria 1 and 2) are protected by a conservation mechanism. (addresses Factors A, D, and E) (USFWS, 2019)

4. Threats have been reduced or eliminated to the degree that this species will remain viable for the foreseeable future. (addresses Factors A, D, and E) (USFWS, 2019)

Recovery Actions:
- Conduct surveys to determine distribution and status of Polygala smallii. Pine rocklands have been thoroughly surveyed in Miami-Dade County. Additional surveys in the historic range of this plant should be performed in the scrub, sandhill, and open coastal spoil of Broward, Palm Beach, Martin, and St. Lucie counties. Fire eliminates litter concealing species, it may kill seeds in the litter or soil surface, or it may enable seeds in the seed bank to germinate. For that reason, suitable habitats which did not contain listed species when unmanaged should be resurveyed after fire events. (USFWS, 1999)
- Protect and enhance existing populations. It is imperative for the recovery of this species that populations not be lost. (USFWS, 1999)

- Collect biological information important to species recovery. Determine population size and viability of all populations. Investigate the genetic relationship of distinct Polygala populations. (USFWS, 1999)
- Develop standardized monitoring. Collect existing and historical data, and place in a central location. Convene a meeting of all researchers. Monitor status and success of all populations; change management practices if so indicated.Monitor reintroduction success and modify procedures as necessary. (USFWS, 1999)
- Continue to provide public information about scrub, sandhill, and open coastal spoil habitat and its unique flora. (USFWS, 1999)
- Habitat-Level Recovery Actions: Continue to protect existing pine rockland, scrub, sandhill, and open coastal spoil plant habitats. Restore areas to suitable habitat. Research additional habitat relationships. Monitor sites with pine restoration programs to determine success. Continue implementation of the fire education program and modify as necessary, any fire management education program that has been developed. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Implement, continue, or increase habitat restoration efforts (exotic species removal and prescribed fire) at all sites with tiny polygala. • Survey extirpated sites and sites with unknown status annually to monitor for potential reappearance. • Continue to monitor extant populations annually. • Examine extant populations in Palm Beach, Martin, and St. Lucie Counties to determine if they are P. smallii or P. nana. • Conduct a comparative taxonomic study of P. smallii and P. nana using a multi-data approach (e.g., morphology, genetics, geography, ecological factors, etc.). • Survey potential habitat on privately owned sites if landowners will allow access. • If additional sites with tiny polygala are discovered, pursue conservation agreements and/or acquire land. Implement appropriate management for habitat restoration, particularly on sites with former tiny polygala populations. Any opportunities for purchase of properties with tiny polygala or better management under conservation easement should be pursued. • Additional partnerships should be promoted to share information, conduct collaborative research on pine rockland and scrub habitat conservation, and provide land managers and the interested public with information about the ecosystem, threats, recovery actions, and associated rare biota. • Expand work on ex situ propagation and seed banks. • Conduct reintroduction feasibility studies and identify potential recipient sites. • Conduct additional demographic research including population assessments and tracking of habitat changes through time. Monitoring should assess population declines or increases and examine growth and establishment rates. • Conduct genetic studies to examine diversity among sites which may be declining due to isolation and reduced genetic drift. • Conduct research to evaluate reproductive biology. • Conduct research to examine the effects of growing season burns versus non-growing season burns on flowering, seed set, and establishment. • Conduct studies to examine the cyclic occurrence of tiny polygala and determine if select fire-return intervals can reestablish the species to historical locations. (USFWS, 2021)

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SPECIES ACCOUNT: *Polygonella basiramia* (Wireweed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

P. basiramia is a short-lived, perennial herb (Hawkes, University of Pennsylvania, personal communication 1995). When vegetative, the plant consists entirely of basal, compressed stems with narrow, alternate leaves. Ocreae, the sheaths formed at stem nodes, are ciliate. Stems and leaves range in color from green to dark red; red coloration in the stems and leaves appears to be associated with individuals more exposed to sunlight and with older vegetative parts (although even seedlings are often red). As basal stems elongate, plants develop 1 to 46 slender, flowering, spike-like panicles as tall as 0.8 m (Hawkes and Menges 1995). This species is gynodioecious and plants have either only female flowers or hermaphroditic flowers. Individual flowers are small, white to slightly pink with 5 sepals (no petals), pink pistils, and black anthers. The gynoecium consists of 3 united carpels, 1-ovuled, ovary superior. Flowering occurs from the top spikelet downward on each stem. The fruit is a three-sided achene 1 to 3 mm in length. (USFWS, 1999) Wireweed Polygonella basiramia (= ciliata var. b.) (Small) Nesom and Bates Page 4-1149 Federal Status: Endangered (January 21, 1987) Critical Habitat: None Designated Florida Status: Endangered Figure 1. County distribution of wireweed. Recovery Plan Status: Revision (May 18, 1999) Geographic Coverage: Rangewide

Taxonomy

Originally named Delopyrum basiramia by Small in 1924 (Nesom and Bates 1984), this species was later thought to be a variety of Polygonella ciliata by Horton (1963). In 1984 Nesom and Bates recognized P. basiramia as a separate species. This species is commonly known as hairy or tufted wireweed. Polygonella basiramia is most closely related to P. ciliata and P. gracilis (Lewis and Crawford 1995). P. basiramia and P. ciliata are believed to have originated from P. gracilis, but whether they did so independently or from a single intermediate ancestral species is unknown. (USFWS, 1999)

Historical Range

See current range.

Current Range

Lake Wales, Winter Haven, and Bombing Range ridges in central peninsular Florida. It ranges from Lake Pierce in Polk County southward to Venus near the southern tip of the Lake Wales Ridge in Highlands County (USFWS, 1999)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: short-lived (average 0.31 years) (USFWS, 2019)

Breeding Season

Adult: September to December (USFWS, 1999)

Other Reproductive Information

Adult: Wireweed is an obligate seeder: no adult plants survive fire, and all post-fire recruits derive from seed. Flowering begins in September and achenes are produced in late November and early December. Because flowering is sequential, beginning at the top of each spike-like panicle and moving downwards, flowers and achenes are present at the same time mid-autumn. Achenes drop readily from the plant and most fall by mid-January. (USFWS, 2019)

Reproduction Narrative

Adult: Polygonella basiramia is gynodioecious, with individual plants producing either pistillate (female) or perfect flowers (both sexes in a single flower). The ratio of female to hermaphroditic plants is 1:1 at Archbold Biological Station (Hawkes and Menges 1995). Pollinators of P. basiramia include small halictid bees, Perdita polygonellae (a bee specific to the genus Polygonella), Eumenidae wasps, and potentially Glabellula spp. (Bombyliidae) (M. Deyrup, Archbold Biological Station, personal communication 1995). Seed production by female plants greatly exceeds that of perfect plants, with an average of 217.8 seeds per stem for females, but only 32.1 for perfect plants. P. basiramia is an obligate seeder which means that no adult plants survive a fire event and all new growth is from seedlings. On a population level, the number of seeds produced by P. basiramia in one reproductive season is more than 30 times the average plant density, sufficient to replace existing populations if only 3 percent of seeds were able to germinate and survive. (USFWS, 1999)

Habitat Type

Adult: scrub/scrubby flatwoods

Environmental Specificity

Adult: Narrow (USFWS, 1999)

Habitat Narrative

Adult: Polygonella basiramia is most commonly found in rosemary scrub, also known as rosemary phase of sand pine scrub (Abrahamson et al. 1984, Menges and Kohfeldt 1995). At Archbold Biological Station, rosemary scrubs are found only on the higher ridges and knolls at 40 to 50 m in elevation, and are largely restricted to St. Lucie and Archbold soil types (Abrahamson et al. 1984), both well drained white sands (Carter et al. 1989). Outside Archbold Biological Station, rosemary scrubs are generally found on white sands and higher elevations (Hawkes, University of Pennsylvania, personal communication 1998). The fire cycle in rosemary scrub can range from 10 to as long as 100 years (Johnson 1982, Myers 1990). Polygonella basiramia occupies open spaces or gaps between shrubs and can be found in abundance along sandy fire lanes, which provide similar habitat. (USFWS, 1999)

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (inferred) (USFWS, 2019)

Population Narrative:

The last FNAI Element Tracking Summary (FNAI 2015) reported 71 extant occurrences, 47 of which were on managed lands. This was a significant decrease (approximately 40 percent) from the 119 reported occurrences in the last 5-year status review (Service 2010d). At a larger scale, regional persistence of this species is dependent on landscape features and disturbance effects on metapopulation dynamics. Fire may expand or create the open sand gaps within a shrub matrix that support wireweed, but fire also kills established plants. Patchy fires may provide a balance, both creating suitable habitats and providing a fine-grained spatial landscape structure so wireweed can colonize those habitats. (USFWS, 2019).

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time

(Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range.
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of P. basiramia, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the rosemary phase of xeric oak scrub communities to support P. basiramia (USFWS, 1999)

4. When monitoring programs demonstrate that populations of P. basiramia on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. Individuals growing opportunistically in unnatural areas, for example fire lanes, should be excluded from consideration when determining the status of this species. (USFWS, 1999)

Delisting Criteria:
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in rosemary scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution status of Polygonella basiramia. This species' distribution is somewhat questionable for taxonomic reasons. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Though much of the basic biology and ecology of this species is understood, to effectively recover this species additional biological information is needed. (USFWS, 1999)
- Monitor existing populations of Polygonella basiramia. (USFWS, 1999)
- Provide public information about P. basiramia. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

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basiramia (wireweed), Polygonella myriophylla (sandlace), Warea carteri (Carter's mustard), and Ziziphus celata (Florida ziziphus). U.S. Fish and Wildlife Service, Atlanta, Georgia. 23 pp. September 24, 2019.

SPECIES ACCOUNT: *Polygonella myriophylla* (Sandlace)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/27/1993; Southeast Region (R4)

Physical Description

Polygonella myriophylla is a sprawling shrub that looks somewhat like the ornamental creeping juniper (Juniperus horizontalis). Its many branches zigzag along the ground and root at the nodes, forming low mats. The lower parts of the creeping branches have bark that cracks and partly separates in long, flat, interlacing strips. The short lateral branches end in flowering racemes. P. myriophylla has the sheathing leaf stipules (ocreae and ocreolae) typical of the jointweed family. The leaves are needle-like and are from 0.3 to 10.0 mm long. The small, white or cream colored flowers have white petallike sepals up to 3.4 mm long (Kral 1983). (USFWS, 1999)

Taxonomy

Sandlace is one of 11 species of North American Polygonella and one of three species of Polygonella that occur in scrub habitat in south Florida (Lewis and Crawford 1995). The sandlace was first collected in the early 1920s and was subsequently identified and named by Small (1924) as Dentoceras myriophylla. Horton (1963) combined two of Small's genera with the genus Polygonella. P. myriophylla has been commonly called sandlace (Christman 1988), Small's jointweed and woody wireweed (Wunderlin 1982). (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

In the Florida Counties of Orange, Osceola, Polk (Lake Wales Ridge), and Highlands (Lake Wales Ridge). (USFWS, 1999)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual; Vegetative (USFWS, 2019)

Other Reproductive Information

Adult: Sandlace reproduces sexually and vegetatively through the rooting of prostrate branches. Sandlace is killed by fire and will recolonize burned areas by seedling recruitment or clonal growth. Most obligate seeders in Florida scrub and sandhill, including both herbs (e.g., Highlands scrub hypericum, snakeroot, Lewton's polygala) and sub-shrubs (e.g., several species in the genus Dicerandra), recover quickly post-fire via seedling recruitment and often show dramatic aboveground population booms. In sandlace's preferred habitats, recommended FRIs range

from 8 to 16 years for xeric scrubby flatwoods to 15 to 30 years for Florida rosemary scrub (Menges 2007). (USFWS, 2019)

Reproduction Narrative

Adult: Weekley and Menges (2003) confirmed that sandlace does not resprout after fire, but recolonizes burned areas from seed arriving from unburned areas, and perhaps by spreading from unburned areas. Pollinators of sandlace are genus-specific bees and likely a few varieties of wasps. Little is known about seed production and germination for this species, but seedlings do not survive in the vicinity of the mature plants, which are allelopathic, meaning they produce chemicals that inhibit the growth and survival of other nearby plants (Weidenhamer et al.1989). The major allelochemicals are gallic acid and hydroquinone (Weidenhamer and Romeo 2004).

Habitat Type

Adult: Scrub

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Sandlace occupies open, sandy areas within the scrub vegetation, and it appears to require fire or other disturbances that create or maintain these sandy gaps. This species is killed by fire, and reoccupies burned sites from seed (Pedro Quintana-Ascencio, University of Central Florida, pers. comm. 2004). Its abundance can easily be overestimated, because it tends to colonize disturbed areas along easily accessible road cuts and rights-of-way.

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Number of Populations:

2 extant occurrences (USFWS, 2021)

Population Size:

~1.5 million (USFWS, 2021)

Population Narrative:

The previous FNAI Element Tracking Summary (FNAI 2015) reported 72 extant occurrences, 39 of which occurred on managed land. Thirty-three of 72 extant sandlace occurrences were located on private property where they had no protection from development and were unlikely to be appropriately managed. This was a significant decrease (approximately 36 percent) from the previous 5-year status review, which reported 113 extant occurrences. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification

Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated

are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations and sites needed to assure 20 to 90 percent probability of persistence for 100 years (USFWS, 1999)

2. When these sites, within the historic range of P. myriophylla, are adequately protected from further habitat loss, degradation, and fragmentation (USFWS, 1999)

3. When these sites are managed to maintain the seral stage of xeric oak scrub communities to support P. myriophylla (USFWS, 1999)

4. When monitoring programs demonstrate that populations of P. myriophylla on these sites support the appropriate numbers of self-sustaining populations, and those populations are stable throughout the historic range of the species. (USFWS, 1999)

Delisting Criteria:
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub or sand hill habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:
- Determine current distribution of P. myriophylla. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties have been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics. Though much of the basic biology and ecology of this species is understood, to recover this species more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of P. myriophylla. (USFWS, 1999)
- Provide public information about P. myriophylla. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native

Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about where P. myriophylla is found. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. myriophylla and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations that will aid in the recovery and conservation of the white-rayed pentachaeta. Some of these recommendations have already been discussed in our previous status review (Service 2010, p. 28): 1. Conduct surveys at known occurrences at least every five years to determine population trends and habitat changes. 2. Collect information on habitat preferences in order to facilitate the search for suitable habitat for outplanting. Data to be collected should include associated plant communities, soil types, soil nutrients, pollinators, and hydrology of the currently occupied habitat as well as the historically occupied sites. Conditions at currently occupied sites may not represent the habitat that supported the species at historic locations, particularly for white-rayed pentachaeta, which had a far greater range historically and likely more variability between sites. 3. Conduct surveys for potential locations in which to establish new populations. The surveys should also confirm that there is only a single population stretching across both the Triangle and Edgewood Park properties, rather than two or more populations separated by a quarter mile or more. 4. Work with partners and landowners to establish new populations. 5. Work with partners to produce and implement management plans specific to white-rayed pentachaeta conservation at each population site. (USFWS, 2021)

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USFWS. 2021. 5-YEAR REVIEW White-rayed Pentachaeta (Pentachaeta bellidiflora). 8 pp.

SPECIES ACCOUNT: *Polygonum hickmanii* (Scotts Valley Polygonum)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

a small, annual plant, 2 to 5 centimeters tall (1 to 2 inches) in the buckwheat family (Polygonaceae). The leaves are linear and pointed, and the single white flower is in the axil of bracteal leaves. (USFWS, 2009)

Taxonomy

We are not aware of any changes or proposed changes in taxonomic classification or nomenclature since listing. However, prior to listing, the following names were used in unpublished historical documents: a "draft" scientific name, Polygonum muripes pro. sp. (Morgan 1990a, b; Habitat Restoration Group 1992); and a common name, Hickman's smartweed (Denise Duffy and Associates 1997b). Hinds and Morgan (1995) used the common name Hickman's knotweed. (USFWS, 2009)

Current Range

Endemic to Santa Cruz County, California (Fish and Wildlife Service 2000). (NatureServe, 2015)

Critical Habitat Designated

Yes; 4/8/2003.

Legal Description

On April 8, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Polygonum hickmanii (Scotts Valley Polygonum) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in California (68 FR 16970-16990).

Critical Habitat Designation

The critical habitat designation for Polygonum hickmanii includes two CHUs in Santa Cruz County, California. This species critical habitat encompasses approximately 287 acres (ac) (116 hectares (ha)) (68 FR 16970-16990).

Unit 1: Glenwood Site: Unit 1 consists of approximately 87 ha (214 acres) to the west of Glenwood Drive and north and northwest of Casa Way, in the city of Scotts Valley. This unit includes land owned and managed by the Salvation Army and by the Scotts Valley High School District as a preserve, but excludes the rest of the High School, and land to the east of Glenwood Drive, encompassing the parcel known as the Glenwood Development. Most of the land being designated within this unit is privately owned, with a small portion (4 ha (9 ac)) owned by a local agency (High School District). This unit is essential because it supports approximately 25 to 50 percent of the known above-ground numbers of individuals of Polygonum hickmanii, as well as other suitable patches of wildflower field habitat that could be colonized by the species naturally, or used as introduction sites as part of a recovery effort. Much of this suitable, but unoccupied habitat, is slated to be dedicated as ''open space'' as part of the housing development on the Glenwood parcel; therefore, an opportunity may exist to pursue such a recovery effort. The unit

also supports intervening habitat that includes the grassland community that supports the pollinators and seed dispersers that are important to the survival and conservation of P. hickmanii. Additional habitat that is unsuitable for P. hickmanii is also included on the slopes above the wildflower field patches; this additional habitat is necessary to maintain the slope stability and therefore the hydrologic and soil conditions suitable for P. hickmanii and the wildflower field habitat.

Unit 2: Polo Ranch Site: The Polo Ranch site consists of approximately 30 ha (73 ac) to the east of Carbonera Creek on the east side of Highway 17 and north and northeast of Navarra Drive, in the city of Scotts Valley, in Santa Cruz County, California. All land being designated as critical habitat is privately owned. This unit is essential because it supports approximately 50 to 75 percent of the known above-ground numbers of individuals of Polygonum hickmanii, as well as other suitable patches of wildflower field habitat that could be colonized by the species naturally, or used as introduction sites as part of a recovery effort. The unit also supports intervening habitat that includes the grassland community necessary for pollinators and seed dispersers that are responsible for maintaining genetic variability within the species. Additional habitat that is unsuitable for the growth of P. hickmanii is also included on the slopes above the wildflower field patches; this additional habitat is necessary to maintain the slope stability and therefore the hydrologic and soil conditions suitable for P. hickmanii. Much of the unsuitable habitat will be set aside as ‘‘open space’’ as part of the pending housing development, because these slopes are too steep to safely support housing construction.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Polygonum hickmanii critical habitat consists of five components (68 FR 16970-16990):

(i) Thin soils in the Bonnydoon series that have developed over outcrops of Santa Cruz mudstone and Purisima sandstone;

(ii) ‘‘Wildflower field’’ habitat that has developed on these thin-soiled sites;

(iii) A grassland plant community that supports the ‘‘wildflower field’’ habitat and that supports the pollinator activity and seed dispersal mechanisms that typically occur within the grassland plant community;

(iv) Areas around each colony to allow for recolonization to adjacent suitable microhabitat sites; and

(v) Habitat within the subwatersheds upslope to the ridgelines to maintain the edaphic and hydrologic conditions and slope stability that provide the seasonally wet substrate for growth and reproduction of Polygonum hickmanii.

Special Management Considerations or Protections

Special management considerations or protections may be needed to maintain the primary constituent elements for Polygonum hickmanii within the units being designated as critical habitat. In some cases, protection of existing habitat and current ecologic processes may be sufficient to ensure that populations of P. hickmanii are maintained at those sites and have the

ability to reproduce and disperse in surrounding habitat. In other cases, however, active management may be needed to maintain the primary constituent elements for P. hickmanii. We have outlined below the most likely kinds of special management and protection that P. hickmanii may require. (1) The soils on which Polygonum hickmanii is found should be maintained to optimize conditions for its persistence. Physical properties of the soil, such as its chemical composition, surface crust, and drainage capabilities, would best be maintained by limiting or restricting the use or application of herbicides, fertilizers, or other soil amendments. (2) Overspray from irrigation or saturation of soils beyond the normal rainfall season should also be avoided, as this may alter the structure and composition of the grassland community or render the native species more vulnerable to pathogens found in wetter soil regimes. (3) The associated plant communities must be maintained to ensure that the habitat needs of pollinators and seed dispersal agents are maintained. The use of pesticides should be limited or restricted so that healthy populations of pollinators are present to effect pollination and, therefore, seed set in Polygonum hickmanii. The fragmentation of habitat through construction of roads and certain types of fencing should be limited so that dispersal agents may disperse seed of P. hickmanii throughout the unit. (4) Invasive, nonnative species such as brome grasses and other species may need to be actively managed within the grassland community to maintain the patches of open habitat that Polygonum hickmanii needs. (5) Certain areas where Polygonum hickmanii occurs may need to be fenced to protect it from accidental or intentional trampling by humans and livestock. While P. hickmanii appears to withstand light to moderate disturbance, heavy disturbance may be detrimental to its persistence. Seasonal exclusions may work in certain areas to protect P. hickmanii during its critical season of growth and reproduction.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Plant flowers in May (USFWS, 2009)

Reproduction Narrative

Adult: Very little is known regarding the species' biology, and there is no new information since listing. Germination is in the fall or early winter in response to seasonal rains. The plants grow slowly over the next few months, remaining inconspicuous until flowering begins in May. New flowers are produced until climate or microhabitat conditions are no longer favorable. Consequently, seed production ranges from several dozen in a typical individual to several hundred in a robust individual (Morgan, pers. comm. 1998b), while depauperate plants produce few or no seeds (Morgan in California Department of Fish and Game 2003) (USFWS, 2009).

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species occurs with other small annual herbs in patches within annual grasslands. These "wildflower field" patches are generally underlain by shallow, well-drained soils; this species occurs on gently sloping to nearly level shallow soils over outcrops of Santa Cruz mudstone and Purisima sandstone. It is found near the center of the patches where the soil is shallowest and often has a consolidated, crusty surface texture; other species are sparse in patch centers. Associated species include the native herbs Chorizanthe robusta var. hartwegii, Lasthenia californica, Minuartia douglasii, Minuartia californica, Gilia clivorum, Castilleja densiflora, Lupinus nanus, Brodiaea terrestris, Stylocline amphibola, Trifolium grayii, and Hemizonia corymbosa, as well as the non-natives Filago gallica and Vulpia myuros. In many cases, the habitat also supports a crust of mosses and lichens. 200 - 250 m elevation. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2024)

Number of Populations:

1 - 5 (USFWS, 2024)

Population Size:

139 (USFWS, 2024)

Population Narrative:

Restricted to 2 sites (Fish and Wildlife Service 2000). (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on the low number of known populations. Despite efforts to control invasive species through mowing, grazing, and hand removal, combined population numbers across all properties decreased from highs of approximately 2000 individuals in 1997 to a low of five in 2015. The decline in abundance has been associated with a loss of occupied habitat of approximately 85 to 90 percent since the time of listing. The relatively high number of individuals observed in 2019 (234 plants) potentially suggests that hand weeding and close monitoring at the Polo Ranch property may be having a positive effect on the few colonies that are still present (USFWS, 2020). No individuals of Scotts Valley polygonum have been observed at the Salvation Army or High School Preserve properties since 2011 and 2015, respectively (Service 2020, p. 5; Table 1). Polo Ranch continues to support the species at 3 of 12 historical colonies, and at four experimental locations where partners conducted reintroductions by seeding in experimental plots (Marty et al. 2023, pp. 9–10; Marty 2023, entire). The abundance of plants at the historical colonies has declined from 637 in 2020 to 139 in 2023. Weed-removal efforts have remained stable over this time despite change in management from LSA Associates, Inc. to the Wildlife Heritage Foundation. In December 2022,

under a cooperative agreement with the Service, one of our partners reintroduced seed to experimental plots that had not been occupied for a minimum of 5 years at Polo Ranch. They scattered seed over suitable habitat in areas of shallow soil and deeper soil and weeded in the same manner as the historical colonies; as of spring 2023, treatment types did not yield appreciable differences in plant growth (n=1,884 plants across all plots)(Marty 2023, entire). The continued absence of the species at the Salvation Army and High School Preserve properties suggests that reintroduction efforts may be necessary to restore the species to its historical distribution and advance recovery (USFWS, 2024)

Threats and Stressors

Stressor: Urban development/road construction (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/extirpation
Narrative: On Salvation Army land and the Scotts Valley High School Preserve, the five colonies of this population are now being substantially affected by the indirect impacts of development. These five colonies are at risk of extirpation because of the highly disturbed and fragmented nature of the ecosystem, the isolation from other colonies, the proximity to developed areas, and invasive plant species (USFWS, 2009).

Stressor: Recreational use (USFWS, 2009).
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Although the preserve is fenced, Lyons (2004) observed minor disturbance by students traversing to and from the high school in 2003. Gogul-Prokurat (2004) observed a number of golf balls within the preserve. Lyons (2002) previously reported residents using the preserve for golf practice (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Since listing under the Endangered Species Act, Polygonum hickmanii has become listed under the California Endangered Species Act. However, because none of the colonies are on Federal or State lands, the combination of all Federal and State laws has only limited ability to protect this plant species. The inadequacy of existing regulatory mechanisms remains a threat in 2009 (USFWS, 2009).

Stressor: Inadequate preserve design (USFWS, 2009)
Exposure:
Response:
Consequence: Lack of protection
Narrative: A preserve should be large enough to maintain the ecological functions upon which the target species depends, and it should have a ratio of edge to total area that minimizes edge effects and fragmentation. To increase the certainty that the target species will persist over the long term, land uses adjacent to a preserve should be compatible with maintaining the integrity

of the preserve (Service 2003). The Scotts Valley High School Preserve (3.2 hectares; 8 acres) is not large enough to maintain the ecosystem supporting Polygonum hickmanii, and edge effects are present because the single colony is near the preserve boundary (within approximately 18 meters; 60 feet). In addition, adjacent land uses to the immediate north (in particular, athletic fields and parking lot), and east and south of the preserve (residences) are not compatible with maintaining its integrity. Because of this, the preserve has been used for non-compatible purposes, including recreation (Lyons 2002, Gogul-Prokurat 2004), a walking short-cut to and from the school (Lyons 2004), and disposal of waste (Cheap, in litt. 2008). Prior to construction of the high school and the recycled water distribution system, the California Department of Fish and Game (in litt. 1991) recommended the two areas with Polygonum hickmanii be designated as one larger preserve. They stated "Our experiences with small plant preserves have demonstrated that high density residential developments next to small preserves result in significant declines in preserve quality and effectiveness from incompatible land uses if buffer areas between the preserve boundary and the rare plant habitats are too narrow. A 100- foot wide buffer between the plant populations and adjacent development is considered to be the minimum required." See Factor A for additional discussion about alteration and loss of habitat due to proximity to urban areas (USFWS, 2009).

Stressor: Random extinction (USFWS, 2009)
Exposure:
Response:
Consequence: Extinction
Narrative: Species with few populations and/or individuals are vulnerable to random extinction. In this situation, naturally occurring events can cause extinction through mechanisms operating at the genetic level (e.g., decrease in genetic variability), the population level (e.g., lack of ability to attract pollinators because of few individuals), or the landscape level (e.g., storms, drought, fire) (Service 2003). Polygonum hickmanii is at high risk of random extinction. The species is known from only two populations approximately 1.6 kilometers (1 mile) apart. The total occupied area comprises less than 0.4 hectare (1 acre). The most-recent surveys reported 0 individuals on the Polo Ranch in 2006 (Morgan, pers. comm. 2009), “several dozen” individuals on Salvation Army land in 2008 (Morgan, pers. comm. 2009), and 88 individuals on the Scotts Valley High School Preserve in 2003 (Lyons 2004) (USFWS, 2009).

Stressor: Invasive species and competitive native species (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Non-native annual grasses are now a threat to Polygonum hickmanii on all three properties. In particular, much of the habitat on the Scotts Valley High School Preserve and adjacent Salvation Army land is now occupied by non-native grasses, which must be mowed to reduce adverse effects to this species and Chorizanthe robusta var. hartwegii. On the Polo Ranch, competitive native species are also threatening Polygonum hickmanii and its habitat. See Factor A for additional discussion about invasive species and competitive native species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Current climate change predictions for terrestrial areas in the northern hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). The potential impacts of climate change on the flora of California were discussed recently by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change and that species will move to higher elevations and northward, depending on the ability of each species to do so. Increases in species diversity in higher elevations and northern locations due to climate change have the potential to result "...in new species mixes, with consequent novel patterns of competition and other biotic interactions..." with unknown consequences to the species which currently exist there (Loarie et al. 2008). While we lack adequate information to make specific and accurate predictions regarding how climate change in combination with other factors such as small population size will affect Polygonum hickmanii, small-ranged species are more vulnerable to extinction due to these changing conditions (Loarie et al. 2008) (USFWS, 2009).

Recovery

Reclassification Criteria:
Interim recovery objective: Establishing permanent conservation easements over or acquisition of the three properties in Scotts Valley (USFWS, 2009).

Interim recovery objective: ddressing conservation measures for this species in a habitat conservation plan with the City of Scotts Valley (USFWS, 2009).

Recovery Priority Number: 5

Recovery Actions:

- Protect habitat for Santa Cruz Mountains species on private land through habitat conservation plans and landowner agreements. Little to no progress has been achieved. Because the habitat on Salvation Army land and the Scotts Valley High School Preserve is now highly degraded, the Polo Ranch is the only property where the ecosystem may be intact (USFWS, 2009).
- 2. Manage habitat for Santa Cruz Mountains species. Little progress has been achieved regarding this recommended recovery action as it pertains to Polygonum hickmanii. The only beneficial actions we are aware of is the mowing of invasive grasses in the vicinity of the colonies on Salvation Army land and the Scotts Valley High School Preserve, and possibly the placing of a fence around colonies on the Polo Ranch (HuffmanBroadway Group 2008) (USFWS, 2009).
- 3. Conduct research on the life history, ecology, and population dynamics of these species that will contribute to appropriate management strategies. No research has been conducted on Polygonum hickmanii. Monitoring has been conducted only on an irregular basis, and the data have not been used to modify management actions (USFWS, 2009).
- 4. Locate additional habitat/populations within the historic range of the species. Gogul-Prokurat (2004) reported the following. "Surveys of most remaining potentially suitable habitat throughout Scotts Valley and surrounding areas have been conducted by local botanists, and to date, no additional populations…have been discovered. Because the rock outcrop areas in which Scotts Valley polygonum occurs are also home to two other Federally-listed endangered species, the Scotts Valley spineflower…and the Ohlone tiger

beetle..., these areas have been thoroughly surveyed. Although the individual Scotts Valley polygonum plants are small and only visible during the growing season, populations should be relatively easy to locate because the rock outcrops on which they grow are…readily identifiable in the field. It is possible that some privately-owned areas of potentially suitable habitat have not been surveyed…. However, Mr. Randall Morgan, a long-time resident ecologist who is intimately familiar with the area, has thoroughly searched for suitable areas based on topographic maps and on-the-ground surveys. According to Mr. Morgan, most of the habitat likely to support Scotts Valley polygonum in this area has been developed, and it is highly unlikely that additional undeveloped areas with the potential to support the species exist…. The Department searched nine U.S. herbaria for historical records…. A literature search was also conducted. To date, no references to any…populations other than the known localities in Scotts Valley have been located." In sum, no additional habitat or populations have been located, and it now seems unlikely that any more exist (USFWS, 2009).

- 5. Develop and implement a public outreach program. A public outreach program has not been developed. The only beneficial action is Hayes and Taylor (2007) producing a fact sheet with color photos in 2006, which the Elkhorn Slough National Estuarine Research Reserve has posted on its website (USFWS, 2009).
- 6. Evaluate progress of recovery effectiveness of management and recovery actions and revise management plans. The efforts to date for Polygonum hickmanii have not been effective, and management plans have not been appropriately revised (USFWS, 2009).
- Polo Ranch. The Polo Ranch contains the only potentially intact ecosystem with Polygonum hickmanii (and Chorizanthe robusta var. hartwegii). Therefore, we recommend pursuing opportunities for acquisition of the Polo Ranch by a conservation organization to appropriately manage it as a preserve for sensitive plant species (USFWS, 2009).
- Salvation Army land. We recommend pursuing a conservation easement over the area with Polygonum hickmanii (and Chorizanthe robusta var. hartwegii) and that the area be appropriately managed by a conservation organization as a preserve for the plants (USFWS, 2009).
- Scotts Valley High School Preserve. We recommend the preserve and the grassland and revegetation area be protected by a conservation easement with appropriate management by a conservation organization. In addition, we recommend the Scotts Valley High School implement an education program (with assistance from the Ventura Fish and Wildlife Office) for its students and the community that includes conservation of Polygonum hickmanii and Chorizanthe robusta var. hartwegii (USFWS, 2009).
- Because of the high degree of threat and low potential for recovery in the wild, a botanical seed bank for Polygonum hickmanii should be established, with the collections stored at several institutions allied with the Center for Plant Conservation. This would provide for a genetic representation of the species in case of extinction in the wild and also a subsequent source for future re-introductions (USFWS, 2009).
- Because of the high degree of threat and low potential for recovery in the wild, living colonies of Polygonum hickmanii should be established at several botanical gardens allied with the Center for Plant Conservation. This would insure that living specimens of the species could be seen somewhere and also insure there is a living population through time (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-year review: • The conservation easement at Polo Ranch should be finalized with funding to ensure adequate management by a conservation organization that has the capability to adaptively manage for long-term persistence of Scotts Valley polygonum. • Seed banking should continue annually until a sufficient amount of viable seed, from a genetic population that is as diverse as possible, has been established at multiple seed banks. This will ensure redundancy in storage in case of storage failure. Seed should be bulked to allow outplanting at all historical locations. • The most effective means of germination and propagation should be determined, first using Polygonum parryi as a proxy, and then with Scotts Valley polygonum. • Bulked seed should be used to establish greenhouse populations and to outplant Scotts Valley polygonum to all historical locations. The Glenwood Preserve, adjacent to both the Salvation Army property and the Scotts Valley High School Ecological Preserve, should also be considered as a novel outplanting location. The Glenwood Preserve is already managed for the presence of other federally listed plant species and has a similar suite of associated species and environmental conditions. • In order to address the inadequacy of the current preserve designs and management, the creation of a single large management unit that brings together the Salvation Army property, Scotts Valley High School Ecological Preserve, Polo Ranch property, and Glenwood Preserve should be explored. (USFWS, 2020)
- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-year review: • Reintroduction should be expanded within Polo Ranch. • Reintroduction should be implemented at the Scotts Valley High School Ecological Preserve and Salvation Army property. • The Glenwood Preserve, adjacent to both the Salvation Army property and the Scotts Valley High School Ecological Preserve, should also be considered as a novel introduction location. The Glenwood Preserve is already managed for the presence of other federally listed plant species and has a similar suite of associated species and environmental conditions. • In order to address the inadequacy of the current preserve designs and associated management, the creation of a single large management unit that brings together the Salvation Army property, Scotts Valley High School Ecological Preserve, Polo Ranch property, and Glenwood Preserve should be explored (USFWS, 2024).

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SPECIES ACCOUNT: *Potentilla hickmanii* (Hickman's potentilla)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from a woody taproot. Leaves are basal, with 4-7 pairs of deeply cleft leaflets. Stems are prostrate or decumbent, mostly 8-15 cm long. Slender flowering stems, 4-25 mm long, bearing yellow flowers arise from each stem. Blooms April-August. (NatureServe, 2015)

Taxonomy

Astragalus tener var. titi (Figure 4) was first collected by Mrs. Joseph Clemens in 1904. It was first described by Alice Eastwood as Astragalus titi based on those specimens collected by Clemens near Moss Beach, Monterey (Eastwood 1905). Eastwood named the plant A. titi in honor of Dr. F. H. Titus, who also collected specimens of this plant. Jepson (1936) considered these two taxa synonymous. Howell (1938) compared type specimens of A. tener and A. tener var. titi and confirmed two different plants, based on the low decumbent habit and smaller flowers of A. tener var. titi. Barneby (1950) published the name A. tener var. titi, noting differences from A. tener var. tener (alkali milk-vetch) in size of various flower parts, habitat, and geographic range. Astragalus tener var. tener is native to alkaline grass flats in the Central Valley, San Francisco Bay region, and the lower Salinas Valley (Barneby 1950). Additionally, crossing studies and enzyme electrophoresis concluded that A. tener var. titi is a valid taxon(Liston 1992) (USFWS, 2004).

Historical Range

Potentilla hickmanii was historically known from two general areas along the central coast of California: on the Monterey Peninsula in Monterey County, and in the Half Moon Bay area in San Mateo County. The type specimen was collected from the Monterey Peninsula “near the reservoir which supplies Pacific Grove” and described by Alice Eastwood in 1902. Several other collections were made from the Monterey Peninsula during the 1930s, but detail on specific locations is lacking. (USFWS, 2009)

Current Range

California endemic. One extant population in Monterey County. One large population exists in San Mateo County. The total range extent consists of 3 areas and about 9 sq. mi. (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2004)

Breeding Season

Adult: Seeds are produced late in the season (USFWS, 2004).

Reproduction Narrative

Adult: Potentilla hickmanii has protogynous flowers with a stigma that is receptive to pollen before the pollen-bearing anthers open within the same flower (Jones and Stokes Associates 1996). This mechanism can reduce self-pollination and increase the possibility of outcrossing. It is also likely that some level of interpopulational genetic diversity exists (B. Ertter in litt. 1997). Seeds are produced late in the season. Plants may produce little to no seeds in drier years, especially among early-blooming flowers (Jones and Stokes Associates 1996, B. Ertter in litt. 1997). This lack of seed set might be due to the observed absence of pollinators during blooming time of dry years. Natural population increases appear during wet years, although these population increases may not occur during dry years (Doak et al. 2000). Additionally, recent greenhouse research indicates that some plants previously counted as up to five individuals may have been one single plant with a branched caudex (V. Yadon in litt. 2002). Research was conducted during 1998 and 1999 to explore environmental factors that limit seed production and establishment, and how a limitation might vary through the plants' flowering season (Doak et al. 2000). Evidence for pollen limitation of seed set was apparent and pollen augmentation also significantly reduced the probability of reproductive failure (Doak et al. 2000). Reproductive failure may exist if both pollinator visitation and pollen dispersal is low. Doak et al. (2000) observed only one pollinator in the 2-year study (i.e., a small beetle). Additionally, this research discovered that developed, mature seed was found significantly more frequently in plants that were within at least 50 centimeters (20 inches) of each other than in isolated plants (Doak et al. 2000). Potentilla hickmanii will grow and bloom year-round under cultivated conditions. However, cultivated flowers that bloom later in the year tend not to set seed (V. Yadon in litt. 2002). Plants with early flowers that were grown in a hot house set seed apparently without benefit of pollinators (V. Yadon in litt. 2002) (USFWS, 2004).

Habitat Type

Adult: coastal scrub/forest (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits coastal bluff scrub and closed-cone pine forest (Smith & Berg 1988). Freshwater marshes, seeps and streamlets in open forested areas near the coast, 0-75 m. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Population Information and Trends

Population Trends:
Decreasing (NatureServe, 2015)

Population Growth Rate:
Decline of 70-90% (NatureServe, 2015)

Number of Populations:
2 (USFWS, 2020)

Population Size:
~5,000 (USFWS, 2020)

Population Narrative:
Hickman's potentilla occurs in very small numbers (<80) at Indian Village in Monterey County and a larger population (~5,000) occurs on land managed by the Golden Gate National Recreation Area near Montara in San Mateo County. (USFWS, 2020)

Threats and Stressors

Stressor: Development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: current threats to the population at Pebble Beach, Monterey County, are relatively the same as at the time of listing. Because a second population has been discovered since the time of listing (Montara population in San Mateo County) and threats to the population are less than they are for the Pebble Beach, Monterey County, population, the threats to the species overall are less than they were at the time of listing. In addition, the Montara population has been transferred from private ownership to state and local agency ownership (CalTrans and Peninsula Open Space Trust), and long-term plans are to transfer these lands to California State Parks and Golden Gate National Recreation Area, respectively. However, threats to the habitat remain at both locations, and include conversion of coastal terrace prairie habitat by native and nonnative species, alteration in hydrology, and recreation. The Pebble Beach population is threatened with extirpation from alteration and destruction of habitat because the size of coastal prairie where Potentilla hickmanii occurs is less than 0.25 ac (0.1 ha) and the number of individuals is so few; therefore, the remaining individuals may not be able to persist if the condition of the habitat continues to decline (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation on Potentilla hickmanii by mule deer (Odocoileus hemonius) on the Pebble Beach population in Monterey County has been observed by Yadon (in litt. 1997) and others (Jones and Stokes Associates 1996). Since the time of listing, herbivory by voles (Microtus spp.),

snails (various species), and slugs (various species) has also been observed on both vegetative and reproductive structures (Doak et al. 2000). As recently as 2008, Staub (in litt. 2008) noted that gophers (Thomomys sp.) and mice (various species) are likely affecting the population. With so few individuals comprising this population (11 individuals as of 2008), predation exacerbates the threat of stochastic extinction (see Factor E). We have also become aware that the Montara population in San Mateo County is within an area being grazed by cattle (CNDDB 2008). Cattle grazing may be either beneficial or deleterious to the species, depending on the intensity and duration. Cattle grazing may benefit the species by reducing competition from nonnative species. Too little grazing may allow nonnative species to outcompete Potentilla hickmanii, while too much grazing may result in predation or trampling of Potentilla hickmanii. We do not have specific information concerning the intensity or the overall impact of grazing that is occurring within this area (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: This species occurs within a portion of the Monterey Peninsula included in the California Coastal Zone. The Del Monte Forest Land Use Plan of 1984 was developed to comply with the Coastal Act's requirement that all counties prepare a plan for those portions of the Coastal Zone within their jurisdiction. Once the Del Monte Forest Land Use Plan was certified by the Coastal Commission, development permits within the Del Monte Forest coastal zone became the responsibility of the County of Monterey. The County of Monterey also has designated certain areas, including where Potentilla hickmanii grows, as Environmentally Sensitive Habitat Areas. Protection of listed species through the California Coastal Act and local land use designations is dependent upon the discretion of the lead agency involved. Although no projects have been proposed for the site where Potentilla hickmanii grows, these state and local regulations may not protect the species from secondary impacts that occur from such threats as changes in hydrology in adjacent areas and the spread of nonnative species (USFWS, 2009).

Stressor: Competition with nonnative species (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the Monterey Peninsula site, at least five nonnative plant species occur within Potentilla hickmanii habitat. These include: hairgrass, various bromes, tall fescue, and ryegrass (Ferreira 1995, Yadon pers. comm. 2008). Nonnative grasses including Harding grass (Phalaris aquaticus) also occur at the Montara site. Several of these nonnative taxa are known to outcompete and displace native species in general (Bossard et al. 2000). To determine the effects of competition on Potentilla hickmanii, Doak compared the number of inflorescences and the number of flowers on Potentilla hickmanii seedlings within plots where surrounding vegetation was either clipped or unclipped; Potentilla hickmanii seedlings in the clipped plots produced more flowers and inflorescences than those in the unclipped plots (Doak et al. 2000). At the Montara site, pampasgrass was noted as being a potential threat to one colony of Potentilla hickmanii (Kramer 2008) (USFWS, 2009).

Stressor: Reproductive failure (USFWS, 2009)
Exposure:

Response:
Consequence: Reduced number of new plants
Narrative: At the time of listing, we discussed that reproductive failure was a concern, primarily because the Monterey Peninsula population had a very low number of new seedlings established over a 2- year period (Morosco 1997). In addition, low seed set had been observed by several biologists (Ertter in litt. 1997, Yadon in litt. 1997). Since the time of listing, Doak et al. (2000) compared seed set in flowers that were cross-pollinated by hand with those in a control group. Based on number of ovules, each flower has the potential to produce approximately 10 seeds; the researchers found that hand-pollinated flowers achieved a higher seed set than the control group (4.8 per flower compared to 3.2) (Doak et al. 2000). The lack of pollinators observed in the field has been put forth as a potential cause for low seed set by several observers (Yadon in litt. 1997, Ertter in litt. 1997, Doak et al. 2000) (USFWS, 2009).

Stressor: Small numbers of individuals and populations (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of genetic variability/extinction
Narrative: Conservation biology literature discusses that small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). Based on historical records, we believe that urban development and secondary impacts associated with such development has already reduced the distribution of this species in the two areas where it occurs. Indirect effects from urbanization in the watersheds include changes in hydrology, changes in vegetation, and an increase in nonnative species. The effects of competition with nonnative species is most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). While any one of these factors may not be enough to threaten the survival of Potentilla hickmanii independently, its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of Potentilla hickmanii (USFWS, 2009).

Stressor: Alteration of fire frequency (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, we discussed that alteration of fire frequency was a potential threat to all five taxa in the listing rule, due to fire suppression activities that increased on the Monterey Peninsula as development increased over time; we did not discuss specifically how reducing the frequency of fires in the area would affect Potentilla hickmanii. Although Potentilla hickmanii itself is associated with grassland habitats, the small meadow where it occurs is within an opening of Monterey pine forest. Without periodic fire, the pine forest would tend to expand in range over time and eventually shade out the habitat where Potentilla hickmanii occurs. Shading by Monterey pine was also noted as a threat to several colonies of Potentilla hickmanii at the Montara population (Kramer 2008). Based on current information, alteration of fire frequency may continue to be a threat to Potentilla hickmanii at both sites (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward, depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to Potentilla hickmanii at this time (USFWS, 2009).

Recovery

Reclassification Criteria:
At least five viable populations (i.e., populations that are stable or increasing based on a minimum of 10 years monitoring) occur in suitable habitat (addresses Listing Factors A and E). This criterion is relevant and up-to-date. This criterion has not been met. In addition to the two populations known at the time of listing, one outplanting effort is underway at Point Lobos State Park (USFWS, 2009).

All five of the sites are on land that is protected from human-induced disturbance. Funds must be available for appropriate long-term management. As determined by research, protected habitat must be of adequate size (large enough to support a functioning ecosystem; e.g., species present to support seed dispersal and pollination, areas that support fluctuating distributions, areas that harbor suitable unoccupied habitat for population expansion) and configuration to ensure that ecosystem and community processes and associated species (e.g., hydrologic regime, food webs, pollinator fauna, forest meadow communities) are maintained, and that an adequate diversity of sites exist for population expansion and for colonization of new areas as microhabitat conditions change. One of these protected sites should be the Indian Village (Pebble Beach) population; another should be the Montara population in San Mateo County (addresses Listing Factors A and E). This criterion is relevant and up-to-date. This criterion has not been met (USFWS, 2009).

Surrounding vegetation has been managed for a reduction of nonnative plant species and nonnative snails and slugs. The populations should be adequately maintained, such that encroachments by nonnative plants and herbivorous predators (including deer) are not negatively affecting Potentilla hickmanii directly or indirectly (addresses Listing Factor C). Individuals have been caged at the Pebble Beach population, and this has reduced deer browse. However, additional management is needed to control nonnative species. This criterion is relevant and upto-date. This criterion has been partially met for one population (USFWS, 2009).

The populations have been appropriately managed to such a degree that monitoring has determined the populations are of adequate size, density, and number that the trend for each of the populations is projected to be stable or increasing in the future (addresses Listing Factors A and E). Population censusing and demographic studies have been conducted for the Pebble Beach population, but not in a manner that is able to detect long-term trends. This criterion is relevant and up-to-date. This criterion has not been met (USFWS, 2009).

A seed bank has been established at a recognized institution certified by the Center for Plant Conservation (addresses Listing Factor E). This criterion is relevant and up-to-date. This criterion has been partially met in the following way: a portion of seed from the Pebble Beach population that was previously collected for research is being stored at the University of California, Santa Cruz (UCSC); UCSC is not a Center for Plant Conservation affiliate. A small amount of seed was collected from the Montara population in 1995 by staff from the University of California, Berkeley (Jones and Stokes 1996); its current disposition is unknown (USFWS, 2009).

Delisting Criteria:
Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) maintaining and restoring habitat through control of nonnative grass species , and b) control of herbivory by deer and small mammals. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts; the Monterey Peninsula area should be further assessed for potential sites. Two additional, new populations are established and protected where appropriate. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. We expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Even though this is a perennial species, the aboveground portion is herbaceous and dies back each year, and thus responds to some extent like an annual species. Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

Recovery Actions:
- Work with Pebble Beach Company to evaluate current conditions and improve habitat conditions at the Pebble Beach site. Determine if additional measures can be taken to reduce threats from overwatering, invasive nonnative species, and herbivores (a portion of recovery tasks 1.4.3 and 2.3) (USFWS, 2009).
- Continue pollination ecology research initiated by Doak to determine if lack of pollinators is limiting seed set at the Pebble Beach site. Conduct research to identify pollinators at the Montara site and compare with those at Pebble Beach (a portion of recovery task 3.2.3) (USFWS, 2009).
- Seek additional sites for outplanting additional populations in Monterey and San Mateo Counties. State Park lands (aside from Point Lobos) may offer opportunities for outplanting (a portion of recovery task 4.2.3) (USFWS, 2009).

- Coordinate with Peninsula Open Space Trust to determine if management actions need to be taken to protect or enhance habitat for the species on lands they manage prior to transfer to Golden Gate National Recreation Area (GGNRA). Seek assurance from GGNRA that necessary management actions be continued (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-Year Review: 1. Continue management of herbivory and competing species at the Indian Village population. 2. Continue outplanting efforts at Indian Village to increase population size so that adequate natural recruitment is possible. 3. Restore associated native species to the Indian Village site to promote natural ecosystem processes. 4. Finalize and implement the National Park Service plan to manage and restore habitat and outplant Hickman's potentilla at the Montara population. 5. Resurvey and monitor the Point Lobos introduction sites. 6. Evaluate additional introduction sites in San Mateo and Monterey Counties. 7. Continue seed banking efforts until adequate seed from both populations have been stored. (USFWS, 2020)

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SPECIES ACCOUNT: *Primula maguirei* (Maguire primrose)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/21/1985; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb with stems approximately 4-10 cm tall, each bearing 1-3 showy, conspicuous lavender-colored flowers. Blooms May-June. (NatureServe, 2015)

Taxonomy

Primula maguirei was recently determined to be one of four varieties of Primula cusickiana A. Gray (Holmgren and Kelso 2001). The classification is described as Primula cusickiana var. maguirei L.O. Williams (Holmgren and Kelso 2001). The physical features of the plant are as they were when originally classified and this taxonomic reclassification does not change its limited range and geographic restrictions. Primula maguirei is an endemic with unique ecological and physical characteristics; however, the features that distinguish Primula cusickiana var. maguirei from other varieties within Primula cusiskiana are not substantial enough to warrant P. maguirei being classified at the species level (Holmgren and Kelso 2001). We recognize the synonymy (same identity) of P. maguirei = P. cusickiana var. maguirei and find this taxonomic change does not affect the listing or protection of the P. maguirei under the ESA. We recommend that the taxonomy be amended through a technical revision to the list at 50 CFR 17.12 (see section 4). Until that time, we will continue to refer to this species as Primula maguirei (USFWS, 2011).

Current Range

Limited area of Logan Canyon in Cache county, Utah (Tilley et al. 2011).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: insectand hummingbird pollinated. Also able to reproduce asexually (USFWS, 2011)

Breeding Season

Adult: Flowering mid-April to mid-May (USFWS, 2011).

Reproduction Narrative

Adult: Primula maguirei is a perennial, herbaceous plant 50-100 millimeters (mm) (2-4 inches (in.) high, with showy reddish-lavender flowers. Leaves are oblong and 50 mm (2 in. long and 12 mm (0.5 in.) wide. P. maguirei has two types of flowers, the pin and thrum—this is referred to as heterostyly (Davidson and Wolf 2009). On the pin form flower, the female reproductive organs (pistil—produces ovules which become seeds) are higher than the male reproductive organs (stamen—produces pollen). The thrum form is the opposite (Davidson and Wolf 2009). The different lengths of the pin and thrum flowers are adapted for pollination by different

pollinators or different body parts of the same pollinator (Davidson 2010). These flower forms thus promote outcrossing (reproducing with non-related individuals) through sexual reproduction (Darwin 1877 in Bjerregaard and Wolf 2008). Bees, moths, and hummingbirds pollinate Primula maguirei flowers (Davidson 2010). Primula maguirei also can reproduce asexually, using underground rhizomes or horizontal plant stems to produce new shoots. Rhizomes allow storage of water in times of drought. This clonal growth pattern (genetically identical individuals growing together) allows recovery after periods of dormancy, such as during drought conditions (Kelso et al. 2009). The clonal nature of this species also makes it difficult to identify individual plants in the field (Sibul 2006). Primula maguirei is distributed across a linear reach (ca. 16.5 kilometers (km) (10 miles (mi)) of Logan Canyon, with occurrences aggregated in upper and lower portions of the canyon that are separated by some 9.6 km (6 mi) of unoccupied habitat (see section 2.3.1.2). The upper and lower portions of the canyon are characterized by differences in several environmental parameters likely to influence the species' life history. The average temperature over the flowering period is 5°C (9°F) warmer in the lower canyon than it is in the upper canyon (Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). The average relative humidity also is lower (15-20%) in the lower canyon than in the upper canyon (Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). Generally, flowering occurs between mid-April and early June, but due to these environmental differences, plants in the lower canyon may begin blooming 2 to 3 weeks earlier and tend to dry out faster than those in the upper canyon (Bjerregaard and Wolf 2008; Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009). It is unknown if there is sufficient cross pollination between the lower and upper canyon sites (Wolf and Sinclair 1997; Bjerregaard and Wolf 2008) (see section 2.3.1.3 for genetic discussion). Some investigators have noted a period of overlap (10–17 days) where both the lower and upper canyon sites are in flower, but the number of flowering individuals is low during this period (Bjerregaard and Wolf 2008; Davidson and Wolf 2009). However, observations since 2006 have revealed little to no period of overlap, suggesting a very limited potential for gene flow between these two portions of the species' very limited geographic range (Torti 2011b) (USFWS, 2011). Flowering mid-April to mid-May. Plant associates include pink alumroot (Huechera rubescens), mat rockspirea (Petrophytum caespitosum), tadpole buttercup (Ranunculus ranunclulinus), and narrowleaf wildparsley (Musineon lineare) (Tilley et al. 2011) (NatureServe, 2015).

Habitat Type

Adult: cliff ledge (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits damp ledges, crevices, and over-hanging rocks along canyon walls. Almost always on north-facing, moss covered limestone cliffs at or near the canyon bottom in shallow dolomitic soils of the Laketown and Fish Haven geologic formations (Tilley et al. 2011). 1350-1700 m elevation. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal from May to June (England 1990) (NatureServe, 2015)

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

6 - 20 (NatureServe, 2015)

Population Size:

250 - 2500 individuals (NatureServe, 2015); 4000 - 20000 (USFWS, 2011)

Additional Population-level Information:

Our evaluation of the 1990 recovery plan (USFWS 1990), and the original 1985 listing rule (50 FR 33731) indicated that we did not present how we defined a population for Maguire primrose. For this amendment and managing for Maguire primrose in the future, we use NatureServe guidelines for delimiting plant populations (NatureServe 2004) which are based on the proximity of occupied habitat areas to one another. We consider locations within 2 kilometer (km) (1.24 miles (mi)) of each other and suitable habitat in between them to be a single population. Plant locations that are greater than 2 km (1.24 mi) from each other with unsuitable habitat in between them, are considered separate populations (NatureServe 2004). Based on this criterion, there are two populations of Maguire primrose (Lower Canyon and Upper Canyon), and the number of populations has not changed since the time of our listing decision (USFWS 2019).

Population Narrative:

It is estimated that 3000 individuals exist across all 6 populations (Tilley et al. 2011). Past surveys have produced estimates around 1000. 6 known populations (Tilley et al. 2011). (NatureServe, 2015). Low resiliency, representation and redundancy are based on the relatively low number of populations and the relatively restricted geography this species inhabits.

Threats and Stressors

Stressor: Rock Climbing (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: The USFS has funded a number of studies to look at the interactions between rock climbing and Primula maguirei (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). These studies have examined climbing-related impacts at 11 of the 12 EO locations mapped for P. maguirei by the UNHP, and have consistently concluded that climbing-related impacts are not occurring at these sites (TABLE 2). The explanations for the apparent lack of conflict varied by site--at 3 sites, P. maguirei is not (and may never have been) present; of the remaining 8 sites, 1 was assessed as unsuitable for climbing; 2 have been formally closed to climbing by the USFS; another lacked any evidence of impacts despite the presence of P. maguirei within a few meters

of climbing routes; and at the remaining 4 sites, plants are not located along or near climbing routes (Sibul 2006; Torti 2010, 2011a, 2011b; summarized in TABLE 2 this document). Short-term monitoring (1-3 years in duration) at 5 of the 9 EOs where P. maguirei still occurs has indicated that plants are relatively stable, showing no significant mortality or decreased growth at any monitored location (Torti 2011a). These studies have recommended that existing climbing closures remain in effect, but have not recommended additional closures based upon the apparent lack of conflict from existing patterns and levels of climbing activity (Sibul 2006; Torti 2008; Torti and Schen 2009; Torti 2010, 2011a). Instead, these authors recommend that monitoring of both Primula maguirei and climbing use continue in order to gain increased confidence in apparent trends as well as to verify the assumption that climbing routes and/or pressures will not change. We believe that the threats posed by rock climbing may be less than previously assessed, based on the preliminary data and short-term monitoring that has occurred so far, and we concur with the recommendations to continue monitoring to ensure that the species is adequately protected from habitat loss from climbing-related activities. Monitoring should include an adaptive management approach that utilizes the monitoring data to determine the necessity of continued monitoring and management actions. This recommendation is reflected in section 4 (USFWS, 2011).

Stressor: Highway Improvements (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, transportation and utility construction from the mouth of Logan Canyon to the Right Fork of Logan Canyon were considered threats to the species (50 FR 33733, August 21, 1985). Highway and utility construction had the potential to change the geomorphology of the canyon; we believed that construction could result in altered air patterns and the removal of vegetation to an extent that the microclimate habitat of the cliffs would become less suitable for Primula maguirei. Since the time of listing, one highway resurfacing and bridge replacement (Burnt Bridge) project has occurred near the upper canyon Primula maguirei sites, from the Right Fork of Logan Canyon to Garden City (Federal Highway Administration 1995). P. maguirei occurrences along this stretch of highway are about 40-50 feet above the highway. Conservation measures were used to protect the species, such as avoiding construction activity in P. maguirei habitat, limiting removal of canyon-bottom trees (preserving microhabitat conditions of the cliff face), avoiding blasting during the flowering period, and minimizing dust during the flowering period (Federal Highway Administration 1995). Highway widening projects have the potential to impact the species. However, the Utah Department of Transportation (UDOT) does not have plans to improve the highway through at least 2030 (UDOT 2007). Therefore, we do not consider highway projects to be a threat to the species in the foreseeable future (USFWS, 2011).

Stressor: Campground Development (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, we determined that campground and trail development within Logan Canyon area may impact the species (50 FR 33733, August 21, 1985). Furthermore, we were concerned with the indirect effects of altering the microenvironment of Logan Canyon by removing canyon-bottom trees for campgrounds (50 FR 33732, August 21, 1985). Two small

campgrounds are currently within 0.25 mi of three known Primula maguirei locations. We are not aware of any loss of plants from campground activities. No major campground improvements have occurred since we listed P. maguirei and further campground development is now seen as unlikely given the limited space available in the canyon (Duncan 2010, pers. comm.). We no longer consider campground activities as a threat (USFWS, 2011).

Stressor: Maintenance and Improvement to Water Development (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, we determined that utility construction was a threat. More specifically, the Recovery Plan stated that water development and maintenance or improvements of facilities such as reservoirs and water pipelines were threats to the species (FWS 1990). However, the only water facility in the canyon is the DeWitt Pipeline, which supplies 70% of Logan City's water (CH2MHILL 2007). We are not aware of any Primula maguirei occurrences within the DeWitt pipeline route (CH2MHILL 2007). The final biological assessment for the project also included best management practices and mitigation measures to reduce the likelihood negative impacts to the species would occur as a result of the project (CH2MHILL 2007). We are not aware of any additional water improvement projects planned within the vicinity of habitats occupied by P. maguirei. Therefore, we do not currently consider water development to be a threat (USFWS, 2011).

Stressor: Climate Change (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Reliable projections of climate change in the West are particularly difficult due largely to its complex topography (Smith et al. 2001). It is thus difficult to predict the long-term effects of climate change on a species such as Primula maguirei that occurs in a relatively small area (Wolf 2010, pers. comm.). At least one location (Right Fork, EO #007 in TABLE 2) has decreased in the number of individuals and area of coverage in apparent response to dry winter and spring conditions (Shultz 1987 in IHI 1995). Another occurrence (Lower Logan Canyon North, EO #003 in TABLE 2) was located in 1982 during a wet year, but has not been observed again since (Sibul 2006). Although rhizomes may allow P. maguirei to store water in times of drought (see section 2.3.1.1), extreme weather events, such as persistent or prolonged drought conditions, could ultimately exceed the drought tolerance of P. maguirei. In 2008, HOBO data loggers were placed at 10 sites throughout Logan Canyon and programmed to record temperature and humidity every 30 minutes (Torti 2008). Torti also established 124 permanent quadrats over the course of 2 years (2008 and 2009) to record the approximate size of clumps of P. maguirei, the number of stems per clump, the number of flowers per stem, the pin or thrum form of the flower, as well as the general state of the flower's phenology (Torti 2008). Follow-up surveys in 2009 and 2011 suggest that plants within permanent quadrats have been relatively stable, with no significant mortality or reductions in vegetative growth (stems) or reproduction (flowers) (Torti and Schen 2009; Torti 2011a). We recommend that this long-term monitoring effort continue in conjunction with data collection from the HOBO data loggers, so that a climate vulnerability assessment can be completed for this species (see section 4) (USFWS, 2011).

Stressor: Disease or predation (USFWS, 2011)

Exposure:
Response:
Consequence: Loss of individuals
Narrative: In the listing document and Recovery Plan for Primula maguirei, disease and predation were not considered threats to the species (50 FR 33733, August 21, 1985; FWS 1990). Herbivory from rodents is regularly encountered (Sibul 2006; Bjerregaard and Wolf 2008; Torti 2008; Davidson and Wolf 2009; Torti and Schen 2009), primarily from bushy-tailed woodrats (Neotoma cinerea) and similar species (Bjerregaard and Wolf 2008). Snails of the Oreohelix genus were observed directly on plant leaves (Davidson 2010). Insects also may damage fruits of the plants (Sibul 2006). The magnitude of herbivory of a single individual ranges from the single flower being eaten to the entire plant being devoured (Davidson 2010). Herbivory from rodents, snails and insects appears to affect plants; however, we do not have information indicating that it is occurring at unnatural or unsustainable levels. We have no evidence to indicate that this factor is a threat to this species now or for the foreseeable future (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Prior to listing, Primula maguirei was afforded some protection because the USFS designated it as a sensitive species under the NFMA. This designation requires the USFS to analyze the effects of actions they fund, authorize, or carry out that may affect P. maguirei. In the event that ESA protections are removed, the USFS has expressed the intention to once again designate P. maguirei as a sensitive species, thereby reinstating these protections. The USFS also has designated substantial parts of Logan Canyon as a Botanical Special Interest Area, a designation which directs the agency to protect and manage (in part) for the unique botanical resources present, including P. maguirei. This designation also will remain in effect regardless of the ESA status of P. maguirei. In addition, the USFS has funded numerous research projects to better understand the status of this species and its vulnerability to threats, and has closed certain areas to climbing activity as a result of concerns stemming from the perceived threats. If these existing regulatory mechanisms continue to be adequately implemented, as they have been in recent years, we regard them as likely to be sufficient to provide for the long-term protection of the species in the event that it is de-listed (USFWS, 2011).

Stressor: Invasive Species (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Weed infestation is a possible threat to Primula maguirei. Dyer's woad (Isatis tinctoria) is found near 8 of the 9 sites where P. maguirei is found (CH2MHILL 2007). Dyer's woad is primarily found in disturbed sites, such as pastures, rangeland, cropland, woodlands, and areas of disturbed soils such as housing developments (Weber County 2004). Dyer's woad also could invade lands disturbed by fire, roads, and areas associated with grazing. Because P. maguirei grows within the cliff face, in cracks and crevices, we do not anticipate that this infestation will directly affect P. maguirei. It is possible that rockslides could occur in sites occupied by P. maguirei, allowing Dyer's woad to gain a foothold; however, these events are rare and would not occur with great frequency. Efforts to control Dyer's woad or other invasive exotics using herbicides and/or biocontrol agents could affect P. maguirei; however, conservation measures

contained in the Forest Plan are adequate to avoid direct and indirect effects associated with these management activities (USDA 2003). We have no evidence to suggest that invasive exotic species are currently impacting P. maguirei. However, because future infestations of invasive species can be difficult to predict, this threat represents a perpetual challenge that must be periodically assessed and managed appropriately. The Forest Plan directs the USFS to manage the threat of invasive species to the sensitive botanical resources in Logan Canyon Botanical Special Interest Area (USDA 2003). At the present time, we regard this threat as foreseeable, but adequately addressed by existing regulatory mechanisms (USFWS, 2011).

Stressor: Small Population Risks (USFWS, 2011)
Exposure:
Response:
Consequence: Extinction
Narrative: Smaller numbers of plant individuals are more likely to succumb to natural catastrophes (e.g., drought, fire, and flood), environmental stochasticity (e.g., changes in weather, available pollinators, amount of predation), and demographic stochasticity (e.g., fluctuations in survival and fitness). We acknowledge that Primula maguirei is found in a single canyon and this limited range increases the potential for some threats to affect all known populations simultaneously. However, several factors suggest that P. maguirei may be less vulnerable to these risks than its limited geographic distribution otherwise suggests: • Estimates of the total number of plants in the wild have increased from 350 (at listing) to between 4,000-20,000 clumps (see section 2.3.1.2); • The number of locations known to support the species also has increased since the time of listing (also see section 2.3.1.2); • The rugged and isolated habitat (i.e., moist cliff tops, notches and boulders) in which P. maguirei occurs appears generally unsuitable for rock climbing routes, suggesting that although climbing occurs in Logan Canyon, this threat may have less of an effect than previously thought on the habitats in which P. maguirei occurs; and, • Preliminary monitoring data indicates that existing populations have been stable (low rates of mortality over the past 3 years). These increases in abundance and the number of known locations should reduce the risk of extirpation or extinction from stochastic events. However, as noted above (section 2.3.1.2), recent estimates of abundance in Primula maguirei populations are either imprecise (ranging from 4,000-20,000 clumps) or speculative (the presumption of additional locations in areas that have yet to be surveyed). These estimates and assumptions need verification through additional surveys before threats from small population risk can be effectively dismissed (USFWS, 2011).

Recovery

Reclassification Criteria:
Maintain at least two populations (Lower Canyon and Upper Canyon) at a level that demonstrates stable or increasing trend in plant abundance over a consecutive ten-year period. Plant abundance (measured by the number of ramets) may fluctuate within individual sites, but the defined populations should have a stable or increasing growth rate (lambda equal to or greater than 1) over a consecutive ten-year period. The ten-year period may start retroactively (USFWS 2019).

Maintain an estimated range-wide total population size at or greater than 4,000 individuals for a five-year minimum period. This population estimate will be based on a measure of the number of ramets identified in criterion 1, above. The five-year period may start retroactively (USFWS

2019).

The two populations (Lower Canyon and Upper Canyon) demonstrate sexual reproduction by pollinators over a consecutive ten-year period. Sexual reproduction (recorded as the presence of mature fruits that contain viable seeds) should be documented at all eight extant sites within the two populations. This measure does not need to be recorded on an annual basis, but should be recorded every two or three years over a ten-year period. The ten-year period may start retroactively (USFWS 2019).

Long-term habitat protections are in place for the two populations (Lower Canyon and Upper Canyon) to protect Maguire primrose from rock climbing and other potential threats with the U.S. Forest Service via long-term management agreements, conservation agreements, or memoranda of understanding (MOU). Species management would include outreach and education efforts to climbing audiences that would continue to build community support for long-term protections (USFWS 2019).

The two populations (Lower Canyon and Upper Canyon) are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al. 2004). The ex-situ seed collection should contain existing levels of genetic diversity (or representation) of the two populations (USFWS 2019).

Recovery Actions:

- The majority of known locations of Primula maguirei have been mapped in databases maintained by the Utah Natural Heritage Program (UNHP), a program of the Utah Division of Wildlife Resources (UDWR). Therefore, the UNHP has historically provided the primary mechanism for managing and distributing location and trend data for rare species throughout the State, including P. maguirei. However, in June 2011 the UDWR reorganized, in the process eliminating its sole botanist position and, therefore, the botany data management functions formerly provided by the UNHP. At present there is no established mechanism for maintaining or distributing location data for rare plant species in the State of Utah, including P. maguirei. The FWS is engaged in conversations with other partners about assuming this function; however, to date no mechanism has been agreed upon. This data management challenge represents not just the mere maintenance and distribution of historical data, but rather a need to amend older data with more recent information gathered through additional survey and monitoring efforts. With respect to Primula maguirei, new data do exist that have yet to be incorporated into the databases of the UNHP. Specifically, in recent years, additional locations of the species have been discovered by persons not affiliated with or funded by the USFS, FWS, or UNHP; these locations have not yet been provided to these agencies nor have they been captured in the existing UNHP databases. The USFS also is funding ongoing monitoring activities at previously known locations; these activities also provide new information regarding the status of the species at known sites. Because P. maguirei occurs in such close (within a few meters) proximity to established and popular climbing routes, and because of the potential for climbing activities to change in the future (either in location, intensity or both), there is a continual need for periodic monitoring of P. maguirei populations. Therefore, the lack of an established repository to manage and distribute updated data represents a significant barrier to effective communications among relevant management interests as well as the ability of these entities to protect P. maguirei. This criterion has not been met (USFWS, 2011).

- The primary threat at the time of listing and writing the Recovery Plan was rock climbing and rappelling (see section 2.3.2.1). Since listing, the USFS has worked to address these threats through a combination of efforts including education, physical barricades and site-specific climbing closures (U.S. Department of Agriculture (USDA) 2003). Subsequent field observations also have revealed that Primula maguirei tends to occupy moist to perennially saturated habitats that are typically avoided along preferred climbing routes, suggesting that climbing activities may pose less of a threat to this species than previously assessed. Since 2006, the USFS has funded a monitoring program to assess the proximity of P. maguirei plants to climbing routes and apparent correlations between plant survival or growth and climbing activities (Sibul 2006; Torti 2008, Torti and Schen 2009; Torti 2010, 2011a). To date, this monitoring effort has failed to detect climbing-related impacts to the species. This primarily appears due to the degree of spatial separation between plants and climbing routes, the effectiveness of existing climbing closures at deterring entry into occupied habitats, or some combination of these factors. However, at one location, P. maguirei has been found to persist in close proximity (2–3 meters (m)) to well-known climbing routes within a larger area visited by thousands of climbers per year (Torti 2010). These preliminary results suggest that climbers may be avoiding the specific microsites occupied by P. maguirei. To the extent that this is true, this pattern of recreational use may pose even less of a threat than currently believed. However, verification of this assumption would require additional, and more detailed, data collection than is occurring at the present time. Additional protections to Primula maguirei and its habitat are afforded by the designation of substantial parts of Logan Canyon as a Botanical Special Interest Area (USDA 2003). This designation directs the USFS to manage the habitat of P. maguirei in a manner consistent with the needs of that species and other sensitive botanical resources (see section 2.3.2.4). The USFS' combined program of education, physical barriers, selective use of climbing closures and the designation of Logan Canyon Botanical Special Interest Area have collectively and substantively reduced threats to Primula maguirei and its habitat from rock climbing. However, as discussed below, continued monitoring is needed to verify that patterns of climbing use (location and intensity of routes) are stable, and that P. maguirei is persisting in areas not subject to formal site closures. In addition, additional threats unrelated to rock climbing remain in the form of accelerated climate change. The magnitude and intensity of these threats is poorly understood, and would be informed by additional analyses (e.g., climate vulnerability analyses) recommended later in this document. Therefore, this criterion has been partially met (USFWS, 2011).
- We no longer believe over-collection and commercial exploitation is a threat to the species (see section 2.3.2.3). This recovery objective is obsolete (USFWS, 2011).
- Revise the species' taxonomy in the FR to reflect the best available scientific information (USFWS, 2011).
- Federal agencies should work with partners to resurrect the UNHP and ensure the plant portion of the database is populated and maintained (USFWS, 2011).
- Continue monitoring plant survivorship, growth and reproduction in Primula maguirei in conjunction with assessments of climbing patterns and intensities. Iteratively assess the need for changes in climbing closures and monitoring efforts (USFWS, 2011).
- Encourage and implement standardized and quantitative reporting of population parameters (clumps, rosettes, stems) in monitoring reports, and strengthen the use of quantitative measures to assess population (or site-specific) trends (USFWS, 2011).

- Conduct additional surveys in areas of potentially suitable habitat to refine and narrow the range of available estimates of total population size (USFWS, 2011).
- Continue collecting precipitation and humidity data (using HOBO sensors or comparable field equipment) in conjunction with monitoring plant survivorship, growth, and reproduction. Use this information to prepare a climate vulnerability assessment for this species to assess its relative vulnerability to accelerated climate change (USFWS, 2011).
- Encourage the USFS to iteratively assess and manage the potential for invasive exotic species to threaten sensitive botanical resources (species and habitats) in Logan Canyon, including P. maguirei. These activities should specifically ensure that existing infestations of Dyer's woad (Isatis tinctoria) have not expanded or encroached into botanically sensitive habitats (USFWS, 2011).
- Continue and expand prior research regarding the identity and availability of pollinators (USFWS, 2011).

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SPECIES ACCOUNT: *Prunus geniculata* (Scrub plum)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

The scrub plum is a heavily branched, broad-crowned shrub that can reach 2 m in height, although 0.5 m may be more typical at sites with frequent fires. It grows from gnarled, half-buried trunks and spreads by sucker shoots. Its young twigs are strongly geniculate (zig-zag shaped), while its lateral branches are either short, stubby, spur shoots bearing leaves and flowers, or are strongly tapering and spine-like. The bark of old stems is thin, gray, usually lichen-encrusted, and forms small rectangular or square plates. The bark of new shoots is lustrous reddish-brown or purplish and smooth. The scrub plum's leaves are crowded on the spur shoots (an arrangement typical of the Rosaceae family) and are widely spaced on the normal shoots. The stipules are linear-subulate, roughly 5 mm long, green, and pectinately fringed at the margins with reddish glands. The leaf blades are ovate to obovate or elliptic, 1 to 3 cm long, short-acuminate, and serrulate with gland-tipped teeth. The leaf base is rounded or broadly cuneate. The leaf stalk is a third to half as long as the blade. The scrub plum has small, fragrant flowers that are 11 to 13 mm across when open. Like the leaves, flowers found on the spur shoots are rather crowded, while those found on the regular shoots or the spine bases are spaced further apart. The pedicels extend only slightly beyond the bud scales, so the flowers give the appearance of being sessile. The flowers are radially symmetrical with a 3 mm long hypanthium (the cup-shaped structure formed by the united portions of the bases of the sepals, petals, and stamens). The 5 calyx lobes are radially symmetrical, spreading to ascending triangular with acute apices, sparsely ciliate on the margins, reddish or green, with the bottom surfaces smooth and the upper surfaces white-tomentose. The 5 petals are white, spreading, and about 5 mm long. The petal blades are ovate to obovate with rounded tips and attenuated bases ending in short, ciliate-margined claws. The stamens are numerous, roughly 0.5 mm long, and borne on the rim of the hypanthium. The fruit of the scrub plum is an ovoid or ellipsoidal drupe, 12 to 25 mm long, and dull reddish in color. It has a thin, bitter flesh and a slightly flattened seed. (USFWS, 1999)

Taxonomy

Prunus geniculata was first described by Roland M. Harper in 1911 (Harper 1911). There has been no additional treatment of this species. The common name "scrub plum" was first used by Small (Small 1933). (USFWS, 1999)

Historical Range

See current range/distribution.

Current Range

In Florida, the range includes Lake County, west and southwest of Lake Apopka; the southwest and northwest corners of Orange and Osceola counties, respectively; and Polk and Highlands counties, from the City of Lake Wales south to the Highlands County/Glades County border. (USFWS, 2009)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Scrub plum is a rare plant with a very narrow range and small, widely scattered populations. It frequently forms small colonies of several plants but may grow as solitary individuals (unpublished FNAI data). It prefers fairly open areas without a dense canopy, but older plants are able to survive in dense shade (Schultz, pers. obs.). Scrub plum's life history has not been reported in the literature. Many birds, rodents and other mammals are known to be fond of plum fruit and are probably responsible for the dissemination of the species (Van Dersal, 1938). Gopher tortoise (Gopherus polyphemus) could also be a vector. Kral (1983) states that P. geniculata respond vigorously to fire disturbance and historically was probably fire maintained due to its presence in frequently burned sandhills.; ASEXUAL; Perfect; Predominantly outcrossing; SEXUAL; BIOTIC; Birds; Mammals; BIOTIC; Hymenoptera; Insects, other; (NatureServe, 2015). From the various research efforts, we now know that scrub plum: (1) has a rare breeding system characterized by the presence of male and bisexual flowers on the same plant, (2) is partially self-incompatible and that inbreeding depression is high in self-compatible individuals, and (3) experiences high rates of fruit loss due to abortion and pre-dispersal predation. Recent research has also confirmed that scrub plum is long-lived and experiences low mortality, and populations persist for long periods in the absence of fire (Pace-Aldana et al. 2006; Menges et al. 2008; C. Weekley, Archbold Biological Station, personal communication, 2009). Current information also supports previous reports that this species is a strong postburn resprouter (Weekley et al. 2007, Weekley and Menges 2003, Menges et al. 2007) and that recruitment is low (Service 1999; Weekley and Menges 2003, 2007). Weekley and Menges (2008) are currently evaluating the effects of various land management treatments on a number scrubendemic plants, including scrub plum (USFWS, 2009).

Habitat Type

Adult: Turkey oak sandhill and evergeen oak-sand pine (USFWS, 2009)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2009)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2009)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2009)

Site Fidelity

Adult: High (inferred from USFWS, 2009)

Habitat Narrative

Adult: Species inhabits deep, yellow sands of longleaf pine-turkey oak sandhill and white, excessively leached, wind-deposited soils of evergreen scrub oak-sand pine scrub (NatureServe,

2015). High site fidelity and ecological integrity of the population as well as low tolerance range are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Scrub plum's life history has not been reported in the literature. Many birds, rodents and other mammals are known to be fond of plum fruit and are probably responsible for the dissemination of the species (Van Dersal, 1938). Gopher tortoise (Gopherus polyphemus) could also be a vector (USFWS, 2009).

Population Information and Trends

Number of Populations:

64 (USFWS, 2023)

Population Size:

2500 - 10,000 individuals (USFWS, 2009)

Population Narrative:

Responds vigorously to fire disturbance; cannot withstand soil disturbance of shade. Sometimes common, but usually only a few individuals at a site (NatureServe, 2015). FNAI updated its records for scrub plum in the 6 summer of 2008 and confirmed 83 extant populations. These 83 populations contained from 1 to 10,200 plants (A. Johnson, Florida Natural Areas Inventory, personal communication, 2009). Forty-five populations contained 10 or more plants (USFWS, 2009). Prunus geniculata is a long-lived, heavily branched shrub, that thrives in fire-maintained scrub habitat native to ancient ridges in central Florida. There are estimated to be 64 extant populations in 5 counties. Of these populations, 40 are found on conservation lands and 13 of those had their conditions ranked as excellent or good on when last observed. There were 51 populations that are either found on private lands or have lower ranked conditions. Additionally, only six populations on the conservation lands have an estimated size over 100 individuals (USFWS, 2023).

Threats and Stressors

Stressor: Fire Suppression (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The most pervasive threat to scrub plum on public land is habitat degradation due to fire suppression. Most land managing agencies in Florida are not able to use prescribed fire at the rates, frequency, and/or intensity needed to restore and maintain most of Florida's fire-adapted ecosystems (R. Mulholland, Florida Department of Environmental Protection, personal communication, 2007; Service 2006). Consequently, the difficulties land managing agencies currently face in implementing prescribed fires probably have resulted in the degradation of scrub plum habitat in some areas (USFWS, 2009).

Stressor: Urban development (USFWS, 2009)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: Scrub plum that occur on non-conservation private lands also are vulnerable to destruction due to urban development, such as construction of roads; installation of utilities and other infrastructure; and residential, commercial, and industrial construction. Scrub plum on each private parcel is vulnerable to this threat at any time. Several populations are located in areas previously platted for residential development and these populations are at greatest risk, especially when economic conditions improve and residential construction resumes at is historic pace. One small population is imminently threatened by land clearing for commercial development. In 2006, the Service issued an incidental take permit for two fossorial skinks on about 45 acres in west-central Lake County. Several hundred scrub plum plants were also found on this parcel along with six other federally listed plants (Service 2005). The entire parcel has not yet been developed but as land clearing proceeds individual plants will be destroyed (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: On private properties, Federal or State laws provide little protection for scrub plum. Since the majority of extant scrub plum populations occur on unprotected private lands, we conclude that existing regulatory mechanisms are inadequate to protect this species (USFWS, 2009).

Stressor: Low seed viability (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of genetic diversity
Narrative: Scrub plum produce few viable seeds and recruitment is extremely low (Weekley et al. 2007; B. Pace-Aldana, TNC, personal communication, 2008). Loss of seeds due to inbreeding depression reduces the number of germinable seeds. These effects may be exacerbated by habitat fragmentation and fire exclusion (C. Weekley, Archbold Biological Station, personal communication, 2009) (USFWS, 2009).

Recovery

Reclassification Criteria:
Applicable to the South Florida populations: 1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to ensure 20 to 90 percent probability of persistence for 100 years. (USFWS, 1999)

Applicable to the South Florida populations: 2. When these populations, within the historic range of P. geniculata are adequately protected from further habitat loss, degradation, and fire suppression. (USFWS, 1999)

Applicable to the South Florida populations: 3. When these sites are managed to maintain the high pine and xeric oak scrub communities to support P. geniculata; (USFWS, 1999)

Applicable to the South Florida populations: 4. When monitoring programs demonstrate that these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually or vegetatively reproducing at sufficient rates to maintain the population. (USFWS, 1999)

Applicable to the entire species range: The 1996 recovery plan lists four criteria necessary to reclassify the scrub plum from endangered to threatened status: (1) there are eight populations at four sites; (2) at least 10 years of demographic monitoring is conducted at one of these locations; (3) scrub plum is monitored at all locations; and (4) there must be protected locations in Highlands, Polk, and Lake counties. (USFWS, 1996)

Recovery Priority Number: 2

Delisting Criteria:
Applicable to the entire species range: To delist the scrub plum, 20 populations must be present at 5 sites and there must be 10 additional years of monitoring. (USFWS, 1996).

Recovery Actions:

- S1. Determine current distribution of P. geniculata. Conduct surveys for P. geniculata. Conduct surveys for P. geniculata. Maintain distribution of known populations and suitable habitat in GIS database. (USFWS, 1999)
- S2. Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- S3. Conduct research on life history characteristics of P. geniculata. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- S4. Monitor existing populations of P. geniculata. Develop monitoring protocol to assess population trends for P. geniculata. Develop a quantitative description of the population structure of P. geniculata. (USFWS, 1999)
- S5. Provide public information about P. geniculata. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of P. geniculata and other rare species requires a self sustaining, secure number of natural populations. (USFWS, 1999)
- H1. Prevent degradation of existing habitat. Extensive habitat loss, degradation, and fragmentation have already occurred throughout the range of this species. Both urbanization and fire suppression have decreased the available habitat. To date, there are six protected sites for P. geniculata in Polk and Highlands counties. (USFWS, 1999)

- H2. Restore areas to suitable habitat. Native habitats that have been disturbed or that have experienced a long history of fire suppression may be good candidates for future reserves. (USFWS, 1999)
- H3. Conduct habitat-level research projects. Study the response of P. geniculata to various land management practices, such as prescribed fire regimes, vegetative thinning, and control of exotic/invasive vegetation. (USFWS, 1999)
- H4. Monitor habitat/ecological processes. Monitor the effects of land management actions, such as prescribed fire, exotic plant control, etc., on the habitats where P. geniculata occurs. (USFWS, 1999)
- H5. Provide public information about scrub and its unique biota. Educational efforts, especially those conducted by Archbold Biological Station, have been successful. Without these successful efforts, the Lake Wales Ridge NWR would not have been created. Florida's system of biological preserves depends on a broad base of public understanding and support for its funding and future success. In addition to past and ongoing educational efforts by The Nature Conservancy, Bok Tower Gardens, and Archbold Biological Station, future efforts by these organizations, and the Florida Park Service, the Florida Division of Forestry, the South Florida Water Management District, the Florida Native Plant Society, and local garden clubs are crucial in increasing public appreciation of scrub and high pine communities, and their associated plant species. The Arbuckle Appreciation Day sponsored by the Florida Division of Forestry has been especially successful. (USFWS, 1999)
- Recommendation for Future Action from 2009 5-Year Review: Revise the recovery criteria to establish measurable goals for demographic monitoring, including but not limited to: the number of populations that should be monitored, the demographic parameters that should be measured, the demographic performance levels/rates that should be met, and the timeframe within which these levels/rates should be attained/maintained (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Continue demographic monitoring on the Carter Creek tract of the LWRNWR and reinitiate demographic monitoring on TNC's Tiger Creek and Longleaf Pine Preserves. Conduct Level 2 (see Menges and Gordon 1996) monitoring on multiple sites using populations in different habitats and with different management regimes (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Conduct a rangewide survey of genetic diversity in scrub plum. Such a survey could help in identifying populations that might be targeted for acquisition or included as a propagule source for creation of new populations on sites undergoing restoration (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Evaluate breeding system to identify S-locus and assay S-allele diversity within populations to assess the degree of self-incompatibility and role of inbreeding depression in seed viability (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Implement management activities on public lands that contain scrub plum, including prescribed fire at return intervals and intensities necessary to restore and/or maintain the various xeric vegetative communities that support this species (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Purchase or otherwise protect large scrub plum populations on unprotected lands. Protection should target scrub plum populations that are sufficiently large, or could be large if adequately managed, as to be self-sustaining and viable long-term (USFWS, 2009).
- Recommendation for Future Action from 2009 5-Year Review: Explore opportunities to encourage landowners to conserve and manage property known to contain this species

(USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Collaboration with conservation land managers to increase habitat suitability of occupied habitat by promoting beneficial management options to increase population persistence wherever additional opportunities exist when engaging with agency management personnel. • Encourage landowners whose populations occur on conservation lands to monitor occupied habitat for increased data of long-term species trends. • Initiate long-term monitoring programs for populations with highest viability potential on conservation lands to discern long-term species trends (USFWS, 2023).

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SPECIES ACCOUNT: *Pseudobahia bahiifolia* (Hartweg's golden sunburst)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, about 6-15 cm tall, covered throughout with white, wooly hairs. Flower heads (March or April) are bright yellow, and are borne singly at the ends of the branches. (NatureServe, 2015)

Historical Range

The historical distribution of Pseudobahia bahiifolia is not known specifically but is thought to have spread approximately 200 miles along the eastern San Joaquin valley and foothills from Stanislaus County in the south to Yuba County in the Sacramento Valley to the north (Stebbins 1991). The distribution once extended north to Yuba County in the Sacramento Valley, based on the 1847 type collections of Karl Hartweg; however, these occurrences are now extirpated (Stebbins 1991). (USFWS 2007)

Current Range

The current distribution of the majority of P. bahiifolia occurs in two isolated clusters, including six extant occurrences near Friant along both sides of the San Joaquin River in high pumice content soils (Fresno and Madera Counties) and six occurrences near Cooperstown in Stanislaus County. Pseudobahia bahiifolia grows in loam or sandy loam soil associated with Amador and Pentz series (Stanislaus County), Rocklin series (Fresno and Madera County), Amador and Hornitos soils (Merced County) (Stebbins 1991). (USFWS, 2007)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowerind and fruiting occur in March-April (NatureServe, 2015).

Reproduction Narrative

Adult: Grazing levels must be reduced during flowering and fruiting (March-April). Overgrazing during this period has been documented to be detrimental. The greatest threat to this species is destruction of habitat by ag, development and heavy grazing (NatureServe, 2015).

Habitat Type

Adult: Grasslands/woodlands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits non-native grasslands and occasionally grassland-blue oak woodland community ecotones in the Central Valley of California. The composition of the prehistoric grassland communities in this area is unknown; the communities have long-since become dominated by exotic grasses. P. bahiifolia generally occurs in areas with Mima mound topography: small mounds (30 cm to 2 m in height) interspersed with shallow basins that may form vernal pools. The plants nearly always occur on north-northeast facing mound slopes, preferentially on the upper slopes where grass cover is minimal. Plant can also occur along shady creeks or the margins of vernal pools. Plant distribution is closely correlated with certain soil types; prefers highly acidic, shallow soils derived from rhyolitic tuff. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of known populations.

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

23 presumed extant (USFWS, 2023)

Population Size:

10,000 to >1,000,000 individuals (USFWS, 2023)

Population Narrative:

About 32,000 total plants in 1990 (Stebbins 1991 Status Survey, cited in USFWS 1997). 16 Populations (USFWS 1997). (NatureServe, 2015). The current species distribution and abundance of Hartweg's golden sunburst is similar to what we described in our final listing rule and 2007 status review (Service 1997, p. 5543; Service 2007, p. 2). The known occurrences of Hartweg's golden sunburst are concentrated in the eastern San Joaquin Valley in Stanislaus, Madera, Merced, and Fresno Counties (Table 1; Service 2007, p. 6). At the time of the last 5-year review, the distribution of the majority of Hartweg's golden sunburst occurred in two isolated clusters, including six extant occurrences near the community of Friant along both sides of the San Joaquin River in high pumice content soils (Fresno and Madera Counties) and six extant

occurrences near Cooperstown in Stanislaus County (Service 2007, p. 6). The three occurrences (Diversity Database occurrence numbers 6, 7, and 17) near Cooperstown house the largest known populations of Hartweg's golden sunburst and have measured at over 10,000 individual plants (Diversity Database 2023). Currently, there are six known Diversity Database occurrences of Hartweg's golden sunburst that have had over 1,000 individuals estimated or counted during a survey (Vollmar Consulting 2010, pp. 64, 119). In addition, five Diversity Database occurrences of Hartweg's golden sunburst were discovered since the 2007 status review. Two of the new occurrences (Diversity Database occurrences 37 and 38) contained over 1,000 individuals when they were discovered; (Vollmar Consulting 2010, pp. 1, 18; Diversity Database 2023). Abundance of Hartweg's golden sunburst fluctuates greatly from year to year due to weather conditions such as rainfall. The surveys completed since the previous 5-year review do not alter our understanding of the species' current distribution or abundance and population estimates or trends have not been determined (USFWS, 2023).

Threats and Stressors

Stressor: Residential development (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Agricultural conversion (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Flooding (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Protected occurrences (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Overgrazing and trampling (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals
Narrative:

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)
Exposure:

Response:
Consequence: Loss of habitat
Narrative:

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Road maintenance and widening (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Transmission line maintenance (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals
Narrative:

Stressor: Drought (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of geneitc variability
Narrative:

Recovery

Recovery Actions:

- The draft recovery plan is currently under development
- Protect lands with known occurrences of either species of Pseudobahia, particularly those occurrences with the largest and most dense populations, through conservation easements, acquisition in title, or other methods. Manage these properties to protect and enhance growth of P. bahiafolia and P. peirsonii (USFWS, 2007).
- Work with landowners to gain access to their property for surveying and monitoring populations of both Pseudobahia species (USFWS, 2007).
- Conduct coordinated surveys of all recorded occurrences of both species of Pseudobahia. Establish systematic periodic surveys where possible of known occurrences. Begin surveys in potentially suitable habitat of both species of Pseudobahia based on soil type and habitat characteristics (USFWS, 2007).

- Complete and publish the draft recovery plan and ultimately finalize the recovery plan. Much of the information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan (USFWS, 2007).
- Maintain a viable, protected seed collection for both species of Pseudobahia. Ensure sufficient seeds (approximately 5,000 per site, USFWS 2006a) are taken from as many sites as possible to maintain genetic heterogeneity (USFWS, 2007).
- Recovery Priority Number: 5C

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Hartweg's golden sunburst and San Joaquin adobe sunburst. Some of these recommendations have already been discussed in the previous 5- year review (Service 2007, pp. 17–18) and remain valid. 1. Habitat Acquisition, Management, and Restoration. Known occupied sites with Hartweg's golden sunburst and San Joaquin adobe sunburst present should be protected. Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and large unprotected areas currently occupied by the species should be given the highest priority. Large, formerly occupied sites that are unoccupied but have a high restoration potential and the sites with recent occurrences should also be considered. Protected lands must also be adequately managed or restored based on the best available science to enhance the growth of the species. 2. Work with Landowners to Gain Access and Conduct Coordinated Surveys. Gaining access to private lands where no surveying and monitoring has occurred will provide more information on the species. Coordinate surveys in these previously known occurrences and continue surveys in potentially suitable habitat based on soil type and habitat characteristics, similar to the work Vollmar Consulting conducted in 2010. 3. Develop a Recovery Plan. Hartweg's golden sunburst and San Joaquin adobe sunburst were initially included in a "Draft Recovery Plan for Fifteen Plants from the Southern Sierra Foothills, California". This plan was in development in 2007, however, the plan was never finalized. Much information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan. Additionally, the methods of establishing a new population of Hartweg's golden sunburst at Friant Ranch can be incorporated (Live Oak Associates 2015, entire). 4. Maintain a Viable, Protected Seed Collection. For both Hartweg's golden sunburst and San Joaquin adobe sunburst ensure sufficient seeds, approximately 5,000 per site (Cypher 2006, pp. 2–3), are taken from as many sites as possible to maintain genetic heterogeneity. Currently, there are 4,057 seeds of Hartweg's golden sunburst and 37,069 seeds of San Joaquin adobe sunburst stored (California Plant Rescue 2023, unpaginated) (USFWS, 2023).

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SPECIES ACCOUNT: *Pseudobahia peirsonii* (San Joaquin adobe sunburst)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, about 1-6 dm tall, and loosely covered with white, wooly hairs. Flower heads (March or April) have bright yellow rays and are borne singly at the ends of the branches. (NatureServe, 2015)

Taxonomy

Pseudobahia peirsonii has had no changes in its scientific name or to its taxonomic classification since it was first described in 1949 by the California botanist Phillip A. Munz. Common names used for P. peirsonii include San Joaquin adobe sunburst, Tulare pseudobahia, and San Jaoquin adobe sunflower (Stebbins 1991). The San Jaoquin adobe sunburst is the preferred common name since it was used in the original listing notice (62 FR 5542)

Historical Range

The historical distribution of Pseudobahia peirsonii is not known because when the species was first described in 1949, extensive areas with suitable habitat for this species in the lower San Joaquin Valley were already converted to agriculture. This extensive land conversion precluded establishing a meaningful baseline survey of P. peirsonii (Stebbins 1991). (USFWS, 2007)

Current Range

Three major population concentrations of P. peirsonii now include: east of Fresno in Fresno County, west of Lake Success in Tulare County, and northeast of Bakersfield in Kern County (CNDDB 2007). (USFWS, 2007)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Grasslands/woodlands (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (Inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits non-native grasslands and occasionally grassland-blue oak woodland community ecotones in the Central Valley of California. The composition of the prehistoric grassland communities in this area is unknown; the communities have long-since become dominated by exotic grasses. P. peirsonii occurs only on heavy adobe clay soils which retain moisture into the summer dry season (NatureServe, 2015).

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

32 (USFWS, 2007)

Population Narrative:

The plant is found at 32 extant occurrences distributed in Fresno, Tulare and Kern Counties. Population numbers can fluctuate widely from one year to another. This fluctuation is believed to depend on annual climatic conditions, specifically the amount of seasonal rainfall, and also on competition from non-native plants (Stebbins 1989, 1991; E. Cypher, CDFG, pers. comm. 2007). Because of these annual fluctuations, population trends for these species are difficult to deduce and can not be reliably completed in a few years of surveys (Stebbins 1989). Actual plant numbers are not as useful an index of population health as is the condition of occupied habitat and general population condition (62 FR 5542) (USFWS, 2007). The current species distribution of San Joaquin adobe sunburst is similar to what we described in our final listing rule and 2007 status review, with occurrences found in Fresno, Tulare, and Kern counties (Table 2; Service 1997, p. 5543; Service 2007, p. 3). Since the 2007 status review, an additional ten new occurrences were added to the Diversity Database, although one is a historical occurrence that is possibly extirpated (Diversity Database occurrence 54; Diversity Database 2023). The known occurrences of San Joaquin adobe sunburst are in three major population concentrations east of Fresno in Fresno County, west of Lake Success in Tulare County, and northeast of Bakersfield in Kern County (Diversity Database 2023). Two new occurrences (52 and 51) expand the known range of San Joaquin adobe sunburst approximately 15 miles south (Diversity Database 2023). Typically, all occurrences report fewer than 5,000 plants and more often only a few hundred plants (Diversity Database 2023). However, occurrence 53, located at Tollhouse Ranch owned by The Nature Conservancy, observed approximately 3,000 plants in 2015 and then over 11,090 plants in 2016 (Diversity Database 2023). Abundance of San Joaquin adobe sunburst fluctuates greatly from year to year due to weather conditions such as rainfall. The surveys that have been completed since the previous 5-year review do not significantly alter our understanding of the species' current distribution or abundance and population estimates or trends have not been determined (USFWS, 2023).

Threats and Stressors

Stressor: Residential development (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, the threat to P. peirsonii was primarily due to the planned 462-acre combined Quail Lakes housing development and recreational lake in Fresno County that would affect the large occurrence (CNDDB occurrence number 31) of 5,000 plants surveyed in 1990. Completion of this project included compensation for environmental impacts which involved off-site wetland construction, transplantation of P. peirsonii and top soil translocation to a protected area within the development site, and preservation of two high density sub-populations of P. peirsonii within the protected site (EIP Associates 1994). During post-construction monitoring of these sub-populations, P. peirsonii at this location were not seen for four years; however, large numbers were observed in a single season during the fifth year of monitoring (Halstead in litt. 2007). In the 2003 season John Stebbins did not observe any plants at this location (J. Stebbins in litt. 2007). Residential development still remains a threat to P. peirsonii at the following locations (two occurrences): 1. A proposed parcel split of a privately owned 65-acre parcel in Fresno County near the city of Clovis, and the proposed residential development of these sub-parcels, is located within the area described to contain Pseudobahia peirsonii occurrence number 36 (Halstead and Associates 2006, CNDDB 2007). Surveys for P. peirsonii were performed on this property in 2004 and 2005 and no plants were found (Halstead in litt. 2007). We lack adequate information on the reproductive ecology and seed bank dynamics of this species to determine whether or not it may reappear at this site in the future. 2. The proposed Round Mountain Estates project would develop a 600-acre parcel at Round Mountain in Fresno County, an area occupied by about 40 acres of Pseudobahia peirsonii. Surveys in 1993 and 1996 revealed the 40 acres support an apparently stable P. peirsonii population and that current land use continues to be moderate cattle grazing (J. Gurule, Live Oak Associates, pers. comm. 2007). Compensation recommended for this project by the consultant is to protect in perpetuity the 40 acres that contain the P. peirsonii occurrence (Hartesveldt Ecological Consulting Services [now Live Oak Associates] 1996) (USFWS, 2007).

Stressor: Agricultural conversion (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: When federally listed in 1997, conversion of habitat to agricultural use was considered a significant but secondary threat to Pseudobahia peirsonii. Eight of the original recorded occurrences of P. peirsonii had already been extirpated from their locale due to various agricultural conversions by the time Stebbins (1991) surveyed the sites. We do not believe that agricultural conversion presents a serious threat to P. peirsonii at this time since occurrences are now on either public land or private land used for cattle ranching (E. Cypher pers. comm. 2007). However, P. bahiifolia is still threatened by agricultural development, as it was at the time of listing, because of the pressure to convert ranch lands with occurrences of P. bahiifolia to orchards and vineyards (E. Cypher pers. comm. 2007) (USFWS, 2007).

Stressor: Flooding (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Inundation of Pseudobahia peirsonii plants caused by the creation of Lake Success in Tulare County extirpated two of the originally recorded occurrences of P. peirsonii before the species was listed (Stebbins 1989, CNDDB 2007). Three occurrences of P. peirsonii are now found at the Lake Success Recreation Area which is managed by the U.S. Army Corps of Engineers. Two of these occurrences are historically recorded and one occurrence is believed to be a relict of one of the original occurrences that were documented as extirpated when Lake Success was first filled (EDAW 2006a). Flooding at Lake Success continues to be a threat to the three local occurrences of P. peirsonii (E. Cypher in litt. 2007). Excessive rainfall during an exceptionally wet year could raise the level of Lake Success and cause inundation of at least one of the occurrences (E. Cypher in litt. 2007). In addition, two proposals for the improvement of the Lake Success dam could affect at least one other occurrence of P. peirsonii. The U.S. Army Corps of Engineers plans to move the dam 300 feet downstream of its current location and then increase the size of the new spillway (E. Cypher in litt. 2007). Compensation by transplanting was addressed, but is not considered a reliable option for saving the affected populations of P. peirsonii owing to the limited success of previous transplanting efforts (E. Cypher in litt. 2007). As a result of the creation of Lake Success, one population was subjected to the additional threat of adverse recreational activity, since that population was located on the highly impacted shoreline (Stebbins 1989, 62 FR 5542, CNDDB 2007 The Fancher Creek flood control project, completed in the mid-1990s, impacted about 40 percent of the second largest population of Pseudobahia peirsonii (CNDDB occurrence number 30, 62 FR 5542). However, P. peirsonii are still found at the Fancher Creek site and surveys are conducted on a regular basis (P. Bryan in litt. 2007). The possible inundation of at least part of the existing local occurrence during an exceptionally heavy rainfall season remains a threat to this occurrence because no flood control system can protect against all conceivable flood events (Stebbins 1991, Fresno Metropolitan Flood Control District 2007) (USFWS, 2007).

Stressor: Protected occurrences (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Two occurrences of Pseudobahia peirsonii are located on public, nonFederal land in Fresno County owned and managed by the Fresno Metropolitan Flood Control District (CNDDB occurrence numbers 16 and 30). Although these occurrences are monitored by surveys and protected by fencing, flooding remains a possible threat to these occurrences. Lake Success was created when the Tule River was dammed by the earthen Success Dam, which was constructed by the U.S. Army Corps of Engineers in 1961. The property around Lake Success, owned and managed by the U.S. Army Corps of Engineers, located just east of Porterville in Tulare County, contains three occurrences of Pseudobahia peirsonii. Two of these occurrences were previously recorded in the CNDDB as occurrence numbers 10 and 19; however, a new occurrence was also discovered and may be the continuation of a population that was covered by the lake when the Success Dam was first built (EDAW 2006a). The sizes of these populations were recorded as 120 individuals for occurrence 10, 30 individuals for occurrence 19, and 45 individuals for the new occurrence (EDAW 2006a). The population numbers from this recent survey appear to indicate these occurrences are somewhat stable when compared with population numbers recorded in previous surveys (1985, 1986, 1988, 2003) (EDAW 2006a; T. Beyerl, EDAW, pers.comm. 2007). These occurrences receive a certain amount of protection because they are on federally operated public land; however, flooding from this dam remains a viable threat to the local occurrences. Lewis Hill Preserve consists of 110 acres of grass-covered hills with rock outcrops

located north of Porterville in Tulare County. This preserve, owned and managed by the Sequoia Riverlands Trust, contains Pseudobahia peirsonii occurrence number 28, as well as the rare wildflower, Fritillaria striata (striped adobe lily) (Sequoia Riverlands Trust 2007). This preserve is not open to the public. Although formal surveys for the listed plant species have not been conducted since 1990, the presence of P. peirsonii was confirmed by preserve personnel during the 2006 flowering season (H. Destin, Sequoia Riverlands Trust, pers. comm. 2007). Currently the Lewis Hill preserve is not actively managed, but future management activities such as prescribed burns and grazing are being planned to control invasive weedy plants (H. Destin pers. comm. 2007). Before Pseudobahia peirsonii was listed in 1997, as compensation for impacts to the four subpopulations of occurrence number 31 by construction of the Quail Lake residential development in Fresno County (see above), two of the highest-density sub-populations were protected and a new sub-population was created by trans-locating soil from the two impacted sub-populations and seeding the soil with seeds collected earlier (completed in 1993) (62 FR 5542, EIP Associates1994). This compensation was done in compliance with the California Endangered Species Act and California Environmental Quality Act. The area, south of Clovis in Fresno County, containing these sub-populations is protected as natural habitat in perpetuity (EIP Associates 1994). Subsequent monitoring revealed that individuals originating from seeds sewn into the trans-located soil, as well as the individual plants in the original two dense populations, were numerous, healthy, and reproducing in 1998 (J. Halstead in litt. 2007). However, P. peirsonii is not clearly present at Quail Lakes every year and the habitat in the area of the translocated soil appeared to be significantly degraded in 2006 (J. Halstead in litt. 2007, J. Stebbins in litt. 2007) (USFWS, 2007).

Stressor: Overgrazing and trampling (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individual plants
Narrative: Cattle ranching was recognized as a threat to the Pseudobahia species in the original listing rule (62 FR 5542) because of the possibility of excessive grazing and trampling by cattle, which could destroy many individuals of the two species (Stebbins 1989). In 1997, when first listed, about 50 percent of known occurrences of P. peirsonii were found on private property that was used primarily for cattle grazing. Moderate grazing regimes are not believed to seriously affect either of the plant species, and may actually enhance their growth due to the removal of nonnative, aggressive, invasive grasses and forbs (Stebbins 1989, Marty 2005). Cattle do not preferentially target either of the Pseudobahia species while grazing (E. Cypher pers. comm. 2007). In addition, profitable cattle ranching may indirectly benefit the two Pseudobahia species by discouraging residential development of ranch land (E. Cypher pers. comm. 2007). Cattle grazing and trampling are no longer considered a serious threat to either species unless the grazing times are extended, leading to excessive trampling and consumption (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: When listed in 1997, we noted that most of the occurrences of both the Pseudobahia species were located on private land and, thus, State and Federal laws were limited in their ability to regulate potentially detrimental human activity at these locations (62 FR 5542). No significant changes to the Federal or State laws have provided increased protection for these

species (USFWS, 2007).

Stressor: Non-native plants (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The final listing rule noted that the intrusive and aggressive characteristics of herbaceous weedy species appear to be detrimental to habitat quality of the two Pseudobahia species. Plants mentioned as being common non-native associates of P. bahiifolia include Erodium circutarium (red-stem filaree), E. botrys (longbeak stork's bill), Bromus mollis (soft brome or soft chess), and Bromus madritensis ssp rubens (foxtail chess). Plants mentioned as being common non-native associates of P. peirsonii include Avena fatua (wild oats), Brassica kaber (wild mustard), Bromus mollis (soft brome or soft chess), Bromus madritensis ssp rubens (foxtail chess), and Erodium circutarium (red-stem filaree) (62 FR 5542). Non-native grasses and forbs continue to proliferate throughout the range of the two Pseudobahia species and these non-native species continue to invade locations that the two species occupy. Thus, non-native plants remain a significant threat to the two Pseudobahia species (E. Cypher pers. comm. 2007) (USFWS, 2007).

Stressor: Road maintenance and widening (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Stebbins (1991) lists several road maintenance projects that would affect populations of Pseudobahia peirsonii. The most extensive project was the proposed widening of State Route 180 in Fresno County that may destroy plants on both sides of the road. Six other occurrences were also determined to be threatened by road maintenance activities conducted by the California Department of Transportation (CALTRANS) which include spraying herbicides, grading, scraping, slope stabilization, road widening, and road alignment. The listing rule noted that road maintenance activities were a threat to P. peirsonii (62 FR 5542). However, subsequent CALTRANS maintenance activities and road alignment did not appear to directly affect the occurrences of P. peirsonii; rather, the disturbance created from the maintenance appears to indirectly and moderately threaten both species of Pseudobahia by encouraging the growth of non-native weedy vegetation which competes with the two listed species of Pseudobahia (J. Stebbins in litt. 2007) (USFWS, 2007).

Stressor: Transmission line maintenance (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Two occurrences of Pseudobahia peirsonii (CNDDB occurrence numbers 23 and 24) inhabit areas beneath two transmission lines supported by Southern California Edison (SCE). The properties where the transmission lines are located are considered "rights of way", and are mostly within privately owned lands. Stebbins (1991) recognized that these populations would need to be protected from the machinery and traffic (human and vehicular) that would impact the area when maintenance actions were performed on the transmission lines, and this was considered a threat when the species was listed (62 FR 5542). Routine maintenance activities include patrol road maintenance, line maintenance, and overhead canopy maintenance. Routine

maintenance actions are scheduled by SCE annually, avoid the active time periods for local listed plants, and require a minimum of off-road activities (Entrix, Inc. 1997). A more substantial threat to P. peirsonii is from emergency repairs to the power lines due to catastrophic failure, natural disasters, or vandalism where the need to conduct repairs expeditiously would increase the chances of incidental damage to the plants during the repair effort. Entrix, Inc. (1997) conducted a survey for P. peirsonii and found only one occurrence along one of the two transmission lines where the species was thought to occur. SCE maintenance personnel are provided with environmental and endangered species training to ensure they avoid impacting listed species (Entrix, Inc. 1997) (USFWS, 2007).

Stressor: Drought (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing drought was considered a threat to small and marginal populations of either Pseudobahia species (62 FR 5542). Natural cycles of drought are not likely to threaten the larger occurrences of either of the Pseudobahia species owing to the drought-adaptive nature of the plants (E. Cypher pers. comm. 2007). However, where populations persist on only marginal habitat, the addition of prolonged drought conditions is likely to result in higher rates of mortality in the short term, with the effects of low reproductive output and survivorship persisting after the drought has ceased (E. Cypher pers. comm. 2007). It is unknown how quickly the Psuedobahia populations may rebound after severe climatic conditions (USFWS, 2007).

Stressor: Small population size (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of genetic variability
Narrative: The two species of Pseudobahia each require separate and specific soil conditions for successful germination and growth, so that the distribution of these plants is limited to the occurrences of these soil types (Stebbins 1991). The conversion to agricultural use of the geographic areas where these soil types are found began before a baseline survey of either plant could be performed, so the historic distribution can only be assumed based on a variety of factors, including soil type. The conversion to agriculture and to other land uses (discussed above) which are adverse to the proliferation of the two species have resulted in fragmented populations, many of which are of extremely limited population size (E. Cypher pers. comm. 2007). For example, about 67 percent of the P. bahiifolia and 62 percent of the P. peirsonii populations with known counts have less than 100 plants from the last surveys that were recorded (CNDDB 2007). In addition, some of the sites are questionable as to whether they are still producing any plants at all; for example, two of the presumed extant occurrences of P. bahiifolia are single sightings of unknown numbers of plants that have not been verified since 1937 and 1939, respectively (CNDDB 2007). At the time of listing it was recognized that such small populations may be highly susceptible to extirpation due to chance events, inbreeding depression, or additional environmental disturbance (Gilpin and Soule 1988; Goodman 1987, 62 FR 5542). The conservation biology literature commonly notes the vulnerability of species known from one or very few locations and/or from small populations (e.g., Shaffer 1981 and 1987, Primack 1998, Dunning et al. 2006). In particular, small population size makes it difficult for such species to persist while sustaining the impacts of habitat loss, competition with non-native plants, and other impacts such as prolonged drought. If an extirpation event occurs in a

population that has been fragmented, the opportunities for re-colonization will be greatly reduced due to physical isolation from other source populations. The small size of populations, along with the geographic isolation of the separate populations of both Pseudobahia species remains a threat (E. Cypher pers. comm. 2007) (USFWS, 2007).

Recovery

Reclassification Criteria:
Recovery Priority Number: 2

Recovery Actions:

- The draft recovery plan is currently under development (USFWS, 2007).
- Protect lands with known occurrences of either species of Pseudobahia, particularly those occurrences with the largest and most dense populations, through conservation easements, acquisition in title, or other methods. Manage these properties to protect and enhance growth of P. bahiafolia and P. peirsonii (USFWS, 2007).
- Work with landowners to gain access to their property for surveying and monitoring populations of both Pseudobahia species (USFWS, 2007).
- Conduct coordinated surveys of all recorded occurrences of both species of Pseudobahia. Establish systematic periodic surveys where possible of known occurrences. Begin surveys in potentially suitable habitat of both species of Pseudobahia based on soil type and habitat characteristics (USFWS, 2007).
- Complete and publish the draft recovery plan and ultimately finalize the recovery plan. Much of the information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan (USFWS, 2007).
- Maintain a viable, protected seed collection for both species of Pseudobahia. Ensure sufficient seeds (approximately 5,000 per site, USFWS 2006a) are taken from as many sites as possible to maintain genetic heterogeneity (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Hartweg's golden sunburst and San Joaquin adobe sunburst. Some of these recommendations have already been discussed in the previous 5- year review (Service 2007, pp. 17–18) and remain valid. 1. Habitat Acquisition, Management, and Restoration. Known occupied sites with Hartweg's golden sunburst and San Joaquin adobe sunburst present should be protected. Resource agencies and private partner groups should work to ensure land protection through acquisition or easement, and large unprotected areas currently occupied by the species should be given the highest priority. Large, formerly occupied sites that are unoccupied but have a high restoration potential and the sites with recent occurrences should also be considered. Protected lands must also be adequately managed or restored based on the best available science to enhance the growth of the species. 2. Work with Landowners to Gain Access and Conduct Coordinated Surveys. Gaining access to private lands where no surveying and monitoring has occurred will provide more information on the species. Coordinate surveys in these previously known occurrences and continue surveys in potentially suitable habitat based on soil type and habitat characteristics, similar to the work Vollmar Consulting conducted in 2010. 3. Develop a Recovery Plan. Hartweg's golden sunburst and San Joaquin adobe sunburst were initially included in a "Draft Recovery Plan for Fifteen Plants from

the Southern Sierra Foothills, California". This plan was in development in 2007, however, the plan was never finalized. Much information contained in Stebbins' two studies (1989, 1991) is still valid and is directly applicable to a recovery plan. Additionally, the methods of establishing a new population of Hartweg's golden sunburst at Friant Ranch can be incorporated (Live Oak Associates 2015, entire). 4. Maintain a Viable, Protected Seed Collection. For both Hartweg's golden sunburst and San Joaquin adobe sunburst ensure sufficient seeds, approximately 5,000 per site (Cypher 2006, pp. 2–3), are taken from as many sites as possible to maintain genetic heterogeneity. Currently, there are 4,057 seeds of Hartweg's golden sunburst and 37,069 seeds of San Joaquin adobe sunburst stored (California Plant Rescue 2023, unpaginated) (USFWS, 2023).

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SPECIES ACCOUNT: *Pseudognaphalium (=Gnaphalium) sandwicensium var. molokaiense* (`Ena`ena)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/30/2016; Pacific Region (R1) (USFWS, 2016a)

Physical Description

Pseudognaphalium sandwicensium var. molokaiense (‘ena‘ena), a perennial herb in the Asteraceae (sunflower) family, is 10 to 65 cm (4 to 26 in) tall (Wagner et al. 1999, p. 321). The woolly erect to prostrate stems are 10 to 30 cm (4 to 12 in) long and olive green to white or gray in color. Leaves are spatulate to narrowly obovate, the lower ones usually 0.7 to 2 cm (0.3 to 0.8 in) wide, with only the tips of the whitish to pale yellow involucral bracts (below the flower) exposed, the remainder densely woolly (Wagner et al. 1986, pp. 115–116). Yellow flower heads are 1.5 to 7 millimeters (mm) (0.06 to 0.3 in) in diameter, arranged in terminal, corymbose (flat-topped) or sometimes nearly spherical, leafless, or nearly leafless clusters (Wagner et al. 1999, p. 321). Fruit and seeds are not described. Pseudognaphalium sandwicensium var. molokaiense is very densely woolly over the entire plant, and this is a distinguishing feature among the other varieties of this species (Wagner et al. 1986, pp. 115–116; Wagner et al. 1999, p. 321) (USFWS, 2021b).

Taxonomy

Family: Asteraceae.

Historical Range

Historically, this variety was found on the Hawaiian islands of Molokai and Maui, as well as on Oahu and Lanai (USFWS, 2016).

Current Range

Distribution: Moloka‘i, Maui (extant); O‘ahu, Lāna‘i (possibly extirpated) (USFWS, 2022)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Lifespan

Adult: Short (USFWS, 2022)

Reproduction Narrative

Adult: The pollination vectors for Pseudognaphalium sandwicensium var. molokaiense are unknown but may be insects as they have been observed visiting flowers. In general, the composite flower types of Asteraceae are attractive to bees and wasps (Lundin et al. 2018, p. 667) (USFWS, 2021b).

Habitat Type

Adult: The species is found in strand vegetation in dry, consolidated dunes (USFWS, 2016).

Habitat Vegetation or Surface Water Classification

Adult: Strand vegetation (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: sea level to 152 meters (USFWS, 2021b)

Environmental Specificity

Adult: Unknown

Habitat Narrative

Adult: Typical habitat for this variety is strand vegetation in dry consolidated dunes, in the coastal ecosystem (Wagner et al. 1999, p. 321; TNCH 2007; HBMP 2010). Historically, this variety was known from Molokai, Oahu, Maui, and Lanai (HBMP 2010; MNTF 2010, in litt.) (USFWS, 2016). Pseudognaphalium sandwicensium var. molokaiense is a perennial herb found in strand vegetation in dry consolidated dunes on the islands of Molokai and Maui, Hawaii. Historically, this variety was also found on Oahu and Lanai. This variety is known from five populations collectively totaling approximately 200 to 20,000 individuals (depending upon rainfall) in the Moomomi area on the island of Molokai, and from 2 populations of a few individuals at Waiehu dunes and at Puu Kahulianapa on west Maui (USFWS, 2014). Pseudognaphalium sandwicensium var. molokaiense occurs in coastal areas at sea level to 152 meters (m) (0 to 500 feet (ft)), in predominantly arid environments in sandy soil, directly on sand dunes, and on raised limestone plains and bare clay outcrops (BISH 1022301, 1022298, 1022290, 1022303; Haase 2020, in litt.) (USFWS, 2021b).

Dispersal/Migration

Population Information and Trends

Number of Populations:

5 (USFWS, 2022)

Population Size:

>150 (USFWS, 2022)

Population Narrative:

Currently, P. sandwicensium var. molokaiense is known only from two locations on Molokai (as many as 20,000 individuals, depending on rainfall), and from fewer than 25 individuals on the northwest coast of Maui (Moses 2006, in litt.; Starr 2006, in litt.; Kallstrom 2008, in litt.; Oppenheimer 2015, in litt.). This variety was last observed on Lanai in 1960, and on Oahu (5 individuals) in the 1980s (HBMP 2010) (USFWS, 2016). Number of Populations: 5. Number of Individuals: >150 (USFWS, 2022)

Threats and Stressors

Stressor: Feral goats and axis deer (USFWS, 2016b; USFWS, 2014)

Exposure: Habitat degradation and destruction, predation
Response:
Consequence:
Narrative: Pseudognaphalium s. var. molokaiense is threatened by feral goats (Capra hircus) and axis deer (Axis axis) that degrade and destroy habitat and possibly browse upon it (USFWS, 2016b; USFWS, 2014).

Stressor: Nonnative plants (USFWS, 2016b; USFWS, 2014).
Exposure: Competition
Response:
Consequence:
Narrative: Nonnative plants compete for light and nutrients (USFWS, 2016; USFWS, 2014).

Stressor: Climate change (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: The effects of climate change are likely to further exacerbate these threats (Non-native plants and herbivory). Because of these threats, we find that this variety is endangered throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is endangered or threatened in a significant portion of its range (USFWS, 2016b).

Stressor: Low genetic variability (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: This variety experiences reduced reproductive vigor due to low levels of genetic variability, leading to diminished capacity to adapt to environmental changes, and thereby lessening the probability of long-term persistence (Barrett and Kohn 1991, p. 4; Newman and Pilson 1997, p. 361) (USFWS, 2016b).

Stressor: Stochastic events (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Rockfalls and landslides are a threat to the occurrence of this variety on a sea cliff on west Maui (HBMP 2010) (USFWS, 2016b).

Stressor: Climate change (USFWS, 2016b)
Exposure:
Response:
Consequence:
Narrative: Fortini et al. (2013, p. 86) found that, as environmental conditions are altered by climate change, P. sandwicensium var. molokaiense is unlikely to tolerate or adapt to projected changes in temperature and moisture, and is unlikely to be able to move to areas with more suitable climatic conditions (USFWS, 2016b).

Recovery

Reclassification Criteria:
Recovery Priority Number = 3 (USFWS, 2022) Number of populations and individuals needed for each plant species to meet the preventing extinction stage based on population and life history characteristics. Number of Populations = 3. Reproducing Individuals per population = 50 (USFWS, 2022). Number of populations and individuals needed for each plant species to meet the interim stage based on population and life history characteristics. Number of Populations = 3. Reproducing Individuals per population = 300 (USFWS, 2022). Number of population and individuals of each plant species needed for downlisting based on population and life history characteristics. Number of Populations = 5. Reproducing Individuals per population = 500 (USFWS, 2022).

Delisting Criteria:
Number of populations and individuals of each plant species needed for delisting based on population and life history characteristics. Number of Populations = 10. Reproducing Individuals per population = 500 (USFWS, 2022).

Recovery Actions:
- Weed control is conducted for one population on Molokai.
- Weed control

Conservation Measures and Best Management Practices:
- Current Management Actions: • Habitat management and protection— o Mokio, a 1,769 acre parcel that was donated to the Moloka'i Land Trust (MLT) by a private landowner, contains approximately 8 kilometers (5 miles) of rugged shoreline, remnant native coastal strand and dune ecosystems, seasonal wetland, and several ancient Hawaiian sites (Haase 2020, in litt.). Molokai Land Trust primarily conducts restoration activities at the fenced Anapuka Dune Restoration Site in this area (Haase 2020, in litt.). Restoration activities include ungulate control (exclosure) and restoration of common and rare native plants. The population of P. sandwicensium var. molokaiense in this area has responded to this management with increased recruitment (Haase 2020, in litt.). o The Mo'omomi Preserve is a 921 acre site on Moloka'i managed by The Nature Conservancy (TNC) in partnership with the State of Hawai'i's Department of Natural Resources Natural Area Partnership Program. Conservation actions include ungulate control, predator control, invasive plant control, monitoring and research, rare species protection, and community outreach (TNC 2011, p. 2). o The Kalaupapa National Historical Park (NHP) populations of P. sandwicensium var. molokaiense are managed by the National Park Service (NPS). One population is located adjacent to the Kalaupapa Airport and is likely offered a layer of protection from fencing for the facility. • Surveys and monitoring—The Plant Extinction Prevention Program (PEPP) monitors, surveys, collects propagules, and collaborates with other conservation groups for restoration activities at Kahakuloa on Maui, and Kalaupapa and ʻĪlio Point on Moloka'i (PEPP 2014, 2015). PEPP most recently surveyed for P. sandwicensium var. molokaiense at Mo'omomi and ʻĪlio Point in 2020 (Bakutis 2021a, 2021b, in litt.). • Ungulate control— o At Mo'omomi Preserve, 175 acres were fenced in 2017; however, the deer population has been difficult to eradicate (Dunbar-Co 2021, in litt.). o TNC conducts quarterly fence checks at Mo'omomi Preserve to assess if breaches by cattle and feral ungulates have occurred (TNC 2011, p. 11). As of 2019 there were deer remaining within the exclosure (TNC 2017, p. 10; Dunbar-Co 2021, in litt.). In addition, game cameras are used at key sites to monitor and detect the presence of cats, pigs, and deer (TNC 2017, p. 11). o One population at Kalaupapa NHP is located adjacent to the airport and is likely offered a layer of protection from fencing for the facility. • Ecosystem-

altering invasive nonnative plant control— o The MLT works removes invasive plants at Mokio with assistance of volunteers and partner organizations such as TNC and the USDA Natural Resources Conservation Service (Haase 2020, in litt.). o TNC implements a control strategy for removal of Prosopis pallida adjacent to native plant communities. • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum reports 10,628 seeds in storage representing pooled collections from two populations on Moloka‘i at Mo‘omomi Preserve and Mokio (6,721 seeds) and one population on Maui at Kahakuloa (3,907 seeds) (Lyon Arboretum 2019). o The Maui Nui Botanical Garden (MNBG) reports propagation of 14 plants from seeds collected from Mo‘omomi on Moloka‘i. Additionally, MNBG has hundreds of seeds that are in storage, representing at least 20 founders from the Kahakuloa (Pu‘ukāhuli‘anapa) population on Maui. These seeds were collected in collaboration with PEPP (MNBG 2019). o PEPP reported collection of seeds from 24 individuals at Kahakuloa, Maui, in 2015 (PEPP 2015). o In the 1990s, the National Tropical Botanical Garden (NTBG) reported collection and storage of 10,000 seeds from Kaiehu Point at Mo‘omomi on Moloka‘i. The viability of this collection is unknown (NTBG 2019). • Population biology research—By tracking the resurgence of P. sandwicensium var. molokaiense after restoration management, MLT discovered a relationship between clearing and planting activities and the number of plants naturally recruiting. They found a delay of a year or two after clearing areas and recruitment. This is an example of the complexity of the Mokio ecosystem. Areas of Mokio need to be revegetated completely to reduce erosion while small areas should also be left open for recruitment by existing native plants like P. sandwicensium var. molokaiense (Haase 2020, in litt.) (USFWS, 2021b).

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SPECIES ACCOUNT: *Psychotria malaspinae* (Aplokating-palaoan)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

Psychotria malaspinae (aplokating palaoan), a shrub or small tree in the coffee family (Rubiaceae), is known only from Guam. (USFWS, 2015)

Historical Range

Historically, P. malaspinae was known from scattered occurrences on the northeast and southwest sides of Guam, in the forest ecosystem (Merrill 1914, pp. 148–149; Stone 1970, pp. 554– 555; Raulerson and Rinehart 1991, p. 83; Fosberg et al. 1993, pp. 111–112; Costion and Lorence 2012, pp. 54, 85– 86; Bishop Museum 2014—Online Database; Wagner 2012—Flora of Micronesia; WCSP 2012c—Online Database). (USFWS, 2015)

Current Range

It currently occurs on Guam (Mariana Islands) (USFWS, 2015). Distribution: Guam (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forests (USFWS, 2015)

Habitat Narrative

Adult: P. malaspinae was known from scattered occurrences on the northeast and southwest sides of Guam, in the forest ecosystem (Merrill 1914, pp. 148–149; Stone 1970, pp. 554– 555; Raulerson and Rinehart 1991, p. 83; Fosberg et al. 1993, pp. 111–112; Costion and Lorence 2012, pp. 54, 85– 86; Bishop Museum 2014—Online Database; Wagner 2012—Flora of Micronesia; WCSP 2012c—Online Database). (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:
Not available.

Number of Populations:
1 (USFWS, 2020b)

Population Size:
3 (USFWS, 2020b). 8-12 wild and 22 translocated (USFWS, 2020)

Population Narrative:
Currently, P. malaspinae is known from only four occurrences, three with only a single individual each (M and E Pacific, Inc. 1998, pp. 67, 79; Grimm 2012, in litt.), none of which have been observed for at least 5 years; and a fourth recently discovered occurrence with three individuals (Guam Plant Extinction Prevention Program 2015, in litt.). In summary, the species Psychotria malaspinae, a single island endemic, has been reduced to an estimated five individuals in the wild, and possibly fewer since several of these individuals have not been observed for several years, rendering this species vulnerable to extinction. (USFWS, 2015). Only 8 to 12 wild individuals and 22 translocated individuals of this species remain. Five of the Psychotria malaspinae plants are within an ungulate-fenced area (Rididian Point, Andersen Air Force Base, Guam, DoN 2018, in litt), but the remaining wild individuals have no ongoing control of any threats. Only 22 individuals have been propagated; 12 of which were outplanted by GPEPP (GPEPP 2019, in litt.).(USFWS, 2020)

Threats and Stressors

Stressor: Habitat loss from agriculture, urban development, non-native animals and plants, and typhoons (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: There are likely a few scattered individuals or small occurrences such as that recently discovered; however, these remaining individuals are at risk, due to continued habitat loss and destruction from agriculture, urban development, nonnative animals and plants, and typhoons. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Stressor: Herbivory (USFWS, 2015)
Exposure:
Response:

Consequence:
Narrative: Herbivory by pigs and deer, damage by ordnance and live-fire training, combined with the effects of low numbers of individuals, which results in loss of vigor and genetic representation, and limits its ability to compete with other species and adapt to changes in environmental conditions, contribute to the decline of P. malaspinae. (USFWS, 2015)

Stressor: Small population size (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In summary, the species Psychotria malaspinae, a single island endemic, has been reduced to an estimated five individuals in the wild, and possibly fewer since several of these individuals have not been observed for several years, rendering this species vulnerable to extinction. (USFWS, 2015)

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:
- Threat and Recovery Potential: Full species with a high degree of threat and a high degree of recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine population status and current distribution—Determine the distribution and number of all individuals on each island. Assess the status and threats to each population to inform prioritization of conservation effort. • Population biology and taxonomy—Research the genetic composition of populations and congeners to determine taxonomic relationships. • Conduct research to clarify life history information and threats to the populations and their habitat—Conduct research to determine the best way to control the brown treesnake, rodents, and invasive invertebrates. Assess development and land designation and zoning threats to conservation of habitat needed for recovery. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species and those that compete with P. malaspinae at all populations. Implement measures such as fire danger assessments, fire suppression responses, fuel treatments, regulations, and public outreach to prevent fire from burning native limestone forest. • Reduce human disturbance from military activities mortality and reduced viability— increase population resiliency by mitigating ordinance and wildfire threats from military activities. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction. • Reintroduction and translocation—Augment population and increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of predation and typhoons, and climate change. • Develop regulations and policy essential

to recover the species and their habitats— Encourage the development of legislation to ensure protection of the listed species under Commonwealth or Territorial law. Develop and support the implementation of biosecurity plans to prevent the influx of new pests and invasive species into the Territory and inter-island movement of pests and invasive species • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- Current Management Actions: • Surveys and inventories – • The USFWS recommends all sites containing suitable habitat be surveyed for Psychotria malaspinae prior to implementation of projects entailing vegetation or soil disturbance. • Joint Region Marianas (JRM) surveyed for ESA-listed species, including P. malaspinae, at the Naval Munitions Site (NMS) and Naval Base Guam Telecommunication Site, Tarague Triangle, MSA Igloos, THAAD, and other projects to document locations and estimate population densities in sites that are proposed for ungulate exclusion and forest restoration (JRM 2019 and 2020). • Captive propagation for genetic storage and reintroduction • In 2012, the Guam Plant Extinction Prevention Program (GPEPP) was formed to address conservation concerns for a select group of native Mariana Islands plant species. As of May of 2019, GPEPP had propagated 22 individuals of Psychotria malaspinae in the GPEPP's nursery and translocated 12 of these individuals (GPEPP 2019, in litt.). • Habitat protection – • A major biosecurity focus within the Mariana Islands is preventing the spread of the brown treesnake to the CNMI from Guam. Federal agencies support local capacity both in Guam and the CNMI. Efforts include inspection of all arriving cargo from Guam to the CNMI by brown treesnake detection dogs as well as specialized trapping around all major ports of entry. The Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs (U.S. Geological Survey, USFWS), are using aerial applications of acetaminophen to suppress BTS over forested areas in AAFB (Dorr, et al. 2016, in litt.; Phillips 2014, in litt; BTSTWG 2015, entire). In addition, repeated and sustained applications could drastically reduce brown treesnake abundance on a landscape scale (Siers, et al. 2018, in litt.). • An island-wide Habitat Conservation Plan for Guam, that would provide a collaborative and comprehensive approach to endangered species conservation on non-federal lands, is beginning to be developed (USFWS 2020). • A 2020 Memorandum of Understanding between JRM and the USFWS outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative (REPI) to address conservation of upland vegetation communities (DON and USFWS 2020). • Other Natural or Manmade Factors: Limited numbers; ordnance • Range Fire Management Plan for Marine Corps Ranges on Guam. A range fire management plan to reduce range/wildfire potential, protect and enhance natural and cultural resources, integrate applicable permit and reporting requirements and implement ecosystem management goals, sustainable training, and objectives already supported on existing Marine Corps installations is being drafted (JRM 2019). (USFWS, 2020)

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SPECIES ACCOUNT: *Ptilimnium nodosum* (Harperella)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/28/1988; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

An annual herb with slender, erect stems, up to 12 dm high. The roots are shallow, diffuse-fibrous, and the plants have a faint scent of dill. Unlike those of the more common members of this genus, the leaves of P. nodosum are reduced to hollow, quill-like structures. Broad clusters of small white flowers bloom mostly in July and August. (NatureServe, 2015)

Taxonomy

As of 2008, the U.S. FWS treatment includes P. fluviatile (AR, AL; river form, does not produce asexual buds), P. viviparum (MD, WV, VA, NC; river form, produces asexual buds), and P. nodosum sensu stricto (GA, SC; pond form) in P. nodosum, as does Kartesz (1994 and 1999); this is the treatment followed here. However, recent information suggests they may be tentatively treated as distinct entities, although not necessarily as distinct species (David Maddox pers. comm. to Alan Weakley and to Larry Morse). Specifically, a 1994 isozyme study found that there was substantial genetic differentiation among rather than within these three groups, supporting designation as distinct entities (Kress et al. 1994 cited in Douglas 2008). A 2008 DNA study (nuclear rDNA ITS sequences) found that "viviparum" accessions formed a monophyletic group, but "nodosum sensu stricto" accessions did not, with South Carolina populations forming a monophyletic group, but Georgia populations falling at the base of the clade alongside "fluviatile" accessions (Feist and Downie 2008). In summary, although there is clearly more than one distinct entity within the current broad-sense circumscription of P. nodosum, there is not yet a clear consensus on how to divide the material and at what taxonomic level entities should be distinguished. (NatureServe, 2015)

Current Range

Currently known from scattered sites in western Maryland, eastern West Virginia, northeastern Virginia, north-central North Carolina, central South Carolina, central Georgia, northeastern Alabama, and west-central Arkansas. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetatively) and sexual (NatureServe, 2015)

Lifespan

Adult: 1 year (USFWS, 2015)

Breeding Season

Adult: July to August (USFWS, 1990)

Reproduction Narrative

Adult: Ptilimnium nodosum is an annual that reproduces both vegetatively and via seed; it is thought that established patches may persist over the long-term primarily by vegetative reproduction, while novel habitat colonization may occur primarily via seed. These multiple reproduction modes also appear to provide a survival mechanism for variable water levels; since sexual reproduction becomes more difficult within increasing water depth, the plants produce seeds and reproduce sexually in dry years, while in wet years they produce plantlets and reproduce vegetatively. It appears that both forms of reproduction contribute to overall population size in most years, with the contribution of each dependent upon hydrological patterns (Douglas 2008). Marcinko and Randall (2008) studied the mating system of P. nodosum, with the following findings. Flowers were self-compatible, but strong intrafloral protandry essentially prevented autonomous selfing. (NatureServe, 2015)

Habitat Type

Adult: Riverine, and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Spring/spring brook, herbaceous wetland, riparian, temporary pool (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Saturated sites; flooding; water fluctuations (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Prefers saturated habitat, periodic flooding, sunny areas. Restricted to intermediate water depths (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Patches (USFWS, 1990)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 1990)

Site Fidelity

Adult: High (USFWS, 1990)

Habitat Narrative

Adult: Ptilimnium nodosum occurs in three habitat types: rocky/gravelly shoals or cracks in bedrock outcrops beneath the water surface in clear, swift-flowing streams (usually in microsites that are sheltered from rapidly moving water); edges of intermittent pineland ponds or low, wet savannah meadows on the Coastal Plain; and granite outcrop seeps. In all habitat-types, the species occurs in a narrow range of water depths; it is intolerant of deep water and of conditions that are too dry. However, the plants readily tolerate periodic, moderate flooding - something to which few potential competitors are adapted. P. nodosum seeds generally

germinate during short-duration spring floods and the plants have completed their life cycle by late summer or fall, just as water levels are lowest and competing species are moving in. The dominant species at P. nodosum sites is often Panicum hemitimon. Other species may include many sedges in the genera Rhynchospora (e.g., B. perplexa, R. microcarpa), Carex (e.g., C. walteri, C. lupulina), Eleocharis (e.g., E. tricostata, E. melanocarpa), Psilocarva, Dichromena colorata, and Fimbristylis. Dicot associates include Hypericum fasciculatum, ii. denticulatum, H. myrtifolium, Rhexia vircrmnica, R. mariana, B. aristosa, Proserpinaca pectinata, several Ludwicria species, and Sclerolepis uniflora (Kral 1983). (USFWS, 1990; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 1990)

Dispersal/Migration Narrative

Adult: Seeds readily float, so dispersal probably is mediated by water flow; however, safe sites downstream are infrequently and haphazardly found. Further, seeds have no structures to facilitate aerial dispersal and drop quickly to the ground, with many seeds germinating directly under the parent plant. The natural founding of new pond populations is probably very rare because of the plant's (apparently) poor capacity for long distance dispersal and the fragmented dispersion of appropriate habitat. Thus, seed dispersal to new sites is probably a rare event. (USFWS, 1990)

Population Information and Trends

Population Trends:

Long-term trends suggest a decline of 30 to 70%, whereas short-term trends indicate a decline of >50% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

24 (NatureServe, 2015)

Population Size:

~500,000 (NatureServe, 2015)

Population Narrative:

This species may be somewhat resistant, but is sensitive to dry conditions and dependent on narrowly defined hydrologic conditions. Vulnerable to upstream development. Many sites have been lost. Approximately 25% of mapped occurrences are ranked historical or extirpated. Long-term population trends suggest a decline of 30 to 70%, whereas short-term trends indicate a decline of greater than 50%. The total number of known individuals appears to be approximately 500,000. One population (drainage/watershed) in West Virginia is estimated to contain 400,000 plants, and all populations in Arkansas are estimated to total 50,000-100,000 plants in a good year (Douglas 2008). Many of the other extant populations are small; nine of the populations (drainages/watersheds) are estimated to contain less than 400 plants (Douglas

2008). Approximately 45 occurrences are believed extant, about half of which are in Arkansas with the other states in the range having 1-5 each. Thirteen occurrences are considered historical (predominantly in Alabama and South Carolina) and 1 (in Georgia) has been extirpated. The U.S. Fish and Wildlife Service (Douglas 2008) regards 24 "populations" as extant, with "population" defined as "sites located within one drainage or watershed... each may have a number of discrete sites (element occurrences)." Under this view, there are 9 extant populations in Arkansas and 1-3 in each of the other states. (NatureServe, 2015)

Threats and Stressors

Stressor: Water fluctuations (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Fluviatile tends to occupy a narrow range of water depths, manipulations of water flow upstream from populations can easily destroy suitable habitat by inundation or persistent desiccation. Dams, reservoirs, or other water impoundments or diversions would almost certainly threaten any P. nodosum downstream. Natural fluctuation in water flow causes significant yearly variation in subpopulation persistence. Small subpopulations are particularly susceptible to loss during normal high water events. Thus, small populations such as those in North Carolina or Maryland's Fifteen Mile Creek are at significant yearly risk. Hydrological manipulations on rivers with small populations should be strictly avoided or controlled. Nodosum, like Fluviatile, depends on intermediate water levels and is threatened by either dry conditions or total inundation. Thus, the primary threats to Nodosum populations are hydrological manipulation and physical destruction of their pond habitats. (USFWS, 1990)

Stressor: Water quality (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Fluviatile is apparently also sensitive to reductions in water quality. Siltation caused by heavy construction, residential development, and agriculture has been cited as detrimental to the plant. The negative effect of sediment on Fluviatile was substantiated in a greenhouse experiment: turbidity equal to that near a bridge construction site reduced Fluviatile growth rate by 40% (Maddox and Bartgis 1990b). (USFWS, 1990)

Stressor: Stream acidification (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Another greenhouse experiment indicates that stream acidification (especially pH ~ 5.0) may cause significant plant mortality (Maddox and Bartgis 1990b). Plants growing in water with pH approximately equal to 3.4 had a 70% mortality rate; in water with pH = 4.6 plants grew at a significantly lower rate than controls. This is potentially important in Alabama, where the extant population has historically experienced low pH due to mining. At Maryland and West Virginia sites, the pH is typically 7.0. However, the acid neutralizing capacity is very low, suggesting that minor acid inputs could significantly lower pH. Other water quality variables, such as increased sewage or nitrate concentration, may also be detrimental. (USFWS, 1990)

Stressor: Alterations in hydrology (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Coastal plain ponds everywhere are threatened by active drainage for conversion to pine plantations or row crops (Godfrey and Wooten 1979). Lowered water tables are probably detrimental to Nodosum through increased competitive and physiological stress. While hydrological manipulations directly to the pond are clearly detrimental, ditching and other manipulations of the water table from some distance away may affect coastal plain ponds, although the exact area of effect is not known (Pat Phillips, U.S. Geological Survey, pers. comm. 1989). The effective distance of such manipulations clearly is important in determining the zone around a population needed to ensure protection of the hydrological resource. (USFWS, 1990)

Stressor: Dredging (USFWS, 1990)
Exposure:
Response:
Consequence:
Narrative: Occasionally ponds are dredged to create deep ponds for livestock; these deeper water levels probably disrupt the life cycle of Nodosum, a small plant. (USFWS, 1990)

Recovery

Reclassification Criteria:
1. Thirteen populations (the number of currently extant populations) have been relatively stable in population size for five years. (USFWS, 1990)

2. All thirteen populations are permanently protected. (USFWS, 1990)

Delisting Criteria:
1. Thirteen populations (the number of currently extant populations) have been relatively stable in population size for five years. (USFWS, 1990)

2. All thirteen populations are permanently protected. (USFWS, 1990)

3. There are at least 26 self-sustaining populations in existence. To reach this level, at least thirteen new populations will have to be discovered or established. This is the total number of current and historically known populations. (USFWS, 1990)

4. The populations are distributed throughout the historical range from Arkansas to Maryland. (USFWS, 1990)

5. All 26 populations are permanently protected. (USFWS, 1990)

Recovery Actions:
- Protect plants and their habitat through landowner cooperation, land protection, and regulatory authorities. (USFWS, 1990)
- Where needed, seek conservation of watersheds to protect populations. (USFWS, 1990)

- Search for additional populations. (USFWS, 1990)
- Study species and habitat characteristics. (USFWS, 1990)
- Develop a cultivated sources of plants and provide for seed storage. (USFWS, 1990)
- Implement appropriate management techniques, particularly for pond populations. (USFWS, 1990)
- Re-establish populations within the species' historical range. (USFWS, 1990)
- Inform the public about the plant's status and recovery needs. (USFWS, 1990)
- Population surveys and inventories have been performed at all current sites by State Heritage Programs or botanists from various universities. Active population monitoring occurs only in Maryland and West Virginia. (USFWS, 1990)
- Surveys for new populations have been undertaken in all states containing extant populations, except Arkansas. New populations were verified in Maryland in 1988 and Arkansas in 1990. Significant potential habitat or recent unconfirmed records remain to be investigated in Alabama, Georgia, North and South Carolina, Arkansas, southern Missouri, and eastern Oklahoma. (USFWS, 1990)
- The Nature Conservancy, Western Pennsylvania Conservancy, and Maryland Department of Natural Resources have begun a comprehensive program to protect Sideling Hill Creek, including upstream areas as buffer. To date, a number of tracts have been registered in Maryland and Pennsylvania, a tract has been acquired on the border of Maryland and Pennsylvania, and the potential purchase of the most significant tract supporting p. nodosum is being negotiated by the State of Maryland and The Nature Conservancy. (USFWS, 1990)
- The Nature Conservancy has acquired an easement on one Cacapon River subpopulation. Additional subpopulations in West Virginia have been added to the Conservancy's registry program. The U.S. Fish and Wildlife Service contracted with The Nature Conservancy in 1990 to expand landowner contact efforts on the Cacapon River. (USFWS, 1990)
- The Maryland Natural Heritage Program has conducted an extensive two—year investigation of the ecology and life history of Fluviatile (Maddox and Bartgis 1989, 1990a, 1990b). (USFWS, 1990)
- The Maryland Natural Heritage Program has collaborated with the Smithsonian Institution on a study of electrophoretically detectable genetic variation throughout the range of P. nodosum. This study is expected to be completed in spring of 1991. (USFWS, 1990)
- The Maryland Natural Heritage Program has produced and distributed several information brochures on the biology of P. nodosum and its habitat. (USFWS, 1990)
- In a 1988 survey conducted by the Center for Plant Conservation to determine the plant taxa in most imminent danger of extinction, P. nodosum was identified by botanists as a "B" priority taxon, i.e., one which could go extinct in the wild within the next ten years. The Center has assisted in the recovery of the plant: 7,500 seeds have been collected as part of the National Collection of Endangered Plants and are housed at the North Carolina Botanical Garden (NCBG), one of the Center's participating institutions in the region. All seeds were collected from the Tar River area in Granville County, North Carolina. Although not currently being propagated at NCBG, these seeds provide a valuable conservation resource. (USFWS, 1990)

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SPECIES ACCOUNT: *Purshia (=Cowania) subintegra* (Arizona Cliff-rose)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/29/1984; Southwest Region

Physical Description

Arizona cliffrose is a member of the Rose Family (Rosaceae). It is a low, straggling woody perennial usually 1 - 2 meters (in) (3 - 6 feet) high and generally wider than tall. In the Cottonwood population, plants can reach a maximum of 2.4 in (8 feet) tall and 3.7 m (12 feet) in diameter. The horizontal lower branches are spreading, and the central branches are irregularly ascending (Denhain and Fobes 1992b). New shoots tend to be red-brown and pubescent with a red dot below the fascicle. The older branches have light gray bark that becomes shreddy. The herbage is not viscid (sticky), although some resin glands may be present, causing slight stickiness. The shape of Purshia subintegra leaves is variable. The leaves are very narrow and short: averaging about 8 millimeters (mm) (0.3 inch) long (Denham and Fobes 1992b) and 3 mm (0.1 inch) wide. Leaves usually have no lobes, but occasionally have 1 or 2 rounded, shallow lobes or teeth just below the leaf tip. The margins (edges) of the leaves are curled towards the underside (revolute). The upper leaf surface is bright or dark green and usually has no punctate glands. The upper leaf surface is usually loosely arachnoidpubescent (having a few long hairs) on the upper surface, but sometimes it is hairless. The lower surface is densely white-lanate (wooly) and usually has no punctate glands. Each flower is born on a single stalk (peduncle). The end of the peduncle gradually merges with the beginning of the narrowly funnelform hypanthium, the flower part bearing the sepals, petals, and stamens. The average length of the hypanthium plus peduncle is 5.1 mm (< 0.3 inch) (Reichenbacher 1993). The hypanthium has no stipitate (stalked) glands or has few glands. The typical flower has 3 - 7 pistils and 5 white or pale yellow petals that are about 10 mm (0.4 inch) long, slightly smaller than P. stansburiana flowers. Occasionally, flowers have 8 - 12 petals per flower (Denham and Fobes 1992a). As the achenes (fruits) develop, the style remains attached and forms a short, white, feathery plume. (USFWS, 1995)

Taxonomy

Purshia subintegra genetic variability, phenotypic plasticity, and past and recent hybridization with P. stansburiana have complicated taxonomic identification. Phenotypic and genetic variability among populations has been studied using morphometrics and molecular (DNA) analysis. Schaack (1987) described the San Carlos Basin (i.e., Bylas) population of P. subintegra as P. pinkavae, and designated P. subintegra to be of hybrid origin involving a cross between P. stansburiana and P. pinkavae. Kartesz (1994) treats P. subintegra as a hybrid. Reichenbacher (1994) states that although there is some character variation between the four populations of P. subintegra, multivariate analysis clearly indicates they exhibit a coherent syndrome of characters, and the taxonomy developed by Schaack is not supported by the analysis. The Recovery Plan concludes that P. subintegra is distinct from the more common P. stansburiana, despite sometimes overlapping plant characteristics (USFWS 1995). Travis et al. (2008) re-examined the genetic variation within P. subintegra and state that molecular evidence indicates a distinct classification for the Bylas population in support of the hypothesis that this population represents a separate species per Schaack (1987). However, the authors conclude that a broader taxonomic analysis of the genus is necessary to confirm such a distinction. Henrickson's unpublished description of P. subintegra notes considerable variation in key characteristics

within the species. Characteristics used for identification, such as occasionally lobed (or toothed) leaves, exhibit a continuum of variability between and within individuals, change seasonally (e.g., as leaves are shed during drier periods sometimes leaving only unlobed leaves), and sort out independently from other key characteristics. The demarcation between Schaack's pinkavae and P. subintegra is not discrete (Henrickson, pers. comm., 2013). Pending further studies, the USFWS continues to recognize that the four described populations of P. subintegra comprise one distinct species. Regarding nomenclature, Travis et al. (2008) present strong evidence for a hybrid origin of P. subintegra. Based on their molecular data and hypothesized pre-historic biogeography of the region (Anderson 1993), hybridization occurred during the late Pleistocene (11,000 to 13, 000 years before the present). There has been a growing consensus for this explanation and increased use of the following nomenclature indicating a hybrid origin: Purshia ×subintegra (Kartesz 2013; Integrated Taxonomic Information System, 2013). However, such a designation for a species believed to be of hybrid origin is discretionary (International Code of Botanical Nomenclature (Article H:3.3) 2012). (USFWS, 1995))

Historical Range

See Current Range.

Current Range

In Arizona, in Graham, Maricopa, Mohave, and Yavapai counties. All known occurrences of P. subintegra are located in four disjunct populations, which occur along the sub-Mogollon region of central Arizona over a distance of 320 kilometers (200 miles) (Rutman 1992). (USFWS, 2013)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food Source

Adult: sunlgiht

Competition

Adult: yes, especially creasote

Food/Nutrient Narrative

Adult: This species aquires its energy from sunlight via photosynthesis.

Reproductive Strategy

Adult: Flowering plant that attracts pollinators

Lifespan

Adult: many years

Dependency on Other Individuals or Species

Adult: lepidopterans, dipterans, and bees

Breeding Season

Adult: late March through early May

Reproduction Narrative

Adult: Purshia subintegra generally flowers from late March through early May and is visited by a wide variety of insects, including lepidopterans, dipterans, and bees. Typically, hundreds of flowers are produced on each mature plant, which can reproduce for many years (USFWS 1995). Flower and seed production varies between years based on climatic conditions, plant vigor, browsing, and other factors. Native wild bees and introduced honeybees (Apis mellifera) are the most important pollinators, the latter becoming the predominant pollinator later in the flowering season (Fitts et al. 1993). Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995). Experiments have shown that this species is partially self-compatible, but sets significantly more seeds and produces fruit more often when outcrossed (Fitts et al. 1993).

Habitat Type

Adult: desert

Habitat Vegetation or Surface Water Classification

Adult: limestone soils

Geographic or Habitat Restraints or Barriers

Adult: Restricted by competition with other plants

Spatial Arrangements of the Population

Adult: Clumped according to suitable resources

Environmental Specificity

Adult: specialist; narrow habitat requirements

Tolerance Ranges/Thresholds

Adult: unknown

Site Fidelity

Adult: high

Habitat Narrative

Adult: This species has narrow habitat requirements and occurs at four widely separated areas across central Arizona. These sites differ slightly in elevation and associated vegetation, but all sites have limestone soils (generally white but also reddish in color) derived from Tertiary lacustrine (lakebed) deposits. At each site P. subintegra is part of a locally unique vegetative community (Anderson 1993). The geographic and local distribution of P. subintegra appears to be limited by competition from other plant species rather than a requirement for a specific soil type. These soils are relatively infertile and have significantly lower amounts of phosphorus and organic matter compared with surrounding areas where P. subintegra is absent (Anderson 1986, 1993). These surrounding areas are typically dominated by creosotebush (Larrea tridentata), which is thought to have a competitive advantage over P. subintegra due to its aggressive seedling establishment (Anderson 1993). Creosotebush is unable to grow on the relatively

infertile lacustrine soils. However, it has been found growing together with P. subintegra in the Verde Valley, in areas with higher amounts or organic matter and phosphorus. This suggests that the distribution of P. subintegra within these limestone soil conditions is limited primarily by competition from creosotebush, rather than a requirement for specific soil properties (Anderson 1986, 1993, 1996).

Dispersal/Migration

Motility/Mobility

Adult: not mobile

Dispersal

Adult: only the seeds

Dispersal/Migration Narrative

Adult: Fruit dispersal occurs when summer rains dislodge seeds from plants (USFWS 1995).

Population Information and Trends

Population Trends:

Declining

Species Trends:

Declining

Population Growth Rate:

unknown

Number of Populations:

4 (USFWS, 2022)

Population Size:

Unknown, estimated to exceed 40,000

Minimum Viable Population Size:

unknown

Resistance to Disease:

unknown

Population Narrative:

The total number of plants in the four P. subintegra populations is not known, but has been estimated. Not all areas of potential habitat have been surveyed, and in some areas, such as Cottonwood, the presence of hybrids between P. subintegra and P. stansburiana, or introgressed forms, has complicated population estimates (USFWS 2001). Despite the potential conservation significance of hybrids, the USFWS considers these plants to be outside the definition of the species (USFWS 1995) and are not included in population estimates. In 1988, a total number for all four populations (i.e., recovery units) was estimated to exceed 40,000

plants, although a large percentage may have included hybrids (USFWS 1988). About 10,000 plants are thought to currently occur in the predominant subpopulation at Burro Creek (USFWS 2004). At the time of listing, the USFWS estimated 243 ha (600 ac) of habitat at Burro Creek, and 40 ha (100 ac) at Bylas with an estimated 700 plants (USDI 1984). The Horseshoe Lake population is estimated to include 750 plants (USFWS 1987) over an unspecified area. The Cottonwood population covers the largest area, estimated at over 405 ha (1,000 ac) (USFWS 1995), with the amount of occupied habitat recently calculated to be 78 ha (194 ac) (Goodwin 2012). Total Cottonwood population numbers were previously not known, but were conservatively estimated to include tens of thousands of plants (USFWS 2007). The most recent, intensive survey places this number considerably lower, at a total of 8,272 P. subintegra plants within the Cottonwood population (Goodwin 2012). Acceptance of this figure would result in a downward adjustment of the estimated total numbers of known plants in the four populations by one-half, or to about 20,000. This adjustment may be the result of a more intensive survey as opposed to a large scale decline in numbers. We have no demographic trend information from monitoring the four populations, but population viability modeling suggests that P. subintegra will slowly decline in the Cottonwood population under more arid scenarios (Maschinski et al. 2006). Purshia subintegra populations are genetically variable, exhibit phenotypic plasticity in response to environmental conditions, and hybridize with P. stansburiana. Gene exchange through backcrossing hybrids (introgression) of P. subintegra and the more common P. stansburiana has resulted in hybrid swarms in the Cottonwood and Horseshoe Lake populations (USFWS 1995). A hybrid swarm is a “hybrid population,” maintained by backcrossing and/or crossing with other hybrids, which may be stable or spread. The proliferation of hybrids has the potential to negatively affect long-term population dynamics of P. subintegra through interference competition and loss of genetic integrity (Fitts et al. 1993; Baggs and Maschinski 2001b). At the same time, hybridization may act as a mechanism to increase genetic diversity in a population, enhancing adaptation and survival, therefore potentially benefiting conservation of P. subintegra (Baggs and Maschinski, 2001b). Hybrid swarms illustrate the migratory and dynamic nature of evolving plant populations, and may provide the key to the future of the genus and species. For this reason, conservation of these hybrid swarms is important (USFWS 1995). A recent study by Travis et al. (2008) confirmed the presence of a hybrid swarm in the Verde Valley and emphasized its conservation significance. Because introgressed forms appear to possess potential fitness advantages under hotter, drier conditions, they may provide a viable refuge for P. subintegra genome in the face of climate change (Travis et al. 2008). The paper also identified three distinct genetic lineages of P. subintegra: the Cottonwood (Verde Valley) population, which is currently undergoing introgression; the Burro Creek and Horseshoe Lake populations, which exhibit an ancient natural hybrid origin; and the Bylas population, which is genetically distinct from the others. These findings underscore the complex genetics of this species and the importance of conserving all four populations. (USFWS, 2013). For Arizona cliffrose, the four recovery units are analogous to the four known populations of the species, which we will refer to as populations from this point forward. The four populations are Burro Creek, Cottonwood, Horseshoe Lake, and Bylas (USFWS, 2022)

Threats and Stressors

Stressor: Urbanization (USFWS, 1995)
Exposure:
Response:
Consequence:

Narrative: Habitat loss due to urbanization is a serious threat for the Cottonwood Arizona cliffrose population. Urbanization does not appear to be a threat to the other three populations, which are either on Federal land, which precludes urbanization, or they occur where development is unlikely. A significant amount of Arizona cliffrose habitat has already been lost due to development in the Cottonwood area, but the amount of habitat loss has not been estimated. The threat of urbanization continues, because some occupied habitat remains on private lands that could be developed and a substantial amount of habitat is on State Trust land. The transfers of land from Federal ownership into private or State ownership is an indirect threat to Arizona cliffrose. These land exchanges significantly reduce the protections offered by the Endangered Species Act and may contribute to urbanization or other actions causing habitat loss or degradation. These types of transfers would be subject to section 7 consultation procedures. (USFWS, 1995)

Stressor: Mineral Exploration and Development (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Mining and mining-related activities are a serious threat to the long-term survival of this species, particularly in the Burro Creek area. The soils supporting Arizona cliffrose populations are known to contain high quality bentonite (BLM 1993), a type of clay used for cosmetics and pharmaceuticals. Drilling and bulk sample procurement have reduced the number of plants and amount of available or undisturbed habitat in the Burro Creek area. (USFWS, 1995)

Stressor: Cattle and Feral Burro Browsing Effects (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: In 1987, the BLM- Kingman Resource Area began monitoring the effects of livestock browsing on Arizona cliffrose near Burro Creek with the objective of determining the amount of utilization. Internode distances on five branches were measured on each of 50 Arizona cliffrose plants. Cages were constructed around 25 Arizona cliffrose plants to prevent browsing by livestock, wild burros, and mule deer. Twenty-five plants were left uncaged to serve as a control. Their results showed that browsing activity resulted in 65% utilization of Arizona cliffrose (BLM 1993). This high level of utilization can reduce plant vigor and fecundity, cause lack of seedling establishment, and change the form class of Arizona cliffrose plants, causing them to look hedged. Under this level of utilization, more palatable, associated plant species may be overutilized, resulting in disturbed ecosystem functions and degraded ecological values. The BLM continued monitoring Arizona cliffrose utilization after a fence was constructed in 1989 to exclude cattle and burros from an approximately one square mile area. This large exclosure included the caged and uncaged plants that had been monitored since 1987. After the fence was built, utilization of the Arizona cliffrose plants dropped to 16% in 1989 and 18% in 1990 (BLM 1993). Utilization of caged plants was similar to uncaged plants. These results indicate that livestock and burros were responsible for most of the browsing activity on Arizona cliffrose. Some browsing continues within the exclosure, probably from mule deer and other wildlife. Livestock and burros may occasionally enter the exclosure if the fence is not maintained. Most plants appear to be responding favorably to the lower levels of browsing. However, it appears that some plants that were very heavily browsed over a long period of time may never recover. Only observational data are available regarding the effects of livestock grazing on the Bylas

Arizona cliffrose population. At the Graham County population, Bingham (1977) noted that no young plants were observed during a one hour search in the grazed open area, whereas juvenile plants were present along an adjacent fenced ungrazed highway right-of-way. In 1986, the BIA (/n litt. 1986) noted that the absence of quantities of dried manure and lack of hoofprints to the north of Highway 70 indicated low grazing pressure. They also noted that Arizona cliff rose plants south of Highway 70 were browsed, probably because nearby Poison Spring offers a source of water for livestock and wildlife. (USFWS, 1995)

Stressor: Roads and Utilities (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: All of the Arizona cliffrose populations have roads and/or utility right-of-ways within or near them. The Burro Creek population is divided by a graded dirt road paralleled by the Southern Union Gas Company pipeline and Arizona Electric Power Cooperative Incorporated high voltage power line. The gas pipeline has been in existence since at least 1969 (Butterwick 1979). No estimate of the amount of habitat lost to these developments in the Burro Creek area has been made. The Kinginan Resource Management Plan (Kinginan RMP) (BLM 1993 proposed a one-mile wide utilities corridor that overlies Arizona cliffrose habitat. The BLM may grant right-of-ways through this utility corridor (BLM 1993). A graded dirt road (Forest Road 205) and a gated road (Forest Road 530) passes near one of the three Horseshoe Lake subpopulations. Forest Road 479 passes near a second subpopulation. U.S. Highway 70, a two-lane paved road, bisects the population near Bylas. Numerous paved and dirt roads pass through the Cottonwood population. Highway 89A nearly forms the eastern border and Rocking Chair Road passes through the Arizona cliffrose habitat. Its expansion is being planned. Other roads to access housing or for recreational purposes create a network through the habitat. Roads and trails have direct and indirect effects. Road surfaces constitute lost habitat. The amount of habitat and number of plants lost to roads have not been estimated. Roads can change the local hydrology, affecting the amount of precipitation received and absorbed in a local area, changing the direction and speed of runoff, and perhaps changing erosion rates and patterns. These changes can adversely or beneficially affect survivorship and fecundity of individuals. Soil compaction occurs in areas of moderate to heavy vehicle use. Roads can provide access to ORV and other users that may adversely affect Arizona cliffrose and its habitat. ORVs can destroy young plants, harm mature plants, prevent seedling establishment or seed germination, cause soil compaction, and otherwise disrupt the soil surface. Arizona cliffrose plants have colonized a lightly used vehicle trail on the Coconino National Forest. These plants indicate that Arizona cliffrose in the actively reproducing Verde Valley population can recover after light soil surface disturbance. Unknowingly, local residents of the Verde Valley have been using Arizona cliffrose habitat as a parking lot. The parking area is located at the intersection of Rocking Chair Road and U.S. Highway 89A. The area of impact has been expanding during recent years, increasing the number of plants and amount of habitat already lost. The Coconino Forest Plan (U.S. Forest Service 1987) states that the Forest will manage roads adjacent to the Verde Valley Botanical Area to prevent vehicular intrusion." In the same document, the Forest committed to blocking and obliterating existing roads entering the area within the first ten years of plan implementation. To date, road blocking and obliteration has not yet occurred. (USFWS, 1995)

Stressor: Recreation (USFWS, 1995)
Exposure:

Response:
Consequence:
Narrative: The Cottonwood population is adversely affected by recreation of several types. An unofficial shooting range near the eastern portion of this population on the Coconino National Forest has caused the loss of an unknown number of plants and acres of habitat. Shooters park within an Arizona cliffrose population at the base of a small hill and shoot into the population on the hill. The soil at the well-used parking area and roads leading to the shooting range is compacted and eroding, devoid of vegetation, and probably incapable of supporting cliffrose plants unless restored. The area is used not only by shooters, but also by nighttime recreationists. In addition to the shooting range, other spots in the Arizona cliffrose Cottonwood population are frequented by night-time recreationists. These “party spots” are generally severely impacted by vehicles, devoid of vegetation, and littered with trash. ORV recreationists drive through the Cottonwood population, in some cases ignoring signs or cutting fences to gain access to prohibited areas. A fence completely surrounds a section of Arizona State Trust land, which was used by ORV users despite trespass notices. The primary damage to Arizona cliff rose habitat in the Cottonwood area has occurred in Township 16 North, Range 3 East, section 36 by vehicles entering the section from the west. The State Land Department has been successful at notifying the offenders and eliminating this use (Denham /n I/U. 1994). Denham and Fobes (1 992d) also noted ORV damage in the southeast corner of Township 16 North, Range 3 East, section 22 and the northeast corner of section 27. The ORV users entered a parcel of private land via the Coconino National Forest and rode across the property. ORVs are not currently a problem at Horseshoe Lake. The Tonto National Forest Plan (U.S. Forest Service 1985) closed the area to ORV use except where posted as open but has minimally enforced the closure. Despite the presence of a nearby lake and campground, ORV use has not yet been reported within the subpopulations. The amount of recreational activity occurring within the core Burro Creek subpopulation is poorly known. Increased recreational activity may occur within the Clay Hills Area of Critical Environmental Concern (ACEC) when the Burro Creek campground is developed (BLM 1993). The Burro Creek site is a wellknown destination for rock collecting enthusiasts. These visitors may affect Arizona cliffrose by turning over rocks and disturbing seedling establishment microsites. They also may occasionally drive short distances across country to reach collecting sites and crush plants. Whether or not these visitors adversely affect Arizona cliffrose is unknown. (USFWS, 1995)

Stressor: Control of Insect Pests (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: General pesticides are often used to control cropland insect pests and sometimes used to control rangeland insect pests. Two Arizona cliffrose populations (Horseshoe Lake and Cottonwood) occur very close to lands under cultivation. A private parcel of land near Horseshoe Dam is being cultivated to provide food for livestock. We do not know if pesticides are currently being applied on the cultivated lands near Arizona cliffrose populations. Four Arizona cliffrose populations occur in areas that are grazed. High densities of rangeland pests have never been reported within Arizona cliffrose populations. If problem densities develop, however, they may be accompanied by proposals from Federal and State agencies to apply chemical controls, including general pesticides. General pesticides such as malathion, a commonly used rangeland and cropland pesticide, can drastically decrease target and non-target insect populations. Insect population sizes are regulated by a number of variables, including weather, inter-and intra-

specific competition, vertebrate predators,and insect predators and parasitoids (Belovsky 1989, Wang and Walgenbach 1989, Hostetter et a!. 1989, Dysart and Onsager 1989, Lockwood 1993). General pesticides will kill target herbivorous insects as well as the insect predators and parasitoids that regulate the herbivores. Herbivorous insects and their predators and parasitoids are usually in a dynamic balance, rarely reaching high, damaging densities except in unnatural circumstances such as the introduction of nonnative pests or in association with various agricultural practices including livestock grazing (Auerbach 1991, Brusven and Fielding 1989, Belovsky 1989). For a review of the field experiments and models of arthropod predator-prey systems that demonstrate this dynamic ecosystem balance, see Hassell (1978). Herbivorous insects recover more quickly after pesticide applications than do their predators and parasitoids because herbivores tend to have a higher fecundity and shorter generation time. Consequently, herbivorous species will more quickly become resistant to chemicals, and their populations will rebound faster and typically at higher densities because predator/parasitoid controls are lost or reduced. Thus, general pesticide applications tend to exacerbate insect population imbalances rather than resolve them. Concern about applying chemical pesticides within or near endangered plant populations has tended to focus on the adverse effects of pesticides on pollinators. For plants that depend on insects for pollination, seed set may be drastically reduced when pollinator populations are reduced by pesticides (Tepedino and Griswold 1989). Avoiding the blooming period of endangered plants may not remove these adverse effects. Fitts et a!. (1993) provide the following explanation: It is obvious that, for the plant, the most dangerous time to spray is during the blooming period. It is less obvious that it may also be risky to spray when bloom is past; many important pollinators are either eusocial, or multivoltine species, i.e., adults are present throughout the growing season, foraging on other plants. These adults are the progenitors of the next years' pollinator crop; removing them will eliminate progeny and, thus the number of pollinators flying in the following year. Information needed to effectively manage insects as part of the ecosystem containing Arizona cliffrose includes the Identification of all insects beneficial to Arizona cliffrose, including pollinators, and an understanding of their life histories and habitat needs. Until such information is obtained, the U.S. Department of Agriculture, Animal and Plant Health Inspection Service has agreed to restrict certain pesticides within a 4.8 km (three-mile) radius of Arizona cliffrose populations. (USFWS, 1995)

Stressor: Herbicides (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Herbicides are sometimes used to control plant growth along paved roads. Although paved roads pass through the Verde Valley and Bylas Arizona cliffrose populations, we do not know if herbicides are used there. Herbicides should not be used along roadsides within Arizona cliffrose populations because treated plants are destroyed. (USFWS, 1995)

Stressor: Inundation (USFWS, 1995)
Exposure:
Response:
Consequence:
Narrative: Arizona cliff rose plants and habitat were probably inundated when Horseshoe Dam and its spillway were built on the Verde River in 1944-1946 (FraserDesign 1991). Additional plants and habitat were probably lost when the conservation pool level of Horseshoe Lake was raised in the 1950's to the current elevation of 618 in (2,026 feet). Habitat inundation most likely

occurred in the Chalk Mountain area. If the height of the conservation elevation is increased further, the action would probably inundate additional plants and habitat. The Salt River Project, a utility company, operates the reservoir on a daily basis without specific approvals from Reclamation (Project Manager, Arizona Projects Office, Bureau of Reclamation, in !itt. 1994). (USFWS, 1995)

Stressor: Habitat Loss (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: In our 2013 5-year review, we reported that the proposed Bella Montaña Residential Community Development, a 283-hectare (700-acre) parcel, would remove 47 cliffrose plants in the eastern-most known extent of the Cottonwood Recovery Unit (USFWS 2007). We also reported conservation measures proposed as a part of the development to protect and enhance cliffrose habitat (USFWS 2007). At the time of this review, the development has not occurred yet, but the consultant for the project has notified us that the project proponent plans to move forward on this project in the near future (N. Sanders, pers. comm., 2021). The original Coconino National Forest Land and Resource Management Plan (Forest Plan) stated that the Forest Service would withdraw the Verde Valley Botanical Area, which contains approximately 50 to 60 percent of the plants in the Cottonwood Recovery Unit, from locatable mineral entry within 10 years of the implementation of the Forest Plan (USFS 1987). To date, the Forest Service has not completed this withdrawal. However, the current Forest Plan indicates that the Cottonwood Recovery Unit has low potential for mining activity and includes a guideline that botanical areas and areas with federally threatened or endangered species be considered for no surface occupancy or mining leases (USFS 2018) (USFWS, 2022).

Stressor: Herbivory (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: In our 2013 5-year review, we stated that the grazing allotments that contain the Horseshoe Recovery Unit were not active, and these allotments remain inactive. In their revised Land Management Plan, the Tonto National Forest included 3,590 acres, encompassing all the known occurrences of cliffrose in the Horseshoe Recovery Unit within the Horseshoe Recommended Botanical Area (USFS 2022). The Forest Service manages Botanical Areas to maintain or enhance their unique characteristics. Management standards for Recommended Botanical Areas prohibit livestock grazing, mineral extraction, and camping. Additional management guidelines restrict other activities unless necessary to restore or maintain natural conditions or protect natural resources. The finalization of the Horseshoe Botanical Area would address Recovery Actions 1b and 3b. In our 2013 5-year review, we reported that the BLM constructed a fence around the Clay Hills Research Natural Area of Critical Environmental Concern in 1989 to protect the Burro Creek Recovery Unit from the threat of herbivory by livestock and feral burros. After fence construction, browsing utilization of cliffrose decreased from about 65 percent to about 16 to 18 percent (Reichenbacher and Anderson 2022). The BLM continues to monitor the condition of the fence (USFWS 2013) and repaired damaged sections in late 2021 through early 2022 (J. Acton, pers. comm., 2022). Heavy browsing on cliffrose by native ungulates (e.g., mule deer [Odocoileus hemionus]) is evident in the Burro Creek and Horseshoe recovery units. This might be especially prevalent during drought conditions when ungulates

browse on a wider variety of available plants because of limited forage (Reichenbacher and Anderson 2022) (USFWS, 2022).

Stressor: Climate Change (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: In our 2013 5-year review, we identified climate change as a threat to the cliffrose, specifically through decreased seedling recruitment in response to increased aridity and decreased precipitation (USFWS 2013). Climate modeling for 2050 through 2074 projects that increased temperatures will lead to increased monthly mean vapor pressure deficit in Arizona (Alder 2014); thus, cliffrose will continue to experience drought conditions. While we have little quantitative data showing past effects of drought on vegetation in cliffrose habitat, photographs from 2022 repeated at photo points from the 1980s and 1990s in the Burro Creek, Cottonwood, and Horseshoe recovery units show increased dead shrubs and increased dead branches on shrubs, including cliffrose individuals (Reichenbacher and Anderson 2022). Most cliffrose plants in the three recovery units recently observed (Burro Creek, Cottonwood, and Horseshoe) have not flowered in two years and exhibit signs of stress (Reichenbacher and Anderson 2022) (USFWS, 2022).

Recovery

Reclassification Criteria:
We will consider Arizona cliffrose for downlisting when: (USFWS, 2019)

1. A single, long-term monitoring plan for all Arizona cliffrose populations and habitat is developed and implemented. (USFWS, 2019)

2. Land managers conserve existing habitat, in each recovery unit, in perpetuity to prevent further habitat loss and/or degradation. (USFWS, 2019)

3. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 10 years. (USFWS, 2019)

Recovery Priority Number: 8

Delisting Criteria:
In addition to meeting downlisting criteria 1 and 2, we will consider Arizona cliffrose for delisting when: (USFWS, 2019)

1. Each of the four recovery units contains a population of Arizona cliffrose that is stable or increasing over a period of at least 20 years. (USFWS, 2019)

Recovery Actions:

- Produce and implement management plans for each of the four recovery units. This recovery task must be completed before recovery criterion 3 can be met. Commitment of the appropriate Federal and State land management agencies and the San Carlos Indian Community towards managing this sensitive habitat is critical to the recovery and survival of

Arizona cliffrose. If new populations are found, management plans covering those populations should be produced and implemented. (USFWS, 1995)

- Initiate research and other actions needed to monitor the species' status and guide recovery efforts. Best management efforts are guided by good biological and ecological information. Currently, too little is known about Arizona cliffrose to determine the most appropriate management actions to effect recovery and determine population stability. Research, studies, and other actions are needed to provide a sound basis for management. (USFWS, 1995)
- Eliminate or minimize threats to the species. Threats which prevent the recovery of Arizona cliffrose should be eliminated. The most important current threats to Arizona cliffrose are habitat loss due to mineral exploration and development, urbanization, recreation, roads, and utilities, and habitat degradation due to livestock grazing and recreation. Reducing or eliminating these and all other threats will lead to the recovery of Arizona cliffrose. (USFWS, 1995)
- Enforce and apply existing laws and regulations. Full use of all Endangered Species Act regulatory control should be used to manage and protect Arizona cliffrose populations. Arizona State law should also be applied and enforced. (USFWS, 1995)
- Information and education. Exchange of information and ideas among private landowners, the scientific community, the public, and Federal, State and local agencies is essential to a successful recovery program. Scientific information, including results of field and greenhouse research, monitoring data, trip reports, agency reports, and scientific literature should be readily available to all parties interested in the management and survival of Arizona cliffrose. Ideas should be freely exchanged so that optimal recovery strategies can be outlined and implemented. Meetings of interested parties to discuss new information or management issues or strategies should be encouraged. Preliminary or refined research or monitoring data should be presented at local, regional, and national gatherings of professional scientists so that a broad professional audience may have opportunities to comment on, and potentially enhance, recovery of Arizona cliffrose. (USFWS, 1995)
- Recommendations for Future Actions from 2013 5-Year Review: 1) We recommend the development or completion of management plans for the Cottonwood population (including the VVBA), the Horseshoe Lake population, and the Bylas population. The plans for each of these populations would be developed by the respective land managing agency (CNF, TNF, and the San Carlos Apache Tribe) with the offered assistance of the USFWS. These management plans should address newly understood or emerging threats such as climate change and invasive weeds. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 2) We recommend the appropriate agencies analyze the monitoring data they have collected to date to determine demographic trends in their respective P. subintegra populations. This will allow the USFWS to determine whether a given population is viable or on a trend toward viability, in support of downlisting criteria one. The USFWS can assist in coordinating this effort to facilitate consistency and comparability between the various monitoring methods employed by each agency. (USFWS, 2013)
- Recommendations for Future Actions from 2013 5-Year Review: 3) We recommend the modification or addition of standardized long-term demography monitoring techniques to existing monitoring schemes, or the establishment of standardized long-term monitoring protocols within all four populations. The USFWS can facilitate this process and assist in monitoring design and coordinating standardization between agencies. (USFWS, 2013)

- Recommendations for Future Actions from 2013 5-Year Review: 5) We recommend that the terms “viability” and “significant upward trend towards viability,” as used in the first downlisting criterion, be defined or described for P. subintegra for the purpose of developing an objective and measurable criterion. The USFWS will lead this effort in coordination with land managing agencies and subject matter experts. (USFWS, 2013)
- Since 1989, when a fence was set around the main Burro Creek subpopulation, the BLM has continued to monitor grazing on P. subintegra in the main population as well as the two subpopulations. Herbivory of P. subintegra has been low within the ACEC, recorded at 3 to 9.4 percent utilization for the past six years (Peck 2009b; Peck 2012). Grazing use in the two outlier populations has also been low, ranging from 2.5 to 8 percent. The BLM had predicted livestock grazing at these sites would be light because cattle would be less likely to travel in the area due to the rugged terrain and distance from water. Evidence of herbivory at all sites has been attributed to wildlife, and is well below the trigger of 20 percent for determining if reinitiation of formal consultation is necessary (Hall 1993). The ACEC fence is inspected annually and repaired as needed. The VVBA is within the Windmill Allotment. Section 7 consultations with the CNF were conducted in 1992 and 1997 for the Windmill Allotment Management Plan. Grazing has been excluded from the Rocking Chair and Cornville pastures since 1992, while seasonal grazing has continued in the Gyberg pasture under a deferred rest rotation system (USFWS 1995). Range inspection memoranda, from 2001 to 2006, state that there was light to no use of P. subintegra within the North Gyberg Pasture. The Horseshoe Lake P. subintegra population on the TNF is contained within three grazing allotments. Current management in the Sears Club/Chalk and the St. Clair allotments is non-use due to the allotments being vacant (Willard, pers. comm., 2012). The Sears Club/Chalk Allotment, which contains most of the population, is scheduled for evaluation, under the National Environmental Policy Act, in 2013. The three pastures in the Cartwright Allotment (Lime Creek, Professor, and Long Canyon) have been removed from grazing (USFS 2008). Currently, the threat from grazing appears to be at a low level at three of the populations; the level of grazing effects at the Bylas population is not quantified to our knowledge.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • We recommend the development or completion of management plans for the Cottonwood population (including the Verde Valley Botanical Area), the Horseshoe Lake population, and the Bylas population. The respective land managing agency (Coconino and Tonto National Forests, and the San Carlos Apache Tribe) would develop these plans with the offered assistance of the Service. These management plans should address newly understood or emerging threats such as climate change and invasive weeds. This action would address Recovery Action 1. • We recommend the land management agencies (i.e., BLM, Coconino and Tonto National Forests, and the San Carlos Apache Tribe) implement long-term demographic monitoring within all four populations. This will allow the Service to determine whether a given population is viable or on a trend toward viability. The Service can assist in coordinating this effort. This action would address Recovery Action 2c. • We recommend continued research on pollination, seed germination and seedling establishment, propagation, comparison of recruitment rates among populations, life history characteristics, and growth rates to better understand the threats of and potential measures to address climate change. This action would address Recovery Action 2. • We recommend land managers consider caging seedlings during years of high seed production (i.e., years of moderate or high precipitation) to increase recruitment of seedlings into the juvenile stage (Maschinski et al. 2004; Haskins et al. 2018). This action would address Recovery Action 3. • We

recommend collecting seed representing each of the four recovery units, with regular supplemental collections, and maintaining the collection in at least one Center for Plant Conservation partner botanical or seed storage institution. We did not include biobanking as a recovery action in the Recovery Plan. However, after we completed the Recovery Plan in 1995, researchers improved techniques and knowledge that increase the potential contribution of biobanking to cliffrose conservation. We therefore include this recommendation to preserve some of the species' genetic diversity for potential future population augmentations or reintroductions (USFWS, 2022).

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SPECIES ACCOUNT: *Quercus hinckleyi* (Hinckley oak)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/26/1988; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

Quercus hinckleyi is an evergreen shrub, most often forming patchy thickets that grow to a maximum height of 0.75 m. The plant usually has multiple stems, with relatively thin light brown twigs that may become waxy on second year growth. The buds are less than 1 mm long, and reddish brown with short hairs on the margins. The leaves have rose—colored petioles 1-2 mm long, and hairy stipules at the base, 2 mm long, that fall off later in the season. The leaf blades are very characteristic. They are thickened, gray-green, almost rounded, 5-15 mm long and broad, with a spiny tip and 2-3 spiny teeth on each margin. The flowers are unisexual, with the male flowers in 3-5 mm long catkins of only a few flowers each. The female flowers are tiny, inconspicuous, and densely hairy. Acorns are formed annually. They are oval, 8-12 mm broad, and usually only included in the cup at the base. The cup is shallow, up to 3 mm deep, and saucer-shaped. (USFWS, 1992)

Taxonomy

The first known collection was made in 1950 from the Solitario (Presidio County, Texas), and is attributed to Dr. L. C. Hinckley. Dr. C. H. Muller collected specimens from the same location a month later, and eventually described it as a new species, named in honor of Dr. Hinckley (Muller 1951). He placed the species within his series Glaucoideae. The most notable features of this species are its leaves, which are small, smooth, broadly oval, noticeably thickened, and markedly spiny on the margins (superficially holly-like). This, combined with its small stature, thicket-forming habit with intricate, multiple—branched stems, and gray—green color make it easily recognizable and distinctive within its group (series Glaucoideae). (USFWS, 1992)

Current Range

Known from the Chihuahuan Desert of West Texas. All of the populations known are in Presidio County. Other reports exist of additional populations in the area of Shafter, Texas, but these localities have not been recently verified. (USFWS, 1992)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) (USFWS, 1992)

Reproduction Narrative

Adult: All reproduction appears to be vegetative. (USFWS, 1992)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Arid climate with large fluctuations in temperature and low rainfall (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1066.8 and 1372 m (3,500 to 4,500 ft) (USFWS, 1992)

Spatial Arrangements of the Population

Adult: Patchy (USFWS, 1992)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 1992)

Tolerance Ranges/Thresholds

Adult: Moderate to high (inferred from USFWS, 1992)

Habitat Narrative

Adult: Quercus hinckleyi prefers arid, rocky, limestone-derived soils or limestone outcrops at mid-elevations in Chihuahuan Desert shrublands. The development of more arid climates is postulated to have resulted in restriction of the species to a few sites within its old range of distribution, resulting in a patchy distribution of a few populations with relatively few individuals. Quercus hinckleyi occurs in an arid subtropical climate. Climatologists place it in the Trans—Pecos climatic area of Texas, which is extremely variable because of topographic differences. The area generally has great daily temperature fluctuations and an arid profile where evaporation exceeds precipitation. The average temperature is 30.4 C (86.8 F), with 178 days of 32.2 C (90 F) and above temperatures, and 44 days of temperatures below 0 C (32 F). The frost free season is 238 days. The average precipitations is 23.4 cm (9.2 inches). Quercus hinckleyi grows on dry limestone slopes between 1066.8 m and 1372 m (3,500 — 4,500 feet) elevation. Slopes where the species occurs are mostly north and west-facing. The plants are found growing in cracks of solid rocks or extremely rocky soils (Poole 1988a). (USFWS, 1992; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

9 (USFWS, 2020)

Population Size:

204 (USFWS, 2020)

Population Narrative:

We now know that there are 9 confirmed extant EOs in Presidio and extreme western Brewster counties (not 12, as stated in the previous 5-year review). Most new information about the species derives from recent genetic analyses (Backs 2014) of most of the extant populations. Only 123 genetically unique individuals were identified among 204 plants, and the two sites near Shafter had only 7 individuals among 58 plants. Despite the low numbers of individuals, the species has levels of genetic diversity and heterozygosity that are comparable to non-threatened oak species. This is likely due to the very long life spans of the species' clones — perhaps thousands of years. Genetic introgression has occurred between Hinckley oak and its two most closely-related species, sandpaper oak and Vasey shin oak, but this has not risen to the level of genetic swamping; 95 percent of individuals identified as Hinckley oak have little or no introgression from other oaks. Furthermore, existing Hinckley oak hybrids are reservoirs of the species' overall genetic diversity. Based on the elevation ranges and occupied geological formations of known populations, we estimate that 63,631 ha (157,231 ac) of potential habitat exists in Presidio and Brewster counties. It is likely that substantial amounts of potential habitat also exist in adjacent areas of Chihuahua and Coahuila, Mexico. We estimate an MVP size of 1,100 individuals, and recommend that in the specific case of Hinckley oak, this criterion should be applied to the numbers of observed plants rather than the numbers of genetically unique individuals. (USFWS, 2020)

Threats and Stressors

Stressor: Climate change (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Climatic changes of the last 8,000-11,000 years, have resulted in the reduction of suitable habitat and fragmentation of populations. These are the primary reason the plant is rare today (Miller and Powell 1982). (USFWS, 1992)

Stressor: Small population size (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: The species is vulnerable today because few populations are known, and each has a small number of individuals. The population centers are relatively widespread, limiting any potential gene flow. These conditions make the species vulnerable to catastrophic destruction and loss of genetic viability. (USFWS, 1992)

Stressor: Genetic variability (USFWS, 1992)
Exposure:
Response:
Consequence:

Narrative: All observers report a very low level of regeneration in the stands of Quercus hinckleyi, with no juveniles reported, though in some years there have been heavy acorn yields (Bacon 1989, 1990). All reproduction appears to be vegetative. Populations may already have become so isolated, and the numbers of individuals fallen so low, that low genetic diversity has developed in the populations, reducing both fertility and the genetic ability to adapt evolutionarily to the changing environment (Hilsenbeck 1989). (USFWS, 1992)

Stressor: Herbivory (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Native deer are known to browse the plants and eat the acorns (Miller and Powell 1982). Small mammals and birds are also known to eat the acorns, and some epidermal damage caused by disease or insect predation (webs have been found on the branches) has been noted at the type locality (Miller and Powell 1982, U.S. Fish and Wildlife Service 1987, Poole 1988a). (USFWS, 1992)

Stressor: Roads (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: One of the populations is very near a highway and roadway maintenance activities, or any further highway expansion or realignment, could constitute a threat to the species (Poole 1988a). (USFWS, 1992)

Stressor: Grazing (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: In the past, all of the populations were on private land. At least nine of these populations were subject to browsing and acorn consumption by livestock and wildlife, and the possible introduction of exotic game species. Overstocking of cattle or sheep and the introduction of goats or other browsing animals represented a potential threat to the small populations of plants (U.S. Fish and Wildlife Service, 1988). With the 1988 acquisition by the Texas Parks and Wildlife Department, 9 of the 10 known populations are now in the Big Bend Ranch State Natural Area where the species is protected by State Law. Although a specific management plan for Hinckley oak that addresses policies governing cattle grazing or the introduction of exotic species is not yet in place, the Texas Parks and Wildlife Department is currently developing a plan for the Natural Area that should include considerations for this species. (USFWS, 1992)

Stressor: Collectors (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: The rarity of the plant and its distinctive leaves have attracted the attention of collectors and horticulturists. Some taking of acorns in violation of State permit requirements and trespass laws has been reported (U.S. Fish and Wildlife Service 1988). In addition, acorns are

reportedly collected legally every year at the Shafter population, reducing the possible recruitment to the natural population (Poole 1988a). (USFWS, 1992)

Stressor: Hybridization (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Oak species are known to hybridize freely, and hybridization with Quercus pungens var. vasevana (Vasey oak) has been reported at one population of Quercus hinckleyi (U.S. Fish and Wildlife Service 1988). Genetic swamping by nearby native or introduced oak species is a potential problem, both for populations in the wild and any plants maintained under cultivation (Poole 1988a). (USFWS, 1992)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. Attain at least 20 viable self-sustaining populations in at least 4 geographically distinct population centers and attain a total of at least 10,000 individual plants. (USFWS, 1992)

2. Demonstrate population viability at recovery levels for 10 consecutive years. (USFWS, 1992)

Recovery Actions:
- Protect populations from present and future threats. (USFWS, 1992)
- Establish a reserve seed bank and cultivated population. (USFWS, 1992)
- Gather biological data necessary for management decisions. (USFWS, 1992)
- Search for new populations. (USFWS, 1992)
- Develop plans for reintroducing plants into suitable habitat. (USFWS, 1992)
- Determine exact habitat requirements. (USFWS, 2009)
- Develop a model, based on soil types and other appropriate habitat attributes for Hinckley oak, to predict areas of potentially suitable habitat and then survey those areas for the species. (USFWS, 2009)
- Establish a reserve germ bank/cultivated population with a responsible agency/institution. (USFWS, 2009)
- Evaluate present conditions and determine stability requirements for populations. (USFWS, 2009)
- Assess incidence of (and potential threat from) hybridization with nearby oak (Quercus) species and develop management strategies to address any threats associated with hybridization. (USFWS, 2009)
- Assess potential threats to the species associated with climate change and develop management strategies to address these threats. (USFWS, 2009)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Survey potential habitats on accessible lands in Presidio, Brewster, and adjacent counties (recovery plan action 41), as well as in Areas Naturales

Protegidas and Parques Nacionales in the Mexican states of Coahuila and Chihuahua. 2. Monitor condition of existing populations periodically, and conduct complete censuses approximately every 5 years (recovery plan action 15). Protect known hybrid individuals to conserve additional Quercus hinckleyi genetic diversity (Backs et al. 2016). Map individual clones to aid conservation of unique genotypes (Backs et al. 2015). 3. Support efforts to propagate, by seeds as well as cuttings or micropropagation, for augmentation, reintroduction, and ex-situ conservation (recovery plan actions 3211, 3212, and 334). Attempt hand pollination to maximize outcrossing and conserve unique genotypes (Backs et al. 2015). 4. Establish a germ plasm bank (refugium of live plants) for ex-situ conservation of as many of the species' unique genotypes as possible. Note that white oak acorns lose viability rapidly in storage; hence, seed banking is not a viable option. (Recovery plan action 2; Beckman et al. 2019). 5. Develop an augmentation and reintroduction program to increase size and genetic diversity of individual populations and to increase the number of populations (recovery plan action 42, 5, 6; Backs et al. 2015). 6. Conduct public outreach to promote public support for the species conservation (recovery plan action 7). 7. When possible, given workloads, conduct a Species Status Assessment (SSA), and use the SSA to revise the recovery plan. Establish recovery criteria that quantify the levels of resilience, redundancy, and ecological and genetic representation necessary for long-term species viability. Explain how each criterion and time frame was derived, how populations and metapopulations should be delimited, specify whether individuals may be ramets, genets, or both, and clarify whether sexual reproduction means simply the production of viable acorns or actual recruitment from acorns. Revise the reproduction and recruitment time frame to reflect realistic patterns observed in woody plants of the Chihuahuan Desert. Clarify that the species' recovery can include populations in Mexico, if any are discovered. (USFWS, 2020)

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SPECIES ACCOUNT: *Ranunculus aestivalis (=acriformis)* (Autumn Buttercup)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/21/1989; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A perennial herb, 3-6 dm tall that bears 6-10 bright yellow flowers, usually high above most of the deeply divided leaves. The late summer-early fall flowering season gives the plant its common name. A recent study by Van Buren et al. (1994) concluded that this is a distinct species, rather than a variety of R. acriformis. The taxon is probably a relict of the moister Pleistocene Era and is now severely limited to the little suitable habitat remaining in what is now a semi-arid region. (NatureServe, 2015)

Taxonomy

The phylogenetic relationship of the autumn buttercup with closely related taxa has been studied since the completion of the Recovery Plan, but its taxonomic treatment continues to be disputed. The autumn buttercup was recommended to be a separate species based upon a genetic analysis of molecular markers that showed a clear separation of the autumn buttercup from other varieties of Ranunculus acriformis (Van Buren 1994; Van Buren et al. 1994). Environmental characteristics of the occupied habitat also clearly separated autumn buttercup habitat from habitat occupied by closely related taxa (Van Buren and Harper 1996); however, morphological characteristics were not so clear (Van Buren 1994). Due to genetic separation, Van Buren et al. (1994) recommended reclassifying the variety R. acriformis var. aestivalis to a full species R. aestivalis. A taxonomic review was later published in 1997 in the Flora of North America, and the author retained the varietal rank of R. acriformis var. aestivalis (Whittemore and Parfitt 1997). It must be noted that the author states it was his preference to retain the varietal rank and that the molecular results of Van Buren et al. “are consistent with either interpretation.” The 4th edition of A Utah Flora, published in 2008, disagrees with both treatments, and considers it a variety of R. acris based upon morphological characteristics (Welsh et al. 2008). The latest taxonomic review was published in 2012 for the Intermountain Flora, and the authors accepted the species rank, R. aestivalis, recommended by Van Buren et al. (Holmgren et al. 2012). Two online plant databases accept the species rank, R. aestivalis, the USDA PLANTS Database (USDA PLANTS Database 2012) and The Biota of North America Program (Kartesz 2011). Given the recent taxonomic evaluation which accepts the autumn buttercup as a valid species rank, we recommend updating the synonymy (same identity) of R. acriformis var. aestivalis = R. aestivalis and find this taxonomic change does not affect the listing or protection of the autumn buttercup under the Act. The recovery priority number will change from 6 to 5 when the full species rank is accepted. We recommend the taxonomy be amended through a technical revision to the list at 50 CFR 17.12 (see section 4). We also will formally request the name be changed in ITIS database. Until the name can be changed in the Federal Register, we will continue to refer to this species as R. acriformis var. aestivalis (USFWS, 2013).

Current Range

"The autumn buttercup is probably the rarest and most restricted plant in Utah. Marcus E. Jones first collected it during 1894 in a wet meadow near Panguitch, 38 km northwest of Bryce Canyon

National Park. Named for its late-summer flowering habit, the autumn buttercup was not formally described until 1948. It is among the most graceful and showy members of the genus in the western United States." (Spence, Van Pelt and Franklin 1991: 1). The General Federation of Womens Clubs Sevier River Valley Preserve was purchased in 1989 to protect the only known buttercup plants in the wild, chiefly through exclusion of livestock grazing. The Great Basin Field Office is responsible for stewardship of the 44-acre property. GENERAL ELEMENT OCCURRENCE LOCATION INFORMATION. R. acriformis var. aestivalis's only known occurrence is in Garfield County, Utah. Due to the sensitivity of the site, directions may be obtained by contacting the Utah land steward of the Conservancy in Salt Lake City.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Wind and insect pollinated (NatureServe, 2015)

Lifespan

Adult: Life expectancy of R. acris is about 3.8 years (NatureServe, 2015).

Breeding Season

Adult: Vegetative plants and reproductive plants with buds, flowers, fruits, or dehisced achenes have all been observed between late August and early September. During this same time period, well-developed seedlings, with up to several leaves, have also been surveyed (Mutz 1984) and counted (Spence 1991) (NatureServe, 2015).

Reproduction Narrative

Adult: Phenotypic Patterns: R. acriformis var. aestivalis appears to reproduce sexually. To date, the only field observations have been in late summer or early fall. Vegetative plants and reproductive plants with buds, flowers, fruits, or dehisced achenes have all been observed between late August and early September. During this same time period, well-developed seedlings, with up to several leaves, have also been surveyed (Mutz 1984) and counted (Spence 1991). The riparian environment may be instrumental in extending the bloom for this population; however, it is still curious that autumn buttercup blooms as late as it does (late July to early October). Its closest relatives flower in June and July. Floral initiation does not apparently occur in the first year of life. The age at which it does occur is unknown (Mutz 1984). According to Sarukhan and Harper (1973) the life expectancy of R. acris is about 3.8 years. The autumn buttercup is similar to this species in many respects. The Ranunculus genus includes species which reproduce through self-fertilization, out-crossing, and apomixis. To date, autumn buttercup has not exhibited any observed asexual reproductive strategies (Mutz 1984). Pollination: Pollination mechanisms for autumn buttercup probably include wind and insects. The only documented pollinators are unidentified bees, and various flies and moths (Schelz, personal communication). Ants inhabit several mounds in the area, but none have been observed on the flowers (Mutz 1984). Harper (1957) reports that the flowers of Ranunculus are visited by a great number of insect species including the honey bee. Seed Dispersa: Mutz (1984)

speculates that autumn buttercup's seeds dehisce independently, since both partially bare and completely bare receptacles have been observed (NatureServe, 2015). Seed Biology: Germination Strategies. Nothing of significance is known about autumn buttercup's seed longevity, dormancy, viability, germination, or seedling establishment and maintenance requirements. However, Sarukhan's (1974) study of Ranunculus acris, a closely related plant with very similar environmental requirements, indicate that the seeds may be depleted by the next seed producing season. In his study, after predation and germination had occurred R. acris showed a reduction of c. 90% in the living seed population. Leck (1989) indicates that wetland seed banks typically contain seed with one of four germination strategies. Types 1 and 2 are represented by large seed output with total volumes greater than 10 cubic mm. Type 3 is represented by seed with total volumes greater than 1 cubic mm and less than 10 cubic mm. The majority of Type 3 seed, in a wetland seed bank, is a transient component with a relatively smaller persistent component. The fourth germination strategy is represented by seed with a seed volume less than 0.1 cubic mm. These seeds provide a relatively large persistent seed bank with little annual recruitment. Type 4 seeds are more abundant in subsurface than surface samples (Leck 1989). R. acriformis var. aestivalis seed can therefore be classified as either Type 2 or Type 3. England (1990) feels its seed volume is greater than 10 cubic mm and would therefore be Type 2. Type 2 seeds typically function as transient winter or summer seed bank components (Leck 1989). If, however, autumn buttercup's seed strategy is similar to that of Type 3, Leck's (1989) observations from studies of both Type 3 and Type 4 strategies could be useful. Seed distribution and establishment: Wetland seed bank studies revealed that seeds in bogs, swamps, and prairie marshes were deeply buried, with only 20 to 50 percent occurring in the top 5 cm (Leck 1989). Leck (1989) further states that seed distribution patterns are primarily related to variations in seed rain; that variable soil compression, seed survival, and seed bank strategies may also be related to distribution patterns; and that graminoids typically comprise more than 50 percent of seed in wetland seed banks. Seed ecology: Seedlings have been observed in small vegetative openings in friable soil on the mounds. The increased available light and solar radiation might be conducive for seed germination and seedling establishment in these clearings. However, unobserved seedlings may also be present but difficult to locate in more densely vegetated localities (NatureServe, 2015).

Habitat Type

Adult: Seeps/bogs (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Seeps/bogs

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species is found in the Sevier River Valley, where fresh water seeps and springs surface, creating marshy or bog-like conditions. Within this wet environment, are slightly drier, peaty hummocks upon which most of the plants grow. In addition, plants have been found on a somewhat drier site not associated with hummocks. The surrounding region is semi-arid and sagebrush-dominated. The elevation is 1938-1965 m. BIOLOGICAL HABITAT: The autumn buttercup has only been found along the west slope of the Sevier River Valley where fresh water seeps and springs surface and create marsh\bog conditions. Within this marshy environment are mesic islands of peaty hummocks upon which most of the autumn buttercups grow. However, in 1990 about 30 plants were found together on a drier site that does not contain the mounds. Spence (1991) provides a detailed, current description of the habitat at the more recently discovered site. The biological habitat is a low growing herbaceous community. It is characterized by the dominant species, Juncus articus var. balticus (Spence 1991). Forb-dominated mounds occur throughout the marsh, and the inter-mound areas are primarily graminoid. R. acriformis var. aestivalis's frequently associated species are Achillea millefolium (infrequently found elsewhere in the studied area), Juncus articus var. Balticus, Carex nebrascensis, Aster occidentalis, Plantago eriopoda, Glaux maritima, Trifolium spp., Carex aquatilis, Hordeum Jubatum (Mutz 1984), Dodecatheon spp., and Eleocharis spp. (USFWS 1992). In addition, moss is frequently found between plants. Other forb-dominated mounds occur throughout the meadow which appear comparable to autumn buttercup's habitat, except that some of the inter-mound areas are persistently pooled with water. R. cymbalaria, an aquatic species, replaces R. acriformis var. aestivalis on these more saturated mounds (Mutz 1984). PHYSICAL HABITAT Climate: The dry semi-arid climate has an average annual temperature of 64.4 degrees F. This middle latitude, cold desert has a growing season of about 100 days. The mean January temperature for Panguitch is 23.5 degrees F and the mean July temperature is 64.6 degrees F. Recorded August temperatures range from 44.7 to 83.0 degrees F, September temperatures range from 38.8 to 76.9 degrees F, and October temperatures are between 27.8 and 60.1 degrees F (Mutz 1984). The regional climatological data also indicates 9.9 inches annual precipitation for Panguitch (6625 feet elevation) most of which (70%) is received between April and September (Mutz 1984). Air and Water Quality. Field tests indicate good quality water present at the site (Mutz 1984). The pH was tested at 7.6. There was less than 0.2 gm/l iron, and the moderate hardness of 395 mg/l is probably due to calcium. Mutz (1984) speculates that additional mounds which are similar to autumn buttercup in wetness may differ in water quality. The water originates from seeps and springs both on and off of the western edge of the property near the highway. The direction of water flow from the various sources is northeast through the wet areas of the preserve (Baird 1988). Since there is little traffic and no major industrial polluters in the area, the air quality is also presumed good (Mutz 1984). Topography and Physiography: The autumn buttercup habitat occurs in a transition zone between a well-developed, Carex-dominated bog community and a dry upland sagebrush area (USFWS 1992). The Sevier River Valley bottom is Quaternary alluvium which supports sagebrush communities as close as 24 yards from the river (Mutz 1984). Multiple springs occur along the river valley, and it is speculated that mesic areas near these springs could provide suitable habitat for the autumn buttercup (Baird 1988). Observations of the habitat indicate as much as 100% vegetation coverage (little rock or wood cover), a friable soil surface (perhaps a key factor in seed germination), and underlying sandy or gravelly layers which may be indicative of active stream beds of the past (Mutz 1984). Slope: The two known populations are located on a very gentle east-facing slope above the bottom of the Sevier River Valley. The plants and the

hummocks have various subtle exposures, but the general relief of autumn buttercup's habitat is relatively flat. Because the topography is rather level, the extant population has full exposure to the sun and wind throughout the growing season. Substrate: The peaty hummocks are about seven inches high, less than two feet in diameter, and probably are a result of long-term habitat alteration by livestock grazing. The soil is compacted between them. Near the base of these little hummocks is a band of lighter brown, loamy soil, approximately two inches thick (Mutz 1984). The knoll upon which the hummocks occur at one population may be a result of a raised peat bog uplifted by the up-welling waters of the surrounding spring (England 1989a). Schelz (personal communication) questions whether the uplifting action of the extensive vole and/or ant activity in the area may be the source of the mounds. The soil's composition is a very dark, clay loam which is high in organic matter (Spence 1991). The roots of the plants can reach up to and beyond 17 inches. The soil ranges from dry to saturated, and the low area surrounding the plants is not generally pooled with water, unlike the mounds which support R. cymbalaria. The absence of the autumn buttercups on these comparable forb-dominated mounds in more boggy areas may infer that a mesic soil is preferable to a constantly wet one (Mutz 1984). To date, there has been no known technical soil analysis, nor government soil surveys, conducted on the extant population's substrate. Spence (1991) lacked time and funds for a survey, and wished to minimize disturbance (NatureServe, 2015). High ecological of the community and site fidelity as well as low tolerance ranges are based on the specific habitat needs of the species and the need for a relatively pristine habitat (no grazing/trampling).

Dispersal/Migration

Dispersal

Adult: Wind/water/livestock (NatureServe, 205)

Dispersal/Migration Narrative

Adult: Dispersal mechanisms are presumed to be wind, which can effectively whip the long pedicels; water, which can only transport the seed short distances due to its slow movement in the bog; and possibly livestock, through consumption and defecation of viable seeds (Mutz 1984). With Ranunculus acris, many seeds are eaten by birds but it is doubtful if much of this is still viable when voided (Harper, 1957) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

Two known occurrences. Additional but as-yet unsurveyed potential habitat exists. (NatureServe, 2015). POPULATION TRENDS Summary: Ranunculus acriformis var. aestivalis developed over the eons with two vital conditions that it seemingly requires for survival. The first is the historic availability of fresh water seeps and springs and the resulting marsh/bog habitat that was always there along the Sevier river (this water is what drives the whole system for the autumn buttercup). The second is the lack of intensive grazing by large animals such as

cows and horses. When white people moved into the area these two vital conditions disappeared. Settlers immediately diverted the water from the seeps and springs to ponds and irrigation ditches, effectively changing the habitat drastically. And, they unleashed untold numbers of large domestic grazing animals into the area. Thus the autumn buttercup was getting hit from both ends; no suitable habitat for its roots to sink into and draw nourishment, and constant flower and stem decapitation by the grazers (NatureServe, 2015). Low representation, resiliency and redundancy are based on the low number of known populations and individuals.

Threats and Stressors

Stressor: Livestock grazing (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals/habitat degradation
Narrative: We assign a high overall threat level for livestock grazing practices at the present time, not because grazing and trampling are inherently detrimental to autumn buttercup, but because an appropriate grazing regime is not currently implemented on the Preserve and we do not have sufficient population trend data to assess the suitability of the grazing regime at the Dale Ranch population. We will re-evaluate this threat level when we have more information regarding appropriate grazing practices (USFWS, 2013).

Stressor: Water Diversion for Agricultural Development (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: We do not have data on the hydrology of the wet meadow on the Preserve and no documentation to suggest the spring is affected by nearby agricultural water use. If water development commences in the future that may affect the autumn buttercup populations, or we have hydrologic data which suggests agricultural water use is affecting autumn buttercup habitat, we will re-evaluate the degree of threat this poses to the species (USFWS, 2013).

Stressor: Development of Buildings and Structures in Habitat (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In the Recovery Plan, we identified construction of corrals and outbuildings associated with agricultural land use to be a threat to the autumn buttercup. We believed that structures would lead to an increased use of the immediate area around them and would likely degrade the wet meadow habitat. However, there have been no corrals or outbuildings built within the known habitat for the two extant populations. There is no concern of these structures being built on the Preserve, and there are no new structures on the Dale Ranch property. Given the high water table and periodic flooding that occurs in the wet meadows, it is unlikely that large structures will be built on the habitat. Therefore, we no longer believe this to be a threat because this threat is presently not occurring, nor has it occurred in the past 21 years. However, if future development does occur, we will re-evaluate the degree of threat this poses to the species (USFWS, 2013).

Stressor: Invasive Species (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive species were not considered a threat to autumn buttercup in the Recovery Plan. However, in the years following livestock removal from the Preserve, a noxious weed, Scotch thistle (Onopordum acanthium) increased ten-fold and completely occupied some areas where autumn buttercup originally occurred (Spence 1996). The Nature Conservancy developed a weed management plan and began controlling the Scotch thistle in 1995 and the spread of Scotch thistle continues to be controlled as per their weed management plan (TNC 1995). Scotch thistle was not documented to be a threat to autumn buttercup on the Dale Ranch (USFWS 2011; USFWS 2012). We conclude that invasive species are a low threat since weeds are being controlled on the Preserve, and are negligible on Dale Ranch. The intensity of this threat is presently low as well and the exposure of this threat is low (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Herbivory occurs at high intensity levels at one of the two extant populations. Small rodents may have devastating consequences for individual plants and populations. Therefore, we conclude the threat posed by small mammal herbivory is high, and is greater than previously assessed (USFWS, 2013).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, prior to listing, autumn buttercup had no significant State or Federal protections. Under the Act's protection, a review of Federal actions potentially impacting the species can be performed. Because the species occurs on private land, two of the three high threats to the species cannot be addressed by regulatory mechanisms (small mammal herbivory and inappropriate grazing practices). As documented in section 2.3.2.5, climate change is a high threat to the species that can be addressed by regulatory mechanisms, but the Clean Air Act of 1970 presently does not regulate greenhouse gas emission levels. We assign an overall threat level to this factor as high because climate change is a high threat to the species and is not adequately addressed by the existing Federal regulatory mechanisms (USFWS, 2013).

Stressor: Vulnerability due to Small Population Sizes (USFWs, 2013)
Exposure:
Response:
Consequence: Extinction
Narrative: The threat posed by small population size and small range of autumn buttercup is high when evaluated cumulatively with small mammal herbivory, invasive weed species, and climate change. We have attempted to alleviate this threat through three separate reintroduction efforts (see section 2.2.3.(6) after acknowledging that the greatest impediment to recovery was small population size (USFWS 2007)). However, these reintroduction efforts have not been successful (USFWS, 2013).

Stressor: Lack of Scientific Knowledge/Monitoring (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: The lack of scientific knowledge to identify the meaningful threats contributing to the population decline of autumn buttercup has caused the species to be managed ineffectively. While not a threat in and of itself, lack of scientific knowledge and monitoring information affects our ability to manage and recover the species. We acknowledge the complexity of biotic interactions directly and indirectly affecting autumn buttercup. We could promote population growth on the Preserve if we could better quantify the threats the species faces and better understood how the threats could be alleviated. We consider this factor to have a high level of impact to the species because we believe that beneficial management is crucial to preventing the extinction of autumn buttercup by providing the essential ecological processes necessary to recover the species (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Our current understanding is that the habitat of autumn buttercup was sensitive to historic climate change in the region, and the restricted range of the species can be explained by the prolonged period of aridity during the Holocene post-glacial epoch (12,000 years before present). Autumn buttercup has not been able to maintain a large range or robust population under current climate conditions, and therefore does not appear to have the adaptive capacity (Glick et al. 2011; Dawson et al. 2011) to adjust to a future climate change scenario of prolonged arid conditions. Extinction risk from climate change is predicted to be higher for species such as autumn buttercup with small ranges, particularly for those species whose current distributions are constrained by climate variables (Schwartz et al. 2006). We conclude that autumn buttercup is vulnerable to climate change, and that the threat of climate change to autumn buttercup is high, mainly due to the range-wide scope, the imminent and future immediacy, and the high exposure of the threat. There are uncertainties in our threat evaluation since downscaled climate projections are not available for our specific location and aquifer, and a vulnerability assessment has not been performed for autumn buttercup. We will re-assess the degree of threat climate change poses on autumn buttercup when more information becomes available (USFWS, 2013).

Recovery

Reclassification Criteria:
Reclassification criteria have not been established.

Delisting Criteria:
The amended delisting criteria include the following: 1. Maintain the TNC population and at least three introduced populations at a level that demonstrates an increasing trend in the 5-year mean (average) adult plant abundance over a consecutive ten-year period. Adult plant abundance may fluctuate on an annual basis, but the defined populations should have an increasing 5-year mean over the ten year time period. Maintain the Junction population at a level that demonstrates a stable trend in the 5-year mean (average) adult plant abundance over

a consecutive ten-year period. Adult plant abundance may fluctuate on an annual basis, but the defined populations should have a stable 5-year mean over the ten-year time period. 2. Maintain an estimated range-wide total population size at or greater than 20,000 adult plants over a five year minimum period. This population estimate is based on the mean adult plant abundance measure identified in criterion 1, above. 3. The three introduced populations collectively demonstrate 80 percent of the genetic variation of the two natural populations over a minimum of five generations (a consecutive ten-year period). Genetic variation (measured as the number and frequency of unique alleles within a population) is anticipated to vary from year-to-year, but we expect this measure will provide a meaningful evaluation of population-level genetic diversity over time. 4. Long-term habitat protections and habitat management plans are in place for the five populations to protect autumn buttercup habitat and manage for habitat suitability, livestock grazing, small mammal herbivory, and other potential threats. Habitat protection on private and Federal lands can be achieved via fee acquisition, land trades, conservation easement, or long-term management agreements. Habitat management plans should include site-specific measures to address the maintenance of suitable habitat, herbivory, and weed control to improve plant establishment and minimize threats in occupied habitat. Consideration of the water source(s) and hydrologic regime should be included in habitat protections and management plans to the extent practicable. Management plans for spring-fed water sources likely need contingency plans for supplemental water during low-flow periods. The combination of habitat protection, maintenance of suitable habitat, and threat minimization will support increasing trends in adult plant abundance and population resiliency, as we state in criterion 1. 5. The two natural populations (TNC and Junction) are represented in an ex-situ seed collection that is managed according to the Center for Plant Conservation guidelines (Guerrant et al 2004). The ex-situ seed collection should contain existing levels of genetic diversity (or representation) of the two populations. (USFWS, 2020)

Recovery Actions:

- Taxonomy: We recommend revising the species' taxonomy in the Federal Register to reflect the best available scientific information (USFWS, 2013).
- Taxonomy: We recommend formally requesting the name be changed in the ITIS plant database (USFWS, 2013).
- Surveys: We recommend the Utah Heritage Program identify potential habitat and survey for autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend that qualified scientists monitor and evaluate threats to autumn buttercup in conjunction with population monitoring of both extant and reintroduced autumn buttercup plants on the Preserve (USFWS, 2013).
- Research & Monitoring: Since there is a complex web of processes that occur within grazed wet meadow habitat (small mammal herbivory, vegetative competition, livestock trampling, weed suppression, litter removal), we recommend qualified scientists assess the relative importance of each process with regard to autumn buttercup abundance and distribution on the Preserve (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists assess whether small mammal herbivory is reduced when livestock grazing is reintroduced and to monitor their population levels in tandem with the autumn buttercup on the Preserve. We recommend the scientists identify measures to reduce small mammal populations and that The Nature Conservancy implement these measures on the Preserve at least in the near-term to reduce the threat of herbivory and encourage the recovery of autumn buttercup (USFWS, 2013).

- Research & Monitoring: We recommend initiating discussions with landowners about land use practices (stocking rates and seasonality of grazing) the ranchers believe would benefit the autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists reinitiate a multi-year demography study of subpopulations both on the Preserve and other available populations to study survivorship, growth, and reproduction. This study should include a seedbank component to determine seed longevity in soil, and seedling recruitment patterns at different microsites (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists perform a minimum viable population analysis for the species based upon data collected from the demography study (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists document the identity and availability of pollinators, and determine the breeding system of autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists perform a climate change vulnerability assessment of autumn buttercup (USFWS, 2013).
- Research & Monitoring: We recommend qualified scientists implement long-term monitoring of the hydrology in the wet meadow habitat on the Preserve to document water table fluctuations on a regular basis (USFWS, 2013).
- Research & Monitoring: We recommend The Arboretum at Flagstaff, or another qualified and permitted botanic garden, assess the drought tolerance and plant response to drought by evaluating plant establishment, growth and reproduction of autumn buttercup under different water regimes in a greenhouse setting (USFWS, 2013).
- Ex-situ Conservation: We recommend The Arboretum at Flagstaff, or another qualified and permitted botanic garden, collect seed annually of wild (not reintroduced) autumn buttercup plants (USFWS, 2013).
- Administrative Actions: We recommend the USFWS host an annual workshop to prioritize, assess, and fulfill recovery actions (USFWS, 2013).
- Administrative Actions: Once we have new survey and research data, we recommend that the USFWS revise the Recovery Plan to explicitly address the relevant listing factors. The number of plants and populations referenced in the current recovery plan that are required for long-term viability of autumn buttercup are unsupported by our current understanding of the population status. The revised Recovery Plan will include objective, measurable criteria which, when met, will result in a determination that the species be removed from the Federal List of Endangered and Threatened Plants. The Recovery Plan also will estimate the time required and cost to carry out those measures needed to achieve the goal for recovery and delisting (USFWS, 2013).
- Administrative Actions: We recommend that the USFWS support autumn buttercup recovery by providing personnel and fiscal resources yearly to implement recovery actions (USFWS, 2013).
- Administrative Actions: We recommend that the USFWS and The Nature Conservancy write a management plan for the Preserve (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Recommended future actions: Based on recent discussions with conservation partners, we recommend implementing another plant reintroduction on TNC lands, securing habitat protection for private lands in the Junction population, managing for genetic diversity, and evaluating suitable

habitat followed by pilot introductions on BLM lands in the upper Sevier River drainage, the East Fork Sevier River drainage, and near Otter Creek (USFWS 2019). The suite of recommended future actions identified in the previous 5-year review still provides the full list of recommendations until more species-specific life history information is identified (USFWS 2013). (USFWS, 2020)

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SPECIES ACCOUNT: *Remya mauiensis* (Maui remya)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling, many-branched shrub 1 - 2 m tall, forming loosely tangled clumps that sprawl on or among the branches of other vegetation. The flower heads are dark yellow (NatureServe, 2015).

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2016). The genus is endemic to Maui & Kauai, this species is restricted to west Maui (NatureServe, 2015).

Historical Range

It is known from west Maui (Wagner et al. 1999m, p. 353). Historically, this species also occurred in Maui's lowland wet ecosystem (TNC 2007; HBMP 2010) (USFWS, 2016).

Current Range

Current range includes West Maui (NatureServe, 2015). It occurs in Kauaula, Puehuehunui, Ukumehame, Papalaua, Pohakea, and Manawainui (USFWS 2012; 2014).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Remya mauiensis (Maui remya) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 18 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Remya mauiensis includes 18 CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Gouania hillebrandii, Kadua coriacea, Remya mauiensis, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and Tetramolopium capillare, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by Ctenitis squamigera, Cyanea obtusa, Hesperomannia arbuscula, Hibiscus brackenridgei, Lysimachia lydgatei, Neraudia sericea, Schiedea salicaria, Sesbania tomentosa, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry

species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants Hibiscus brackenridgei and Schiedea salicaria, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Ctenitis squamigera, Cyanea obtusa, Gouania hillebrandii, Hesperomannia arbuscula, Kadua coriacea, Lysimachia lydgatei, Neraudia sericea, Remya mauiensis, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Spermolepis hawaiiensis, Tetramolopium capillare, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants Ctenitis squamigera, Remya mauiensis, Santalum haleakalae var. lanaiense, and Zanthoxylum hawaiiense, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by Asplenium dielerectum, Bidens campylotheca ssp. pentamera, or Colubrina oppositifolia, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) Palmeria dolei—Unit 1—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 1— Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Colubrina oppositifolia, Ctenitis squamigera, Remya mauiensis, Santalum haleakalae var. lanaiense, or Zanthoxylum hawaiiense, or by the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the

species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 2 (and) Palmeria dolei—Unit 3—Lowland Wet (and) Pseudonestor xanthophrys—Unit 3— Lowland Wet (and) Newcombia cumingi—Unit 1—Lowland Wet This area consists of 65 ac (26 ha) of State land at Moomoku, on the northwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant Santalum haleakalae var. lanaiense. Although Maui—Lowland Wet—Unit 2 is not currently occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, or Wikstroemia villosa, by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), or by the Newcomb's tree snail (Newcombia cumingi), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 3 (and) Palmeria dolei—Unit 4—Lowland Wet (and) Pseudonestor xanthophrys—Unit 4— Lowland Wet This area consists of 1,247 ac (505 ha) of State land at Honanana Gulch on the northeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants Bidens conjuncta, Cyanea asplenifolia, and Pteris lidgatei. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 3 is not known to be occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 4 (and) Palmeria dolei—Unit 5—Lowland Wet (and) Pseudonestor xanthophrys—Unit 5— Lowland Wet This area consists of 864 ac (350 ha) of State land at Kahakuloa Valley on the northeastern slopes of west Maui. These units include the mixed

herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). They are occupied by the plants Bidens conjuncta and Cyanea asplenifolia. These units also contain unoccupied habitat that is essential to the conservation of this these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 4 is not known to be occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 5 (and) Palmeria dolei—Unit 6—Lowland Wet (and) Pseudonestor xanthophrys—Unit 6— Lowland Wet This area consists of 30 ac (12 ha) of State land at Iao Valley on the eastern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 5 is not known to be occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 6 (and) Palmeria dolei—Unit 7—Lowland Wet (and) Pseudonestor xanthophrys—Unit 7— Lowland Wet This area consists of 136 ac (55 ha) of State land at Honokowai and Wahikuli valleys on the western slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 6 is not currently occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, Bidens micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia

arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 7 (and) Palmeria dolei—Unit 8—Lowland Wet (and) Pseudonestor xanthophrys—Unit 8— Lowland Wet This area consists of 898 ac (364 ha) of State land at Olowalu Valley, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units are occupied by the plant Alectryon macrococcus. These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Wet—Unit 7 is not currently occupied by the plants Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Wet—Unit 8 (and) Palmeria dolei—Unit 9—Lowland Wet (and) Pseudonestor xanthophrys—Unit 9— Lowland Wet This area consists of 230 ac (93 ha) of State land at upper Ukumehame Gulch, on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Maui—Lowland Wet—Unit 8 is not currently occupied by the plants Alectryon macrococcus, Asplenium dielerectum, Bidens conjuncta, B. micrantha ssp. kalealaha, Clermontia oblongifolia ssp. mauiensis, Ctenitis squamigera, Cyanea asplenifolia, C. glabra, C. kunthiana, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Hesperomannia arborescens, H. arbuscula, Huperzia mannii, Isodendrion pyrifolium, Kadua laxiflora, Peucedanum sandwicense, Phyllostegia bracteata, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Wikstroemia villosa, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) Palmeria dolei—Unit 19—Montane Mesic (and) Pseudonestor xanthophrys—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuehunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Lysimachia lydgatei, Remya mauiensis, and Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants Geranium hillebrandii, Huperzia mannii, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) Palmeria dolei—Unit 20—Montane Mesic (and) Pseudonestor xanthophrys—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant Geranium hillebrandii, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) Palmeria dolei—Unit 21—Montane Mesic (and) Pseudonestor xanthophrys—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their

small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) Palmeria dolei—Unit 22—Montane Mesic (and) Pseudonestor xanthophrys—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Remya mauiensis and Santalum haleakalae var. lanaiense, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 6 (and) Palmeria dolei—Unit 35—Wet Cliff (and) Pseudonestor xanthophrys—Unit 35— Wet Cliff This area consists of 1,858 ac (752 ha) of State land, and 253 ac (102 ha) of privately owned land, at the summit ridges of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). They are occupied by the plants Alectryon macrococcus, B. conjuncta, Ctenitis squamigera, Cyrtandra munroi, Remya mauiensis, and Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 6 is not known to be occupied by the plants Bidens campylotheca ssp. pentamera, Bonamia menziesii, Cyanea glabra, C. lobata, C. magnicalyx, Cyrtandra filipes, Dubautia plantaginea ssp. humilis, Gouania vitifolia, Hesperomannia arborescens, H. arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Lysimachia lydgatei, Plantago princeps, Platanthera holochila, Pteris lidgatei, or Tetramolopium capillare, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 7 (and) Palmeria dolei—Unit 36—Wet Cliff (and) Pseudonestor xanthophrys—Unit 36— Wet Cliff This area consists of 556 ac (225 ha) of State land along Honokowai ridge on the northwestern side of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). These units are occupied by the plants Cyrtandra filipes and C. munroi, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the

expansion of the existing wild populations. Although Maui—Wet Cliff—Unit 7 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. conjuncta, Bonamia menziesii, Ctenitis squamigera, Cyanea glabra, C. lobata, C. magnicalyx, Dubautia plantaginea ssp. humilis, Gouania vitifolia, Hesperomannia arborescens, H. arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Lysimachia lydgatei, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Tetramolopium capillare, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Wet Cliff—Unit 8 consists of 337 ac (137 ha) of State land along Kahakuloa ridge on the north side of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 5). Although Maui—Wet Cliff— Unit 8 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. conjuncta, Bonamia menziesii, Ctenitis squamigera, Cyanea glabra, C. lobata, C. magnicalyx, Cyrtandra filipes, C. munroi, Dubautia plantaginea ssp. humilis, Gouania vitifolia, Hesperomannia arborescens, H. arbuscula, Isodendrion pyrifolium, Kadua laxiflora, Lysimachia lydgatei, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, or Tetramolopium capillare, we have determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Remya mauiensis critical habitat consists of five components. Lowland dry (west Maui), Lowland mesic (west Maui), Lowland wet (west Maui), Montane mesic (west Maui) and Wet cliff (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy:

Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Lifespan

Adult: < 10 years (USFWS, 2010)

Reproduction Narrative

Adult: It is a short-lived perennial (fewer than 10 years) (USFWS, 2014).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Moist forests (NatureServe, 2015); mixed mesophytic forests (USFWS, 1997)

Geographic or Habitat Restraints or Barriers

Adult: 2,790 - 4,100 ft. elevation (USFWS, 1997)

Environmental Specificity

Adult: Moderate (inferred from USFWS 2016; 1997)

Habitat Narrative

Adult: Inhabits moist forests on gulch slopes (NatureServe, 2015). Remya mautensis grows chiefly on steep, north or northeast-facing slopes at 850-1,250 meters (2,790-4,100 feet) elevation and is found primarily in mixed mesophytic forests, or the remnants of such forests (Herbst 1988) (USFWS, 1997). It occurs in the lowland mesic, montane mesic, wet cliff, and lowland dry ecosystems (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Presumed extinct until rediscovery in 1971 (USFWS, 1997)

Species Trends:

Increasing (USFWS, 2014)

Number of Populations:

~10 (USFWS, 2022)

Population Size:

>190 (USFWS, 2022)

Population Narrative:

Overall, Remya mauiensis has increased from 156 individuals reported in the last 5-year review to approximately 500 individuals in 6 locations (USFWS 2012; 2014). The species was thought to be extinct until its rediscovery on the slopes of Manawainui Gulch, West Maui, in 1971 by L.E. Bishop, W. Gagnd, and S. Montgomery (USFWS, 1997). New Status Information: • There are

three populations at one location, Kaua‘ula, west Maui, totaling approximately 400 individuals (PEPP 2017; Oppenheimer 2018, in litt.) and one population at Pāpalaua-Manawainui Gulches (undetermined number of individuals) (PEPP 2017). There is no new information regarding the status of populations at Lihau, Pōhākea, and Ukumehame. • In 2016, 18 critical habitat units in five ecosystems (lowland dry, lowland mesic, lowland wet, montane mesic, and wet cliff) were designated on west Maui for Remya mauiensis (12,536 ac; 5,074 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018). At the time of the last 5-year review in 2017, there were an estimated 175–335 individuals at an estimated 10 populations. Only two previously known populations have been monitored since, Mākaha and Koai‘e (Kishida and Perlman 2018; Perlman and Kishida 2017). Currently, the number of individuals at Mākaha remains unchanged; while approximately 15 new individuals were discovered at Koai‘e (Kishida and Perlman 2018; Perlman and Kishida 2017). Currently, there are at least 190 wild individuals of Remya kauaiensis on Kaua‘i (USFWS, 2022)

Threats and Stressors

Stressor: Ungulates (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: It is clear that habitat well-suited for Remya mautensis and likely within its former range has been destroyed or degraded by cattle, goats, and pigs, and that the remaining extant individuals are found growing only in areas relatively inaccessible to these animals. Browsing and grazing by feral and domesticated livestock have impacted Remya mautensis and its habitat through outright destruction of the plants and secondarily through erosion that results from the loss of vegetation, trampling and rooting by these animals (Herbst 1988) (USFWS, 1997).

Stressor: Invasive plants (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Browsing and associated habitat disturbance caused by feral ungulates have favored the invasion and spread of numerous aggressive, alien plant species that may compete for space, light, water, or nutrients. Such alien species have replaced Remya mautensis throughout its presumed former habitat (Herbst 1988). Competition from alien plants may also be the reason for the low number of Remya mautensis in areas such as Manawainui Plant Sanctuary, where populations have been protected from ungulates (R. Hobdy, personal communication 1995) (USFWS, 1997).

Stressor: Invertebrate herbivory (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Not available

Stressor: Fire (USFWS, 2014)
Exposure:
Response:

Consequence:
Narrative: Remya mautensis occurs in a fire-prone area (dry much of the year), and is jeopardized with extinction by brush fires set accidentally or intentionally (Herbst 1988) (USFWS, 1997).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that Remya mauiensis is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.889 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions, including the possibility of assisted translocations, are needed to conserve this taxon into the future (USFWS, 2018)

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on Maui and at least one other island where they now occur or occurred historically (USFWS, 1997).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1997).

3. Each population should persist at this level for a minimum office consecutive years before downlisting is considered (USFWS, 1997).

Recovery Priority Number: 5

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on Maui and at least one other island where they now occur or occurred historically (USFWS, 1997).

2. Each population must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1997).

3. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1997).

Recovery Actions:
- Protect current populations, manage threats and monitor (USFWS, 1997).

- Conduct research essential to conservation of the species (USFWS, 1997).
- Expand current populations (USFWS, 1997).
- Establish new populations as needed to reach recovery objectives (USFWS, 1997).
- Validate and revise recovery objectives (USFWS, 1997).
- Evaluate the status of Remya mauiensis in the Manawainui Plant Sanctuary exclosure; if warranted, initiate alien plant control (USFWS, 1997).
- Using seeds from existing populations, establish and maintain outplanted populations within the Manawainui Plant Sanctuary exclosure (USFWS, 1997).
- Captive propagation for genetic storage and reintroduction: Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Reintroduction / translocation – Augment current natural populations to increase numbers of individuals (USFWS, 2014).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Control invasive introduced plant species within the vicinity of all known populations of R. mauiensis (USFWS, 2014).
- Population viability monitoring and analysis – Continue monitoring activities for all known populations of R. mauiensis (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).
- New Management Actions: • Surveys and inventories—In 2016, the Plant Extinction Prevention Program (PEPP) noted that additional surveys of known populations on west Maui were needed to determine if elevation to PEPP status (fewer than 50 wild individuals) of this species was necessary (PEPP 2016). • Captive propagation for genetic storage and reintroduction—In 2017, Lyon Arboretum Micropropagation Laboratory reported three containers of propagules of Remya mauiensis from collections made in 2012 in storage. The Lyon Seed Conservation Laboratory reports over 99,000 seeds in storage from collections representing multiple individuals from populations at Kaua'ula and Pōhākea (Lyon Arboretum 2017).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2014. Thus, the following recommendations for future actions are reiterated for 5-year review for 2018. • Surveys and inventories—Continue to survey for additional populations of Remya mauiensis in areas of potentially suitable habitat on west Maui. Reassess the status of populations at Lihau, Pōhākea, and Ukumehame. • Ungulate monitoring and control—Construct exclosure fences to protect currently unfenced populations from the negative impacts of feral pigs, goats, cattle, and axis deer. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations of R. mauiensis. • Captive propagation for genetic storage and reintroduction— o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage

due to this species' vulnerability to climate change. • Reintroduction and translocation—Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Climate change adaptation strategy—Research the suitability of habitat for reintroducing this species in the future due to impacts of climate change. • Alliance and partnership development—Work with the West Maui Mountains Watershed Partnership to continue ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated and updated for the 5-year review for 2022. • Surveys and inventories— o The historical range of Remya kauaiensis should be surveyed intensively, preferably in Kaua'ula, Honopū, Kalalau, and Mōhihi. o Determine if historical populations are extirpated. o Determine sites that have the highest likelihood of maintaining reintroductions. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Remya kauaiensis. • Site and habitat protection—Develop and implement effective control measures to reduce the impact drought and landslides. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change, including hurricanes. • Predator and herbivore monitoring and control—Determine and implement effective methods to control rodents. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy to reduce impacts of reduced viability due to low numbers. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within and between populations and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered through historic range to reduce impacts from landslides (USFWS, 2022).

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SPECIES ACCOUNT: *Rhodiola integrifolia ssp. leedyi* (Leedy's roseroot)

Species Taxonomic and Listing Information

Listing Status: Threatened; 04/22/1992; Great Lakes-Big Rivers Region (R3) (USFWS, 1992)

Physical Description

Leedy's Roseroot is a perennial herb with multiple leafy stems from a scaly root crown that is usually visible in the rock crevices where the plants are growing. Leaves are glaucous, oblong, blue-green, and thick-succulent, with irregularly toothed to entire margins. The dark red and yellow flowers (May-August) are arranged in rounded clusters at the ends of the stems. (NatureServe, 2015)

Taxonomy

Listed as a subspecies of Sedum integrifolium, a revised scientific name of Rhodiola integrifolia ssp. leedyi, as treated by Kartesz (1999) was accepted by the USFWS in 2010 (USFWS, 2010).

Historical Range

Apparently the Leedy's roseroot is not known to have occurred in historical times in other locations than present. (USFWS, 2015)

Current Range

Leedy's roseroot is found today in only six locations in two widely separated states. Four populations of several thousand plants each are found in Fillmore and Olmsted Counties, Minnesota. The other two are in upstate New York, a large population on the shores of Seneca Lake and a single plant at Watkins Glen. (USFWS, 2015). Also occurs at Harney Peak, Black Hills National Forest, South Dakota (Olfelt and Freyman 2014, p. 908). (USFWS, 2015b).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Usually sexual reproduction; some vegetative (USFWS, 1998)

Dependency on Other Individuals or Species

Adult: Bees and syrphus flies as pollinators (USFWS, 1998)

Breeding Season

Adult: Flowers in June (USFWS, 1998)

Other Reproductive Information

Adult: Olfelt (1998, p. 16) found a seed germination rate for Leedy's roseroot of 77% and described this as high for a rare plant, but lower than that of related subspecies. (USFWS, 2015b).

Reproduction Narrative

Adult: Flowering occurs in early June. Clausen (1975) reports bees and syrphus flies as pollinators; Sather (1993a) observed bees on New York plants. Seeds are winged and adapted for wind dispersal. Seeds produced by plants at Glenora Cliff, New York, sometimes germinate in their follicles and produce seedlings on the parent plant (Clausen 1975). Plants grown in a Minnesota greenhouse from seed flowered their first season after germination (Joel P. Olfelt, University of Minnesota, pers. comm. 1996). Although, newer growth on the long-lived rootstocks breaks off to form clones, which have lived at least 36 years in cultivation (Clausen 1975), Olfelt and Luby (in press) report finding little clonal reproduction. Of 81 stems they assayed, 75 had unique markers, indicating those 75 stems had not been produced by cloning. (USFWS, 1998)

Habitat Type

Adult: Cliff ledges and talus slopes (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Ground water or cool air (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1998)

Environmental Specificity

Adult: Very narrow specialist (USFWS, 1998)

Habitat Narrative

Adult: The habitat is limited to north or east-facing talus slopes or cliff ledges where ground water (primarily in New York) or cool air (primarily in Minnesota) constantly seep through the strata or between the rocks, maintaining a cool, wet environment throughout the summer. (NatureServe, 2015; USFWS, 1998)

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 1998)

Dispersal

Adult: Wind dispersal of seeds (USFWS, 1998)

Dispersal/Migration Narrative

Adult: Plants are specific to a particular habitat which limits dispersal. The preferred cold air cliff faces with seepages are rare. (USFWS, 1998)

Population Information and Trends

Population Trends:

Unknown. Inferred from information (USFWS, 2021)

Number of Populations:

6 (USFWS, 2015)

Population Size:

>4,000 individuals (USFWS, 2021)

Adaptability:

Low (inferred from NatureServe, 2015)

Population Narrative:

Populations may be increasing or decreasing (NatureServe, 2015). USFWS (2015) indicates that the four Minnesota populations have several thousand plants each, but NatureServe (2015) indicates only 1500-2000 plants in all Minnesota populations. The New York population at Seneca Falls consists of "a large population" (USFWS, 2015) or "several thousand plants" (NatureServe, 2015). There is one plant at Watkins Glen, NY; it is likely introduced. (USFWS, 2015; NatureServe, 2015). The South Dakota population of Leedy's roseroot occurs on Black Hills National Forest on a cliff at approximately 7,000 feet above sea level. White spruce (Picea glauca) is the dominant overstory species on the north-northeast facing slope directly below the cliff; and ponderosa pine (Pinus ponderosa) is the dominant tree species in the general vicinity (U.S. Forest Service, in litt.). About seven patches of Leedy's roseroot may inhabit only a total of 10-50 square meters of the cliff face (Fig. 4; U.S. Forest Service, in litt. 2001; 2011). (USFWS, 2015b). The most recent census data indicate that the population at the Glenora Cliffs site in New York has increased since the most recent census and remains above 4,000 plants. At the Glenora Falls site, the population of 45-50 plants did not change between 2017 and 2020. The single individual that makes up the Watkins Glen State Park population in New York was inadvertently destroyed during construction of a new trail. Partners at the State University of New York College of Environmental Science and Forestry have applied for Section 6 funding to collect seeds from plants at New York sites, propagate Leedy's roseroot in a greenhouse environment, and outplant individuals at Watkins Glen State Park (Wiley (NYFO) pers. comm. January 27, 2021). All Minnesota populations have increased since the most recent census in 2020, although overall trends since 1997 are mixed with the Whitewater WMA population declining and populations at Simpson Cliffs, Deer Creek, and Bear Creek being relatively stable (Olfelt 2020a; Appendix B). No changes were noted for the South Dakota population of Leedy's roseroot in 2016 and 2017 (USFWS, 2021).

Threats and Stressors

Stressor: Ground water contamination (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Contamination of ground water is likely though filling or dumping in sink holes adjacent to the cliffs. Sink holes are highly vulnerable because they provide direct access to the ground water and are the main source of seepage on the cliffs. (USFWS, 1992)

Stressor: Agricultural pesticides (USFWS, 1992)
Exposure:
Response:

Consequence:
Narrative: The use of agricultural pesticides in adjacent upland farmland (cropland in Minnesota and vineyards in New York) may directly affect the quality of the ground water. (USFWS, 1992)

Stressor: Residential development (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: In New York, homes are being built above the cliffs. Many homeowners have built stairs down the cliffs to Seneca Lake and some have cleared vegetation from the cliff or cut trees at the top of the cliff to enhance the view. Some trees have been simply dumped over the cliffs. (USFWS, 1992)

Stressor: Road building and quarrying (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Road building and quarrying in the karst region of Minnesota would affect the subsurface water flow in an area and change the required groundwater seepage at a cliff face. (USFWS, 1992)

Stressor: Erosion and rock slides (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: The slopes where the roseroot occurs are unstable. Natural erosion of the cliffs occurs and may denude the vegetation. Heavy runoff may directly dislodge plants from cliffs or may result in gullies being cut into a population site. Logging above some of the Minnesota sites may also cause erosion affecting the cliffs. (USFWS, 1992)

Stressor: Grazing (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Grazing may damage plants on the lower, gentler slopes of the cliffs where dislodged plants have again taken root.

Stressor: Climate change and catastrophic wildfire (USFWS, 2015b).
Exposure:
Response:
Consequence:
Narrative: Leedy's roseroot already inhabits the highest elevation habitat available in the ecoregion and would not be able to move to higher – and presumably cooler and moister – habitats if climate change rendered its current habitat unsuitable. In addition, as ponderosa pines succumb to mountain pine beetle, drop needles, and fall the risk of a wildfire in forest around the Leedy's roseroot population is likely to increase (C. Monks, pers. comm. 2014). (USFWS, 2015b).

Recovery

Delisting Criteria:
All three privately owned Minnesota populations must be protected by conservation easements or fee acquisition by a public agency or private conservation organization. (USFWS, 1998)

The Whitewater Wildlife Management Area, Minnesota, population must be protected from or removed from any confirmed contamination threat and has been demonstrated to be self-maintaining for five years. (USFWS, 1998 and USFWS 2021)

The Glenora Falls, New York, population must be protected. (USFWS, 1998)

Habitat for 4,000 plants in multiple sites, evenly distributed along a 2-mile stretch of Glenora Cliff, New York, must be protected. The two most-distant subpopulations protected at Glenora Cliff must be at least 1.5 miles apart. (USFWS, 1998)

Protected populations must be geographically distinct, self-sustaining, and have been protected for five consecutive years by measures that will remain effective following delisting. (USFWS, 1998)

Recovery Actions:
- Map all populations, and identify all affected landowners. (USFWS, 1998)
- Determine hydrologic relationships between upland areas and S. integrifolium ssp. leedyi populations. (USFWS, 1998)
- Establish and administer a permanent infrastructure for Leedy's roseroot site protection and secure funding for that protection. (USFWS, 1998)
- Contact landowners, landowner associations, and land trusts; secure their involvement in conservation strategies; compensate them for costs of fee acquisition, enrollment in conservation easements or other programs; prepare management plans for public and private protected areas. (USFWS, 1998)
- Establish, implement, and review a monitoring program. (USFWS, 1998)
- Provide public education, including advance landowner contact. (USFWS, 1998)
- Develop and maintain a genetic bank. (USFWS, 1998)
- 2015 recommended actions - 1. Review threats to the species, beginning with the information in this review, to ensure that recovery criteria are revised appropriately to address all significant threats to the species. Prepare a list of threats based on this assessment and have it reviewed by species' experts to ensure that it is complete and accurate. Finally, revise the recovery criteria, as appropriate. (USFWS, 2015b).
- 2015 - 1.1: Determine whether and to what degree any Leedy's roseroot populations are threatened by the instability of their cliff side habitats and whether heavy rains are likely to pose a threat any population. Use this information to determine whether the recovery criteria should be revised to address specific related threats and revise the criteria, if appropriate. (USFWS, 2015b).
- 2015 - 1.2: Determine whether and to what degree any Leedy's roseroot populations are threatened by gully formation or by poor soil conservation practices. Revise the recovery criteria to address this factor if it poses a threat. This potential threat may currently be most relevant to the population at Whitewater Wildlife Management Area in Minnesota. (USFWS, 2015b).

- 2015 - 1.3: Determine whether grazing or logging poses a direct or indirect threat to any Leedy's roseroot population. If they do, revise the recovery criteria to ensure that no site is considered to be protected unless the threats are adequately minimized. (USFWS, 2015b).
- 2015 - 1.4. Consider revising the recovery criteria to clarify that the protections required for each Leedy's roseroot population must preclude the following: 1.4.1. Filling or dumping material into any sink holes where that activity could result in exposure of Leedy's roseroot to harmful contaminants or alteration of groundwater flows to cliffs where Leedy's roseroot occurs; 1.4.2. The use of any pesticides or herbicides where it would result in the exposure of Leedy's roseroot to harmful compounds; and, 1.4.3. Road building or quarrying that would affect groundwater flows in any Leedy's roseroot cliff side habitats. (USFWS, 2015b).
- 2015 - 1.5: Consider revising the recovery criteria to require that protection of Leedy's roseroot habitat at the Glenora Cliff site in New York would preclude the construction of stairs, vegetation clearing (except for invasive species), laying of pipes, and dropping felled trees where these activities would likely cause adverse effects to Leedy's roseroot. (USFWS, 2015b).
- 2015 - 1.6. Consider revising the recovery criteria to further clarify that the populations around Seneca Lake must be protected from residential development, cliff-face alteration, and hydraulic fracturing (fracking) that could affect ground water quality and flow. (USFWS, 2015b).
- 2015 - 1.7. Review the preliminary hydrogeological assessment prepared for Leedy's roseroot in Minnesota (Spetzman and Cremers 1999) and develop a plan to assess the risk of groundwater contamination for each of the four Minnesota populations and measures that would protect the taxon from this threat. Consider engaging the appropriate regional hydrologist with the Minnesota Department of Natural Resources, Division of Ecological and Water Resources to help develop this plan. Ensure that the plan is sufficient to determine the following: 1.7.1. The extent to which transport of agricultural chemicals into sinkholes poses a risk of exposing Leedy's roseroot to contaminated groundwater. 1.7.2. The locations of sinkholes – or the areas in which they may occur – that should be protected to ensure that each Leedy's roseroot population is safe from effects to groundwater flows or groundwater contamination. 1.7.3. The area in which road building or quarrying may expose Leedy's roseroot to the effects of any changes in groundwater discharge. 1.7.4. The specific practices that would need to be implemented to mitigate any specific threats of exposing Leedy's roseroot to changes in groundwater discharge or to contaminated groundwater and to alleviate any ongoing exposure. It may also be prudent to carry out similar actions in New York. (USFWS, 2015b).
- 2015 - 2. Revise the recovery plan to address the Leedy's roseroot population that is now confirmed in South Dakota. (USFWS, 2015b).
- 2015 - 3. It may still be unclear whether the taxon may be conserved by relying only on the protection of the seven known extant populations. The seven populations include four in Minnesota; two in New York; and, one in South Dakota. Consider developing a range wide viability assessment that assesses the species' recovery criteria and determines whether extant populations would ensure sufficient redundancy and representation for the subspecies; and to develop criteria that may be used to determine whether or not the populations that are essential to recovery are sufficiently resilient. (USFWS, 2015b).
- 2015 - 4. Define "self-sustaining" per the recovery criteria or eliminate it from revised criteria. (USFWS, 2015b).

- 2015 - 5. Ensure that an adequate seed banking program is established for Leedy's roseroot. (USFWS, 2015b).
- Enrollment in permanent conservation easements, private land trusts, or landowner associations with effective land management plans to minimize impacts on S. integrifolium ssp. leedyi populations. (USFWS, 1998)
- Acquisition of fees to provide tax relief or other compensation to landowners. (USFWS, 1998)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: • Manage each population as a unique management unit o Prioritize conservation of large population centers at the Glenora Cliffs and WWMA sites o Prioritize conservation of genetic diversity at the Deer Creek site by collecting seeds • Evaluate abiotic and biotic factors associated with Leedy's roseroot in New York, Minnesota, and South Dakota sites o Use information to develop management recommendations • Revise recovery criteria to address threats related to cliff instability and heavy rains • Conduct DNA microsatellite analysis on South Dakota population and additional populations in New York (USFWS, 2021).

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SPECIES ACCOUNT: *Rhododendron chapmanii* (Chapman rhododendron)

Species Taxonomic and Listing Information

Listing Status: Endangered; 5/23/1979; Southeast Region (R4)

Physical Description

Chapman's rhododendron is a small (0.5 - 2m in height), evergreen shrub with stiffly ascending branches. Leaves are alternate, 3 to 6cm long, obovate with tapered bases, obtuse or rounded apices, somewhat wrinkled, and with entire but curled undermargins. Shade leaves are less wrinkled and curled. Petioles are from 2 to 6mm long. New stems, petioles and under surface of leaves are usually scurfy, dotted reddish brown. Flowers, borne in terminal clusters, have light pink, funnel-shaped corollas about 3cm long with 5 fused petals. Fruit capsules, about lcm long, are borne in clusters which persist several years and are present on almost all plants. It blooms prolifically with large clusters in late March to early April. (USFWS, 1983)

Taxonomy

Asa Gray (1877) described R. chapmanii and credited Chapman (1860) with recognizing the taxon as a variety growing in the sandy pine barrens of west Florida (Duncan and Pullen, 1962). Recent authors treat as R. minus var. chapmanii (Godfrey, 1988; Duncan & Pullen, 1962; Luteyn et al., 1996). Kartesz (1994) treats as full species. R. minus var. minus occurs in Georgia and southern Appalachians (Duncan & Pullen, 1962) (NatureServe, 2015).

Historical Range

Endemic to Florida, in Gulf, Liberty, Gadsden, and Clay counties. (USFWS, 2019a)

Current Range

Endemic to Florida and restricted to Gulf, Liberty/Gadsden and Clay counties. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Blooms in mid-March to early April (USFWS, 2019a)

Reproduction Narrative

Adult: Although R. chapmanii flowers and fruits abundantly, no seedlings were observed in the 1996 monitoring event (author, pers. obs.), and only one was found in the 1985 monitoring event (Hardin, et al., 1985). Plants are grown from seed for the nursery trade (Hardin, et al., 1985), so presumably they are reasonably easy to germinate and grow in captivity.; Ann Redmond made notes and diagrams of five plants that she excavated to a depth of ca 20 cm near the permanent monitoring plots in Gulf and Liberty/Gadsden counties (Redmond, 1985).

She observed that clumps of stems, which would have been considered several "plants" for monitoring purposes from an above-ground point of view, often were found to arise from the same underground rootstock when excavated. Thus there were actually fewer genetic individuals present than there were stem clumps tagged. She also noted evidence of areas in the rootstock where former stems had died and rotted away and evidence of grafting between stems from different sources. From her rough diagrams it appears that the underground biomass of rootstock plus roots would exceed the biomass of the aboveground stems. All of the excavations showed rhizomes heading out from the central rootstock to beyond the area of the excavation which generally covered an area of less than 1 square meter. PHENOLOGY: Rhododendron chapmanii has a fairly narrow two to three week flowering period which may begin from mid- March to early April (Duncan and Pullen, 1962; Hardin et al., 1985; Schultz and Johnson, 1996). A hard freeze in January and March 1985 may have delayed and reduced flowering in that year by killing the buds (Hardin, et al., 1985) (NatureServe, 2015).

Habitat Type

Adult: Bbetween upland mesic or scrubby flatwoods and floodplain swamps or baygalls; mesic pine flatwoods (USFWS, 2019a)

Habitat Vegetation or Surface Water Classification

Adult: Terrestrial

Dependencies on Specific Environmental Elements

Adult: Acidic sandy soil (USFWS, 2019a)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2019a)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Rhododendron m. chapmanii usually occurs in a transitional area between upland mesic or scrubby flatwoods and floodplain swamps or baygalls. This species is also found within mesic pine flatwoods or on the lower elevations of the sandhills. Consequently, it appears to require acidic sandy soil, good to moderately welldrained to somewhat poorly drained sandy soils of 0-5% slope, and no flooding. The Camp Blanding population grows on the edge of xeric hammock next to a stream bank. The plants tolerate full sun to moderate shade (Negron-Ortiz, 2010, pers. observ.), and heavy shade once they are mature as at Camp Blanding (Hall 2005). (USFWS, 2019a)

Dispersal/Migration

Population Information and Trends

Population Trends:

Declining (USFWS, 2019)

Number of Populations:

4 (USFWS, 2024)

Population Size:

approximately 3,000 clumps (USFWS, 2019a)

Population Narrative:

Rhododendron m. chapmanii is restricted to the Florida panhandle with only three known opulations occurring in coastal Gulf County, Liberty and Gadsden counties in the vicinity of Hosford, and Clay County on the Camp Blanding Military Reservation. The population near Hosford is the largest and is privately owned by AgReserve Inc., which may maintain timber production and agricultural uses of the lands. The smallest and most geographically isolated of these populations is within the Florida National Guard post at Camp Blanding, about 165 miles east of the Hosford population. Throughout Florida, surveys and censuses collectively recorded about 55 occurrences or sites. Although we have limited information regarding trends, current data assessment suggest the presence of only 35 sites (about 36 % decline). In May 2019 FNAI performed a comprehensive review of all R.m. chapmanii element occurrences (EO2). The 55 areas where the species was observed are currently mapped as 23 EOs. This is based on NatureServe 2004 guidance (EO separation distance of 1 km) with the addition of separation based on differences in management practices, threats, and habitat conditions. If considering only the parameter of 1 km separation distance, the 23 EOs technically represent 15 EOs (J. Annis, FNAI, 07/02/2019, pers. comm.). (USFWS, 2019a). Rhododendron chapmanii is a small evergreen shrub presently comprised of four populations located in five Florida counties four of which are in the panhandle. A new occurrence was recorded in 2022, increasing the total occurrences to 16 and extending the geographic range 80km northwest from the nearest known population (USFWS, 2024).

Threats and Stressors

Stressor: Urbanization (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: In addition to being one of the largest private landowners in northwest Florida, the St Joe Company is also one of the largest real estate operating companies in the Southeast. This Company develops both residential and commercial properties along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2070 along with a growth of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Since the species occurs on Company-owned property in Gulf, Liberty, and Gadsden counties, Florida, there is no guarantee that these properties will not be utilized for residential or commercial development in the near future. Therefore, residential or commercial development is a threat. (USFWS, 2019)

Stressor: Forestry practices (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The timber industry in North Florida became well established in the 1850s. Privately owned companies grow trees for their byproducts by mechanically preparing the site for

planting, planting seedlings, and mechanically harvesting the trees. Harvesting typically involves thinning, and later clear cutting the site; the process is then repeated. The St. Joe Company had close to a million acres in timber in the eastern region of the panhandle and they plan to continue to harvest and replant indefinitely. Tree farming, i.e., privately owned forest managed (clearcutting, mechanical site preparation, and pine plantations) for timber production, is a primary threat since there are many thousands of acres of tree farms. In 2013, the St Joe Company sold more than 380,000 acres of its land to AgReserves, Inc., a for-profit company that has primarily focused on cattle grazing. The land sold included timberlands in Bay, Calhoun, Franklin, Gadsden, Gulf, Jefferson, Leon, Liberty and Wakulla counties. The safety of the Hosford population, sold to AgReserves, Inc., is undetermined because it is not protected. Also, the Gulf County population is primarily on tree farm land; therefore, tree farming is a threat to this species. (USFWS, 2019)

Stressor: Fire suppression (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Suppression of fire continues to threaten pineland and savanna flora as fire is an important element in the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Prescribed burnings are needed to maintain optimal habitat for R.m. chapmanii populations; specifically to avoid the encroachment of Cyrilla racemiflora L. (swamp titi). (USFWS, 2019)

Stressor: Drainage (USFWS, 2019)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Drainage of adjacent bogs to increase areas of pine plantings affects seasonal hydrology. Drained sites become more desiccated, and this affect processes such as seed germination and seedling establishment. Therefore, drainage of adjacent bogs is still a threat due to tree farming activities. (USFWS, 2019)

Stressor: Overutilization (USFWS, 2019)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The Recovery Plan identified this as a threat to R.m. chapmanii. Specifically, the Plan suggested that this species was taken from the wild for ornamental purposes (Tatum and Lake 1979). According to Simmons (1983), numerous plants were removed in the late 1940's from the Camp Blanding for the nursery trade. Similarly, 100-200 plants were removed from the Hosford population (USFWS 1983). Therefore, this species was a 'commercially exploited plant'3 and is still sold by several nurseries (e.g., https://shop.shadygardensnursery.com/). This activity does not currently seem to be a major problem because most cuttings and seeds come from plants collected in the past. However, we cannot discount the possibility of sporadic plant removal.

(USFWS, 2019)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act (Act) of 1973, as amended prohibits the removal of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in knowing violation of state law or regulations or in the course of any violation of a state criminal trespass law. However, the Act does not provide protection for plants on private lands or unless it's in violation of state law. Several populations of R.m. chapmanii occur on private timberland. While the Act requires federal agencies to carry out programs for the conservation of endangered and threatened species, no such programs are stipulated for private landowners. Neither section of the Act provides protection for plants on private lands as long as the activity is permissible under state/local laws. Seeds of both threatened and endangered species found on federal lands are regulated under the Act. In addition, the seeds of an endangered species are regulated if they are going to be purchased/traded/bartered in interstate commerce. Since R.m. chapmanii is an endangered species, the seeds are regulated under the specified conditions. However, the seeds are not regulated if they are provided freely (no exchange of money, goods, or services; 7 CFR 319.37.2, USDA 2008). The State requires permission of private landowners for collecting of state-listed plants from their property. Rhododendron m. chapmanii is protected under Florida State Law, chapter 581.185: Preservation of native flora of Florida, which includes preventions of take, transport, and the sale of the plants listed under the State Law. The rule Chap. 5B-40, Florida Administrative Code, contains the "Regulated Plant Index" (5B-40.0055) and lists endangered, threatened, and commercially exploited plant species for Florida; defines the categories; lists instances where permits may be issued; and describes penalties for violations (Coile and Garland 2003). This law does not protect habitat. Based on the information summarized above, the existing regulatory mechanisms are deemed inadequate for plants. (USFWS, 2019)

Recovery

Reclassification Criteria:
1. The dense 10-acre population near Hosford is maintaining a stable or increasing population of healthy plants. (USFWS, 1983).

2. The remaining part of the Hosford population continues to occupy at least 200 acres with at least 500 plants. (USFWS, 1983)

3. The Gulf County population continues to occupy at least 200 acres with at least 500 plants. (USFWS, 1983)

4. The Camp Blanding population continues to have at least 20 plants. (USFWS, 1983)

5. There is a permanent increase of about 1,000 plants at any combination of sites 2, 3, and 4 to increase to a total of at least 2,000 plants at these sites. (USFWS, 1983)

Recovery Priority Number: 8C

Delisting Criteria:
1. The three (3) existing populations (Hosford, Gulf, and Clay) and their occupied habitat are conserved, restored, and properly managed, and monitoring demonstrates that the populations are stable or increasing over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A and D). (USFWS, 2019b)

2. At least five (5) new populations are discovered or established within the historic range of the species on lands protected by a conservation mechanism, and exhibit stable or increasing trends over multiple prescribed burn cycles, evidenced by a type of recruitment and/or multiple size-classes (addresses Factors A and E). (USFWS, 2019b)

3. Threats (e.g. urban development, timbering, agriculture, inadequate fire management, invasive species) have been reduced and/or managed to a degree that R. m. chapmanii will remain viable into the foreseeable future (addresses Factors A and D). (USFWS, 2019b)

Recovery Actions:
- 1. Highest priority for the recovery of Chapman's rhododendron should be to reverse the habitat and population declines that are occurring in the wild population. This can be accomplished through a combination of protection, management and monitoring. Most important in accomplishing this goal is to establish and maintain a strong, friendly and longlasting working relationship with the St. Joe Paper Company, which owns over 99 percent of the wild population and its habitat. The Company has expressed a willingness to help (pers. comm.), and, indeed, has already taken some steps to protect the species and its habitat. Camp Blanding guards the small population there rather closely, and has expressed willingness to help manage the site. (USFWS, 1983)
- 2. Strengthening existing populations by planting nursery-grown plants is clearly less important than habitat protection and management. Tt may nevertheless prove to be essential for long-term survival of the species. Tt provides a tested (plantings have been done by Simons in the wild in Suwannee, Levy and Putnam Counties with 100 percent success rates) and easy method to quickly strengthen a population. (USFWS, 1983)
- 3. Establish new populations. Determine historical range. Locate suitable habitat. Obtain permission and cooperation for establishing planting. Collect seed. Grow plants and plant out in December - January at a 20 by 20 foot spacing (about 100 per acre). (USFWS, 1983)
- 4. Research is the lowest priority, because it seems least important from the standpoint of the immediate and near-term needs of the species. However, the farther one looks into the future, the more important research is. The amount of research recommended here is the minimum necessary to provide for implementation of this recovery plan. (USFWS, 1983)
- The level of occupancy of the three existing populations persists as at least: 5,000 acres for Hosford, 6,000 acres for Gulf County with a minimum of 2,000 clumps, and 30 clumps for Clay County (addresses Factors A and D) and management with prescribed fire is implemented on a 3 to 5 year return interval. (USFWS, 2019b)
- Foster a partnership with the current landowner of the AgReserves, Inc. to promote the protection of the Hosford population (found in Liberty and Gadsden counties) and help implement best management practices (e.g., prescribed fire, mowing/fuel reduction, invasive species removal) (addresses Factors A and D). (USFWS, 2019b)

- A long-term ex-situ conservation program is ongoing to help avert the risk of extinction from stochastic events, environmental catastrophes, or development. The living collection should emphasize the privately owned Hosford population and coastal areas (see Justification of criteria 1 and 3). The collection should be maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach (addresses Factors A and E, and representation). The full genetic diversity represented in the Hosford population needs to be protected through ex-situ management efforts. (USFWS, 2019b)
- The contribution of sexual reproduction to population maintenance is assessed via research related to in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed germination, seedling survival and growth) (addresses Factors A, D, E, and resiliency). (USFWS, 2019b)
- The genetic composition within and among populations is assessed to clarify species boundaries, define evolutionarily significant units, detect inbreeding, identify clonal reproduction, and determine effective management (addresses Factors A, D, E; informs the ecological principle of representation). (USFWS, 2019)
- Assess the R. m. chapmanii demographic responses (e.g., recruitment, reproduction, and mortality) to hurricane and fire disturbances (addresses Factor E and resiliency). (USFWS, 2019b)
- A comprehensive census is conducted throughout the present distribution and on new locations where appropriate habitat exists (addresses Factor A and redundancy). (USFWS, 2019b)
- Acquisition of the following private lands will benefit the status of this species: - Several land parcels adjacent to the SJSBP, Gulf County that has Chapman's Rhododendron and a suite of other rare species. - The Hosford population located in Liberty and Gadsden counties. (USFWS, 2019a)
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution. Follow a standardized method for accurate population counts to ensure consistency in collected data. (USFWS, 2019a)
- Conduct surveys for new populations where similar habitat exists. This action can include the use of aerial photographs and species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. Follow a standardized method for accurate population counts to ensure consistency in collected data. (USFWS, 2019a)
- Garden propagation and reintroduction. An ex-situ seed collection should be actively pursued and implemented to help avert the risk of extinction from stochastic events, environmental catastrophes, or development. The living collection should emphasize the privately owned Hosford population and coastal areas, and maintained at botanical gardens and other Service approved facilities for research, recovery, and public outreach. (USFWS, 2019a)
- Complete a population genetic study to determine the levels and distribution of genetic diversity within and among populations of R. m. chapmanii. The study should test whether the Camp Blanding population is an artificial (planted) population. The Recovery Plan deemed it "unlikely" that this population was planted, but this would provide a further test. (USFWS, 2019a)
- The contribution of sexual reproduction to population maintenance is assessed via research related to in-situ soil seed bank, seed viability, and seedling recruitment (in-situ seed

germination, seedling survival and growth). (USFWS, 2019a)
- Assess the R. m. chapmanii demographic responses (e.g., recruitment, reproduction, and mortality) to hurricane disturbance. (USFWS, 2019a)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES • Foster a working relationship to establish protection and management agreements with private landowner AgReserve, Inc. • Hosford population: A comprehensive survey is needed to assess the status of the plants and corresponded habitat. This recommendation is a priority. • Conduct surveys/inventories/demographic studies on each known population every five years. Note: Atlanta Botanical Garden initiated a detailed demographic study of Chapman's rhododendron in 2021 at St. Joseph State Buffer Preserve (CP #F20AC10631). • Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated, or in potential suitable habitat suggested by the species distribution modeling developed by FNAI (2022). • Acquisition of land parcels adjacent to the St. Joseph State Buffer Preserve, Gulf County that has Chapman's rhododendron and a suite of other rare species (USFWS, 2024).

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SPECIES ACCOUNT: *Rhus michauxii* (Michaux's sumac)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/28/1989

Physical Description

A low-growing, densely hairy, dioecious shrub, mostly 0.3 to 0.6 m tall. Leaves are pinnately compound with 7-13 leaflets that are coarsely toothed. Female plants produce erect clusters of greenish-yellow to white 4-5 parted flowers and conspicuous red drupes. Flowers from April to June. Fruits persist from August through September or October (NatureServe, 2015).

Taxonomy

Andre Michaux discovered this species on July 20, 1794 in Mecklenburg County, NC (the area is now part of Union County). He named the species Rhus pumila in 1803; however, since the specific epithet pumila had already been used for another species, Sargent assigned the name R. michauxii in 1895 (Barden and Matthews 2004). There have been no changes to the taxonomic classification or nomenclature since Rhus michauxii was listed as endangered in 1989 (USFWS, 2014).

Historical Range

Historically endemic to the Inner Coastal Plain and lower Piedmont of North Carolina, South Carolina, and Georgia (USFWS 1989). HISTORIC RANGE: From the time of its discovery in 1895 until 1989, half of the known occurrences of Rhus michauxii have been extirpated (USFWS 1989). Thirty-two occurrences were historically reported from 23 counties in NC, SC, and GA (USFWS 1989). Four occurrences historically known from Cobb, Columbia, Newton, and Rabun counties, GA, are believed extirpated (Murdock and Moore 1991, Patrick 1993). Historical collections are known from Florence, Kershaw, and Oconee counties, SC. Following extensive, unsuccessful searches of their last known locations, as well as other areas of suitable habitat, Michaux's sumac is believed extirpated from the state (USFWS 1989, Murdock and Moore 1991). Historical and/or extirpated NC records exist (year last seen in parentheses) for Durham (1949), Franklin (1914), Hoke (1981), Johnston (1833), Lincoln (prior to 1917), Mecklenburg (pre-1800s), Moore (1901), Orange (1964), Robeson (1982), Wake (1942), and Wilson (1958) counties (Murdock and Moore 1991, NCNHP 1993). Considered extirpated from Florida, where the original collection was made in 1961 in Alachua County (Murdock and Moore 1991). Apparently by 1989 the collection site had been developed and was occupied by at least one residential home. Kathy Burkes of FNAI notes: "Whether the plants seen in 1961 were waifs carried far afield from the Piedmont by humans or other animals in "recent" times, or were true relicts of a former wide distribution reaching south into Florida is another question. We may never know for sure about that." (NatureServe, 2015).

Current Range

When the recovery plan was completed in 1993, R. michauxii was believed extant at 21 sites in NC and GA. No populations were known from VA at that time. R. michauxii was believed to be extinct at 20 sites in the coastal plain and piedmont of NC, South Carolina (SC), GA and Florida (FL). Since listing, additional occurrences have been found in GA, NC and VA. As of 2014, there are 43 parent populations, rangewide. The GANHP database currently lists four extant occurrences of R. michauxii and two additional subpopulations are considered historical or

extirpated. NCNHP records currently indicate a total of 33 extant populations. An additional 13 sites in NC are now considered historical, extirpated or failed to find. The VANHP database indicates that there are six occurrences extant within the state with no known historical or extirpated populations. This information is summarized in Table 1 and additional information about each element occurrence (EO) is included in Appendix C. Following current NatureServe methodology, some of these sites are now considered sub-populations or sub-sets of larger populations or principal EOs. See Table 1 for an additional explanation of this methodology. Several populations of R. michauxii are now considered historical or extinct, including all previously known sites in FL and SC. Rhus michauxii was collected in Alachua County, FL in 1961. Attempts to relocate this population in 2006 (and prior to 2006) were unsuccessful (Herring 2006). Three sites known from SC (one site each in Florence, Kershaw and Oconee counties) were considered extirpated before the species was federally listed as endangered in 1989. (USFWS, 2021)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (USFWS, 2014)

Reproduction Narrative

Adult: Most of the surviving populations appear to contain plants of only one sex and therefore reproduce only vegetatively, if at all. Due to the rhizomatous nature of the species, this may mean that the single-sex populations are clones of one or a few individuals; two populations sampled for genetic diversity by Sherman-Broyles et al. (1992) appeared to each consist of a single clone (USFWS, 1993). Single sex populations that are clonal in nature prohibit sexual reproduction and seed production in this species. In populations where seeds are produced, it appears that seed germination is very low (USFWS, 2014). Although specific pollinators are unknown, Michaux's sumac, like other species in the genus, is probably pollinated by insects. Sherman-Broyles et al. (1992) observed that bees visited the flowers of other sumac species and that birds dispersed the fruits (USFWS, 1993).

Habitat Type

Adult: Open Woodland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Michaux's sumac occurs in sandy or rocky open woods, sometimes in association with circumneutral soils (USFWS 1990). In the fall line sandhills region it occurs in submesic loamy swales. In the eastern Piedmont, it occurs on sand soils derived from granite. In the central Piedmont, it occurs on clayey soils derived from mafic rocks (Weakley 2004). In all of its habitats, Rhus michauxii is dependent upon some form of disturbance to maintain the open quality of its habitat (USFWS 1989). Periodic, naturally occurring fires provided such disturbance historically. Today, however, many of the Michaux's sumac occurrences are in areas that are artificially disturbed, such as highway and railroad rights-of-way, pine plantations, edges of cultivated fields, and other cleared lands (USFWS 1989, TNC 1991-93, NCNHP 1993, Center for Plant Conservation 2002). Although roadside occurrences appear to be thriving in the presence of some level of disturbance (i.e., mowing), they are always under the constant threat of catastrophic disturbance. Roadbed widening or heavy equipment activity on cleared lands, for example, may dramatically reduce the number of individuals. These reductions, if they come at a crucial stage in the species' reproductive cycle (i.e., during flower or fruit production), could have severe long-term effects on the population. Although it appears that Michaux's sumac can rebound from large disturbances, it is not clear how much genetic diversity is lost with each disturbance. In the North Carolina Sandhills region, naturally occurring Rhus michauxii appears to be restricted to slightly loamy, but still well- drained, sites which are scattered through longleaf pine/scrub oak/wiregrass woodlands. Loamy soil sites are usually found in slight depressions, swales, or along lower slopes and are quickly recognized by their high diversity of herbs, especially with regard to their high number of legume, composite and grass species (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance range are inferred based on specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Birds? (USFWS, 1993)

Dispersal/Migration Narrative

Adult: Sherman-Broyles et al. (1992) observed that bees visited the flowers of other sumac species and that birds dispersed the fruits (USFWS, 1993).

Population Information and Trends

Population Trends:

Short-term Trend: Decline of <30% to relatively stable. Long-term Trend: Decline of 30-50% (NatureServe, 2015)

Number of Populations:

38 (USFWS, 2021)

Population Narrative:

Currently, state natural heritage programs recognize 38 extant natural populations (31 in North Carolina, one in Georgia and six in Virginia), plus four additional introduced populations in Georgia and one in North Carolina. Of these populations, 18 are ranked A or B by their respective natural heritage programs. According to natural heritage program records, the ranks of eight populations (13 occurrences) have improved and 34 populations (51 occurrences) have remained stable. The ranks of 11 populations (20 occurrences) have declined since the 2014 5-Year Review indicating that those occurrences have fewer stems than previously observed, or possibly even disappeared. (USFWS, 2021)

Threats and Stressors

Stressor: Fire suppression (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: This species is threatened by fire suppression and the ecological succession (competition and/or shading by woody species) that occurs in areas that are not burned on a regular basis (USFWS, 2014).

Stressor: Low reproductive capacity (NatureServe, 2015)
Exposure:
Response:
Consequence: Population degradation
Narrative: Low reproductive capacity resulting from the geographic isolation of small single-sex populations is a threat to this species (USFWS 1990) (NatureServe, 2015).

Stressor: Logging (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/Loss of plants
Narrative: Forested populations are threatened by timber operations. Logging activities can crush plants and 9 or compact the soil where they grow (USFWS, 2014).

Stressor: Herbicides (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of plants
Narrative: Sites located within utility rights-of way are threatened by herbicide use, mowing during critical growth periods, and ground disturbing activities (USFWS, 2014).

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Habitat destruction, the result of development or land conversion, also threatens this species (Boyer 1996) (USFWS, 2014).

Stressor: Climate change (USFWS, 2014)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: The effects of climate change on this species are unknown at this time. However, since this species occurs on dry soils in fire maintained habitat, it seems reasonable to believe that it will not be negatively affected by the predicted increase in droughts and wildfires (USFWS, 2014).

Recovery

Delisting Criteria:
1. It has been documented that at least 19 self-sustaining populations exist and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 1993).

2. All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 1993).

Recovery Actions:
- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats and fire regime; monitor population size and evidence of reproduction (sexual, asexual and seed viability); discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2014).
- Search for additional populations throughout the range of the species (USFWS, 2014).
- Prioritize known sites for protection (USFWS, 2014).
- Protect additional populations through fee simple acquisition, conservation easements, etc. (USFWS, 2014).
- Develop management plans including the use of prescribed fire for all protected populations (USFWS, 2014).
- Develop standardized monitoring protocols, initiate long-term population monitoring and determine the criteria for sustaining populations (USFWS, 2014).
- Reinstate monitoring that was initiated in the early 1990s by Boyer (1996) (USFWS, 2014).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2014).
- Compare, genetically, the populations of questionable taxonomy in VA with those known from NC and GA (especially populations suspected of hybridizing with other species of Rhus) (USFWS, 2014).
- Work with NC Botanical Garden to conserve seeds and germplasm, and develop propagation protocols (USFWS, 2014).
- Consider augmenting populations to increase genetic variation (USFWS, 2014).

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed in the 2014 5-Year Review remain important to the conservation and recovery of Rhus michauxii and efforts to accomplish those actions should continue. Since the 2014 5-Year Review, progress has been made on several recommendations for future actions. • Surveys have resulted in the discovery of four new

populations and one new subpopulation of Rhus michauxii. • The Georgia Plant Conservation Alliance has augmented Rhus michauxii populations with plants of the opposite sex and created three new safeguarding populations with male and female plants from different locations. Rhus michauxii has been reintroduced to a previously known site in North Carolina. • Research has been conducted on the pollination ecology of Rhus michauxii. • A genetics study looking at purported hybrids of Rhus michauxii is ongoing at Virginia Tech Conservation Management Institute. • The NCBG, SBG and ABG conserve seeds and maintain live Rhus michauxii plants in their collections for research, reintroductions and education. • The Service has encouraged land managers to develop and implement management plans by providing a template management plan to managers. The Service recommends initiating or continuing the following efforts that will contribute to the recovery of the species: • Consider updating/amending the recovery plan to include quantifiable downlisting criteria. • Revisit known populations that have not been visited in recent years. • Monitor the habitat condition of each site including threats and fire regime. • Monitor population size and evidence of reproduction (sexual, asexual and seed viability). • Discuss conservation options with landowners, where appropriate. • Provide updates about each population visited to natural heritage programs. • Search for additional populations throughout the range of the species. • Prioritize unprotected sites for protection. • Protect additional populations through fee simple acquisition, conservation easements, etc. • Encourage the development of updated management plans, including the use of prescribed fire, for all protected populations. • Develop standardized monitoring protocols, initiate long-term population monitoring and determine the criteria for self-sustaining populations. • Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship). • Identify which populations contain hybrids and determine if they pose harm to the species and/or need special management considerations. • Work with the North Carolina Botanical Garden to conserve seeds and germplasm, and develop propagation and out-planting protocols. • Develop a plan to augment single-sex populations in order to increase genetic variation. (USFWS, 2021)

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SPECIES ACCOUNT: *Ribes echinellum* (Miccosukee gooseberry)

Species Taxonomic and Listing Information

Listing Status: Threatened; 8/19/1985; Southeast Region (R4)

Physical Description

A bushy shrub that reaches 1 m in height and often forms patches that are several meters in diameter. Leaves are small (1-2 cm long), closely spaced, and more-or-less 3-lobed. Stems are armed with spines. Flowers (late February into early April) are inconspicuous, greenish-white. Fruits are spiny green berries (NatureServe, 2015).

Taxonomy

Recent work using molecular phylogenetic approaches has confirmed the distinctness of this very rare shrub (Morgan & Soltis 1993, Senters & Soltis 2003, Shultheis & Donoghue. 2004) (NatureServe, 2015).

Historical Range

See Current

Current Range

Occurs in three locations: along the shores of Lake Miccosukee in Jefferson County, Florida, and along Stevens Creek and a site on the Sumter National Forest, Edgefield Ranger District in McCormick County, South Carolina. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetative/Sexual (USFWS, 2015)

Other Reproductive Information

Adult: Details of R. echinellum's reproductive biology (protandry, andromonoecy), pollination and insect visitation (most abundant visitors: Bombus impatiens and Habropoda laboriosa), and vegetative reproduction (common by cuttings and by rooting at the stem whenever the decumbent branches come in contact with the ground) can be found in the last 5-year review (USFWS, 2022).

Reproduction Narrative

Adult: Vegetative reproduction is common by cuttings and by rooting at the stem whenever the decumbent branches come in contact with the ground (Jones 1986; Engstrom 2011). Fire appears to promote clonal reproduction by increasing the number of plant clumps (Slapcinsky and Gordon 2005). No evidence of strong clonality was found by the genetic study of Oleas et al. (2014); however, in SC putative clonality was higher and especially high at the Sumter NF. The

Sumter NF subpopulation is represented by one large cluster and eight small subgroups (each 1–2 m2), which might explain the clonality results. Sexual reproduction might occur (Jones 1986), but recruitment appears to be limited or absent (Negrón-Ortiz 2014). Seed germination potential assessed with 1% tetrazolium solution indicated that out of 173 Florida seed tested, 60 % were viable (Negrón-Ortiz, 2014, pers. observ.) In addition, an ongoing in-situ study indicated 25 % seed germination. However, none of the Florida seedlings survive a full year (Negrón-Ortiz 2014, pers. observ.) (USFWS, 2015). Floral biology and flower visitors were observed and described for the Florida and South Carolina populations (Caitling 1998). The author concluded that pollinators and/or visitors were not the limiting factor determining the species' abundance. Below is a detailed account of the findings. a. Floral biology and behavior at anthesis. The stamens are the first reproductive structure elongating within one or two days of floral anthesis. It is followed by reflexing of the calyx lobes and dehiscence of the anthers. The style elongates within one to three days of stamen elongation, separates into two parts, reaching an equal or longer length than the stamen. This floral maturation suggests protandry (male function precedes female function), a breeding system that promotes outcrossing. Interestingly, the style failed to elongate in 20% of the flowers, but unfortunately, the author did not provide a description of these flowers to assess whether these flowers are female sterile. If they are female-sterile, the breeding system is not simple protandry, but also andromonoecious (species that have bisexual and male flowers on the same plant). b. Insect visitation and pollination. The author recorded five different visitors to the flowers, with Bombus impatiens Cresson (bumble bee) and Habropoda laboriosa Fab. (southeastern blueberry bee) as the two most abundant visitors for both Florida and South Carolina populations. Visitation movements occurred between and within plants (USFWS, 2015).

Habitat Type

Adult: Hardwood forest (USFWS, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2015)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2015)

Site Fidelity

Adult: High (inferred from USFWS, 2015)

Habitat Narrative

Adult: Jefferson County, Florida: Miccosukee gooseberry is found over an area of 105-110 acres between 24.4 to 36.6 m of elevation, at sites of high floristic diversity (Table 3), on mesic and well drained soils with underlying limestone (Schultz and Hardin 1985, USFWS 2000). These sites are dominated by deciduous species (Table 3, Harper 1925), with the west-facing slope dominated by a mixed hardwood forest containing trees such as hickories, elms, white ash, hackberries, and oaks (Table 3) (Catling 1998, USFWS 2000) and a shrub layer dominated by buckeye and poison ivy. The site, located in the bottomland hammock is dominated by American beech and southern magnolia. McCormick County, South Carolina Steven's Creek Heritage

Preserve: The plants are found over an area of 35 acres along Steven's Creek on a steep north facing slope containing stands of deciduous hardwood trees. The forest community was described by Radford (1959) as mixed mesophytic. It is also floristically very rich with species of Carya and Quercus accounting for over 50% of the composition of the tree size-class (Table 3). The soil texture is considered a sandy loam with high pH (6.7 to 7.4) and calcium levels (Jones 1986). Sumter National Forest, Long Cane Ranger District The site is characterized by a lower slope with an easterly aspect. The plants are found over an area of 30 acres. The forest, a mature (<100 years) hardwood forest with a sparse understory, is dominated by cherrybark oak, swamp chestnut oak, painted buckeye, and southern sugar maple. In addition, scarlet oaks, beech, witch hazel and ironwood are common members of the community. The soil is Tatum, a derivative from fine-grained phyllite, with pH ranging from 6.2 to 6.4 (USSFWS, 2015). Narrow environmental specificity and clumped spatial arrangement of the population are based on the species specific habitat needs and known populations. High ecological integrity of the community and site fidelity as well as low tolerance range are inferred based on the specific habitat needs of the species and the small number of populations known to exist.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Coville (1924) postulated that birds with long bills (mockingbirds, catbirds, or thrushes) would be adapted to opening the berries to eat the seed. The daily range of these species would be limited, therefore the potential dispersal distance would be limited. Dissemination by these agents would by internal means (NatureServe, 2015).

Population Information and Trends

Number of Populations:

2 (USFWS, 2022)

Population Size:

Florida ~ 5,000 plants, South Carolina ~ 9,870 plants (USFWS, 2015)

Population Narrative:

Grows extremely densely with as many as 500 stems in a .04 ha circular plot (USFWS 2008). The population at the type locality in Florida was estimated to be approximately 5000 plants (Schultz and Hardin 1985 cited by USFWS 2008). As many as 9,870 clumps are present at the Steven's Creek, South Carolina site (Gaddy 2008). The Sumter National Forest, South Carolina site has approximately 270 ramets (USFWS 2008). Two occurrences in close proximity are believed extant in Jefferson County, Florida. In the disjunct area of McCormick County, South Carolina, it is known from two sites, Steven's Creek Heritage Preserve and Sumter National Forest, Edgefield Ranger District. (NatureServe, 2015) Short-term Trend Comments: The Steven's Creek site may be declining (USFWS 2008). The Sumter National Forest and Florida sites appear to be stable (USFWS 2008). Low representation, resiliency and redundancy are inferred based on low number of populations and specific habitat needs of the species. Ribes echinellum (Coville) Rehder (Miccosukee gooseberry) is a small shrub known from only two disjunct populations (Figure 1). In Florida, R. echinellum is located along the north shoreline of Lake Miccosukee near Monticello, Jefferson County. In South Carolina, it is found at two main sites (or subpopulations) in McCormick County: 1) Stevens Creek Preserve, a site 1.5 m northeast of Clark Hill, and 2)

Sumter National Forest, Long Cane Ranger District (Catling et al. 1998; Figure 1). The Florida population was discovered in 1924, and the South Carolina sites were found in 1957 and 1981. It has a critically imperiled (G1) global status and is considered a species of highest priority under the SC Wildlife Action Plan (https://www.dnr.sc.gov/swap/main/chapter2-priorityspecies.pdf) (USFWS, 2022).

Threats and Stressors

Stressor: Development (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The threat of habitat destruction or alteration is greatest at the Florida site where R. echinellum occurs exclusively on private property. There is no guarantee that the properties will not be developed for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes in the future, although the owners have not given any indication that they intend to do so (USFWS, 2015).

Stressor: Predation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Deer browsing, feral hogs rooting and fruit predation by the cotton mouse are listed as threats to this species (USFWS, 2015).

Stressor: Non-native species (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The proliferation of non-native (invasive) species represents a threat to R. echinellum in the Steven's Creek population and to some extent at Sumter NF and in Florida. In Florida, the invasive species Japanese climbing fern (Lygodium japonicum) and Chinese privet (Ligustrum spp.) were observed on the Mays Pond conservation easement property (Negrón-Ortiz, 2007, pers. observ.). Chinese privet, coral ardisia (Ardisia crenata), and nandina (Nandina domestica) are abundant in places on Norias Plantation (Engstrom, 2010, pers. comm.). Thus this threat is not a significant concern at the current time. The manager for Steven's Creek (M. Bunch) noted significant invasion of the gooseberry site by Chinese privet and Japanese honeysuckle (Lonicera japonica), predominantly in the riparian area and on the north facing outcrops. The SC Department of Natural Resources hosted several volunteer workdays, and staff has worked on the problem at Steven's Creek reducing the Chinese privet, mostly by manual removal. They have conducted a limited amount of cutting and painting Chinese privet stumps using glyphosate and started controlling the Japanese honeysuckle by hand pulling. The riparian area, which was most heavily covered with Chinese privet, is now greatly improved with about 70% of this invasive removed. The same invasives have been reported for the Sumter NF subpopulations, but this threat is not currently significant (USFWS, 2015).

Stressor: Drought (USFWS, 2015)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: Prior to 2007, the South Carolina and Florida populations were facing a severe drought. Currently, drought is not a threat for the FL population (USFWS, 2015).

Recovery

Reclassification Criteria:
Not relevant.

Recovery Priority Number: 11

Delisting Criteria:
Not developed - a recovery plan has not been issued. (USFWS, 2015)

Recovery Actions:

- There is no Recovery Plan for this species. (USFWS, 2015)
- Management: Foster a working partnership between Tall Timbers, the Service, and the Mays Pond conservation easement for the Florida population. (USFWS, 2015)
- Management: Foster a working partnership with the Norias Plantation and Reed property landowners. (USFWS, 2015)
- Management: Fence a larger area at Steven's Creek to protect the plants from deer herbivory and to better assess the impact of browsing on R. echinellum.
- Management: Monitoring and managing for invasive species i. Frequent inventories or surveys of the Florida population for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the South Carolina populations conducted by SC DNR staff and volunteers and by Sumter NF staff. ii Eradicate the feral hog population at the Steve's Creek and Long Cane sites. Starting in May 2015, USDA APHIS has been trapping hogs for the Forest Service in compartment 314 as an effort to protect R. echinellum from hog damage. This should reduce hog damage in both the SNF and Steven's Creek. iii. Fence a larger area at Steven's Creek to protect the plants from feral hog damage. Fencing should consist of woven wire at least 28 inches in height to exclude feral hogs. The fence should be staked tightly against the ground to prevent uprooting and access to protected areas. (USFWS, 2015)
- Management: Fire management: Slapcinsky et al. (2010) reported that R. echinellum is not fire-dependent, although plant density increased gradually for three years post-fire, and reproduction increased the second year post-fire. This species has responded in different ways to fire. Management protocols cannot be implemented until a comprehensive study is conducted. i. Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure. ii. Address the following questions: What is the effect of local fire temperature, or the range of fire temperatures tolerable for the persistence of the species? How often should a prescribed fire be performed? Determine whether the lower size classes, (<30 cm tall), that were increased after fire represent 1) seedlings recruited from a seed bank present in the soil, 2) rooting branches no longer connected to the plants and growing as new clumps, and/or resprouts of fire killed stems. (USFWS, 2015)

- Management: Silvicultural practices: South Carolina population: Silvicultural practices in pine plantations upslope from R. echinellum are recommended to promote open woodlands dominated by native pines (shortleaf or longleaf) (SCDNR 2013). Upslope from the Sumter NF population is an area soon to be proposed for longleaf pine woodland restoration, creating more open conditions for pollinators. (USFWS, 2015)
- Research: Reproductive biology studies: The lack of sexual reproduction over long-term may threaten this species, and requires further evaluation (Gordon, 2008, pers. comm.; Negrón-Ortiz, 2012-2014, pers. observ.). a. Since recruitment from seed appeared rare (Negrón-Ortiz, 2013-2014, pers. observ.), seed germination and seedling survival studies should be expanded and continue at the FL population, and initiated at the South Carolina population. It would be desirable to compare open pollinated to hand-crossed (within source population, and between FL-SC) in seed set and seed germination. b. Establish an experimental garden Since the two populations of R. echinellum show low genetic diversity, signatures of bottlenecks, and excess of heterozygous which might be caused by overdominance (heterozygote has higher fitness than either homozygote; Oleas et al. 2014), an experimental garden comprising plants from both populations (FL-SC) could be established allowing natural pollination or using manual pollen transfer. The site could be where a population could be controlled (e.g. botanical garden). Fruits from crosses may then be planted, and seed germination and seedling establishment monitored. (USFWS, 2015)
- Research: Expand the seed predation study carried out by Engstrom and Radzio (2014): To answer whether the small cotton mouse is driving changes in seedling recruitment, a series of exclosures and control plots could be established at the FL population. The exclosure plots will prevent small-mammals access the plots. To determine predation of fruits, fruits should be counted before they ripen; then seed germination, seedling recruitment and plant establishment should be monitored in the experimental plots for up to three years. (USFWS, 2015)
- Research: Determine the effect of spring moisture on seed germination and recruitment.
- Research: Ex-situ initiatives: Germplasm should be separately collected from the two different populations, as the Bayesian genetic structure indicates that the FL and the SC represent different genetic clusters. Within populations, cuttings should be obtained from individuals located at greater spatial distances. Seeds from two Florida subpopulations (FL3 and FL4, see Oleas et al. 2014) should be chosen for ex situ collection because both are the localities with the highest genetic diversity. (USFWS, 2015)
- Research: The genetic study by Oreas et al. (2014) can inform reintroduction (establishment of R. echinellum in an area which was once part of its historical range) and augmentation (addition of R. echinellum plants to an existing population with the goal of strengthen numbers or provide a more varied genetic structure). According to the study, Florida subpopulation FL 4 shows higher level of genetic diversity and the individuals of this group might be considered good candidates for augmentation or reintroduction programs within the FL population. (USFWS, 2015)
- Research: Establish or implement monitoring for both Florida and South Carolina populations, as needed. Note: The Sumter NF already has a monitoring program, and Steven's Creek began a long-term study in February 2008. Given the limited distribution of the species, a monitoring program should be implemented. Jones (1986) suggested a monitoring program at 10 year intervals, which was implemented to some extent by TNC but at one year interval from 1992 to 2001 in Florida. a. In Florida, TNC transects are well-

established with the re-bar and metal labels in Mays Pond North and Mays Pond South. Data should be collected on these transects every five years to monitor these subpopulations. In the future, all trees >10 cm DBH and all R. echinellum patches should be mapped within each transect. This will provide guidance for positioning the survey tape and monitoring clumps (a rooted stem or tight cluster of stems that is separated by at least 10 cm from the next closest rooted stem; Engstrom 2011) within patches (group of clumps that are at least 1 m from any other clump or patch; Engstrom 2011) will provide another dimension to R. echinellum dynamics. b. The entire Florida population, which has been geo-referenced, should be re-surveyed every five years. The approximate number of clumps, patches, flowers and fruits should be noted at each GPS point. c. For both the Florida and the South Carolina populations, permanent plots could be established, and for each plot: Establish size classes (clump length and width), and estimate population size (density and abundance of individuals and/or clumps) and reproductive clumps (no. of flowering plants, and no. of flowers, fruits and seeds/fruits per plant). The length of longest stem should be used as one of the monitoring clump. This is an ongoing effort for the FL population. (USFWS, 2015)

- Research: Conduct surveys/inventories on potentially new sites, between Northern Florida and South Carolina. This action can include the use of GIS to initially determine potential sites, and later inspection for plants. South Carolina DNR recommend additional surveys of both the steeper bluffs with basic mesic forests and the drier sites along the Steven's/Turkey Creek drainage throughout the adjoining Sumter NF. (USFWS, 2015)
- Research: Population genetic studies: Molecular studies will help clarify the extent and pattern of genetic variability throughout these populations and potential sources of rarity (e.g., unique alleles). A genetic study of the South Carolina sites is encouraged. (USFWS, 2015)
- Research: The development of a Biological Species Status Assessment is recommended for this species. The assessment will provide an in-depth account of the species' overall viability and extinction risk. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES Assessing Florida Population 1. Establish a working group to support regional conservation work for R. echinellum The Southeastern Plant Conservation Alliance (SE PCA) is managed by the Atlanta Botanical Garden (ABG). A pilot project funded ($15K) by the Service in 2020 will contribute to assess the status of the Florida private lands population (reproductive status, provide baseline data, and collect fruit per Center for Plant Conservation guidelines for propagation and seed banking) to prevent extirpation. Efforts to date: • 2021-2022: Pilot project will be initiated in FY22. The ABG applied for FWS funding for additional demographic and ex situ/ in situ work, including baseline demography and additional work in both states. Since proposal was not awarded, the SE PCA will attempt to find further funding to compliment and leverage the $15K pilot project that will go towards the 1st year work in FL - this would also allow SE PCA to work in both states to maximize benefits and accomplish several Recovery actions. ♦ Assess the species' overall viability, and the risk of endangerment / extirpation of the FL population. • ABG recruited and will be advising Emory Univ. graduate student Joseph Stockert. Joseph will be monitoring R. echinellum survival, growth, and reproduction across the species range from 2022-2025. Data will be used to parameterize structured demographic models to provide a comprehensive assessment of the status of these remnant populations, i.e., projected growth rate of each population. Management 1. Foster a working partnership between Tall Timbers, the

Service, and the Mays Pond conservation easement for the Florida population. 2. Foster a working partnership with the Norias Plantation and Reid property landowners. Ongoing by several partners. 3. Fence a larger area at Stevens Creek to protect the plants from deer herbivory and to better assess the impact of browsing on R. echinellum. 4. Monitoring and managing for invasive species i. Frequent inventories or surveys of the Florida population for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the South Carolina populations conducted by SC DNR staff and volunteers and by Sumter NF staff. ii. Eradicate the feral hog population at the Steve's Creek and Long Cane sites. Starting in May 2015, USDA APHIS has been trapping hogs for the Forest Service in compartment 314 as an effort to protect R. echinellum from hog damage. This should reduce hog damage in both the SNF and Stevens Creek. iii. Fence a larger area at Stevens Creek to protect the plants from feral hog damage. Fencing should consist of woven wire at least 28 inches in height to exclude feral hogs. The fence should be staked tightly against the ground to prevent uprooting and access to protected areas. iv. Most of the habitat where R. echinellum occurs is relatively free of invasive nonnative plants. However, the transitional area from the slope forest (north) to the swamp hammocks (south) has some dense Chinese privet and coral ardisia populations. The gooseberry could benefit by eradicating these non-natives, and controlling the high densities of Carolina laurel cherry (T. Engstrom, 2021, pers. comm.) 5. Fire management Slapcinsky et al. (2010) reported that R. echinellum is not fire-dependent, although plant density increased gradually for three years post-fire, and reproduction increased the second-year post-fire. This species has responded in different ways to fire; therefore, management protocols cannot be implemented until a comprehensive study is conducted. We suggested studies to assess the effect of fire on density, fecundity, and size structure. Address the following questions: 1. What is the effect of local fire temperature, or the range of fire temperatures tolerable for the persistence of the species? 2. How often should a prescribed fire be performed? 3. Determine whether the lower size classes, (<30 cm tall), that were bank present in the soil, rooting branches no longer connected to the plants and growing as new clumps, and/or resprouts of fire killed stems. 6. Silvicultural practices South Carolina population: Silvicultural practices in pine plantations upslope from R. echinellum are recommended to promote open woodlands dominated by native pines (shortleaf or longleaf) (SCDNR 2013). Upslope from the Sumter NF population is an area soon to be proposed for longleaf pine woodland restoration, creating more open conditions for pollinators. Research 1. Reproductive biology studies The lack of sexual reproduction over long-term may threaten this species and requires further evaluation (Negrón-Ortiz 2018). a. Since recruitment from seed appeared rare (Negrón-Ortiz 2018), seed germination and seedling survival studies should be expanded and continue at the Florida population, and initiated at the South Carolina population. It would be desirable to compare open pollinated to hand-crossed (within source population, and between FLSC) in seed set and seed germination. In addition, the effect of spring moisture on seed germination and recruitment could also be explored. b. Establish an experimental garden at a botanical garden. Since the two populations of R. echinellum show low genetic diversity, signatures of bottlenecks, and excess of heterozygous which might be caused by overdominance (heterozygote has higher fitness than either homozygote; Oleas et al. 2014), an experimental garden comprising plants from both populations (FL-SC) could be established allowing natural pollination or using manual pollen transfer. Fruits from crosses may then be planted, and seed germination and seedling establishment monitored. 2. Ex-situ initiatives Germplasm should be separately collected from the two different populations, as the Bayesian genetic structure indicates that the Florida and the South Carolina represent different genetic clusters. Within populations, cuttings should be obtained from individuals located at greater spatial distances. Seeds from Mays Pond FL3 and FL4 (Oleas et al. 2014) should be chosen for ex situ collection because both are the localities with the highest genetic

diversity. 3. Expand the seed predation study carried out by Engstrom and Radzio (2014) To answer whether the small cotton mouse is driving changes in seedling recruitment, a series of exclosures and control plots could be established at the Florida population. The exclosure plots will prevent small mammals access the plots. To determine predation of fruits, fruits should be counted before they ripen; then seed germination, seedling recruitment and plant establishment should be monitored in the experimental plots for up to three years. 4. In-situ initiatives: Augmentation/Reintroduction The genetic study by Oleas et al. (2014) can inform reintroduction (establishment of R. echinellum in an area which was once part of its historical range) and augmentation (addition of R. echinellum plants to an existing population with the goal of strengthen numbers or provide a more varied genetic structure). According to the study, Mays Pond FL4 shows higher level of genetic diversity and the individuals of this group might be considered good candidates for augmentation or reintroduction programs within the Florida population. 5. Establish or implement monitoring for both Florida and South Carolina populations, as needed. Note: The Sumter NF already has a monitoring program, and Stevens Creek began a long-term study in February 2008. Given the limited distribution of the species, a monitoring program should be implemented. Jones (1986) suggested a monitoring program at 10-year intervals, which was implemented to some extent by TNC but at one year interval from 1992 to 2001 in Florida. a. In Florida, TNC transects are well-established with the re-bar and metal labels in Mays Pond North and Mays Pond South. Data should be collected on these transects every 5-10 years to monitor these subpopulations. In the future, all trees >10 cm DBH and all R. echinellum patches should be mapped within each transect. This will provide guidance for positioning the survey tape and monitoring clumps (a rooted stem or tight cluster of stems that is separated by at least 10 cm from the next closest rooted stem; Engstrom 2011) within patches (group of clumps that are at least 1 m from any other clump or patch; Engstrom 2011) will provide another dimension to R. echinellum dynamics. b. The entire Florida population, which has been geo-referenced, should be re-surveyed every 10 years. The approximate number of clumps, patches, flowers and fruits should be noted at each GPS point. c. For both the Florida and the South Carolina populations, permanent plots could be established, and for each plot: Establish size classes (clump length and width) and estimate population size (density and abundance of individuals and/or clumps) and reproductive clumps (no. of flowering plants, and no. of flowers, fruits and seeds/fruits per plant). The length of longest stem should be used as one of the monitoring clumps. This is an ongoing effort for the Florida population. 6. Conduct surveys/inventories a. On potentially new sites, between Northern Florida and South Carolina. This action can include the use of GIS to initially determine potential sites, and later inspection for plants. South Carolina DNR recommend additional surveys of both the steeper bluffs with basic mesic forests and the drier sites along the Stevens/Turkey Creek drainage throughout the adjoining Sumter NF. b. Map the entire boundary of R. echinellum every 10-15 years. The distribution of the FL population was mapped in 1985 and a re-survey of the same location, 25 years later, verified its boundary remains the same. 7. Population genetic studies Molecular studies will help clarify the extent and pattern of genetic variability throughout these populations and potential sources of rarity (e.g., unique alleles). A genetic study to understand diversity and clonality of the South Carolina sites is encouraged (USFWS, 2022).

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SPECIES ACCOUNT: *Rorippa gambellii* (Gambel's watercress)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial rhizomatous (with creeping underground stems) branched herb that can grow up to 2 meters (6 feet) tall (this height is confirmed by John Chesnut [in litt. 1998] at Oso Flaco Lake). It roots at lower stem nodes, while the upper stem generally remains erect (Figure 2, Photo 2). It blooms from April to July, producing dense inflorescences (flower clusters) with white flowers; the lateral inflorescences may bloom through August. The inflorescences produce 15 to 30 fruits with about 10 to 30 seeds each (Price 1989). The plant has pinnate (feather-shaped) leaves with 7 to 13 uniform leaflets, which are angular and dentate (toothed) in the upper leaves. Small lobes are present at the base of the leaf stalk. Lower flower stalks often have bracts (specialized leaves), and pedicel (flower stalk) junctions with the main stem are flat. These characters separate this taxon from a look-alike, watercress (Rorippa nasturtium-aquaticum), whose three to seven lateral leaflets are entire or wavy-margined and smaller than the terminal leaflet; the leaflets are more lobed than angular in the upper leaves. The smaller flowers of Rorippa nasturtium aquaticum are supported by pedicels without bracts or flat stem junctions. Moreover, the linear and narrower fruits of Rorippa gambelii have more finely reticulate (net-patterned) seeds, which are arranged in one row per chamber, versus two rows per chamber in Rorippa nasturtium-aquaticum. (USFWS, 1998)

Taxonomy

Nasturtium gambelii was originally described as Cardamine gambellii in 1876 based on a specimen collected by William Gambel in 1844 in the vicinity of Santa Barbara (Watson 1876). Nasturtium gambelii, the currently recognized name, was originally listed by the Service as endangered under the name Rorippa gambellii (Service 1993). While the circumscription of the species (the limits of the species characters and range) has remained constant since its original description, it has been recognized under several different names (some of the names have similar spelling, but because they were recorded with slightly different names they are listed separately), including Cardamine gambellii (Watson 1876, Abrams 1944), Cardamine gambelii (Jepson 1923; Munz 1959, 1968, 1970, 1974; Hoover 1970; Roberts 1989), Rorippa gambelii (Smith 1976, 1998; Roberts 1998; Service 1998, CNPS 2001), Rorippa gambellii (Al-Shehbaz and Rollins 1988, Rollins 1993, Service 1993, Skinner and Pavlik 1994), Nasturtium gambellii (Al-Shehbaz and Price 1998), and Nasturtium gambelii (Index of California Plant Names 2009). (USFWS, 2011)

Historical Range

Historically, Nasturtium gambelii occurred in cismontane regions (on the coastward side of the mountains) of central and southern California, in Orange, San Bernardino, Los Angeles, Santa Barbara, and San Luis Obispo Counties, California. (USFWS, 2011)

Current Range

Pure Nasturtium gambelii plants are currently known from one remaining wild population on Vandenberg Air Force Base in Santa Barbara County, California (Keil 1997, CNDDB 2010), and one additional site where plants were introduced in October 2008 on the Refuge in San Luis

Obispo County, California. (USFWS, 2011)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinating (NatureServe, 2015)

Reproduction Narrative

Adult: Pollinator exclusion experiments have been conducted on this species in the field (Mazer et al. 1994) and demonstrated seed set in bagged specimens. No pollinators were ever seen in 2 seasons of fieldwork. Soil cores taken from the sites where Rorippa are still extant show a viable seed bank in the soil throughout the spring and summer growing season. These seeds germinated under greenhouse conditions. Detailed mortality and longevity data are not yet available for these dormant seeds. The average lifetime fruit and seed production for the Black Lake Canyon population of Rorippa has been estimated at 85.8 fruits and 882 seeds.; Rorippa gambelii requires permanent fresh or brackish wetland areas. It is intolerant of competition and seems to require clearings to survive. Encroaching eucalyptus trees are competing for water and light, and alleopathic effects from the trees may also be harming the Rorippa population. No known diseases or pests attack Rorippa. The very limited distribution of this species and changes in local hydrology are threatening it with extinction.; Predominantly selfing (NatureServe, 2015).

Habitat Type

Adult: Wetlands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits permanent wetlands, fresh or brackish, in marshes or along the borders of lakes and slow-flowing streams or ditches. Soils are acidic sandy peats. Sea level to 450 m elevation. (NatureServe, 2015). High eclogical integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the limited number of populations and the specific haibtat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal needs further research (USFWS, 1998)

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

1 (USFWS, 2022)

Population Narrative:

There is currently only one extant, non-hybridized Gambel's watercress population at VSFB, consisting of two separate colonies that occupy a total of 0.024 hectare/0.06 acre (Lum 2021, pers comm). Abundance is unknown due to difficulty of discerning genetically unique individuals above-ground. Currently, we do not have any proposed outplanting projects for the species. (USFWS, 2022) . In 2020, the Service funded a project designed to evaluate the hybridization potential of Gambel's watercress and learn more about its reproductive biology and breeding strategy in an ex situ, greenhouse setting. Santa Barbara Botanic Garden (SBBG) staff made three bulk Gambel's watercress seed collections from the two extant patches at VSFB to start this work in August of 2021. They collected a total of 3,371 seeds from the eastern patch and 1,888 seeds from the western patch. SBBG will bank any seeds not used in direct support of the project (Schneider 2021, pers comm). These banked seeds are of use for additional seed bulking efforts, outplanting recovery projects, and can serve as backup in the event of catastrophic loss of the species. (USFWS, 2022)

Threats and Stressors

Stressor: Development/Urbanization (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Since the time of listing, there has been a loss and degradation of habitat due to development and urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development and urbanization. Some of this habitat loss has occurred in watersheds that are classified as impaired by the Regional Water Quality Control Board due to excessive amounts of nitrogen and other nutrients (California State Water Resources Control Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998). The excessive growth of some vegetation (e.g., willows, bulrush, Typha (cattails)) causes type conversion of habitat (such as at Black Lake Canyon and Oso Flaco Lake) and a decline in the quantity and quality of habitat suitable for Nasturtium gambelii. Most of the historical populations and their surrounding areas are urbanized and/or indirectly impacted by urbanization, which has further limited this species' ability to colonize adjacent suitable habitat. These conditions also limit sites and opportunities for successful

introductions and reintroductions. (USFWS, 2011).

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Herbivory has been noted on plants at the introduced site on the Refuge (M.A. Elvin, pers. obs. 2009) and on plants under propagation at University of California, Irvine (UCI) Arboretum (Barry Nerhus, U.C. Irvine, pers. comm. 2006). While this plant may be able to withstand some herbivory, the herbivory may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. The extent of this threat is not known, but the loss of even a few flowers due to herbivory, if it led to an even slight decrease in reproductive success, may have a significant effect on the long-term survival of N. gambelii because there are so few individuals remaining in the wild. Therefore, the relative threat from predation is greater now than was thought to be the case at the time of listing, because there are fewer populations and fewer individuals per population than at the time of listing (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: From the time of listing until recently, existing regulatory mechanisms appear to have done little to ameliorate threats to Nasturtium gambelii, and substantial threats remain; however, recent efforts to improve protections may provide additional benefit to the species in the future. Other Federal and State regulatory mechanisms (e.g., CEQA, California Coastal Act) provide discretionary protections for the species based on current project review and permitting practices (USFWS, 2011).

Stressor: Small population size (USFWS, 2011)
Exposure:
Response:
Consequence: Extinction/lack of genetic diversity
Narrative: The conservation biology literature commonly notes the vulnerability of taxa known from very few locations or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). The small size of the gene pool of the species (Mazer et al. 2000) may depress reproductive vigor, or increase the likelihood that a single human-caused or natural environmental disturbance (e.g., flood, drought, disease) could cause the extinction of Nasturtium gambelii. Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (having identical pairs of alleles for any given gene), which could result in the expression of disadvantageous traits (Menges 1991). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). The existence of less than five populations and the small number of individuals in these populations places Nasturtium gambelii at extreme risk of extinction due to low levels of genetic diversity (USFWS,

2011).

Stressor: Other natural or manmade factors (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/extinction
Narrative: Natural catastrophes such as fire, landslide, or prolonged drought could result in the loss of populations (Shaffer 1981), particularly for species with fewer than five populations. An increase in urban development has reduced the range of Nasturtium gambelii considerably. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. Increasing development in the area will likely increase threats from stochastic events. We believe that the existence of one known wild population and the small number of individuals in the population exacerbate the risk of extinction to Nasturtium gambelii from stochastic events.

Stressor: Competition with nonnative species (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The effects of competition with nonnative species are most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of Nasturtium gambelii independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of N. gambelii (USFWS, 2011).

Stressor: Nutrient loading in watersheds (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Threats identified since the time of listing include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or historically supported Nasturtium gambelii. These nutrient levels can cause excessive growth of vegetation (biostimulation) in some species that may out-compete N. gambelii plants. The excessive growth of other vegetation (both native and nonnative) can have direct effects on N. gambelii individuals. The other plants can outcompete N. gambelii individuals for essential physical and biological elements (i.e., space for growth, food, water, light, minerals). This stress likely effects the survival of some individual plants or occurrences and increases the impact of threats to the species from stochastic events (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Park et al. (1989) projected that of the saltmarshes along the coast of the contiguous United States, 30 percent would be lost with a 1.6-foot (0.5-m) SLR, 46 percent with a 3.3-foot (1-m) SLR, 52 percent with a 6.6-foot (2-m) SLR, and 65 percent with a 9.8-foot (3-m) SLR. While we cannot project directly to California from the estimates of Park et al. (1989) who focused on the

east coast and Gulf coast of the United States, we can anticipate that with a projected SLR of up to almost 6.6 feet (2 m) that much of the coastal saltmarshes in California would be lost by 2100. Beaches, dunes, and coastal areas would be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 (CCC 2001, Heberger et al. 2009). This is estimated to result in erosion and shoreline retreat between 459 and 1 ,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because Nasturtium gambelii historically occurred in coastal dune habitats throughout its range, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks for this species (USFWS, 2011).

Stressor: Genetic swamping (USFWS, 2011)
Exposure:
Response:
Consequence: Lack of genetic variability
Narrative: The N. gambelii plants at Oso Flaco Lake appear to be genetically compromised and introgressed with the locally abundant nonnative species N. officinale based on morphological and molecular evidence of hybridization (Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2009, 2010; CNPS 2009). The N. gambelii population (at VAFB) has at least two individuals that may be of hybrid origin with N. officinale (Prince 2008a, 2008b). The introgression of N. gambelii plants at Oso Flaco Lake and the potential introgression of two N. gambelii plants at VAFB (Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2009, 2010; CNPS 2009) suggest the species is in danger of extinction.

Recovery

Reclassification Criteria:
1. When new plants are established so that there are at least 5 populations of at least 500 individuals each (USFWS, 1998)

2. When some of the populations occur in permanently protected habitats within the Black Lake Canyon and the dune lakes area (USFWS, 1998)

3. When some of the populations are in other areas of suitable habitat with the species' historical range in the United States (USFWS, 1998)

4. When the populations remain viable for at least 5 years. Viable populations are defined as those that are showing natural reproduction and either stable or increasing in size over time, without artificial augmentation(USFWS, 1998)

Delisting Criteria:
1. If threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. The most outstanding management needs currently are: a) controlling competition with nonnative species and hybridization with common watercress, and b) managing water conditions, particularly flow and nutrient loads, that the species depends on. (USFWS, 2019)

2. If populations are established across the species ecological settings (in addition to Black Lake Canyon and the Dune Lakes area in San Luis Obispo County), including suitable site(s) in the Santa Barbara County and Ventura County region (e.g.; the San Antonio Creek drainage on Vandenberg Air Force Base or comparable sites); and coastal wetlands in Los Angeles, Orange, or San Bernardino Counties (USFWS, 2019)

3. If the populations remain viable for at least 10 years. Because this species has narrow microhabitat conditions that it will tolerate, particularly with respect to water flow and nutrient loads, and in light of fluctuations that can occur with climatic conditions and local water availability and nutrient loading, the persistence of populations with these varying conditions over time needs to be confirmed. (USFWS, 2019)

Recovery Actions:

- 1. Protect, maintain, and enhance species habitats. The most important immediate objective in the recovery plan for and Rorippa gambelii is the protection of its habitat. - Coordinate among agencies involved in recovery activities. - Define and maintain the sensitive Resource Area boundary and restrictions at Black Lake Canyon. - . Establish protection agreements. - Acquire key land parcels and conservation easements. Enhance existing habitat at Black Lake Canyon. - Continue to protect, maintain, and enhance habitat in the Dune Lakes area. - . Communicate species and habitat protection information to all concerned parties. (USFWS, 1998)
- 2. Document and monitor population and habitat characteristics. - Conduct plant surveys. - Protect newly discovered populations. - Monitor all populations and habitats. (USFWS, 1998)
- 3. Conduct research on the ecology and biology of the species. - Identify potential impacts of conducting research. - Determine population characteristics and life history of the species. - valuate species' tolerances. - Investigate the effects of genetic diversity. (USFWS, 1998)
- 4. Augment existing populations. In addition to protecting existing and newly discovered habitats of Rorippa gambelii, monitoring these populations and their habitats, and conducting research on the biology and ecology of the species, attempts should be made to augment existing populations. (USFWS, 1998)
- 5. Establish new populations. Because Rorippa gambelii currently has very restricted distribution in California, establishment of new populations within the historic range of the species at potentially suitable sites other than at historic sites should be attempted. If new populations are successfully established, it will reduce the likelihood that a catastrophic event could result in the extinction of the species with its current restricted distribution. (USFWS, 1998)
- 6. Evaluate Progress and Update Management and Recovery Guidelines. Results of all recovery activities should be evaluated and incorporated into updated management and recovery guidelines for the species. All relevant information should be distributed. (USFWS, 1998)
- Work with the U.S. Air Force at Vandenberg Air Force Base to implement site-specific management activities in the immediate future to avoid and alleviate threats (such as from stochastic events) to prevent the loss of the last, known remaining wild population (USFWS, 2011).

- Work with others to establish new populations in the near future to reduce the risk of extinction to Nasturtium gambelii in each of the two ecological regions of its historical range in California (coastal central California and coastal southern California) (USFWS, 2011).
- Work with others to establish and maintain ex situ stock populations with at least one institution in each of the three ecological regions of its historical ranges (USFWS, 2011).
- Work with the Central Coast Regional Water Quality Control Board to determine nutrient levels in the watersheds which historically supported Nasturtium gambelii in the recent past (particularly Black Lake Canyon and Oso Flaco Lake) to determine what may have led to the loss of N. gambelii form these sites, and work with local landowners and stakeholders to alleviate (and remove) any threats to N. gambelii that are associated with water quality (USFWS, 2011).
- Continue genetic analyses to determine the extent of variation within and between Nasturtium gambelii populations and the magnitude of the threat of gene swamping from N. officinale to help determine an appropriate recovery and reintroduction strategy (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Conduct annual monitoring of both the VSFB and Oso Flaco Lake Gambel's watercress populations. Include counting and reporting the number of above ground vertical stems and global positioning system (GPS) mapping of occupied spatial area, co-occurring and co-dominant vegetation, presence of natives versus nonnative species, percent canopy cover, hydrological conditions, timing of phenology, and presence of potential insect pollinators. Consistent data collection and reporting will allow for meaningful comparisons and analyses of trends. 2. Implement threats management activities at each population, including vegetation management such as trimming and removal, invasive weed abatement, and sediment removal and erosion controls. 3. Document the presence and extent of common watercress within the San Antonio Creek and Osos Flaco Lake watersheds. Improve assessment of morphological traits of pure versus hybrid Gambel's watercress to better facilitate rapid visual assessments of introgression in the field. Conduct control and eradication of common watercress where appropriate. 4. Develop an effective rapid method for sequencing and genotyping to characterize Gambel's watercress genetic population structure and accurately evaluate abundance. 5. Determine if the seed bank harbors additional Gambel's watercress genetic diversity. If so, introduction/reintroduction projects may utilize such grown out plants and potentially restore lost genetic integrity to the species. 6. Determine how vegetative succession and other hydrological changes associated with eutrophication and biostimulation are affecting the species and employ remedial measures to restore occupied habitats to optimal conditions for recovery. 7. Research the species reproductive biology to evaluate and quantify hybridization with common watercress, including self-compatibility, breeding system, seed viability, and morphology of pure and hybrid lineages. Work to better understand the species pollinators, fruiting and seed production, and optimal ecological factors that favor Gambel's watercress growth and population expansion. 8. Conduct genetic studies and other controlled experiments to evaluate the hypothesis that hybrid individuals have reduced viability and that when we remove common watercress, selective forces may act over successive generations to return genotypes back to pure Gambel's watercress forms. (USFWS, 2022)

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SPECIES ACCOUNT: *Sanicula purpurea* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

Sanicula purpurea is a stout and erect perennial member of the Apiaceae (parsley family). It ranges in height from 8 to 36 cm (3.1 to 14.2 in) with stems originating from numerous kidney- to heart-shaped basal leaves that are 3 to 7-lobed and 2 to 8 cm (0.8 to 3.1 in) wide. The small purple or cream-colored flowers form branched terminal umbels of 6 to 10 flowers. Fruits are spherical, prickly, and 2.0 to 3.5 mm (0.08 to 0.14 in) long and 2 to 3 mm (0.08 to 0.12 in) wide (Wagner et al. 1999).

Historical Range

See current range/distribution

Current Range

Sanicula purpurea is known from Oahu and Maui. On Oahu, it occurred along the Koolau Mountain summit crest from 700 to 1,698 m (2,300 to 5,570 ft) elevation on wet, windswept slopes. Currently, on Oahu, 45 individuals are found as part of six occurrences at Helemano-Punaluu divide (10 individuals), north Kaukonahua-Punaluu Summit (8), Kaukonahua-Kahana summit (22), Waimalu-Kahaluu summit divide (1), Puu Keahiakahoe (1), and Wailupe-Waimanalo summit divide (3) (HINHP Database 2001; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003). On West Maui, 200 individuals are distributed throughout seven scattered occurrences along 2.5 km (1.6 mi) of the Puu Kukui trail and on the West Maui Natural Area Reserve in the Puu Kukui watershed. In total, there are 245 individuals of S. purpurea known to remain in the wild (Service 1999b; K. Kawelo, U.S. Army, pers. comm. 2003; J. Lau, HINHP, pers. comm. 2003).

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Sanicula purpurea under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Hawaii (81 FR 17790-18110). On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Sanicula purpurea under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Sanicula purpurea (77 FR 57648-57862). The critical habitat designation includes 14 critical habitat units, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Sanicula purpurea includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat designation for Sanicula purpurea includes seven CHUs in Maui County, Hawaii. Approximately 1,399 ac (567 ha) of federal, private and state land on the Island of Maui (west Maui) are being designated as critical habitat for Sanicula purpurea. (81 FR 17790-18110).

Maui—Montane Wet—Unit 6 (and) Palmeria dolei—Unit 15—Montane Wet (and) Pseudonestor xanthophrys—Unit 15— Montane Wet This area consists of 1,113 ac (451 ha) of State land, and 286 ac (116 ha) of privately owned land, at the summit and surrounding areas on west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). They are occupied by the plants Bidens conjuncta, Calamagrostis hillebrandii, Cyanea kunthiana, Geranium hillebrandii, Myrsine vaccinioides, and Sanicula purpurea. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Wet—Unit 6 is not known to be occupied by the plants Acaena exigua, Cyrtandra oxybapha, Huperzia mannii, Phyllostegia bracteata, or Platanthera holochila, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat desisgnation for Sanicula purpurea includes 14 critical habitat units, covering two ecosystem types, which encompass approximately 30,056 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; Oahu—Wet Cliff—Units 6, 7, 8.

Oahu—Lowland Wet—Unit 6 [790 ac (320 ha)]. This area consists of 790 ac (320 ha) of privately owned land in the lowland wet ecosystem, in privately owned land on the windward side of the Koolau Mountains, and includes Kahawainui, Ihiihi, Wailele, and Koloa gulches. Oahu—Lowland Wet— Unit 7 [1,787 ac (723 ha)]. This area consists of 1,499 ac (606 ha) of State land and 288 ac (117 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, within the Kaipapau and Haula Forest Reserves and Sacred Falls State Park, from Puukainapuaa to Kaluanui (Sacred Falls). Oahu— Lowland Wet—Unit 8 [3,041 ac (1,231 ha)]. This area consists of 1,386 ac (561 ha) of State land and 1,655 ac (670 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, partially within the Ahupuaa O Kahana State Park, including Waihoi Springs, and Punaluu, Kahana, Waikane, Waikeekee, and Uwao streams. Oahu—Lowland Wet—Unit 9 [15,728 ac (6,365 ha)]. This area consists of 3,827 ac (1,545 ha) of State land, 147 ac (60 ha) of City and County of Honolulu land, 4,509 ac (1,825 ha) of Federal land (U.S. Fish and Wildlife Service), and 7,245 ac (2,932 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, partially within the Ewa FR Waimano Section and the Oahu Forest National Wildlife Refuge. This area extends along the Koolau summit from Waipio to Manaiki Stream. Oahu—Lowland Wet—Unit 10 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) of privately-owned land in the lowland wet ecosystem in private land on the windward side of the Koolau Mountains, along Kaalaea Stream. Oahu—Lowland Wet— Unit 11 [124 ac (50 ha)]. This area consists of 124 ac (50 ha) in the lowland wet ecosystem, owned by the City and County of

Honolulu on the windward side of the Koolau Mountains, along Waihee Stream. Oahu—Lowland Wet—Unit 12 [53 ac (21 ha)]. This area consists of 28 ac (11 ha) of City and County of Honolulu land and 26 ac (10 ha) of privately-owned land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Kahaluu Stream and tributary. Oahu—Lowland Wet—Unit 13 [75 ac (30 ha)]. This area consists of 74 ac (30 ha) of City and County of Honolulu land and 1 ac (0.5 ha) of State land in the lowland wet ecosystem on the windward side of the Koolau Mountains, along Heeia Stream and tributaries. Oahu—Lowland Wet— Unit 14 [478 ac (193 ha)]. This area consists of 274 ac (111 ha) of State land, 195 ac (79 ha) of City and County of Honolulu land, and 9 ac (4 ha) of privately owned land in the lowland wet ecosystem on the leeward side of the Koolau Mountains, extending from the Wilson Tunnel area southeast to Moole Stream. Oahu— Lowland Wet—Unit 15 [407 ac (165 ha)]. This area consists of 407 ac (165 ha) in the lowland wet ecosystem in State of Hawaii Department of Land and Natural Resources Land Division land on the windward side of the Koolau Mountains in Maunawili Valley, including Omao and Maunawili streams and Kapakahi and Pikoakea Springs. Oahu—Lowland Wet—Unit 16 [2,507 ac (1,014 ha)]. This area consists of 1,533 ac (621 ha) of State land, 365 ac (148 ha) of City and County of Honolulu land, and 608 (246 ha) of privately owned land in the lowland wet ecosystem in on the leeward side of the Koolau Mountains, partly within the Honolulu Watershed Forest Reserve, extending from the eastern side of Nuuanu Valley southeast along the Koolau summit to Kulepeamoa Ridge.

Oahu—Wet Cliff—Unit 6 [151 ac (61 ha)]. This area consists of 151 ac (61 ha) in the wet cliff ecosystem on State land on the windward side of the Koolau Mountains in Kaipapau Gulch, entirely within the Kaipapau Forest Reserve. Oahu—Wet Cliff—Unit 7 [144 ac (58 ha)]. This area consists of 144 ac (58 ha) in the wet cliff ecosystem in State land on the windward side of the Koolau Mountains in Hauula Gulch, entirely within the Hauula Forest Reserve. Oahu—Wet Cliff—Unit 8 [4,649 ac (1,881 ha)]. This area consists of 1,479 ac (598 ha) of State land, 1,281 ac (519 ha) of City and County of Honolulu land, 5 ac (2 ha) of Federal land, and 1,884 ac (762 ha) of privately owned land, in the wet cliff ecosystem along the summit of the Koolau Mountains, overlapping portions of Sacred Falls State Park, the Waiahole FR (Waiahole and Iolekaa sections), the Kaneohe and Honolulu Watershed FRs, and the Nuuana Pali State Wayside.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Sanicula purpurea critical habitat consists of one component (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium. Species- specific physical or biological features: Bogs.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Sanicula purpurea critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Sanicula purpurea occurs within the Lowland wet and Wet cliff ecosystems in the Koolau Mountain caldera complex:

Oahu—Lowland Wet—Units 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Oahu—Wet Cliff—Units 6, 7, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: >65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the

critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for Sanicula purpurea to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, and limiting factors for S. purpurea are unknown. S. purpurea is considered to be a short-lived perennial (Service 1999b).

Habitat Type

Adult: Montane bogs

Habitat Narrative

Adult: Sanicula purpurea occurs in open mixed montane bogs or Metrosideros polymorphadominated mixed montane bogs and windswept shrublands within the cloud zone between 415 and 959 m (1,361 and 3,146 ft) elevation. Associated native plant species include Bidens spp., Cheirodendron spp., Dicanthelium koolauense, Gahnia beechyi, Leptecophylla tameiameiae, Lycopodium spp., Machaerina angustifolia, Plantago pachyphylla, Sadleria pallida, and Vaccinium spp. (HINHP Database 2001).

Dispersal/Migration

Population Information and Trends

Number of Populations:

4 (USFWS, 2022)

Population Size:

27 total (USFWS, 2022)

Population Narrative:

New Status Information: • In 2012, Army Natural Resources reported 76 immature individuals, three mature, and two seedlings at East Range (Oʻahu) (Army Natural Resources 2018). Currently, two populations on west Maui total fewer than 10 individuals, and two populations in the Koʻolau Mountains of Oʻahu total approximately 16 individuals (PEPP 2015, 2016, 2017a, 2017b, 2018; Oppenheimer 2018, in litt.). There is no new information regarding the status of populations on west Maui at Paunau and the ʻEke Crater area (last observed in the early 2000s). The Oʻahu population at the Koʻolau summit at Wailupe has not been monitored since 2013 (Ching 2018, in litt.). The IUCN recently estimated as many at 60 individuals in eight subpopulations for both islands (Keir et al. 2016). • In 2012, critical habitat was designated in 14 units on Oʻahu in two ecosystems (lowland wet and wet cliff) (30,058 ac; 12,162 ha) (77 FR 57648, September 18, 2012). In 2016, two critical habitat units in one ecosystem (montane wet) were designated on west Maui for Sanicula purpurea (1,479 ac; 599 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018). Currently, there is one known population on Maui at Honokōhau totaling three mature and one immature individual (Plant Extinction Prevention Program (PEPP) 2022). Two additional populations known from Maui, at Honokōhau and Honokōwai, were monitored in 2020 and no individual plants were observed (PEPP 2020, 2022). On Oʻahu, three populations

are known from Helemano, Kaukonahua, and Schofield-Waikāne totaling 21 mature plants (Ching-Harbin et al. 2020; 2021; Ching-Harbin and Thomas 2021). Approximately four additional populations from O‘ahu and Maui have not been monitored in over 15 years, and the status of the plants is unknown. The International Union for the Conservation of Nature (IUCN) assessment of Sanicula purpurea from 2016 estimated as many at 60 individuals in eight subpopulations for both islands (Keir et al. 2016). • Currently, there are approximately 11 founder lines represented in ex situ storage and propagation collections, including seeds in seed banks and plants in a nursery or living collection (USFWS, 2022).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: Threats to Sanicula purpurea on Oahu include potential effects of on-going and future Army training activities, habitat degradation by feral pigs, competition from non-native plant species, reduced reproductive vigor, and a risk of extinction due to the small number of existing occurrences and stochastic events. The non-native plant species Axonopus fissifolius and Clidemia hirta threaten S. purpurea by altering its habitat and competing with it for nutrients, light, and space (HINHP Database 2001; Service 1999b).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that Sanicula purpurea is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.705 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Recovery Actions:

- A State-wide management plan should be developed and implemented for the long-term conservation of all known occurrences of Sanicula purpurea. This plan should also include broader landscape actions that are needed for the recovery of this plant throughout its range. The recovery plan for this species identifies the following important conservation actions: construction of exclosures protect the known occurrences from feral pigs and goats, subsequent control and/or removal of ungulates, and removal of competitive non-native plant species. Priority for all of these actions should be given to those occurrences with only a few individuals (e.g., Waimalu-Kahaluu Summit Divide, Puu Keahiakahoe). Additional surveys are also needed throughout suitable habitat to locate new occurrences and update the status of those occurrences that have not been seen in recent years (Service 1999b). Ongoing Conservation Actions: Sanicula purpurea is found in bog habitat in the Puu Kukui watershed owned by Maui Land and Pineapple on Maui. Since 1988, Maui Land and

Pineapple has managed Puu Kukui Watershed and is receiving funding from the Service to survey for rare plants on their lands and build feral ungulate exclosures to protect listed species, including S. purpurea, that occur in the watershed. Maui Land and Pineapple have also constructed a boardwalk in Puu Kukui that spans the known range of this occurrence of S. purpurea. Entry into this area is strictly regulated to prevent the inadvertent introduction of competitive non-native plant species (Service 1999b; 68 FR 25934).

- New Management Actions: • Surveys and inventories—In 2016, the Plant Extinction Prevention Program (PEPP) noted that Sanicula purpurea on Oʻahu should be elevated to "POP" status (potential PEPP, with fewer than 50 individuals in the wild) and that additional surveys of known populations on west Maui were needed to determine if elevation to a "POP" status was necessary (PEPP 2016). • Captive propagation for genetic storage and reintroduction— o In 2017, collections were made from five of 10 founders from Helemano (Oahu) and two of 27 founders from East Range (Oahu) (PEPP 2017b). o The Oahu Army Natural Resource Program's seed bank stores seeds from one founder from Opaeula and five founders from Helemano (Army Natural Resources 2018). o In 2017, the Lyon Seed Conservation Laboratory reported 53 seeds in storage from Honokōhau (west Maui) and 81 seeds in storage from Honokōwai (west Maui) (Lyon Arboretum 2017) (USFWS, 2018).
- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are reiterated for 5-year review for 2018. • Surveys and inventories—Continue to survey for additional populations of Sanicula purpurea in areas of potentially suitable habitat on west Maui. Reassess the status of populations at Paunau and ʻEke on west Maui, and the status of the population at the Koʻolau summit at Waimānalo on Oahu. • Ungulate monitoring and control—Maintain existing fences to protect populations from the negative impacts of feral pigs. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations of S. purpurea. • Rodent predation and herbivory—Control rats in the vicinity of known populations. • Slug herbivory—Develop and implement methods to control slugs. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Human disturbance—Continue to maintain fencing to protect populations from hiking and trail maintenance impacts. • Stochastic events—Reduced viability—Research life-cycle aspects of the species that affect seed production, viability, and regeneration. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for its recovery. • Alliance and partnership development—Work with the west Maui and Oahu land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2023. • Surveys and inventories— o The historical range of Sanicula purpurea should be surveyed, including populations at Paunau and ʻEke on Maui, and populations on Oahu. o Continue surveys for populations of S.

purpurea in areas of potentially suitable habitat on Maui and O‘ahu. o Determine suitable locations for reintroductions. • Ungulate monitoring and control—Continue to maintain fenced exclosures and construct new fences to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Sanicula purpurea within and around all wild populations. • Fire prevention and control—Develop and implement fire prevention management plans and monitor populations after fire occurrence. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change, including increasing temperatures, periods between rain events, and frequency and intensity of hurricanes. Additional management actions may be needed, such as locating microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and implement effective methods for control of rodents and slugs around wild populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and initiate plans for reintroductions. • Build resiliency, redundancy, and representation — Increase species’ viability through habitat restoration, threat control, and reintroduction and translocation. Continue reintroduction into suitable habitat that is being managed for known threats to this species to reduce impacts of erosion, treefall, flooding, and hurricanes. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2022).

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SPECIES ACCOUNT: *Sarracenia oreophila* (Green pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 10/21/1979

Physical Description

A perennial, carnivorous herb arising from rhizomes. The leaves consist of two types: tubular or pitcher-shaped leaves, appearing in the spring, that grow 2-7.5 dm tall, which, in late summer begin to wither and are replaced by flat, prostrate leaves that persist until the following spring. Flowers 5-parted, with yellow petals 4-5.5 cm long; pendent, borne singly on an erect, leafless scape to 7 dm tall. Flowering Season: early May to early June (NatureServe, 2015).

Taxonomy

Distinct species, one of only three species of Sarracenia with a geographical distribution outside the coastal plain (NatureServe, 2015).

Historical Range

Historically, the distribution of Sarracenia oreophila spanned five different geographical provinces: The Cumberland Plateau, Blue Ridge, Piedmont, Ridge and Valley, and East Gulf Coastal Plain (U.S. Fish and Wildlife Service 1985) (NatureServe, 2015).

Current Range

Restricted to areas of the Cumberland Plateau and the Ridge and Valley province in these four regions: Coosa Valley, Lake Chatuge, Lookout Mountain, and Sand Mountain (USFWS 2013). Extent of occurrence was calculated during the 2015 conservation status review to be approximately 9,000 sq. km. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Carnivory is the most striking interaction between members of the genus Sarracenia and other species, though the precise benefit to pitcher plants from this highly specialized adaption is not understood. Christensen (1976) found that when insects were fed to Sarracenia flava, there was no consequent increase in Ca, Mg, or K in the plants' leaf tissue. However, nitrogen and phosphorus did increase, indicating that carnivory may be useful in soils low in these elements. Folkerts (1982) suggests that carnivory may be used to obtain micronutrients, such as molybdenum, which are present at very low levels in a low pH environment. Folkerts (1982) also proposes that carnivory may be important at times of nutrient stress since nutrient levels in bogs decrease over the course of the growing season. Another possibility is that the breakdown of prey detritus from decaying pitchers may help fertilize the soil around the plants (Christensen 1976) (USFWS, 2013).

Breeding Season

Adult: The flowers of the green pitcher plant mature in late April at lower elevations, and mature in May at higher elevations (Troup 1982) (NatureServe, 2015).

Reproduction Narrative

Adult: Sarracenia oreophila reproduces both sexually and asexually, though in some situations, reproduction may be limited to asexual means, resulting in large spreading clones (Troup and McDaniel 1980). Humphrey (1987) estimates that green pitcher plants do not become sexually mature until they are 6-7 years old. The flowers of the green pitcher plant mature in late April at lower elevations, and mature in May at higher elevations (Troup 1982). Cross pollination is needed for seed to set (Troup and McDaniel 1980). Insects associated with S. oreophila flowers which may act as pollinators include flies (Sarcophaga spp.), honeybees (Apis spp.) and bumblebees (Bombus spp.) (Troup and McDaniel 1980). Fruits mature in early autumn, but seed may not be released right away (Troup and McDaniel 1980). Seeds are apparently water dispersed (Troup and McDaniel 1980) (NatureServe, 2015).

Habitat Type

Adult: Streambanks/Bogs/Flatwoods (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sandy and highly acidic soils (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Historically, the distribution of Sarracenia oreophila spanned five different geographical provinces: The Cumberland Plateau, Blue Ridge, Piedmont, Ridge and Valley, and East Gulf Coastal Plain (U.S. Fish and Wildlife Service 1985). The present distribution of S. oreophila is restricted to the Cumberland Plateau, Blue Ridge, and Ridge and Valley provinces (U.S. Fish and Wildlife Service 1985), with known, extant populations in northeastern Alabama (Jackson, Marshall, DeKalb, Cherokee and Etowah Counties), northeastern Georgia (Towns county) and adjacent North Carolina (Clay County) (Humphrey 1987). Three distinct habitat types have been described for S. oreophila. They are sandstone streambanks, with 13 extant colonies in the Cumberland Plateau; mixed oak or pine flatwoods, with 5 extant colonies in the Cumberland Plateau; and seepage bogs, with 5 extant colonies in the Cumberland, 2 colonies in the Blue Ridge, and 2 colonies in the Ridge and Valley provinces (U.S. Fish and Wildlife Service 1985). The soils in all of these habitats are sandy and highly acidic. Woodland and bog soils are sandy clays and loams with an upper layer of organic material, while the streambank soils are composed almost purely of sand (U.S. Fish and Wildlife Service 1985) (NatureServe, 2015). High ecological integrity of the community and site fidelity along with low tolerance ranges are inferred based on the specific habitat needs of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal is poorly understood for this species. However, a study of a related, wide-spread pitcher plant species, Sarracenia purpurea, indicates that seed dispersal distance from parent plants is typically only a few inches (Ellison and Parker 2002). These authors further suggest that water may facilitate dispersal over longer distances for Sarracenia species. Indeed, flooding events are thought to be responsible for the establishment of some green pitcher plant colonies (G. Folkerts 1992). For example, flooding may have transported seeds from upland bog colonies to suitable streambanks within the Little River watershed (Emanuel 1998) (USFWS, 2013).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:

Likely stable as fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to impacts such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including S. oreophila, have become critically imperiled (NatureServe, 2015).

Number of Populations:

13 (USFWS, 2020)

Adaptability:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. (NatureServe, 2015)

Population Narrative:

At this time, green pitcher plant continues to meet the definition of endangered under the ESA. Since completion of the last 5-year review (available online at https://ecos.fws.gov/docs/five_year_review/doc4366.pdf), available information on the species' populations and trends indicate that the species is in an overall decline. This overall trend is driven in large part by the apparent losses of two populations within the Little River system in Alabama. As such, there are currently 13 extant populations of green pitcher plant. Continued conservation work (e.g., habitat management) has contributed to the species' continued existence throughout its historic range. However, inconsistent and unavailable monitoring of various populations increases the uncertainty associated with this assessment. Continued and improved monitoring is needed to adequately understand and assess the status, trends, and threats to green pitcher plant, particularly for populations occurring on public and conservation lands. Currently, eight populations occur at least in part on public or conservation lands, which is less than occurred on such lands at the time of the 2014 5-year review. Conservation of the remaining populations requires continued support and cooperation of private landowners, without which, these populations may decline and become extirpated. Green pitcher plant

conservation efforts have been encouraged, engaged in, and/or funded by the U.S. Fish and Wildlife Service, National Park Service, TNC, universities, state Plant Conservation Alliances, and various state agencies. (USFWS, 2020)

Threats and Stressors

Stressor: Development (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/Loss of populations
Narrative: Development of land for agriculture and housing is a threat to this species (USFWS, 2013).

Stressor: Fire suppression (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire is an integral part of maintaining green pitcher plant bog habitats (Service 1994; Boyer and Carter 2011; NatureServe 2013). In the absence of regular fires, competing plant species encroach on green pitcher plant habitats and out-compete the pitcher plants for resources (e.g., nutrients and light) (Troup and McDaniel 1980; Jennings and Rohr 2011). Encroachment of competing vegetation can lead to the eventual elimination of green pitcher plants (44 FR 54922). Furthermore, excessive fuel accumulation may occur at sites where fire has been excluded or occurs rarely, thus increasing the risk of re-introduced fires having potentially detrimental effects to green pitcher plants (Hermann 2014, in litt.). Alternatively, burning too frequently (e.g., multiple annual fires) or regularly burning during unfavorable seasons (e.g., winter) may reduce habitat suitability for green pitcher plants (Service 1994). Similarly, frequent application of early growing season burns may eliminate seedling recruitment (Determann 2013c, in litt.) (USFWS, 2013).

Stressor: Over-collection (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individual plants/loss of populations
Narrative: Over-collection was cited as a reason for listing the green pitcher plant in 1979 (44 FR 54922) and was considered a serious threat when the current recovery plan was revised 15 years later (Service 1994). Recent reviews of threats to carnivorous species note that over-collection of wild plants and plant parts remain a persistent threat to Sarracenia species (McPherson 2007; Jennings and Rohr 2011). More recently, over-collection pressure from plant poachers may have declined as evidence (e.g., holes in the ground) of removal of whole green pitcher plants is limited, but not absent (Emanuel 2002; ALNHP 2012; Byrd 2013a; Determann 2013b, in litt.; Hermann 2013, in litt.; Hodges 2013c, in litt.; Shew 2013c, in litt.). Collection pressure may have been somewhat ameliorated by limited, legal interstate sale of commercially grown green pitcher plants from 16 U.S. Fish and Wildlife Service issued Section 10 permitted growers and sellers. However, Hermann (2013, in litt.) proposed that poaching of individual green pitcher plants may not be readily apparent as evidence of poaching could be easily obscured. Alternatively, Hodges (2013b, in litt.) suggested that poaching of plants may have shifted to unauthorized seed collection. Byrd (2013a) stated that several green pitcher plant populations are easily accessible

and, thus, are vulnerable to illegal collection by poachers. Indeed, Byrd (2013a) noted that plants from at least one of these populations were recently poached (USFWS, 2013).

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individual plants/loss of populations
Narrative: Green pitcher plant receives some legal protection in Georgia and North Carolina; however, these laws do not protect against habitat destruction. Collection of green pitcher plants on public lands without a permit is prohibited in Georgia under the Georgia Wildflower Preservation Act of 1973. No such provisions are afforded to plants found on privately-owned lands in the State. North Carolina General Statute 106-202.12- 202.19, also known as the Plant Protection and Conservation Act, authorizes the State to establish a list of protected plants and regulate the collection, sale, and transport of plants on this list. Green pitcher plant is included on the North Carolina's list of protected plants. The species does not receive any specific legal protections from State laws or regulations in Alabama USFWS, 2013).

Stressor: Genetics (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of genetic variability
Narrative: As summarized by Godt and Hamrick (1996), small population sizes have been associated with low genetic diversity and reduced fitness in a variety of plant species. Within populations of S. oreophila, genetic diversity is relatively low and related to population size and geographic isolation. Specifically, small and isolated populations exhibit less genetic diversity than larger, less isolated populations (Godt and Hamrick 1996). Effects of small population size and low genetic diversity on S. oreophila's fitness have yet to be assessed. However, together, low genetic diversity, small population sizes, and isolation of some populations may limit S. oreophila's ability to respond and adapt to stochastic environmental events and future climate change (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The precise magnitude and impacts of climate change on the southeastern United States are uncertain, but models have projected that climate change in the region may include increased temperatures of 2 to 4°C (3.6 to 7.2°F) accompanied by reduced average annual precipitation by the end of the century (Joyce et al. 2011). Climate change has the potential to affect distribution and abundance of plants by influencing seasonal weather patterns, frequency and timing of severe weather events, and myriad plant physiological responses (Hawkins et al. 2008). The specific impacts of climate change on green pitcher plant populations are poorly understood; however, a variety of impacts are possible. For example, climate change may threaten green pitcher plant populations if the habitats that the species relies on become drier as a result of higher temperatures and reduced rain (Devall and Parresol 1998; Wilcox 2012). Indeed, Wilcox (2012) notes that pitcher plant declines at a TNC preserve in North Carolina were associated with two droughts and lower water tables during the early 2000s. However, Davenport (2007) suggests that climate change's effects might be somewhat ameliorated for this

species if drier climates increase the frequency of fires that maintain green pitcher plant habitats. In addition, climate change may disrupt plant-pollinator interactions via phenological shifts in flowering and/or pollinator activity (Memmott et al. 2007; Hawkins et al. 2008), which may thereby reduce sexual reproduction of green pitcher plants. Any disruption in pollinator efficacy may further threaten isolated green pitcher plant populations that are already pollinator limited (sensu D. Folkerts 1999). While disease is not currently known to threaten green pitcher plants, climate change has the potential to promote the spread of infectious diseases among plants, particularly if arthropod vectors become more widespread and abundant (Anderson et al. 2004; Garrett et al. 2006; Hawkins et al. 2008). Given the variety and complexity of the potential effects of climate change on plant species and communities (cf. Hawkins et al. 2008; Walther 2010), more research is needed to assess its potential long-term impacts on green pitcher plant populations and habitats (USFWS, 2013).

Stressor: Livestock disturbance (USFWS, 2013)
Exposure:
Response:
Consequence: Degradation of habitat
Narrative: Trampling and soil disturbance from cattle have destroyed or degraded several green pitcher plant habitats and populations (Service 1994; Gunn 1994, in litt., 1996, in litt.; Emanuel 2002; NCNHP 2012) (USFWS, 2013).

Stressor: Logging (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Logging/forestry activity is listed as a threat to this species (USFWS, 2013).

Recovery

Recovery Actions:

- Work with federal and state entities, non-governmental organizations, and private individuals to permanently protect and manage existing habitats and populations, including the development and implementation of management plans, as needed (USFWS, 2013).
- • Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2013).
- Study and evaluate efficacy of a variety of prescribed fire regimes (USFWS, 2013).
- Study and evaluate efficacy of alternative management strategies to prescribed fire, such as hand clearing, mowing, and limited herbicide application (USFWS, 2013).
- Update population inventories, create detailed maps of all populations and their habitats to assist with population management, and attempt to relocate populations (USFWS, 2013).
- Characterize genetic diversity and representation of current ex situ safeguarded collections. Expand ex situ preservation of genetic stock, including long-term cryopreservation of seeds as well as live collections, to represent all populations with increased emphasis placed on preserving and safeguarding individual genets within and across populations (USFWS, 2013).
- Continue and expand conservation genetics work to include all populations and determine effective population sizes (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTION The previous 5-year review included a list of recommendations to improve recovery of the species. Accomplishments toward these recommended actions are summarized below. • The Service, non-government conservation organizations (e.g., TNC, APCA), State (ADCNR) and Federal (NPS) agencies, are cooperating together and with private landowners to manage existing populations. One site with green pitcher plant in Alabama has been purchased by NPS, expanding federal ownership and protections of this species. • Prescribed fires continue to be implemented on private and publicly owned green pitcher plant populations where appropriate. The Service and partners (e.g., TNC) continue to promote and support prescribed fires on private lands. • While prescribed fires are being implemented, no new studies have been conducted to improve prescribed fire's efficacy as a management tool. • No new studies have been conducted to improve prescribed fire's efficacy as a management tool. • Monitoring has continued to be conducted at various populations, including some population mapping. Attempts to relocate populations that have not been revisited in years have been made with limited success. • Characterizing genetic diversity and representation of current ex situ safeguarded collections remains a need, as does expansion of ex situ safeguarding collections. • Some genetics work has been conducted, but key conservation genetics questions remain, such as effective population sizes and inclusion of all known populations to genetics studies. (USFWS, 2020)

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SPECIES ACCOUNT: *Sarracenia rubra ssp. alabamensis* (Alabama canebrake pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 3/10/1989

Physical Description

An insectivorous perennial herb with light green, red-veined leaves that form erect, vase-like structures, 1-5 dm tall (in late summer, these are enlarged and turn yellow-green). Flowers are 5-merous, with maroon petals that are constricted medially, to 2.5 cm in width and 3.6 cm in length; pendent, borne singly on an erect, leafless scape to 60 cm in height. Flowering season: late April to early June (NatureServe, 2015).

Taxonomy

There is taxonomic uncertainty within the genus Sarracenia as a whole but the Services and others recognize the taxon as a subspecies within the "rubra complex" (i.e., Sarracenia rubra ssp. alabamensis) (USFWS, 2018).

Historical Range

The Alabama canebrake pitcher plant is a carnivorous plant that is endemic to central Alabama, with all known populations, extant and extirpated, found in the Fall Line Hills ecoregion (USFWS, 2019). Species historically occurred in Autauga, Chilton, and Elmore Counties, Alabama. In Autauga County one population has since been extirpated (Byrd 2016) and the remaining five now represent three populations, with two populations continuing as distinct populations and three of the former populations now representing three sub-populations comprising one population. No extant populations are known to occur in Elmore County (USFWS, 2018).

Current Range

There are currently seven natural, extant populations of Alabama canebrake pitcher plant known (Autauga County – 3; Chilton County – 4) (USFWS, 2018). All are found in the Fall Line Hills ecoregion (see Griffith et al. 2001 for ecoregion description). Furthermore, within this ecoregion, most of the species' populations are known from the Upper Alabama subbasin (8-digit hydrologic unit code: 03150201) while the remaining populations are known from the Lower Coosa subbasin (03150107) (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: This is a carnivorous plant, although it is unclear what benefit it receives from its carnivory (USFWS, 1992). Studies found that Alabama canebrake pitcher plants captured comparatively more flying insects than crawling insects, likely due to the species' relatively tall

stature (USFWS, 2018).

Reproductive Strategy

Adult: Vegetatively

Lifespan

Adult: Perennial herb, 60+ years (USFWS, 2012)

Dependency on Other Individuals or Species

Adult: Likely pollinators for this species are small bumblees (USFWS, 2018).

Reproduction Narrative

Adult: Seedling recruitment was reported to be absent from the majority of populations (Brewer and Chesser 2009), further inhibiting recovery efforts, as well as long-term viability and evolutionary potential. Because the species can reproduce vegetatively, seedling recruitment may not be paramount at sites experiencing light to moderate levels of fire exclusion; however, vegetative reproduction may not compensate for mortality or the lack of sexual reproduction at some sites (Brewer and Chesser 2009) (USFWS, 2012). Likely pollinators are small bumblebees (Bombus spp.) which have a flight distance of 1 mile; at distances greater than 1 mile, pollen flow (and consequent gene flow) is restricted by the inability of pollinators to traverse this distance (USFWS, 2018).

Habitat Type

Adult: Hillside seepage bogs and in bottomland or streamside vegetation(USFWS, 2012)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Sarracenia rubra ssp. alabamensis inhabits two distinct habitat types that share similar floristic composition. The majority of sites are characterized as hillside seepage bogs, permanently saturated areas that attain their greatest development where an impervious layer of clay lies in close proximity to the ground surface. Precipitation, once reaching this clay zone, becomes restricted and is gradually propelled along a sloping gradient until surfacing further downslope. The other habitat type occurs in association with bottomland or streamside vegetation. Unlike the foregoing habitat, moisture conditions are generally maintained with greater connection to topography and precipitation amounts (USFWS, 2012). All extant populations of S. rubra ssp. alabamensis occur in close association with the following combination of arborescent and herbaceous species (which therefore serve as the best indicators of suitable habitat): Osmunda cinnamomea (cinnamon fern), Rhynchospora chalarocephala (loosehead beak sedge), Dichanthelium scoparium (velvet panicgrass), Xyris torta (twisted yellow-eyed grass), Eriocaulon decangulare (tenangle pipewort), Arundinaria

gigantea (giant cane), Cleistes bifaria (small spreading pogonia), Calopogon tuberosus (tuberous grass pink), Platanthera ciliaris (yellow-fringed orchid), Viola primulifolia (white violet), Rhexia nashii (maid Marian), Eryngium integrifolium (blue coyotethistle), Asclepias rubra (red milkweed), Magnolia virginiana (sweetbay magnolia), Solidago rugosa (wrinkle-leaf goldenrod), Eupatorium fistulosum (joe pye weed), Fuirena squarrosa (hairy umbrella-sedge), and Sphagnum spp. Bottomland and streamside populations generally contain a greater proportion of woody species and A. gigantea (U.S. Fish and Wildlife Service 1992, Garrett 2004, Schotz 2006) (USFWS, 2012). It is most vigorous in open bogs and declines when the habitat becomes overgrown with woody vegetation (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Seed dispersal is poorly understood but studies with similar pitcher plants indicate seed dispersal distances from parent plants at typically a few inches and water or birds may facilitate dispersal over longer distances, but this remains unstudied for Alabama canebrake pitcher plant (USFWS, 2018).

Dispersal/Migration Narrative

Adult: Brewer and Chesser (2009) at the University of Mississippi recently completed a study correlating seedling recruitment and population dynamics in relation to site differences. They found that seedling recruitment was greater on sites with higher soil moisture content as opposed to drier sites. This correlation held true even when comparing unmanaged wet sites to managed dry sites (USFWS, 2012).

Population Information and Trends

Population Trends:

Stable (USFWS, 2018)

Species Trends:

Stable (USFWS, 2018)

Number of Populations:

8 (USFWS, 2023)

Population Narrative:

Given proper habitat conditions, this species has demonstrated high fecundity - able to grow quickly and reproduce. According to anecdotal information furnished by wildflower enthusiasts, some sites historically contained thousands of plants. Was likely stable when fires were allowed to burn freely and naturally across the landscape, covering thousands of acres. Only recently, within the past 60 years, has public sentiment changed in opposition to free-ranging fires, due to the impact such fires have on timber production, agriculture, and development. Consequently, a broad range of fire maintained species, including Sarracenia rubra ssp. alabamensis, have become critically imperiled (NatureServe, 2015). Short-term trends indicate that species has remained stable, despite the recent loss of one small population and apparent local population declines at some sites which are likely offset by population increases at the largest sites. Currently, there are seven natural, extant populations of this species (3 in Autauga

County and 4 in Chilton County) where a population is considered distinct if separated by at least 1 mile from nearest known neighbors; no new populations have been discovered since 2012. Currently, individual subpopulations range in size from 3 or 4 plants to well over 200 and all populations are privately owned. Only 3 populations are comprised of 100 or more individuals, while 2 populations have fewer than 10 individuals (Byrd 2016, 2017, Yawn 2018). Several attempts to augment and establish populations are known but information on sites is limited and their contribution to recovery is uncertain. Conservation efforts in cooperation with various entities has occurred and 3 populations are permanently protected and managed by TNC but three populations have been extirpated since the species was listed (USFWS, 2018). The species is currently only found in Autauga and Chilton Counties and is considered extirpated in Elmore County, Alabama. Of Alabama canebrake pitcher-plant's 12 known populations, 8 are extant (including one small population consisting entirely of transplanted individuals and their progeny), and 4 are extirpated. While one population was discovered since the 2018 5-year review, another population has since been extirpated. In addition to few extant populations, small population size remains a threat with most (5 of 8) populations having less than 100 plants. Only 3 populations have 100 or more plants and only 1 population has over 1,000 plants. Two populations occur on conservation lands; however, one of these protected populations is also the largest known population (encompassing nearly threequarters of the species' entire known population in the wild). While overall population size has increased since the mid-1990s by over 48%, active recruitment of the species is generally low, with recent observations noting seedlings at only 3 populations, which represent only a small fraction of individuals within each of these populations. Discovery of additional populations and population augmentation have also contributed to recent population increases (USFWS, 2023).

Threats and Stressors

Stressor: Woody succession (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The inability to regularly burn some sites has reduced habitat suitability by allowing continued encroachment of woody species that increase shade for this shade-intolerant species (USFWS, 2012).

Stressor: Fire suppression (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: All populations occur in fire-maintained habitat, requiring an active prescribed burning regimen to sustain species viability and site integrity. As with all pitcher-plants, S. rubra ssp. alabamensis is intolerant of shade, quickly becoming depauperate and unable to reproduce with the encroachment of woody vegetation. Therefore, site integrity and viability of all populations are inherently linked to regular prescribed burning. Efforts by U.S. Fish and Wildlife Service, ALNHP, TNC, and Atlanta Botanical Gardens to adequately maintain specific populations have been hampered by difficulties in obtaining permission to apply prescribed fires at some of the known populations and unfavorable burning condition (USFWS, 2012).

Stressor: Gravel mining (USFWS, 2012)

Exposure:
Response:
Consequence: loss of habitat
Narrative: Gravel mining in close proximity to another population has adversely altered the hydrology of the site, further hampering recovery efforts (Byrd 2011, Tassin in litt. 2011b) (USFWS, 2012). However, the cooperation and interest in conserving this site by the landowner has allowed land management activities to reduce the impacts of gravel mining induced hydrologic alterations (Byrd 2016, 2017, ANHP 2018, Yawn 2018) (USFWS, 2018).

Stressor: Drainage of wetlands/bogs (USFWS, 2012)
Exposure:
Response:
Consequence: loss of habitat
Narrative: Alabama canebrake pitcher plant populations continue to be threatened by development and incompatible land use, such as drainage for agriculture and livestock grazing (USFWS, 2012).

Stressor: Habitat modification (USFWS, 2018).
Exposure:
Response:
Consequence:
Narrative: The species continues to be threatened by development, agricultural activities, gravel mining, and livestock management (Schotz 2006, Byrd 2016, 2017, ANHP 2018, Yawn 2018), which can exacerbate threats posed by inadequate habitat management (e.g., fire exclusion) and encroachment of competing vegetation (including non-native invasive species)(USFWS, 2018).

Stressor: Hydrologic alterations (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Two populations have historically been subjected to hydrological alterations as a result of beaver (Castor canadensis) activities, one of which was nearly extirpated by flooding. Beaver trapping has occurred at one of these populations to reduce their impact (USFWS, 2018).

Stressor: Inadequate habitat management (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Inadequate habitat management threatens the long-term viability of some populations. All populations occur in habitat requiring periodic fire to maintain site ecological integrity and population viability. The lack of prescribed fire or periodic mowing and hand clearing of competing vegetation at some sites allows for unchecked growth of woody species and other fast-growing herbaceous species that can increase shade and competition for resources. Alabama canebrake pitcher plant is intolerant of shade, with individual plants and, ultimately, populations, quickly becoming depauperate and unable to reproduce following woody species encroachment and consequent increased shade. Prescribed fires and other vegetation clearing activities help to maintain Alabama canebrake pitcher plant's necessary open, sunny habitat. In addition, over the years, ANHP, TNC, and ABG have occasionally had difficulties

obtaining landowner permission to apply prescribed fires at some sites, thus hampering necessary efforts to adequately maintain these sites (Byrd 2016, ANHP 2018). One small population was recently lost, possibly due to incompatible road right-of-way maintenance, such as herbicide application (Byrd 2016). Habitat management is need to promote seedling recruitment. Alabama canebrake pitcher plant continues to be extremely vulnerable due to the small number of populations and small population size at many of these sites (USFWS, 2018).

Recovery

Reclassification Criteria:
1. At least 10 geographically distinct populations of sufficient size within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. Populations are considered to be geographically distinct when they are separated by at least 1 mile (1.6 kilometer) from their nearest neighbors. (Addresses Factors A, B, E) (USFWS, 2019).

2. These 10 populations are protected by a conservation mechanism that addresses the conservation needs of the Alabama canebrake pitcher plant. (Addresses Factors A, D) (USFWS, 2019).

3. Protected populations are managed to promote open canopies, integrity of native plant communities, and Alabama canebrake pitcher plant growth. (Addresses Factors A, E) (USFWS, 2019).

Recovery Priority Number: 6

Delisting Criteria:
In addition to meeting downlisting criteria, the Alabama canebrake pitcher plant will be considered for delisting when the following criteria are met:

4. At least 10 additional geographically distinct populations of sufficient size (as described in Criterion 1) within the Fall Line Hills ecoregion in Alabama exhibit stable or increasing population trends, as evidenced by natural recruitment and multiple generations over an appropriate time span. (Addresses Factors A, B, D, E) (USFWS, 2019).

5. The Upper Alabama and Lower Coosa sub-basins within Fall Line Hills ecoregion each support at least three (3) viable populations protected by a conservation mechanism. (Addresses Factors A, E) (USFWS, 2019).

Recovery Actions:
- A. Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- B. Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- C. Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- D. Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).

- E. Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way (USFWS, 2012).
- F. Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012). Efforts have expanded to include Auburn University's Donald E. David Arboretum (USFWS, 2018).
- G. Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- H. Update the recovery plan, as appropriate (USFWS, 2012).
- Continue use of prescribed fires at protected sites and encourage owners of unprotected sites to conduct prescribed fires as frequently as possible (USFWS, 2012).
- Continue to track population trends and evaluate management needs as a means to gather baseline data and implement long-term monitoring efforts (USFWS, 2012).
- Continue surveys in vicinity of known populations and revisit all known historical sites regularly (USFWS, 2012).
- Work to secure protection, either through conservation easements or acquisition, of privately-owned populations (USFWS, 2012).
- Renew contact with state and county highway departments to ensure proper protective measures are implemented for those areas where plants occur on roadside rights-of-way. 10 (USFWS, 2012).
- Continue to preserve genetic material from all populations to the extent possible through long-term seed storage and propagation efforts at the Atlanta Botanical Gardens, Georgia (USFWS, 2012).
- Implement all other tasks identified in the recovery plan, as appropriate (USFWS, 2012).
- Update the recovery plan, as appropriate (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Current recovery criteria are presented in the Recovery Plan Amendment (Service 2019) while the Recovery Plan (Service 1992) provides a detailed discussion of necessary recovery actions. During this status review, new and/or targeted potential recovery activities were identified and are included below. These actions are recommended to support and promote recovery of the Alabama canebrake pitcher-plant. Use of a numbered list for these recommendations is for convenient reference only and does not necessarily imply prioritization of any activity over others. Recovery Activities 1. Continue the use of prescribed fire at protected sites and encourage and cooperate with landowners of unprotected sites to conduct prescribed fire as frequently as possible to maintain favorable habitat conditions. 2. Where use of prescribed fire is not feasible, use fire surrogates such as hand clearing and mowing of competing vegetation to maintain favorable habitat conditions. 3. Work with landowners and cooperators to secure adequate protection of privately-owned populations. 4. Work with state, county, and local transportation departments to ensure proper protective measures are implemented for those areas where Alabama canebrake pitcher-plants occur within roadside rights-of-way. 5. Continue to preserve genetic material from all populations through long-term seed storage and live plant collections ex situ (off-site). Monitoring and Research Activities 1. Continue to track population trends and evaluate management needs and efficacy. 2. Expand surveys in the vicinity of known populations and revisit known historical sites regularly to locate and/or relocate populations. 3. Determine the extent that current ex situ collections represent the genetic diversity of in situ populations and expand ex situ collections if necessary (USFWS, 2023).

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SPECIES ACCOUNT: *Sarracenia rubra ssp. jonesii* (Mountain sweet pitcher-plant)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) (USFWS, 2015) 9/30/1988

Physical Description

An insectivorous perennial herb with waxy-green, maroon-veined leaves that form erect, vase-like "pitchers" with ascending "lids." The pitchers are usually about 4.5 dm tall and are often partially filled with a broth of decaying insects. The sweet-smelling flowers are borne singly, each nodding on erect flowering stems that are usually taller than the pitcher. Flower petals are pendulous, maroon on the outside and yellowish, tinged with red on the inner surface. Blooms in spring. (NatureServe, 2015)

Taxonomy

Treated as a subspecies of Sarracenia rubra by Kartesz (1994 checklist), but considered a distinct species (S. jonesii) by North Carolina Heritage Program (1993), CITES (2001), and FNA (vol. 8, 2009). (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to a few mountain bogs and waterslides in southwest North Carolina and northwest South Carolina on both sides of the Blue Ridge divide (U.S. Fish and Wildlife Service 1990). Four populations are in the French Broad River drainage in Henderson and Transylvania Counties, North Carolina, five are in the Saluda River drainage in Greenville County, South Carolina, and one population is in the Enoree River drainage also in Greenville County, South Carolina (U.S. Fish and Wildlife Service 1990). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: Carnivory is the most striking interaction between members of the genus Sarracenia and other species, though the precise benefit to pitcher plants from this highly specialized adaption is not understood. Christensen (1976) found that when insects were fed to Sarracenia flava, there was no consequent increase in calcium, magnesium, or potassium in the plants' leaf tissue. However, nitrogen and phosphorus did increase, indicating that carnivory may be useful in soils low in these elements. Folkerts (1982) suggests that carnivory may be used to obtain micronutrients, such as molybdenum, which are present at very low levels in a low ph environment. Folkerts (1982) also proposes that carnivory may be important at times of nutrient

stress since nutrient levels in bogs decrease over the course of the growing season. Another possibility is that the breakdown of prey detritus from decaying pitchers may help fertilize the soil around the plants (Christensen 1976). In addition to carnivory, pitcher plants have intricate relationships with several different animal taxa. Members of the genus Sarracenia are the exclusive food of at least five species of moth (Damman and French 1987), and other insects are known to live inside pitchers (U.S. Fish and Wildlife Service 1990). Some insects may be restricted to S. jonesii (T. Gibson, pers. comm., in U. S. Fish and Wildlife Service 1990).

Reproductive Strategy

Adult: Asexual and sexual (NatureServe, 2015)

Lifespan

Adult: Perennial herb (USFWS, 1990)

Breeding Season

Adult: Flowering occurs from April to June, with fruits ripening in August (U.S. Fish and Wildlife Service 1990) (NatureServe, 2015).

Reproduction Narrative

Adult: REPRODUCTION: Reproduction in S. jonesii occurs by seed and by fragmentation of the rhizomes, but the relative importance of sexual versus vegetative reproduction is not known (U.S. Fish and Wildlife Service 1990). Flowering occurs from April to June, with fruits ripening in August (U.S. Fish and Wildlife Service 1990). Pollinators of S. jonesii are not know, but bumblebees are important pollinators of other species of Sarracenia (U.S. Fish and Wildlife Service 1990). Water is the only known means of seed dispersal (U.S. Fish and Wildlife Service 1990). GENETICS: Many populations of S. jonesii are small and have likely been isolated for a long time. Consequently, inbreeding depression may be occurring (U.S. Fish and Wildlife Service 1990).; ASEXUAL; Perfect; Predominantly outcrossing; SEXUAL; Vegetative spread; ABIOTIC; Water; BIOTIC; Insects, other (NatureServe, 2015).

Habitat Type

Adult: Bogs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/Specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The mountain sweet pitcher plant occurs in two types of habitat, depression bogs and cataract bogs. Most commonly, this species is found in depression bogs with flat to gently

sloping topography in valley bottoms not subjected to flooding (Schafale and Weakley 1990; U.S. Fish and Wildlife Service 1990). The soils of these bogs are deep, poorly drained loam/sand/silt, with high organic matter and acidic pH. The soil series is usually Toxaway silt loam or Hatboro loam (U.S. Fish and Wildlife Service 1990). These bogs are palustrine and usually fed by seepages. The moisture level within the bogs ranges from permanently saturated to intermittently dry (Schafale and Weakley 1990). In the cataract bog habitat, the pitcher plants grow in thin strips along the edges of the waterfall, or on soil islands actually on the granite rock face where moisture conditions are appropriate (U.S. Fish and Wildlife Service 1990; S. Benjamin, pers. observ.). Shrub species associated with Sarracenia jonesii populations include Rhus vernix (poison sumac), Aronia arbutifolia (chokeberry), Alnus serrulata (alder), Rhododendron maximum (rhododendron), Rhododendron viscosum (azalea), Viburnum cassinoides (viburnum), Kalmia angustifolia (sheep laurel) and Kalmia latifolia (mountain laurel) (U.S. Fish and Wildlife Service 1990). Associated herb species include several sedges (Carex leptalea, C. muricata, C. folliculata, and C. collinsii), twigrush (Cladium mariscoides), beak rush (Rhynchospora alba), bulrush (Scirpus expansus), and several Sphagnum species (U.S. Fish and Wildlife Service 1990) (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity and low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: At least some seed dispersal is by water; however, little else is known, including how far seeds can be dispersed by this vector and others and what conditions are optimal for dispersal (USFWS, 1990).

Population Information and Trends

Population Trends:

Short term trend: Decline of 10-30% (NatureServe, 2015)

Number of Populations:

15 (USFWS, 2021)

Population Narrative:

The species persists in 12 extant populations across North and South Carolina, in remnant bog habitats that are subject to repeated threats from the continued alteration of the surrounding landscape, particularly the ecological processes (namely hydrologic regimes) which render these wetlands suitable for species such as S. jonesii (USFWS, 2013). NatureServe (2015) notes that there is a short-term population decline of 10-30%. Low resiliency, representation and redundancy are inferred based on the low number of populations and the specific habitat requirements of this species.

Threats and Stressors

Stressor: Stream channelization (USFWS, 2013)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: This, in conjunction with stream channelization efforts throughout the surrounding watershed, continues to work against the processes which create new wetland acreage, which in turn forces those species that are dependent upon these habitats to be confined to whatever remnant acreage that remains (USFWS, 2013).

Stressor: Lack of beaver dams (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Beavers were largely eliminated from much of the southern Appalachian landscape by the turn of the last century. Although still active, their effectiveness at creating new wetland habitat is severely hindered by humans who regard beavers as a nuisance species, and repeatedly breach beaver impoundments (USFWS, 2013).

Stressor: Wetland draining (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Because many bogs are located in low-lying flat areas favored for agriculture, they often have been the focus of wetland ditching and draining efforts which have left the hydrology of these sites inherently altered. Further compounded by a nearly complete absence of natural disturbance regimes (such as grazing and/or fire) that may have played a role in keeping woody vegetation at low densities, the structure and composition of southern Appalachian wetlands faces a nearly constant and synergistic set of threats (USFWS, 2013).

Stressor: Lack of fire (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Periodic fire may have also played an historical role in keeping some mountain bog habitats structurally open, with the higher light levels favored by species such as S. jonesii. Most Sarracenia species occur in fire-prone habitats, and many Sarracenia species decline during periods of prolonged fire suppression. The historical role of fire in mountain bogs is less clear than in coastal plain habitats, but the presence of fire-adapted species such as pitch pine (Pinus rigida) certainly suggests a role for fire in the formation and maintenance of these habitats. However, the extent to which fire suppression may be causing or exacerbating woody vegetation encroachment in bog habitats is presently speculative, at best (USFWS, 2013).

Recovery

Delisting Criteria:
Criterion 1: It has been documented that at least four populations within each drainage (Enoree, French Broad, and Saluda Rivers) are self-sustaining and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival (USFWS, 2013).

Criterion 2: …All 12 of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations (USFWS, 2013).

Recovery Actions:

- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners. Search for additional populations. Determine habitat protection priorities. Evaluate habitat protection alternatives (USFWS, 1990).
- Determine and implement management necessary for long-term reproduction. establishment. maintenance, and vigor. Determine population size and stage-class distribution for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in a suitable habitat within the species' historic range (USFWS, 1990).
- Develop a cultivated source of plants and provide for long-term seed storage (USFWS, 1990).
- Enforce laws protecting the species and/or its habitat (USFWS, 1990).
- Develop materials to inform the public about the status of the species and the recovery plan objectives. Prepare and distribute news releases and informational brochures. Prepare articles for popular and scientific publications (USFWS, 1990).
- Annually assess success of recovery efforts for the species (USFWS, 1990).
- Recovery Task 2.1: Determine population size and stage class distribution for all populations • Map the spatial extent of each population, assess flower abundance and (of lower priority, only if time permits) the abundance of pitchers/clumps. Perform these assessments in a manner that ensures comparability to the baseline maps and other data obtained for these sites in 1991 and 1992 (Rudd and Sutter 1998 and references therein). Assess whether the spatial extent and/or abundance of populations has remained stable, increased or decreased since that time, accounting for any increases due to population augmentation efforts. Record information on environmental parameters that can impact the plant (e.g., light availability and depth to water table) to examine possible correlations with these parameters and the population size and stage class distribution for all populations (USFWS, 2013).
- Recovery Task 2.7: Develop techniques and re-establish populations in suitable habitat within the species' historic range. • Work with the Atlanta Botanical Garden (ABG) to summarize prior reintroduction, augmentation and introduction activities across all populations. Using this information, conduct site visits as needed to obtain current estimates of transplant survivorship for prior augmentation efforts. • Use this information, supplemented by updated data on overall spatial extent (obtained from mapping) and estimates of flower/pitcher abundance, to assess each population for its current potential to be self-sustaining without augmentation. For populations where augmentation is deemed necessary (this may currently be most populations), establish preliminary population objectives clarifying the minimum desired number of plants at each location, and a strategy and timeline for meeting this objective through augmentation. Work with ABG and

landowners to implement actions required to meet this objective at as many sites as possible, and then discontinue additional augmentation while monitoring is undertaken to determine transplant survivorship and population trends at the new (augmented) baseline (USFWS, 2013).

- Recovery Task 3: Develop a cultivated source of plants and provide for long-term seed storage • Review the provenance of material currently held as seeds or otherwise represented in exsitu holdings at botanical gardens (esp. ABG but also the North Carolina Botanical Garden) to ensure that all known extant populations are represented. • Work with ABG to assess the viability of seed collections, and the longevity of seeds held in long-term storage (USFWS, 2013).
- Recovery Task 6: Annually assess success of recovery efforts • The two existing recovery criteria (for de-listing) are largely redundant; revise criteria that are more specific, objective, and measurable. • Establish down-listing criteria (for reclassification from endangered to threatened). • Finalize technical revision to the federal list of threatened and endangered plant species, changing taxonomy from Sarracenia rubra ssp. jonesii to Sarracenia jonesii.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTION The 2013 5-year review included a list of recommendations to improve recovery of the species. These actions, listed below, remain applicable to species recovery. x Map the spatial extent of each population, assess flower abundance and (of lower priority, only if time permits) the abundance of pitchers/clumps. Perform these assessments in a manner that ensures comparability to the baseline maps and other data obtained for these sites in 1991 and 1992 (Rudd and Sutter 1998 and references therein). Assess whether the spatial extent and/or abundance of populations has remained stable, increased or decreased since that time, accounting for any increases due to population augmentation efforts. x Work with the Atlanta Botanical Garden (ABG) to summarize prior reintroduction, augmentation, and introduction activities across all populations. Using this information, conduct site visits as needed to obtain current estimates of transplant survivorship for prior augmentation efforts. x Use this information, supplemented by updated data on overall spatial extent (obtained from mapping) and estimates of flower/pitcher abundance, to assess each population for its current potential for self-sustainability without augmentation. For populations where augmentation is deemed necessary (this may currently be most populations), establish preliminary population objectives clarifying the minimum desired number of plants at each location, and a strategy and timeline for meeting this objective through augmentation. Work with ABG and landowners to implement actions required to meet this objective at as many sites as possible, and then discontinue additional augmentation while monitoring is undertaken to determine transplant survivorship and population trends at the new (augmented) baseline. x Review the provenance of material currently held as seeds or otherwise represented in exsitu holdings at botanical gardens (especially ABG but also the North Carolina Botanical Garden) to ensure that all known extant populations are represented. x Work with ABG to assess the viability of seed collections, and the longevity of seeds held in long-term storage. x The two existing recovery criteria (for de-listing) are largely redundant; devise revised criteria that are more specific, objective, and measurable (in accordance with Service Recovery Planning Guidance). x Devise downlisting criteria (for reclassification from endangered to threatened) similarly in accordance with Service Recovery Planning Guidance. x Finalize technical revision to the federal list of threatened and endangered plant species (previously submitted to the Service Atlanta Regional Office), changing taxonomy from Sarracenia rubra ssp. jonesii to Sarracenia jonesii. In light of new information, additional future actions are recommended below: x Work with partners and species experts to develop a standardized monitoring protocol that could be used on many different types

of mountain sweet pitcher plant sites. x Work with partners and land managers to conduct range-wide monitoring. x Provide support and, if feasible, pool resources for management and monitoring. x Continue to support research efforts investigating species biology, hybridization, and management techniques. x Determine what constitutes a “self-sustaining” population and determine the appropriateness of the criterion for a species dependent on active management. (USFWS, 2021)

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SPECIES ACCOUNT: *Scaevola coriacea* (Dwarf naupaka)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A prostrate perennial herb, barely woody in older portions. Flowers are yellowish green externally, cream-colored within. (NatureServe, 2015)

Taxonomy

Genus found in Australia, coasts of tropical Asia, Africa, and Polynesia. Although this species has been collected on all of the major Hawaiian Islands, the evidence suggests that it was never well established on any but Maui island. (NatureServe, 2015)

Historical Range

historical occurrences from Mokuhooniki Islet (off Coast of East Molokai), Niihau, Kauai, Oahu, Lanai, and Hawaii. (NatureServe, 2015)

Current Range

Island Distribution: Found on Molokai and Maui. Extirpated on Kauai, Nihau, Oahu, Lanai and Hawaii (USFWS, 2021c)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers year-round (USFWS, 1997).

Reproduction Narrative

Adult: This species is salt-tolerant, relatively long-lived, and flowers year round (USFWS, 1997).

Habitat Type

Adult: Coastal sand dunes (USFWS, 1997; NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1997)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1997)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1997)

Site Fidelity

Adult: High (inferred from USFWS, 1997)

Habitat Narrative

Adult: Species inhabits dry coastal shrublands on consolidated calcareous sand dunes and thin basaltic soils. (NatureServe, 2015). Scaevola coriacea usually occurs in relatively hot, dry coastal sites on low, consolidated sand dunes near sea level. The sites receive high insolation, and most of the vegetation is at or near ground level (USFWS, 1997). Clumped spatial arrangement of the population and narrow environmental specificity are based on the geography of the known locations and the unique habitat requirements of this species. High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively small geographic range in which it is known to occur.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2014)

Number of Populations:

~3 (USFWS, 2021c)

Population Size:

103 (USFWS, 2021c)

Population Narrative:

Fragility unknown. Only current occurrence consists of about 100 plants. 1 current (between 1982 and 1997) occurrence and 15 historical occurrences, one of which is destroyed. (NatureServe, 2015). New status information: In addition to those populations cited in the previous 5-year review, new observations include the following: ? The Plant Extinction Prevention Program [PEPP] (2010) reported three individuals of S. coriacea on Mokapu Islet off of Molokai. ? On Maui, there were 98 wild mature individuals and 2 immature individuals of S. coriacea (PEPP 2011). ? On Moku Hooniki Islet, off of Molokai, two of the four wild individuals remained (PEPP 2013). Overall, the numbers of individuals have decreased from approximately a 108 wild individual reported in the previous 5-year review to approximately 103 wild mature individuals (PEPP 2010, 2011, 2013) (USFWS, 2014).

Threats and Stressors

Stressor: Ungulates (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Habitat degradation and herbivory by ungulates is listed as a threat to this species (USFWS, 2014).

Stressor: Invasive introduced plants (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive introduced plants are listed as a threat to this species (USFWS, 2014).

Stressor: Development (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Development is listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Off-road vehicles (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Off-road vehicles are listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Landslides and flooding (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Landslides and flooding are listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Over-collection (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Collecting impacts are listed as a threat to this species (USFWS, 2014).

Stressor: Rodents (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Rodent predation/herbivory is listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Snails (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Invertebrate herbivory is listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Slugs (USFWS, 2014)

Exposure:
Response:
Consequence: Loss of individuals
Narrative: Slug herbivory is listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Fire (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Fire is listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Low numbers (USFWS, 2014)
Exposure:
Response:
Consequence: Extinction
Narrative: Low numbers are listed as a threat to the at least one population of this species (USFWS, 2014).

Stressor: Climate change
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change is listed as a threat to this species (USFWS, 2014).

Recovery

Reclassification Criteria:
This species is a short-lived perrenial. For downlisting, a total of five to seven populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon maybe eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1997).

Delisting Criteria:
This species is a short-lived perrenial. For delisting, a total of 8 to 10 populations of each taxon should be documented on Maui and at least one other island where they now occur or occurred historically. As with downlisting, there maybe cases in which a particular taxon maybe eligible for delisting even if all 8 to 10 of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an

endangered species within the foreseeable future throughout all or a significant portion of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of five consecutive years (USFWS, 1997).

Recovery Actions:

- Surveys/inventories – Survey geographical and historical range for a current assessment of the species' status (USFWS, 2014).
- Captive propagation genetic storage and reintroduction o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' high vulnerability to climate change (USFWS, 2014).
- Ungulate monitoring and control – Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Control invasive introduced plant species within the vicinity of all known S. coriacea populations (USFWS, 2014).
- Predator / herbivore monitoring and control – Control slugs, giant African snails (Achatina fulica), and rodents within the vicinity of all known S. coriacea populations (USFWS, 2014).
- Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. As a species likely to wink out by 2100, ensure that adequate genetic storage is maintained as viable material (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).

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SPECIES ACCOUNT: *Schenkia (=Centaurium) sebaeoides* (Awiwi)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (Region 1) (USFWS, 2016)

Physical Description

It is an annual herb about 6 to 20 cm (2.4 to 8 in) tall. The leaves are rather fleshy, inversely ovate or elliptic, and 0.7 to 3.2 cm (0.3 to 1.3 in) long by less than 2 cm (1 in) wide. Flowers are stalkless and are arranged along the stems near their ends. The fused sepals are 8 mm (0.3 in) long and are divided into uneven lobes. The white or pale pink petals are fused into a tube up to 10 mm (0.4 in) long, with lobes up to 4.5 mm (0.2 in) long. The cylindrical capsules are up to 9.5 mm (0.4 in) long and contain numerous tiny brown seeds. (USFWS, 1999)

Taxonomy

A new taxonomic treatment of the polyphyletic genus Centaurium was published in 2004. This new classification defines monophyletic groups reflecting the phylogenetic relationships within the subtribe Chironiinae of the Gentianaceae family. For this purpose, the establishment of a new genus, Zeltnera, along with the reinstatement of the genera Gyrandra and Schenkia, resulted in numerous new species combinations. Fifteen genera were recognized, to include 108 species. Of them the genus Schenkia comprises only five species: S. spicata is broadly distributed in Eurasia and north Africa; S. australis, S. clementii, and S. japonica are confined to Australia and the Pacific region; while S. sebaeoides is the only species endemic to Hawaii (Mansion 2004). (USFWS, 2010)

Historical Range

Historically, Centaurium sebaeoides was known from scattered localities on State and private land on the islands of Kauai, Oahu, Molokai, Lanai, and Maui (Wagner et al. 1990). (USFWS, 1999)

Current Range

Island Distribution: Found on Kauai, Lanai, Maui, Molokai and Oahu. (USFWS, 2021c)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On March 18, 2003 (Revised March 30, 2016), the U.S. Fish and Wildlife Service (Service) designated critical habitat for Centaurium sebaeoides (Awiwi) (aka Cyrtandra oxybapha) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 10 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Schenkia (=Centaurium) sebaeoides (Awiwi) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Schenkia (=Centaurium) sebaeoides (77 FR 57648-57862). The critical habitat designation includes 15 critical habitat units, which encompass approximately 1,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Schenkia (=Centaurium) sebaeoides includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Alectryon macrococcus (Mahoe) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Hawaii (68 FR 9116-9479).

Critical Habitat Designation

The critical habitat designation for Centaurium sebaeoides includes 10 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant Marsilea villosa, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 1 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant Marsilea villosa and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahiu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants Pittosporum halophilum, Schenkia sebaeoides, and Tetramolopium rockii, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 3 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Peucedanum sandwicense, or Sesbania tomentosa, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants Peucedanum sandwicense and Pittosporum halophilum, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 4 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants Brighamia rockii, Peucedanum sandwicense, and Pittosporum halophilum, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 5 is not known to be occupied by Bidens wiebkei, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants Bidens wiebkei, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, and Ischaemum byrone, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 6 is not known to be occupied by Brighamia rockii, Hibiscus brackenridgei, Marsilea villosa, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuipuhipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 9 consists of 170 ac (69 ha) of State land and 0.3 ac (0.1 ha) of privately owned land, from Poelua Bay to Mokolea Point on the northwestern coast of west Maui. This unit is occupied by the plants Schenkia sebaeoides and Sesbania tomentosa, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 9 is not known to be occupied by Brighamia rockii, we have determined this area to be essential for the conservation and recovery of this coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Coastal—Unit 10 consists of 147 ac (60 ha) of State land and 26 ac (10 ha) of privately owned land, from Kahakuloa Head to Waihee Point on the northeastern coast of west Maui. This unit is occupied by the plant Schenkia sebaeoides, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also

contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 10 is not known to be occupied by Brighamia rockii or Sesbania tomentosa, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to the small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Coastal—Unit 11 consists of 6 ac (3 ha) of State land on Mokeehia Island on the northeastern coast of west Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 11 is not currently occupied by Brighamia rockii, Schenkia sebaeoides, or Sesbania tomentosa, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat desisgnation for Schenkia (=Centaurium) sebaeoides includes 15 critical habitat units, covering one ecosystem type, which encompasses approximately 1,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 2 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem on Mokuaula, an islet east of Kalanai Point on the northeastern coast of Oahu. This unit is State-owned and is classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 3 [15 ac (6 ha)]. consists of 15 ac (6 ha) in the coastal ecosystem, on the larger of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu–Coastal–Unit 4 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) in the coastal ecosystem, the smaller of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 5 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem, the larger of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 6 [9 ac (4 ha)]. This area consists of 9 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 7 [67 ac (27 ha)]. This area consists of 67 ac (27 ha) in the coastal ecosystem, on the larger of two islands (Manana Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 8 [10 ac (4 ha)]. This area consists of 10 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Kaohikaipu Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 9 [80

ac (33 ha)]. This area consists of 80 ac (33 ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puuokipahulu). Oahu—Coastal—Unit 10 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) in the coastal ecosystem, owned by the City and County of Honolulu at Halona Point on the leeward side of Koko Crater, extending from Sandy Beach to Kahauloa. Oahu—Coastal—Unit 11 [20 ac (8 ha)]. Thi area consists of 20 ac (8 ha) of privately owned land in the coastal ecosystem, at Ihiihilauakea on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 12 [11 ac (5 ha)]. This area consists of 11 ac (5 ha) of City and County land in the coastal ecosystem, at Nonoula on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

The critical habitat designation for Alectryon macrococcus includes one CHU in Kauai County, Hawaii (68 FR 9116-9479).

Kauai 11—Centaurium sebaeoides—a: This unit is critical habitat for Centaurium sebaeoides and is 155 ha (385 ac) on State land (Hono o Na Pali NAR, Puu Ka Pele Forest Reserve, and Milolii, Nualolo, and Na Pali Coast State Parks). This unit contains Awaawapuhi, Honopu, Kalalau, Milolii, and Nualolo Valleys; Hanakoa, Hoolulu, Kalalau, and Waiahuakua Streams; Mukuaiki and Puanaiea Points; and Kalalau Beach. This unit provides habitat for four populations of 500 mature, reproducing individuals of the annual Centaurium sebaeoides and is currently occupied with between 22 and 52 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species. The habitat features contained in this unit that are essential for this species include, but are not limited to, volcanic or clay soils or cliffs in arid coastal areas. This unit provides for four populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Centaurium sebaeoides critical habitat consists of two components. Coastal (west Maui and Molokai) and Lowland dry (Lanai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla,

Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Schenkia (=Centaurium) sebaeoides critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Schenkia (=Centaurium) sebaeoides occurs within the indicated ecosystem in the Waianae Mountain caldera complex and the Koolau Mountain caldera complex:

(i) Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. Coastal. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (E) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Alectryon macrococcus critical habitat consists of two components (68 FR 9116-9479):

(i) Volcanic or clay soils or on cliffs in arid coastal areas and containing one or more of the following native plant species: Artemisia spp., Bidens spp., Chamaesyce celastroides, Cyperus phleoides, Dodonaea viscosa, Fimbristylis cymosa, Heteropogon contortus, Jacquemontia ovalifolia, Lipochaeta spp., Lycium sandwicense, Lysimachia mauritiana, Melanthera integrifolia, Panicum fauriei, Panicum torridum, Scaevola sericea, Sida fallax, or Wikstroemia uva-ursi; and

(ii) Elevations between 0 and 147 m (0 and 483 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua

coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C.

magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for Schenkia (=Centaurium) sebaeoides to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (USFWS, 1999)

Breeding Season

Adult: April (USFWS, 1999)

Key Resources Needed for Breeding

Adult: Rainfall (USFWS, 1999)

Reproduction Narrative

Adult: Centaurium sebaeoides has been observed flowering in April. Flowering may be induced by heavy rainfall. Populations are found in dry areas, and plants are more likely to be found following heavy rains (USFWS 1995). (USFWS, 1999)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1999)

Habitat Narrative

Adult: This species is found on dry shrublands primarily at coastal sites with coralline or basaltic substrates. On Molokai, Schenkia sebaeoides grows in volcanic or clay soils or on cliffs in arid dune ecosystems at elevations between sea level and 409 meters (0 and 1,341 feet). On Kauai, Schenkia sebaeoides typically grows in volcanic or clay soils or on cliffs in arid coastal areas at elevations between sea level and 147 meters (483 feet). On Oahu, Schenkia sebaeoides typically grows in volcanic or clay soils or on cliffs in arid coastal areas or on coral plains below 368 meters (1,207 ft) elevation. (USFWS, 1999; USFWS, 2010; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

~20 (USFWS, 2021c)

Population Size:

thousands? (USFWS, 2021c)

Population Narrative:

Currently, on Kauai there are a total of three populations with approximately 22 to 52 individuals on State-owned land. On Molokai, there are at least four populations containing thousands of individuals. On Oahu, two populations have between 100 to 130 individuals total. On West Maui, the most recent estimates are 7 to 8 populations, with several 1,000 plants. Lanai had one population in Maunalei Valley with approximately 23 individuals (Hawaii Biodiversity and Mapping Program 2009; USFWS 1999). The number of individuals fluctuates dramatically with the seasons. The total number of populations statewide is estimated to be 17 or 18, with as many as 6,000 individuals when rainfall is abundant. (USFWS, 2010)

Threats and Stressors

Stressor: Rats (USFWS, 2013)
Exposure:

Response:
Consequence:
Narrative: Rats are a newly described threat to this species at the Halona Gulch area (S. Ching, pers. comm. 2011). (USFWS, 2013)

Stressor: Drought (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Drought is another threat not previously mentioned for this species, as reported at Halona Gulch and Kaena Point (S. Ching, pers. comm. 2011). (USFWS, 2013)

Stressor: Fire (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: In July 2009, a fire in the Manini/Alau vicinity of Kaena Point burned designated critical habitat for Schenkia sebaeoides (U.S. Army Garrison 2009). Fire was not previously reported as a threat at this location. (USFWS, 2013)

Stressor: Invasive plant species (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: On Molokai, other major threats to this species include competition with invasive introduced woody plant species such as Casuarina equisetifolia (ironwood), Casuarina glauca (saltmarsh), Leucaena leucocephala (koa haole), Prosopis pallida (kiawe), Schinus terebinthifolius (Christmasberry), Syzygium cumini (Java plum), and Tournefortia argentea (tree heliotrope). On Maui, competing invasive introduced plant species include Cynodon dactylon (Bermuda grass), Digitaria ciliaris (crabgrass), and Pluchea indica (Indian fleabane) (Hawaii Biodiversity and Mapping Program 2009; National Tropical Botanical Garden 2009; Wood 2009). The major threats to this species on Kauai include competition from invasive introduced plant species (Factor E) including Casuarina equisetifolia, Bryophyllum pinnatum (airplant), Furcraea foetida (Mauritius hemp), Pluchea carolinensis (sourbush), Portulaca pilosa (pigweed), Plantago lanceolata (narrow-leaved plantain), Lantana camara (lantana), Leucaena leucocephala (haole koa), Prosopis pallida, Schinus terebinthifolius, Syzygium cumini (Java plum), and Tournefortia argentea (tree heliotrope). The major threats on Oahu include competition from invasive introduced plant species Leucaena leucocephala, Casuarina equisetifolia, C. glauca, Leucaena leucocephala, Prosopis pallida, Schinus terebinthifolius, Syzygium cumini, and Tournefortia argentea. Site invasion by Casuarina spp. appears to be particularly damaging because of the smothering leaf litter layers that exclude most other plant species. (USFWS, 2010)

Stressor: Overgrazing (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Indirect effects of overgrazing, such as trampling and erosion, are also likely contributors to the decline or disappearance of the species depending on the severity, timing,

longevity, and nature of the disturbance. (USFWS, 2010)

Stressor: Off-road vehicles (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Destruction of plants growing in coastal sites by off-road vehicles may also be an important source of mortality (Medeiros et al. 2000). (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to Schenkia sebaeoides. However, current climate change models do not allow us to predict specifically what those effects, and their extent, would be for this species. (USFWS, 2010)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 1999)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure with the following minimum numbers ofmature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. (USFWS, 1999)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1999)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on islands where they now occur or occurred historically. (USFWS, 1999)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with the following minimum numbers of mature individuals per population: 100 for long-lived perennials, 300 for short-lived perennials, and 500 for the annual taxa. (USFWS, 1999)

3. Each population should persist at this level for a minimum of five consecutive years. (USFWS, 1999)

Recovery Actions:
- Exclosures should be constructed around the known populations of Centaurium sebaeoides on State and private land to reduce impacts from feral ungulates. Subsequent control or removal of ungulates from these areas will alleviate their impact on native ecosystems. Additionally, those populations that have only a few remaining individuals, such as at Mokio Point and Manaeopapa on Molokai should be fenced and protected immediately. (USFWS,

1999)

- A long-range management plan to control alien plants such as koa haole needs to be developed. Additionally, populations that have only a few remaining individuals such as those at Mokio Point and Manaeopapa on Molokai should be weeded and protected immediately. (USFWS, 1999)
- Implement a coordinated effort of fire protection actions for endangered plant species on State and private land where just a few individuals occur. (USFWS, 1999)
- Construct exclosures and remove ungulates in wild populations. (USFWS, 2013)
- Control invasive introduced plant species in wild populations. (USFWS, 2013)
- Develop and implement fire management plans for populations at risk of fire. (USFWS, 2013)
- Monitor populations which are fluctuating or ephemeral based on rainfall, since the former presence of the species at a given location would indicate that a seed bank might be present. (USFWS, 2013)
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2013)
- Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon. (USFWS, 2013)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Surveys and inventories— o The historical range of Schenkia sebaeoides should be surveyed intensively. o Determine if historical populations are extirpated. o Determine sites that have the highest likelihood of maintaining reintroductions. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Schenkia sebaeoides. • Site and habitat protection—Develop and implement effective control measures to reduce the impact of drought. • Fire monitoring and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Predator and herbivore monitoring and control—Determine and implement effective methods to control insect pests. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy to reduce the impacts of drought and fire. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within the population (and between populations) and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2021b)
- New Management Actions: • Surveys and inventories— PEPP continues to monitor individuals of Schenkia sebaeoides in existing populations on Kaua‘i and O‘ahu (PEPP 2021). • Captive propagation for genetic storage and reintroduction— 3 o The Lyon Seed Conservation Laboratory reports 422,371 seeds in storage from 95 wild plants from Kaua‘i, O‘ahu, and Maui and an additional 1,170

seeds for research purposes (Lyon 2020). o National Tropical Botanical Garden (NTBG) reports approximately 1,000 seeds from 2 wild plants from Kaua‘i (NTBG 2020). o Maui Nui Botanical Garden (MNBG) reports 3,750 seeds from 7 founders (MNBG 2020). • Reintroduction—There are currently no outplantings of Schenkia sebaeoides. (USFWS, 2021b)

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SPECIES ACCOUNT: *Schiedea haleakalensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A shrub about 3-6 dm tall, with numerous ascending to erect stems. Leaves narrow. Flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Genus endemic to Hawaiian Islands, species endemic to east Maui. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to crater of Haleakala, East Maui. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Schiedea haleakalensis under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes six detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Schiedea haleakalensis includes six CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Subalpine—Unit 1 (and) Palmeria dolei—Unit 24—Subalpine (and) Pseudonestor xanthophrys—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants Bidens micrantha ssp. kalealaha and Geranium arboreum, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Asplenium peruvianum var. insulare, Geranium multiflorum, Phyllostegia bracteata, Schiedea haleakalensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and

space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) Palmeria dolei—Unit 25—Subalpine (and) Pseudonestor xanthophrys—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Geranium multiflorum, and Schiedea haleakalensis, and by the forest bird, the akohekohe (Palmeria dolei). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants Asplenium peruvianum var. insulare, Bidens micrantha ssp. kalealaha, Geranium arboreum, Phyllostegia bracteata, or Zanthoxylum hawaiiense, or by the forest bird, the kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 1 (and) Palmeria dolei—Unit 26—Dry Cliff (and) Pseudonestor xanthophrys—Unit 26— Dry Cliff This area consists of 755 ac (305 ha) of federally owned land (Haleakala National Park), from Pakaoao to Koolau Gap on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 1 is not known to be occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, Diplazium molokaiense, Geranium multiflorum, Plantago princeps, or Schiedea haleakalensis, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 2 consists of 688 ac (279 ha) of federally owned land (Haleakala National Park) from Haupaakea Peak to Kaupo Gap on east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Geranium multiflorum, Plantago princeps, and Schiedea haleakalensis, and contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 2 is not known to be occupied by the plants Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, or Diplazium molokaiense, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 3 (and) Palmeria dolei—Unit 27—Dry Cliff (and) Pseudonestor xanthophrys—Unit 27— Dry Cliff This area consists of 200 ac (81 ha) of federally owned land (Haleakala National Park) near Papaanui on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). It is occupied by the plant Plantago princeps, and contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Dry Cliff—Unit 3 is not currently occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, Diplazium molokaiense, Geranium multiflorum, or Schiedea haleakalensis, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Dry Cliff—Unit 4 (and) Palmeria dolei—Unit 28—Dry Cliff (and) Pseudonestor xanthophrys—Unit 28— Dry Cliff This area consists of 315 ac (127 ha) federally owned land (Haleakala National Park), along Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and the subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 5). Although Maui—Dry Cliff— Unit 4 is not currently occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, Diplazium molokaiense, Geranium multiflorum, Plantago princeps, or Schiedea haleakalensis, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Schiedea haleakalensis critical habitat consists of two components. Sub-alpine (east Maui) and Dry cliff (east Maui) (81 FR 17790-18110):

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special

management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Probably requires cross-pollination by small insects for seed set. Small flies and moths have been noted visiting the flowers at both known populations (Loope and Medeiros 1 994c) (USFWS, 1997).

Breeding Season

Adult: Fruits and seeds have been observed in August/ September (USFWS, 1997).

Reproduction Narrative

Adult: Little is known about the life history of Schiedea haleakalensis. This species is known to be gynodioecious (bearing female and both-sexed flowers on separate plants) (Stephen Weller,

University of California at Irvine and A.C. Medeiros, personal communication 1994) and, hence, probably requires cross-pollination by small insects for seed set. Small flies and moths have been noted visiting the flowers at both known populations (Loope and Medeiros 1 994c). These insects are generally relatively short- flighted. Fruits and seeds have been observed in August/ September. There are no obvious dispersal devices for seeds other than gravity and water-borne movement (USFWS, 1997).

Habitat Type

Adult: Dry subalpine cliffs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1997)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 1997)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1997)

Site Fidelity

Adult: High (inferred from USFWS, 1997)

Habitat Narrative

Adult: Dry subalpine cliffs with native shrubs. (NatureServe, 2015). The current habitat of Schiedea haleakalensis is in rock cracks on sheer cliffs at 1,800 and 2,440 meters (5,910 and 8,010 feet) elevation adjacent to barren lava and predominantly native subalpine shrublands and grasslands. The substrate is cinder, weathered volcanic ash, or bare lava with little or no soil development. Periodic freezing temperatures occur in this habitat. Associated native species include Artemisia mauiensis, Bidens micrantha, Dubautia mensiezii, Styphelia tameiameiae, Vaccinium reticulatum, and Viola chamissoniana (Medeiros, Loope, and Holt 1986) (USFWS, 1997). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations. Species only survives on precipitous cliff faces not accessible to goats (USFWS, 1997)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: There are no obvious dispersal devices for seeds other than gravity and water-borne movement (USFWS, 1997).

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

2 (USFWS, 2023)

Population Size:

8 individuals (USFWS, 2023)

Population Narrative:

New Status Information: • In 2011, there were 18 observed individuals at Kaupō Gap. Currently, Schiedea haleakalaensis is found in two occurrences, one at Leleiwi Pali (seven individuals) and one at Kaupō Gap (one individual) (Robertson 2016, in litt.) • In 2016, six critical habitat units in two ecosystems (subalpine and dry cliff) were designated on east Maui for Schiedea haleakalensis (27,819 ac; 11,258 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018).

Threats and Stressors

Stressor: Feral goats (USFWS, 1997)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The primary threat historically responsible for the endangerment of this species is habitat degradation and herbivory by feral goats (USFWS, 1997).

Stressor: Small population size (USFWS, 1997)
Exposure:
Response:
Consequence: Extinction
Narrative: The very small remaining number of individuals of Schiedea haleakalensis and the limited and scattered distribution of the species are threats since a single natural or human-caused environmental disturbance could be catastrophic to all or a significant part of the populations. In addition, the limited gene pool may depress reproductive vigor. Just as importantly, a very small, scattered population may not receive adequate cross-pollination (USFWS, 1997).

Stressor: Slugs (USFWS, 1997)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Feeding by slugs (Milax gagates): Based on recent unpublished evidence, recruitment of Schiedea germinants [seedlings]can be catastrophically suppressed by herbivory of alien slugs in the Waianae Mountains of Oahu (Steve Weller and Ann Sakai, University of California at Irvine, personal communication 1994). Nocturnal herb ivory by the invasive garden slug Milax gagates has been observed to partially defoliate larger, established plants of Schiedea haleakalensis in the western Kaupo population (A.C. Medeiros, personal observation 1994). This slug is now widespread on upper Haleakala Volcano in a variety of high-elevation sites, arid to wet, and has been observed feeding on such rare native plants as the green sword (Gagne 1983) (USFWS, 1997).

Stressor: Ants (USFWS, 1997)
Exposure:
Response:

Consequence: Loss of habitat/Loss of pollinators
Narrative: Invasion of habitat and elimination of pollinators by the Argentine ant (Iridomyrmex humlis): This ant species is capable of reducing or eliminating native pollinators wherever it invades on Haleakala Volcano (Cole et al. 1992). As of 1994, the invasion had descended from Kalahaka on the rim of Haleakala Crater to the crater floor very near the Holua population of Schiedea haleakalensis (USFWS, 1997).

Stressor: Feral ungulates (USFWS, 1997)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Feral ungulates: Although feral goats have been removed from Haleakala National Park by a program of active management and are no longer an immediate threat to native plant species within the park, the potential for the ingress and reestablishment of goats exists. Maintenance of a goat-free situation requires continuation of an active management program, which requires substantial sustained commitment by Haleakala National Park and funding for fence maintenance and goat removal (USFWS, 1997).

Stressor: Fire (USFWS, 1997)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The possibility of fire is a threat to the existence of Schiedea haleakalensis; a single fire could affect a significant portion of the population of Schiedea haleakalensis (A.C. Medeiros, personal communication 1990) (USFWS, 1997).

Stressor: Nonnative invasive plants
Exposure:
Response:
Consequence:
Narrative: Two additional nonnative invasive plants, Pinus radiata (Monterey pine) and Cortaderia jubata (pampas grass) are observed to be a threat to Schiedea haleakalaensis, by modifying and degrading habitat, and by direct competition (Robertson 2016, in litt.) (USFWS, 2018).

Stressor: Drought degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Drought is observed to be a threat to populations of S. haleakalensis at Leleiwi Pali and Kaupō Gap (Robertson 2016, in litt.). Over the last 100 years, the Hawaiian Islands have experienced an annual decline in precipitation of over nine percent, increasing to as much as 15 percent within the last 20 years (US-NSTC 2008; Chu and Chen 2005; Diaz 2005). Drought affects plants directly by desiccation. The increase in drought frequency and intensity leads to a self-perpetuating cycle of increase in cover of nonnative plants, increase in the number of fires, and an increase of erosion (US-GCRP 2009; Warren 2011) (USFWS, 2018).

Stressor: Climate change loss or degradation of habitat

Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that S. haleakalensis is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.605 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:
For downlisting, a total of five to seven populations of Schiedea haleakalensis should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 2011).

Recovery Priority Number: 2

Delisting Criteria:
For delisting, a total of eight to ten populations of Schiedea haleakalensis should be documented on islands where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with 300 mature individuals per population for long-lived perennials. Each population should persist at this level for a minimum of five consecutive years before delisting is considered (USFWS, 2011).

Recovery Actions:
- Continue to collect seeds and other propagules for genetic storage and reintroduction (USFWS, 2011).
- Maintain the fences around existing populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced species around known populations (USFWS, 2011).
- Survey areas where Schiedea haleakalensis has been reported to determine current status of the species (USFWS, 2011).
- Develop and implement methods to control slugs and ants (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).
- Propagate to augment the existing populations (USFWS, 2011).
- Research limiting factors to reintroduction success and possible solutions (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Work with the National Park Service, Plant Extinction Prevention Program, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).

- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- New Management Actions: • Captive propagation for genetic storage and reintroduction— o Haleakalā National Park (HNP) maintains a living collection of S. haleakalensis, and hand-pollination has produced more than 5,000 seeds for storage and propagation (Robertson 2016, in litt.). The HNP reported 900 seeds representing five individuals in storage in 2013; 58 plants representing four individuals in storage in 2015; and 119 plants representing four individuals in storage in 2016. o Lyon Arboretum Micropropagation Laboratory reported 32 containers of propagules of S. haleakalensis in storage, representing one founder (Lyon Arboretum 2017). o The University of California–Irvine reported one plant representing one individual in storage in 2014 (USFWS, 2018).
- Recommendations for Future Actions: Drought and two nonnative invasive plants are additional threats; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Surveys and inventories—Survey areas where Schiedea haleakalensis has been reported to determine current status of the species on east Maui. • Ungulate monitoring and control—Maintain fencing to provide protection from negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species around all populations of S. haleakalensis. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation— o Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. o Research limiting factors contributing to failure of reintroduced individuals and populations. • Rodent predation and herbivory—Control rats in the vicinity of all populations. • Invertebrate predation and herbivory—Develop and implement methods to control slugs and ants. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the National Park Service, the Plant Extinction Prevention Program, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2023. • Surveys and monitoring—Survey for additional populations of Schiedea haleakalensis in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to maintain fenced exclosures and construct new fences to protect reintroduced individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Initiate control of established ecosystem-altering nonnative invasive plant species, and those that compete with Schiedea haleakalensis within and around all wild and translocated populations. • Fire prevention and control—Develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change, including increasing temperatures, periods between rain events, and frequency and intensity of hurricanes. Additional

management actions may be needed, such as locating microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and implement effective methods for rodents and slugs around wild and translocated populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Build resiliency, redundancy, and representation — Increase species' viability through habitat restoration, threat control, and reintroduction and translocation. Continue reintroduction into suitable habitat that is being managed for known threats to this species to reduce impacts of erosion, treefall, flooding, and hurricanes. • Research— o Conduct genetic studies to determine genetic variation and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2023).

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SPECIES ACCOUNT: *Schiedea hawaiiensis* (Ma`oli`oli)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Perennial herbs or subshrubs, pale yellowish green throughout or stems purple-tinged in lower portion of the plant. Stems 3-7 dm long or perhaps longer, ascending to sprawling when longer. Leaves opposite. Leaf blades 4-5.8 cm long, 1.7-2.8 cm wide, ovate to elliptic-ovate. Inflorescences panicle-like, 30-40 cm long. Capsules broadly ovoid, 3.5-4 mm long. (NatureServe, 2015)

Taxonomy

Kartesz (1999) includes Schiedea hawaiiensis in S. diffusa, however, Wagner et al. (1999) resurrect it from synonymy (the 1990 edition included it). Only known from one individual discovered in 1996 (per Wagner 1999). Also accepted as distinct by Wagner et al. (2012). (NatureServe, 2015)

Historical Range

Schiedea hawaiiensis is endemic to the island of Hawaii in the Hawaiian Islands. It has been recorded from only two locations, both in the northern part of the island. It is on the Pohakuloa Training Area in the saddle between Mauna Kea and Mauna Loa (volcanoes). (NatureServe, 2015)

Critical Habitat Designated

Yes; 4/11/2024.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), designate critical habitat for 12 federally endangered species on the island of Hawai‘i under the Endangered Species Act of 1973 (Act), as amended. In total, approximately 119,326 acres (48,289 hectares) on the island of Hawai‘i, in the State of Hawaii, fall within the boundaries of the critical habitat designation. This rule extends the Act’s protections to these species’ designated critical habitats.

Critical Habitat Designation

Hawaii 55—Schiedea hawaiiensis-a, identified in the legal descriptions in paragraph (k) of this section, constitutes critical habitat for Schiedea hawaiiensis on Hawaii Island. In unit Hawaii 55—Schiedea hawaiiensis-a

Primary Constituent Elements/Physical or Biological Features

the physical and biological features of critical habitat in dry forest ecosystem are:

(i) Elevation: Less than 9,500 ft (2,900 m).

(ii) Annual precipitation: Less than 79 in (200 cm).

(iii) Substrate: Well-drained, sandy loams or loams from volcanic ash or cinder; weathered basaltic lava.

(iv) Canopy contains one or more of the following native plant genera: Acacia, Colubrina, Diospyros, Erythrina, Melicope, Metrosideros, Myoporum, Myrsine, Sophora.

(v) Subcanopy contains one or more of the following native plant genera: Achyranthes, Euphorbia, Leptecophylla, Nototrichium.

(vi) Understory contains one or more of the following native plant genera: Dodonaea, Doryopteris, Heteropogon, Pellaea.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Montane dry ecosystem (USFWS, 2013)

Habitat Narrative

Adult: Currently, S. hawaiiensis is known from 25 to 40 individuals on the U.S. Army's Pohakuloa Training Area (PTA) in the montane dry ecosystem, in the saddle area between Moana Loa and Mauna Kea (Gon III and Tierney 1996 in Wagner et al. 2005d, p. 92; Wagner et al. 2005d, p. 92; Evans 2011, in litt.). In addition, there are over 150 individuals outplanted at PTA (Kipuka Alala and Kalawamauna), Puu Huluhulu, Puu Waawaa, and Kipuka Oweowe (Evans 2011, in litt.) (USFWS, 2013).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information available.

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

1 (USFWS, 2020)

Population Size:

12 (6 mature, 6 immature) (USFWS, 2020)

Population Narrative:

There is one population of six mature and six immature wild individuals of Schiedea hawaiiensis on the island of Hawai'i. A landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections was made by Fortini et al. (2013) and, although their analysis was not conducted specifically for S. hawaiiensis, at the genus level, Schiedea has one of the highest vulnerability scores. Feral ungulate control is ongoing within exclosures for the wild and reintroduced populations; however, fencing must be maintained and monitored for ingress. Nonnative plant control is conducted at wild and reintroduced populations. More than 900 individuals have been reintroduced and recruitment has been observed; however, survivability is very low (only 67 individuals currently survive). Experimental reintroductions have been conducted at two other habitats in an attempt to address this issue; however, the long-term success is unknown. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (pigs, goats, sheep, and mouflon), nonnative plants, fire, hurricanes, and drought. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Severe episodes of drought cannot only directly kill individuals of a species or entire populations, but drought frequently leads to an increase in the number and intensity of forest and brush fires. Potential adverse impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (pigs, goats, sheep, mouflon, and rats) is considered an ongoing threat to Schiedea hawaiiensis throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)
Exposure:
Response:
Consequence:

Narrative: Schiedea hawaiiensis faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Habitat destruction or direct predation by ungulates, nonnative plants, drought, and fire are threats to the 25 to 40 individuals of Schiedea hawaiiensis (USFWS, 2013).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor: Ungulate degradation and destruction of habitat (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Degradation and destruction of habitat by established ecosystemaltering invasive plant species (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Fire degradation and destruction of habitat (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Drought degradation and destruction of habitat (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Climate change degradation or loss of habitat, including hurricanes (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Predation and herbivory by ungulates (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Predation and herbivory by rats (USFWS, 2020)

Exposure:
Response:
Consequence:
Narrative:

Stressor: Herbivory by nonnative game birds (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Stressor: Low numbers of individuals and populations (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Recovery priority numbers are assigned to species or subspecies based on the degree of threat, the potential for recovery, and their taxonomic status (i.e., full species vs. subspecies) and range from 1C (highest, "C" indicating the potential for conflict with human economic activities) to 18 (lowest) (USFWS 1983a, 1983b). All of the 15 species have a high degree of threat to their habitat and continued existence (Table 2). These threats are ongoing and include habitat loss and degradation by invasive nonnative plant species, feral ungulates, predation or herbivory by nonnative invertebrates and vertebrates, diseases, climate change, and the stochastic and demographic consequences associated with a low number of individuals and populations. Pittosporum hawaiiense and Pritchardia lanigera are assigned a recovery priority number of 2 based on a high degree of threat, a high potential for recovery because their threats are well understood and can be alleviated, and because of their status as full species. Bidens micrantha ssp. ctenophylla is assigned a recovery priority number of 3, based on a high degree of threat, a high potential for recovery because its threats are understood and can be alleviated, and because of its status as a subspecies. Cyanea marksii, Cyanea tritomantha, Cyrtandra nanawaleensis, Cyrtandra wagneri, Drosophila digressa, Phyllostegia floribunda, Platydesma remyi, Schiedea hawaiiensis, Stenogyne cranwelliae, and Vetericaris chaceorum are assigned a recovery priority number of 5, based on a high degree of threat, a low potential for recovery due to a small number of individuals and some threats being well understood while others are difficult to mitigate, and because of their status as a species. Bidens hillebrandiana ssp. hillebrandiana and Schiedea diffusa ssp. macraei are assigned a recovery priority number of 6, based on a high degree of threat, a low potential for recovery due to a small number of individuals and some threats being well understood while others are difficult to mitigate, and

because of their status as subspecies (USFWS, 2019).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to search suitable habitat for individuals of Schiedea hawaiiensis in recent and historical locations. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. Monitor exclosures for ingress. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with S. hawaiiensis at all populations. • Fire prevention and control—Implement more effective fuel load control. • Predation and herbivory by ungulates—Continue to fence and monitor populations for ungulates. • Predation and herbivory by rats—Implement alternate methods to rodenticide to better protect wild and reintroduced S. hawaiiensis and to protect the Hawaiian hawk. • Predation and herbivory by nonnative game birds—Develop and implement effective controls for game birds. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds for storage and propagation efforts. • Reintroduction and translocation—Continue to establish and augment populations to increase numbers of populations and individuals in suitable habitat to reduce the impacts of competition with nonnative plants; ungulate, rat, and game bird predation; drought, fire, climate change, and hurricanes. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Alliance and partnership development—Continue to collaborate with partners in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

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SPECIES ACCOUNT: *Schiedea kealiae* (Ma`oli`oli)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub with weakly ascending to sprawling stems 2 - 5 dm long that form loose clumps. Small flowers are borne in terminal clusters (NatureServe, 2015).

Taxonomy

A member of the pink family (Caryophyllaceae) (USFWS, 2003).

Historical Range

The species is endemic to Oahu, Hawaii (NatureServe, 2015). Historically, Schiedea kealiae was known from the northern Waianae Mountains and one collection from the Palikea area, near the southern end of the same mountain range (USFWS 1996b; 1998).

Current Range

Currently, populations are located on the cliffs above Dillingham Airfield and Camp Erdman and at Kaena Point at the northern end of the Waianae Mountains (USFWS, 2003).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Schiedea kealiae (Ma`oli`oli) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Schiedea kealiae (77 FR 57648-57862). The critical habitat designation includes 10 critical habitat units, which encompass approximately 1,493 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Ctenitis squamigera includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Schiedea kealiae includes 10 critical habitat units, covering two ecosystem types, which encompass approximately 1,493 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 13, 14, 15, Oahu— Lowland Dry—Units 1, 2, 8, 9, 10, 11.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of

privately owned land in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of State land, 2 ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

Oahu—Lowland Dry—Unit 1 [102 ac (41 ha)]; This area consists of 49 ac (20 ha) of State land and 53 ac (22 ha) of privately owned land in the Waianae Mountains, extending from Haili Gulch to Kawaipahai. Oahu—Lowland Dry— Unit 2 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland dry ecosystem in the Waianae Mountains, on Federal land within Kaena Point State Park. Oahu—Lowland Dry—Unit 8 [99 ac (40 ha)]. Oahu—This area consists of 96 ac (40 ha) of privately owned land and 3 ac (1 ha) of State land as part of the old railroad right-of-way in the lowland dry ecosystem, at the Kalaeloa Barber's Point Harbor area. Oahu—Lowland Dry—Unit 9 [37 ac (15 ha)]. This area consists of 17 ac (7 ha) of City and County land, 3 ac (1 ha) of privately owned land, 1 ac (0.5 ha) of State land, and 16 ac (6 ha) of Federal (Pearl Harbor NWR) land in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry— Unit 10 [43 ac (17 ha)]. This area consists of 43 ac (17 ha) of State land (DHHL) in the lowland dry ecosystem at Kalaeloa. Oahu—Lowland Dry—Unit 11 [166 ac (67 ha)]. This area consists of 166 ac (67 ha) of federal land (U.S. Navy) in the lowland dry ecosystem at Kalaeloa.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Schiedea kealiae critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Schiedea kealiae occurs within the Coastal and Lowland dry ecosystems in the Waianae Mountain caldera complex:

Oahu—Coastal—Units 1, 13, 14, 15. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Oahu— Lowland Dry—Units 1, 2, 8, 9, 10, 11. (A) Elevation: <3,300 ft (<1,000 m). (B) Annual Precipitation: <50 in (<130 cm). (C) Substrate: Weathered silty loams to stony clay, rocky ledges, little weathered lava. (D) Canopy: Diospyros, Myoporum, Pleomele, Santalum, Sapindes. (E) Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. (F) Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Plumbago, Sicyos, Sida, Waltheria.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Schiedea kealiae to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat

areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: cross-pollination, self-pollination (USFWS, 1998)

Lifespan

Adult: < 10 years (USFWS, 2013)

Breeding Season

Adult: December (USFWS, 1998)

Key Resources Needed for Breeding

Adult: Wind (USFWS, 2013)

Reproduction Narrative

Adult: The species is considered to be wind pollinated (S. Weller, University of California, Irvine, pers. comm. 2012). This species is a short-lived perennial (fewer than 10 years) (USFWS, 2013). It has been observed in flower in December. A series of self pollinations, within-population crosses, and crosses among occurrences has demonstrated that many related Schiedea species experience moderately strong inbreeding depression (USFWS, 1998).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Dry shrublands and forests (NatureServe, 2015); Erythrina sandwicensis or Pisonia sandwicensis forest (USFWS, 2010)

Geographic or Habitat Restraints or Barriers

Adult: 200 - 1,000 ft. elevation (USFWS, 2010)

Habitat Narrative

Adult: Inhabits dry shrublands and forests on headlands, cliffs and cliff ledges not far from the coast (NatureServe, 2015). Schiedea kealiae is usually found on steep slopes and cliff faces at elevations from 60 to 305 meters (200 to 1,000 feet), in dry remnant Erythrina sandwicensis (wiliwili) or Pisonia sandwicensis (aulu, papala kepau, alaa) forest (USFWS, 2010).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

4 (USFWS, 2003)

Population Size:

at least 150 mature and 100 immature (USFWS, 2019)

Population Narrative:

Currently, there are 4 occurrences totaling between 265 and 315 plants (USFWS, 2003). Currently there are at least 150 mature and 100 immature individuals of Schiedea kealiae in the Wai‘anae mountains of O‘ahu. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that S. kealiae is extremely vulnerable to the effects of climate change. Predation by Giant African Snails is a threat to seedlings. Collection and propagation for storage is ongoing (USFWS, 2019)

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: It is threatened by competition with the nonnative plant species Leucaena leucocephala, Panicum maximum, and Schinus terebinthifolius (USFWS, 2003).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2013).

Stressor: Predation (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: Seedlings of Schiedea species occurring in mesic or wet sites are apparently consumed by introduced unidentified slugs and snails, which have been observed feeding on Schiedea membranacea, a mesic forest species from Kauai (USFWS, 2010).

Stressor: Lack of pollinators (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: Not available

Stressor: Small population size (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: This species is at risk of extinction from naturally occurring events and/or reduced reproductive vigor due to the small number of existing occurrences. The Kaena Point occurrence is additionally threatened by naturally occurring rock slides and fire (HINHP Database 2001; Service 1998b; 61 FR 53089) (USFWS, 2003).

Stressor: Habitat destruction and modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Feral ungulates, especially goats (Capra hircus) and pigs (Sus scrofa), as well as fires and landslides (Perlman 2008) (USFWS, 2010).

Recovery

Reclassification Criteria:
1. A total of five to seven populations of the species should be documented on Oahu and at least one other island where it now occurs or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:
1. A total of 8 to 10 populations of the species should be documented on Oahu and at least one other island where it now occurs or occurred historically (USFWS, 1998).

2. Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).

- Validate and revise recovery criteria (USFWS, 1998).
- Control competing alien plant species (USFWS, 1998).
- Control of introduced snails and slugs (USFWS, 1998).
- Research on pollinators (USFWS, 1998).
- Reduce substrate loss (USFWS, 1998).
- Provide protection from fire (USFWS, 1998).
- Captive propagation for genetic storage and reintroduction - Continue collecting material for genetic storage and propagation for reintroduction. Investigate new propagation methods (USFWS, 2013).
- Invertebrate control research - Investigate slug herbivory and appropriate insect control methods (USFWS, 2013).
- Ungulate exclosures - Fence remaining populations to protect them from the impacts of feral ungulates (USFWS, 2013).
- Ecosystem-altering invasive plant species control - Remove competing invasive introduced plant species within fenced areas and maintain those areas free of invasive introduced plants (USFWS, 2013).
- Fire protection – Develop and implement fire prevention plans to protect the most vulnerable populations (USFWS, 2013).
- Population biology research - Implement genetic studies to assess the viability of remaining populations. Investigate the causes of reproductive failure and techniques to improve natural recruitment (USFWS, 2013).
- Surveys / inventories – Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Alliance and partnership development - Initiate planning and contribute to implementation of ecosystem level restoration and management to benefit this taxon (USFWS, 2013).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats except for additional data on this taxon’s vulnerability to climate change and predation and herbivory by Giant African Snails. There is no significant new information regarding the species’ biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2019. • Surveys and inventories—Survey geographical and historical range for a thorough assessment of the species' status. • Ungulate monitoring and control—Fence the remaining population to protect plants from impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with Schiedea kealiae at the remaining population. • Fire protection—Develop and implement fire prevention plans to protect the most vulnerable populations. • Drought remediation—Protect populations from competition by nonnative plants and fence and remove feral ungulates to prevent further effects of drought such as erosion. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Invertebrate control and research—Implement effective slug and nonnative snail control at all populations, focusing especially on the Giant African snails at Keālia. • Captive propagation for genetic storage and reintroduction—Continue seed collection for genetic storage and propagation for reintroduction. Investigate effective propagation methods. • Reintroduction—Establish new populations and

augment existing populations, keeping close track of maternal source used for ex situ propagation. • Population biology research— o Continue to conduct genetic studies to assess the genetic variability and the viability of remaining population. o Continue to investigate the causes of reproductive failure and implement techniques to improve natural recruitment. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2019)

- New Management Actions: • Captive propagation for genetic storage and reintroduction— o The Army Natural Resources Program-Oʻahu (ANRP) reports collection and storage of 2,586 seeds from one population representing 10 individuals (U.S. Army 2018). o The Lyon Seed Conservation Laboratory reports 7,408 seeds in storage collected in 2014 representing 22 individuals from one population (Lyon Arboretum 2018). o Waimea Arboretum reports nine plants in refugia representing two wild individuals in 2013, 60 plants representing two wild individuals in 2014, four plants representing one wild individual in 2015, and 2 plants representing one wild individual in 2017 (Waimea Arboreum 2013, 2014, 2015, 2017). o Pahole Rare Plant Facility (PRPF) reports seven plants in refugia representing one individual from Keālia (PRPF 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Schiedea obovata* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub 3-10 dm tall, with somewhat fleshy leaves, and congested clusters of 7-12 white and green flowers. (NatureServe, 2015)

Historical Range

Historically, this species was known from the northern and southern parts of the Waianae Mountains (USFWS, 2016)

Current Range

Endemic to Waianae Mountains of Oahu (NatureServe, 2015).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Schiedea obovata under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Schiedea obovata (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Schiedea obovata includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Schiedea obovata includes 11 critical habitat units, covering two ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Schiedea obovata critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Schiedea obovata occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Schiedea obovata to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat

areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-fertilizing (USFWS, 2016)

Lifespan

Adult: 3-6 years (USFWS, 2016)

Breeding Season

Adult: Flowers and fruit are produced year-round, especially in response to rainfall during winter and spring (USFWS, 2016).

Reproduction Narrative

Adult: Plants generally flower after two years of growth, and are normally self-fertilizing (Makua Implementation Team 2003). Flowers and fruit are produced year-round, especially in response to rainfall during winter and spring. Seed dispersal mechanism is unknown, although the plant's "false berry" possibly may attract fruit-eating birds that may disperse the seeds (Makua Implementation Team 2003). Plants survive 3 to 6 years, or less under drought conditions (Service 1995a, Service 1998a). Population units in the wild have been known to disappear for a number of years and then reappear after large rainfall events, apparently owing to persistence of seeds in the soil seed bank (U.S. Army Garrison 2004a). Other demographic information for S. obovata in the wild is unknown, including number of seeds produced, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Forested ridges and slopes (USFWS, 2016)

Habitat Narrative

Adult: Schiedea obovata occurs on ridges and slopes in lowland diverse mesic forests dominated by Acacia koa and Metrosideros polymorpha, at elevations of 560 to 760 m (1,837 to 2,494 ft) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

One wild (2 subpopulations). 3 reintroduced populations (USFWS, 2024)

Population Size:

23 wild; 1,073 reintroduced (USFWS, 2024)

Population Narrative:

Currently, two population units, Kahanahaiki to Pahole and Keawapilau to West Makaleha, total 389 individuals located on Federal and State lands (68 FR 35950) (Table SB 36). The Kahanahaiki to Pahole population unit has met numerical criteria for stabilization (defined for this species as 100 mature individuals per population unit) (Makua Implementation Team 2003). The existing population units also are located within low and very low fire risk zones for training-related wildfire. Demographic data indicate Schiedea obovata is increasing in numbers only due to augmentation efforts and the discovery of a new population unit in North West Makaleha. About 82 percent of all of individuals are augmentations from greenhouse-propagated stock. Recruitment of seedlings and immature plants into the mature population is limited by predation by non-native slugs and snails that feed on and damage leaves and stems (Makua Implementation Team 2003; U.S. Army Garrison 2004a; U.S. Army Garrison 2005b). One study noted, for example, that seedling mortality doubled when exposed to slug herbivory (U.S. Army Garrison 2005b). Furthermore, slugs have the potential to completely halt seedling regeneration in several sites (U.S. Army Garrison 2004a, 2005b). Thus, S. obovata is characterized by declining in the current range and two existing population units with low numbers, of which one is exceeding minimum numerical criteria for stabilization and increasing through augmentation and discovery of new individuals (USFWS, 2016). Currently there are approximately 425 wild individuals (96 percent are immature plants) of Schiedea obovata in the Waiʻanae mountains of Oʻahu. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that S. obovata is extremely vulnerable to the effects of climate change. Collection, propagation, and reintroductions into fenced and managed areas are ongoing. Currently, the reintroductions consist of 124 mature plants and 168 immature plants, with 200 seedlings recruiting. (USFWS, 2019). Currently, there are two wild subpopulations in one population unit (Keʻawapilau to Makaleha) totaling 17 mature and 6 immature individuals (Army Natural Resources Program on Oʻahu [ANRPO] 2023a, p. 114; Appendix 4-1). Additionally, there are 1,073 total reintroduced individuals across three population units (Kahanahāiki to Pahole, Keʻawapilau to Makaleha, and Mākaha), of which 340 individuals are mature plants (ANRPO 2023b, Appendix 4-1). • Currently, there are approximately 96 founder lines represented in ex situ storage and propagation collections, including seeds in seed banks, explants in tissue culture, vegetative material, and plants in a nursery or living collection (ANRPO 2023b, Appendix 4-3) (USFWS, 2024).

Threats and Stressors

Stressor: Slugs and snails (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Schiedea obovata is particularly vulnerable to predation by non-native slugs and snails (Makua Implementation Team 2003; U.S. Army Garrison 2005b) (USFWS, 2016).

Stressor: Residential development (USFWS, 2016)
Exposure:
Response:

Consequence: Loss of habitat/loss of individuals
Narrative: Residential development is listed as a threat to this species (USFWS, 2016).

Stressor: Reforestation (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Reforestation with non-native trees is listed as a threat to this species (USFWS, 2016).

Stressor: Military installations (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Establishment of military installations is listed as a threat to this species (USFWS, 2016).

Stressor: Trampling/collection
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Trampling and illegal collecting by people is listed as a threat to this species (USFWS, 2016).

Stressor: Stochastic events (USFWS, 2016)
Exposure:
Response:
Consequence: Extinction
Narrative: Population units of S. obovata are vulnerable to extirpation from naturally occurring events such as rockslides and/or reduced reproductive vigor due to small population size and limited distribution (56 FR 55770; 68 FR 35950; Service 1995a, 1998a) (USFWS, 2016).

Stressor: Drought (USFWS, 2016)
Exposure:
Response:
Consequence: Population fluctuation
Narrative: This species experiences large population fluctuations related to drought and its natural recruitment is severely reduced by slug predation (U.S. Army Garrison 2005c) (USFWS, 2016).

Stressor: Climate change loss or degradation of habitat (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: —Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Schiedea obovata is extremely

vulnerable to the impacts of climate change, with a vulnerability score of 0.944 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2019)

Recovery

Reclassification Criteria:
Recovery Priority Number: 5

Delisting Criteria:
Conservation actions that should be implemented for the recovery of Schiedea obovata are described in the introduction to the "Status and Environmental Baseline of the Species and Critical Habitat" section. Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve stabilization of all existing populations (Service 1995a, 1998a). At least 50 mature, reproducing individuals are needed per population unit to attain stabilization criteria for short-lived perennials. However, because of the common, large declines or fluctuations in numbers of S. obovata, the Makua Implementation Team (2003) identified a stabilization target of at least 100 mature individuals for each population unit of this species. An increased stabilization criterion is needed because any adverse disturbance during a major low point in a population unit's fluctuation could extirpate that unit. In addition to stabilizing the two existing population units, a third population unit must be established by reintroduction and managed for stabilization outside the action area. Research on slug control in forest settings is needed to find ways to reduce this threat to S. obovata and associated native plants (USFWS, 2016).

The Makua Implementation Team (2003) has developed stabilization protocols for Schiedea obovata, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). This species occurs in the Kahanahaiki, Pahole, and West Makaleha Management Units where it will benefit from population unit and/or ecosystem-level protection. The Army and the Hawaii Division of Forestry and Wildlife have been outplanting this species within fenced exclosures since 1999. The Kahanahaiki to Pahole population unit is located within the fenced Kahanahaiki and Pahole Management Units, and the North West Makaleha site within the Keawapilau to West Makaleha population unit is fenced. Fence construction is planned for the entire West Makaleha Management Unit in 2007. Invasive weeds are controlled at extant S. obovata sites, but not at historical sites. Schiedea obovata seed can be successfully stored and remain viable for several years, and outplantings have been successful (U.S. Army Garrison 2005b). In 2005, this species was represented in the following ex situ collections: one cutting in a nursery (Army Environmental Division, Oahu), 14 plants in a botanical garden (Waimea Valley Audubon Center), 161 seeds in micropropagation (Harold L. Lyon Arboretum), 236,814 seeds in seed storage (Lyon Arboretum Seed Storage Facility), and 13 seedlings in micropropagation (Harold L. Lyon Arboretum) (Service 2005b) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information

regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and inventories—Continue to survey geographical and historical range for a thorough assessment of the species' status. • Ungulate monitoring and control—Continue to fence and monitor wild and reintroduced populations to protect plants from impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species, and those that compete with Schiedea obovata at all wild and reintroduced population. • Fire protection—Implement fire management plans and coordinate fire response efforts. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Rodent control—Continue to implement effective rat control at all populations. • Invertebrate control—Continue to implement effective slug and nonnative snail control at all populations. • Captive propagation for genetic storage and reintroduction—Continue seed collection for genetic storage and propagation for reintroduction. • Reintroduction—Continue to establish new populations and augment existing populations, keeping close track of maternal source used for ex situ propagation. • Population biology research—Study populations of Schiedea obovata with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Alliance and partnership development—Work with the ANRP, the Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2019)

- New Management Actions: • Ungulate control—The ANRP and State of Hawai'i Native Ecosystems Protection and Management group has constructed fences and maintain the integrity of fences in the areas protecting wild and outplanted populations at Kahanahāiki, Ke'awapilau, West Makaleha, and Mākaha (ANRP 2018). • Nonnative invasive plant control—The ANRP reports that nonnative plant control is conducted at Makaleha West, Kahanahāiki to Pahole, and at Mākaha (ANRP 2018). • Rodent predation or herbivory—The ANRP has found that Goodnature™ A24 rat traps are more effective than the Victor® snap traps, and these traps are deployed in the Kahanahāiki to Pahole management areas (ANRP 2018). • Slug control—Testing showed that Ferroxx® is a more effective slug control than Sluggo®, and this toxicant is currently used to protect individuals of Schiedea obovata from herbivory by slugs at the Pahole and West Makaleha management units (U.S. Army Garrison 2010). • Captive propagation for genetic storage and reintroduction— o The ANRP reports that while the Kahanahāiki to Pahole population sites are now extirpated, five individuals were collected from prior to their extirpation and are adequately represented in ex situ collections. There are 86 wild plants represented in ex situ collections from the Ke'awapilau to West Makaleha populations (ANRP 2018). o The Lyon Seed Micropropagation Laboratory reports one wild plant from Pahole represented by 148 explants (Lyon Arboretum 2018.). • Reintroductions—The ANRP reports outplanting sites containing 91 mature, 167 immature plants at Kahanahāiki to Pahole (with 200 seedlings recruiting), with some sites comprised of a mix of outplanted individuals and individuals that naturally-recruited from these outplanting efforts. There are 13 mature and 1 immature outplants in Ke'awapilau to West Makaleha, and 20 mature outplants in Mākaha. Thorough monitoring at all three outplanting sites have shown a decline in population size (ANRP 2018). (USFWS, 2019)
- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2019. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2024. • Surveys and inventories— o Continue surveys for populations of Schiedea obovata in areas of potentially suitable habitat. o Determine suitable locations for reintroductions. • Ungulate monitoring and

control—Continue to maintain fenced exclosures and construct new fences to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with S. obovata. • Site and habitat protection—Develop and implement effective threat control measures to reduce the impact of small population size. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change, including increasing temperatures, periods between rain events, and increasing frequency and intensity of hurricanes. Additional management actions may be needed, such as locating key microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and continue to implement effective methods to control rats and slugs. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Build resiliency, redundancy, and representation — Increase species' viability through habitat restoration, threat control, and reintroduction and translocation into suitable habitat that is being managed for known threats to this species to reduce impacts of climate change degradation and nonnative plant competition. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2024).

References

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SPECIES ACCOUNT: *Schiedea salicaria* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect subshrub or shrub, 3-18 dm tall. Inflorescences terminal, 8-11 cm long. (NatureServe, 2015)

Taxonomy

Hawaiian endemic genus of 22 species, species endemic to west Maui. No varieties recognized by Wagner et al. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the southern and eastern side of West Maui, state of Hawaii. (NatureServe, 2015). Distribution: Maui (USFWS, 2021)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Schiedea salicaria under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two detailed critical habitat units (CHUs), in Maui County in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Schiedea salicaria includes two CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Lowland Dry—Unit 5 consists of 3,615 ac (1,463 ha) of State land, and 43 ac (17 ha) of privately owned land, from Panaewa to Manawainui on the western and southern slopes of west Maui. This unit is occupied by the plants Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Gouania hillebrandii, Kadua coriacea, Remya mauiensis, Santalum haleakalae var. lanaiense, and Spermolepis hawaiiensis, and Tetramolopium capillare, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 5 is not known to be occupied by Ctenitis squamigera, Cyanea obtusa, Hesperomannia arbuscula, Hibiscus brackenridgei, Lysimachia lydgatei, Neraudia sericea, Schiedea salicaria, Sesbania tomentosa, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations

within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 6 consists of 3 ac (1 ha) of State land, and 237 ac (96 ha) of privately owned land, from Paleaahu Gulch to Puu Hona on the southern slopes of west Maui. This unit is occupied by the plants Hibiscus brackenridgei and Schiedea salicaria, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 6 is not known to be occupied by Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Cenchrus agrimonioides, Ctenitis squamigera, Cyanea obtusa, Gouania hillebrandii, Hesperomannia arbuscula, Kadua coriacea, Lysimachia lydgatei, Neraudia sericea, Remya mauiensis, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Spermolepis hawaiiensis, Tetramolopium capillare, or T. remyi, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Schiedea salicaria critical habitat consists of one component. Lowland dry (west Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The

125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some

occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrosser (USFWS, 2021)

Lifespan

Adult: Short-lived perennial shrub (USFWS, 2021)

Reproduction Narrative

Adult: No information found.

Habitat Type

Adult: Dry shrublands (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 2016)

Environmental Specificity

Adult: Narrow/specialist (inferred from USFWS, 2016)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 2016)

Site Fidelity

Adult: High (inferred from USFWS, 2016)

Habitat Narrative

Adult: Species inhabits dry shrublands on steep slopes and ridgetops. (NatureServe, 2015). Currently, this species is found in three occurrences: Kaunoahua gulch (500 to 1,000 individuals), Puu Hona (about 50 individuals), and Waikapu Stream (3 to 5 individuals), in the lowland dry ecosystem on west Maui (TNC 2007; Oppenheimer 2010k, in litt.; Oppenheimer 2010l, in litt.) (USFWS, 2016). Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community

are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

3 (USFWS, 2021)

Population Size:

853-1,405 (USFWS, 2021)

Population Narrative:

While there are no historic records of numbers of populations or individuals, qualitative accounts indicate this species was not uncommon on West Maui (Russell 2004). Decline of 30-70% Original estimated total for this species ranges from about 1,000 to about 2,000. Although, U.S Fish and Wildlife Service currently have an 2005 estimate as 100 to 300 (USFWS 2006). Total number of occurrences are 5, of those 4 are known extant occurrences found on the island of Maui. (NatureServe, 2015). There are between 853 to 1,405 individuals of Schiedea salicaria within three wild population units on west Maui. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that S. salicaria is extremely vulnerable to the effects of climate change. There are seeds and propagules in collection. Collection and propagation are ongoing. (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative animals (goats, axis deer, and cattle), nonnative plants, fire, drought, and hurricanes. The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds on hooves and coats, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

Drought destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities.. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (axis deer, cattle, and goats) is considered an ongoing threat to Schiedea salicaria throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Number of populations and individuals needed for each plant species to meet Preventing Extinction Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 100. (USFWS, 2021) Number of populations and individuals needed for each plant species to meet the Interim Stage target based on population and life history characteristics: Number of Populations: 3. Mature Individuals per population: 600. (USFWS, 2021) Number of population and individuals needed for downlisting based on population and life history characteristics: Number of Populations: 5. Mature Individuals per population: 1000. (USFWS, 2021)

Delisting Criteria:
Number of populations and individuals needed for delisting based on population and life history characteristics: Number of Populations: 10. Mature Individuals per population: 1000. (USFWS, 2021)

Recovery Actions:
- No information found.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to assess the status of known occurrences of Schiedea salicaria in historical locations and potentially suitable habitat. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with S. salicaria. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and other propagative materials for storage and reintroduction. • Reintroduction and translocation—Increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of habitat degradation by feral ungulates, nonnative plants, fire, and events associated with climate change; and predation/herbivory by feral ungulates. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and monitoring—The Maui Nui PEPP monitors occurrences of Schiedea salicaria (Oppenheimer 2019a, b, pers. comm.). • Ungulate control—The wild population of Schiedea salicaria at Waikapū is fenced and the fence is monitored for breeches (Oppenheimer 2019b, pers. comm.). The remaining wild populations are not fenced. • Nonnative plant control—The Maui Nui PEPP and partners removed invasive plants within the fenced exclosure at Waikapū (Oppenheimer 2019b, pers. comm.). • Captive propagation for genetic storage and reintroduction— o The Lyon Arboretum Seed Conservation Laboratory reported more than 4,500 seeds in storage from two accessions representing more than 13 founders of S. salicaria from the population located at Kaunoahua Ridge (Lyon Arboretum 2018). o In 2018, the Olinda Rare Plant Facility had 16 potted plants of S. salicaria growing in their nursery from plants collected at Waikapū (Olinda Rare Plant Facility 2018). (USFWS, 2020)

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Designation and Nondesignation of Critical Habitat on Molokai, Lanai, Maui, and Kahoolawe for 135 Species

Final Rule . 81 FR 17790-18110 (March 30, 2016).

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NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A." USFWS, 2020. Schiedea salicaria (no common name). 5-Year Review. Summary and Evaluation. U.S. Fish and Wildlife Service. Pacific Islands Fish and Wildlife Office Honolulu, Hawaiʻi. 23 pp. USFWS. 2021. Draft recovery plan for 44 species from the islands of Maui, Molokaʻi, Kahoʻolawe, and Lānaʻi (Maui Nui). Portland, Oregon. xvi + 77 pages.

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SPECIES ACCOUNT: *Schiedea sarmentosa* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2017)

Physical Description

A many-branched subshrub 30-45 cm tall. The flowers are borne in terminal clusters. (NatureServe, 2015)

Taxonomy

Schiedea sarmentosa is being resurrected by W.L. Wagner (W.L. Wagner, pers. comm. to Christa Russell, 1994); Kartesz's 1994 Checklist included S. sarmentosa in synonymy of S. menziesii, but the 1999 Synthesis recognizes the taxon as a distinct species. Schiedea menziesii had Candidate, Category 2 status in the 1990 and 1993 USFWS notices of review, but in Oct., 1995, only S. sarmentosa was proposed for listing and the Oct. 10, 1996 determination to list S. sarmentosa, explains that the switch is due to the fact that, "S. sarmentosa was included in S. menziesii by Wagner et al. (1990). Warren Wagner and Stephen Weller, who are preparing a monograph of the genus, now consider S. sarmentosa to be a separate species." S. menziesii is not mentioned in the Oct. 31, 1996 reprint of the List of Endangered and Threatened Wildlife and Plants or in the Sept. 1997 notice of review. (NatureServe, 2015) A member of the pink family (Caryophyllaceae) (USFWS, 2016).

Historical Range

Historically no additional range. (NatureServe, 2015)

Current Range

Current range includes Molokai. (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Schiedea sarmentosa under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Maui County in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Schiedea sarmentosa includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea

lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Schiedea sarmentosa critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana,

Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii

ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Possibly wind pollinated, sexual (USFWS, 1998)

Reproduction Narrative

Adult: The flowers are female on some plants and bisexual on others. The population in Makolelau Gulch has a frequency of females of 31 percent. Based on analyses of pollen-ovule ratios, pollen size, inflorescence structure, and comparison to other Schiedea species tested in a wind tunnel, Schiedea sarmentosa could be wind-pollinated (Steven Weller, University of California, Irvine, personal communication 1997). No other life history information for this species is available (USFWS, 1998).

Habitat Type

Adult: Steeply sloped shrubland (USFWS, 1998)

Habitat Vegetation or Surface Water Classification

Adult: Lwoland dry or mesic shrubland (USFWS, 1998)

Dependencies on Specific Environmental Elements

Adult: Lwoland mesic ecosystem (see population narrative)

Geographic or Habitat Restraints or Barriers

Adult: 2,000 - 2,600 ft. elevation (USFWS, 1998)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1998)

Environmental Specificity

Adult: Narrow/specialist (Inferred from NatureServe, 2015 and USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1998)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015 and USFWS, 1998)

Habitat Narrative

Adult: Dry and moist forests and shrublands. Often on rocky gulch slopes and cliffs. (NatureServe, 2015). Schiedea sarmentosa is typically found on steep slopes in ohia-Dodonaea viscosa (aalii) lowland dry or mesic shrubland between 610 and 790 meters (2,000 and 2,600 feet) elevation (I-THP 1991b, 1993b; HPCC 199 lb. 1992). Associated species include Syphelia tameiameiae (pukiawe), Chenopodium oahuensis (aheahea). Alyxia oliviformis (maile), Pleomele sp. (hala pepe), and Chamaesyce sp. (akoko) (HHP 1993b; HPCC 1991b, 1992) (USFWS, 1998). lumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Increasing (USFWS, 2011)

Number of Populations:

1 (USFWS, 2023)

Population Size:

> 1000 (USFWS, 2023)

Population Narrative:

New Status Information: • There is one population estimated to total more than 1,000 individuals on Molokaʻi (Bakutis 2018, in litt.) • Visits to the Kawela population in 2018 documented suspected hybrids between Schiedea lydgatei and S. sarmentosa (Weisenberger 2018, in litt.). • In 2016, one critical habitat unit in the lowland mesic ecosystem was designated on Molokaʻi for Schiedea sarmentosa (8,770 ac; 3,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018). • Currently, there is one population on Molokaʻi at Kawela gulch, estimated to total more than 1,000 individuals (Bakutis, pers. comm. 2023). • Currently, there are approximately ten founder lines represented in ex situ storage and propagation collections, including seeds in seed banks and plants in cultivation (National Tropical Botanical Garden (NTBG) 2022; University of California-Irvine, 2017) (USFWS, 2022).

Threats and Stressors

Stressor: Feral goats, rats and slugs (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/loss of indivduals
Narrative: Goats, rats (Rattus spp.), and slugs (unidentified species) may eat parts of this plant (Perlman 2010; Wood 2010). Spittle bugs (the juvenile stage of certain leafhoppers) were observed on this species in April 2009 (Oppenheimer 2010). In addition, goats degrade the

habitat through trampling the species (USFWS, 2011).

Stressor: Invasive plants (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive plants are listed as a threat to this species (USFWS, 2011).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence: Loss of habitat
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that S. sarmentosa is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.977 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Recovery

Reclassification Criteria:
A total of five to seven populations of each taxon should be documented on Molokai. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 2011).

Recovery Priority Number: 8

Delisting Criteria:
A total of 8 to 10 populations of each taxon should be documented on Molokai. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 2011).

Recovery Actions:
- Conduct surveys where Schiedea sarmentosa has been reported to determine current status of the species (USFWS, 2011).
- Continue collection of seeds or cuttings for genetic storage and reintroduction (USFWS, 2011).
- Monitor known populations (USFWS, 2011).
- Fence all populations to provide protection from the negative impacts of feral ungulates (USFWS, 2011).
- Control invasive introduced plant species around all populations (USFWS, 2011).
- Control rats in the vicinity of these populations (USFWS, 2011).

- Develop and implement methods to control slugs and spittle bugs (USFWS, 2011).
- Establish additional populations within protected suitable habitat (USFWS, 2011).
- Develop and implement a wildfire management plan (USFWS, 2011).
- Work with the East Molokai Watershed Partnership and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2011).
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2011).
- New Management Actions: • Captive propagation for genetic storage and reintroduction—In 2014, the University of California–Irvine reported 12 plants from Mākolelau in storage, representing 12 different individuals (USFWS, 2018).
- Recommendations for Future Actions: Hybridization may be a new threat to this species; however, we are not aware of any significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Surveys and inventories—Survey areas where Schiedea sarmentosa has been reported to determine current status of the species on Moloka'i. • Ungulate monitoring and control—Fence existing populations to provide protection from negative impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around all populations of S. sarmentosa. • Fire destruction or degradation of habitat—Develop and implement a wildfire management plan. • Captive propagation for genetic storage and reintroduction—Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation— o Augment known populations and reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. o Research methods to increase and maintain numbers of female individuals within populations. o Study the possible effects of hybridization on this species. • Rodent predation and herbivory—Control rats in the vicinity of all populations. • Invertebrate predation and herbivory—Develop and implement methods to control slugs and spittle bugs. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the East Molokai Watershed Partnership program, the Hawai'i Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2023. • Surveys and monitoring—Survey for additional populations of Schiedea sarmentosa at historical populations and areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Schiedea sarmentosa within and around all wild populations. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the

impacts of climate change, including increasing temperatures, periods between rain events, and frequency and intensity of hurricanes. Additional management actions may be needed, such as locating microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and implement effective methods for rodents and slugs around wild populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for future reintroduction. • Build resiliency, redundancy, and representation — Increase species' viability through habitat restoration, threat control, and reintroduction and translocation. Continue attempts at reintroduction into suitable habitat that is being managed for known threats to this species to reduce impacts of erosion, treefall, flooding, and hurricanes. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2023).

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SPECIES ACCOUNT: *Schiedea trinervis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect, branched subshrub 3-8 dm tall. The white and green flowers are borne in clusters of 7-20. (NatureServe, 2015)

Taxonomy

No new taxonomic information has been received since the last 5-year review (USFWS 2009). However, the 2012 supplement to the Manual of the Flowering Plants of Hawaii (Wagner et al. 2012) reiterates the change from the genus Alsinidendron to the currently accepted Schiedea. In 2012, USFWS revised the taxonomic status for this species when it revised critical habitat on Oahu, with no change in range or distribution (USFWS 2012). This species is now listed as Schiedea trinervis (USFWS, 2013).

Historical Range

See current range/distribution

Current Range

Current range: Waianae Mountains of Oahu. Historically no additional range.

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

September 18, 2012, the U.S. Fish and Wildlife Service (Service), revised critical habitat for Schiedea trinervis on Oahu.

Critical Habitat Designation

Oahu—Montane Wet—Unit 1, Oahu— Dry Cliff—Unit 1, Oahu—Dry Cliff— Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, Oahu—Dry Cliff—Unit 8, Oahu—Wet Cliff—Unit 1, Oahu—Wet Cliff—Unit 2, Oahu—Wet Cliff—Unit 3, Oahu—Wet Cliff—Unit 4, and Oahu—Wet Cliff—Unit 5 constitute critical habitat for Schiedea trinervis on Oahu.

Oahu—Montane Wet—Unit 1 consists of 18 ac (7 ha) of City and County of Honolulu land, 352 ac (142 ha) of State land, and less than 1 ac (less than one ha) of privately-owned land in the montane wet ecosystem at the summit of the Waianae Mountains at Kaala, and partially within the Mokuleia Forest Reserve and the Kaala Natural Area Reserve. This unit is occupied by the plants Cyanea acuminata, C. calycina, Labordia cyrtandrae, Melicope christophersenii, and Schiedea trinervis, and includes the wet forest and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 4). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Dry Cliff—Unit 1 consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. This unit is on State land within the Pahole Natural Area Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants Alectryon macrococcus, Cenchrus agrimonioides, Chamaesyce herbstii, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Kadua degeneri, Plantago princeps var. princeps, and Schiedea obovata. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 1 is not currently occupied by Abutilon sandwicense, Achyranthes splendens var. rotundata, Bonamia menziesii, Chamaesyce kuwaleana, Diellia falcata, D. unisora, Dubautia herbtsobatae, Eragrostis fosbergii, Flueggea neowawraea, Gouania meyenii, G. vitifolia, Isodendrion laurifolium, I. pyrifolium, Kadua parvula, Korthalsella degeneri, Lepidium arbuscula, Lipochaeta lobata var. leptophylla, Lobelia niihauensis, Melanthera tenuifolia, Melicope makahae, M. saint-johnii, Neraudia angulata, Nototrichium humile, Peucedanum sandwicense, Phyllostegia kaalaensis, Platydesma cornuta var. decurrens, Pleomele forbesii, Pteralyxia macrocarpa, Sanicula mariversa, Schiedea hookeri, S. trinervis, Silene lanceolata, S. perlmanii, Spermolepis hawaiiensis, Tetramolopium filiforme, T. lepidotum ssp. lepidotum, or Viola chamissoniana ssp. chamissoniana, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 2 consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. This unit is almost entirely within the Makua Keaau Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Dry Cliff— Unit 2 is occupied by the plants Abutilon sandwicense, Alectryon macrococcus, Dubautia herbstobatae, Gouania vitifolia, Kadua parvula, Lepidium arbuscula, Lobelia niihauensis, Melanthera tenuifolia, Melicope makahae, Nototrichium humile, Peucedanum sandwicense, Platydesma cornuta var. decurrens, Pleomele forbesii, Sanicula mariversa, Schiedea hookeri, Tetramolopium filiforme, and Viola chamissoniana ssp. chamissoniana. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 2 is not currently occupied by Achyranthes splendens var. rotundata, Bonamia menziesii, Cenchrus agrimonioides, Chamaesyce herbstii, C. kuwaleana, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Diellia falcata, D. unisora, Eragrostis fosbergii, Flueggea neowawraea, Gouania meyenii, Isodendrion laurifolium, I. pyrifolium, Kadua degeneri, Korthalsella degeneri, Lipochaeta lobata var. leptophylla, Melicope saint-johnii, Neraudia angulata, Phyllostegia kaalaensis, Plantago princeps, Pteralyxia macrocarpa, Schiedea obovata, S. trinervis, Silene lanceolata, S. perlmanii, Spermolepis hawaiiensis, or Tetramolopium lepidotum ssp. lepidotum, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for

expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 3 consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants Abutilon sandwicense, Alectryon macrococcus, Bonamia menziesii, Diellia falcata, Dubautia herbstobatae, Eragrostis fosbergii, Flueggea neowawraea, Gouania meyenii, Isodendrion laurifolium, Korthalsella degeneri, Lepidium arbuscula, Lipochaeta lobata var. leptophylla, Lobelia niihauensis, Melanthera tenuifolia, Melicope makahae, Neraudia angulata, Nototrichium humile, Peucedanum sandwicense, Phyllostegia kaalaensis, Pleomele forbesii, Pteralyxia macrocarpa, Schiedea hookeri, Silene lanceolata, Tetramolopium filiforme, and Viola chamissoniana ssp. chamissoniana. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 3 is not currently occupied by Achyranthes splendens var. rotundata, Cenchrus agrimonioides, Chamaesyce herbstii, C. kuwaleana, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Diellia unisora, Gouania vitifolia, Isodendrion pyrifolium, Kadua degeneri, K. parvula, Melicope saint-johnii, Plantago princeps, Platydesma cornuta var. decurrens, Sanicula mariversa, Schiedea obovata, S. trinervis, Silene perlmanii, Spermolepis hawaiiensis, or Tetramolopium lepidotum ssp. lepidotum, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 4 consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. This unit is partially within the Waianae Kai Forest Reserve, and includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). This unit is occupied by the plants Alectryon macrococcus, Chamaesyce kuwaleana, and Spermolepis hawaiiensis. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 4 is not currently occupied by Abutilon sandwicense, Achyranthes splendens var. rotundata, Bonamia menziesii, Cenchrus agrimonioides, Chamaesyce herbstii, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Diellia falcata, D. unisora, Dubautia herbstobatae, Eragrostis fosbergii, Flueggea neowawraea, Gouania meyenii, G. vitifolia, Isodendrion laurifolium, I. pyrifolium, Kadua degeneri, K. parvula, Korthalsella degeneri, Lepidium arbuscula, Lipochaeta lobata var. leptophylla, Lobelia niihauensis, Melanthera tenuifolia, Melicope makahae, M. saintjohnii, Neraudia angulata, Nototrichium humile, Peucedanum sandwicense, Phyllostegia kaalaensis, Plantago princeps, Platydesma cornuta var. decurrens, Pleomele forbesii, Pteralyxia macrocarpa, Sanicula mariversa, Schiedea hookeri, S. obovata, S. trinervis, Silene lanceolata, S. perlmanii, Tetramolopium filiforme, T. lepidotum ssp. lepidotum, or Viola chamissoniana ssp. chamissoniana, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs

necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 6 consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). The unit is occupied by the plants Cenchrus agrimonioides, Diellia unisora, Flueggea neowawraea, Lepidium arbuscula, Lobelia niihauensis, Melicope saintjohnii, Neraudia angulata, Plantago princeps, Pleomele forbesii, Pteralyxia macrocarpa, and Tetramolopium lepidotum ssp. lepidotum. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 6 is not currently occupied by Abutilon sandwicense, Achyranthes splendens var. rotundata, Alectryon macrococcus, Bonamia menziesii, Chamaesyce herbstii, C. kuwaleana, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Diellia falcata, Dubautia herbstobatae, Eragrostis fosbergii, Gouania meyenii, G. vitifolia, Isodendrion laurifolium, I. pyrifolium, Kadua degeneri, K. parvula, Korthalsella degeneri, Lipochaeta lobata var. leptophylla, Melanthera tenuifolia, Melicope makahae, Nototrichium humile, Peucedanum sandwicense, Phyllostegia kaalaensis, Platydesma cornuta var. decurrens, Sanicula mariversa, Schiedea hookeri, S. obovata, S. trinervis, Silene lanceolata, S. perlmanii, Spermolepis hawaiiensis, Tetramolopium filiforme, or Viola chamissoniana ssp. chamissoniana, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7a consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4), and is occupied by the plants Flueggea neowawraea, Kadua parvula, Melicope saint-johnii, Plantago princeps, Platydesma cornuta var. decurrens,

Pleomele forbesii, Silene perlmanii, and Viola chamissoniana ssp. chamissoniana. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Dry Cliff—Unit 7a is not currently occupied by Abutilon sandwicense, Achyranthes splendens var. rotundata, Alectryon macrococcus, Bonamia menziesii, Cenchrus agrimonioides, Chamaesyce herbstii, C. kuwaleana, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Diellia falcata, D. unisora, Dubautia herbstobatae, Eragrostis fosbergii, Gouania meyenii, G. vitifolia, Isodendrion laurifolium, I. pyrifolium, Kadua degeneri, Korthalsella degeneri, Lepidium arbuscula, Lipochaeta lobata var. leptophylla, Lobelia niihauensis, Melanthera tenuifolia, Melicope makahae, Neraudia angulata, Nototrichium humile, Peucedanum sandwicense, Phyllostegia kaalaensis, Pteralyxia

macrocarpa, Sanicula mariversa, Schiedea hookeri, S. obovata, S. trinervis, Silene lanceolata, Spermolepis hawaiiensis, Tetramolopium filiforme, or T. lepidotum ssp. lepidotum, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Dry Cliff—Unit 7b consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. This area was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the dry cliff ecosystem (see Table 4). Although Oahu—Dry Cliff—Unit 7b is not currently occupied by Abutilon sandwicense, Achyranthes splendens var. rotundata, Alectryon macrococcus, Bonamia menziesii, Cenchrus agrimonioides, Chamaesyce herbstii, C. kuwaleana, Cyanea grimesiana ssp. obatae, Cyrtandra dentata, Diellia falcata, D. unisora, Dubautia herbstobatae, Eragrostis fosbergii, Flueggea neowawraea, Gouania meyenii, G. vitifolia, Isodendrion laurifolium, I. pyrifolium, Kadua degeneri, K. parvula, Korthalsella degeneri, Lepidium arbuscula, Lipochaeta lobata var. leptophylla, Lobelia niihauensis, Melanthera tenuifolia, Melicope makahae, M. saintjohnii, Neraudia angulata, Nototrichium humile, Peucedanum sandwicense, Phyllostegia kaalaensis, Plantago princeps, Platydesma cornuta var. decurrens, Pleomele forbesii, Pteralyxia macrocarpa, Sanicula mariversa, Schiedea hookeri, S. obovata, S. trinervis, Silene lanceolata, S. perlmanii, Spermolepis hawaiiensis, Tetramolopium filiforme, T. lepidotum ssp. lepidotum, or Viola chamissoniana ssp. chamissoniana, the Service has determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 1 consists of 167 ac (68 ha) of State land, 68 ac (28 ha) of City and County of Honolulu land, and less than 1 ac (less than 1 ha) of privately owned land in the wet cliff ecosystem in the Waianae Mountains, near the summit of Kaala, and partially within the Mokuleia and Waianae Kai FRs and the Kaala Natural Area Reserve. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Wet Cliff—Unit 1 is occupied by the plants Cyanea calycina, Melicope christophersenii, and Schiedea trinervis. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations.

Oahu—Wet Cliff—Unit 2 consists of 3 ac (1 ha) of State land in the wet cliff ecosystem in the Waianae Mountains at Puuhapapa, within a small area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Wet Cliff—Unit 2 is occupied by the plants Cyanea calycina and Melicope christophersenii. This unit also contains unoccupied habitat that is essential to the conservation of these species by

providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Wet Cliff—Unit 2 is not currently occupied by Cyanea acuminata, Labordia cyrtandrae, Lobelia oahuensis, Phyllostegia hirsuta, Pteralyxia macrocarpa, Schiedea hookeri, S. kaalae, or S. trinervis, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 3 consists of 16 ac (6 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukanehoa, partially within an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and was recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Although Oahu—Wet Cliff—Unit 3 is not currently occupied by Cyanea acuminata, C. calycina, Labordia cyrtandrae, Lobelia oahuensis, Melicope christophersenii, Phyllostegia hirsuta, Pteralyxia macrocarpa, Schiedea hookeri, S. kaalae, or S. trinervis, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 4 consists of 23 ac (9 ha) in the wet cliff ecosystem on State land in the Waianae Mountains at Puukaua, partially overlapping an area that was part of the Honouliuli Preserve, managed by The Nature Conservancy of Hawaii, and recently acquired by the State. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). This unit is occupied by the plants Phyllostegia hirsuta and Schiedea hookeri. This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Oahu—Wet Cliff—Unit 4 is not currently occupied by Cyanea acuminata, C. calycina, Labordia cyrtandrae, Lobelia oahuensis, Melicope christophersenii, Pteralyxia macrocarpa, Schiedea kaalae, or S. trinervis, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Oahu—Wet Cliff—Unit 5 consists of 31 ac (13 ha) of State land in the wet cliff ecosystem in the Waianae Mountains, at Palikea and north of Palikea. This unit includes the shrubland, the moisture regime, and subcanopy and understory native plant species identified as physical or biological features in the wet cliff ecosystem (see Table 4). Although Oahu—Wet Cliff—Unit 5 is not currently occupied by Cyanea acuminata, C. calycina, Labordia cyrtandrae, Lobelia oahuensis, Melicope christophersenii, Phyllostegia hirsuta, Pteralyxia macrocarpa, Schiedea hookeri, S. kaalae, or S. trinervis, the Service has determined this area to be essential for the conservation and recovery of these wet cliff species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small

numbers of individuals or low population sizes, these species require suitable habitat and space for expansion or reintroduction to achieve population levels that could achieve recovery.

Primary Constituent Elements/Physical or Biological Features

(i) In unit Oahu—Montane Wet—Unit 1, the physical and biological features of critical habitat are: (A) Elevation: 3,300 to 6,600 ft (1,000 to 2,000 m). (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Well-developed soils, montane bogs. (D) Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. (E) Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. (F) Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

(ii) In units Oahu—Dry Cliff—Unit 1, Oahu—Dry Cliff—Unit 2, Oahu—Dry Cliff—Unit 3, Oahu—Dry Cliff—Unit 4, Oahu—Dry Cliff—Unit 6, Oahu—Dry Cliff—Unit 7a, Oahu—Dry Cliff—Unit 7b, and Oahu—Dry Cliff—Unit 8, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Less than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

(iii) In units Oahu—Wet Cliff—Unit 1, Oahu—Wet Cliff—Unit 2, Oahu—Wet Cliff—Unit 3, Oahu—Wet Cliff—Unit 4, and Oahu—Wet Cliff—Unit 5, the physical and biological features of critical habitat are: (A) Elevation: Unrestricted. (B) Annual precipitation: Greater than 75 in (190 cm). (C) Substrate: Greater than 65 degree slope, shallow soils, weathered lava. (D) Canopy: None. (E) Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. (F) Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Little information found although NatureServe (2015) notes the species reproduces sexually.

Reproduction Narrative

Adult: SEXUAL; (NatureServe, 2015). Alsinidendron trinerve flowers and fruits throughout the year with the possible exception of fall (USFWS 1995) (USFWS, 1998).

Habitat Type

Adult: Wet/mesic forest (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2013)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 1998; USFWS, 2013)

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 1998; USFWS, 2013)

Site Fidelity

Adult: High (USFWS, 1998; USFWS, 2013)

Habitat Narrative

Adult: Species inhabits slopes or ridges in wet forest or wetter portions of diverse mesic forest. Also found in drier forests. (NatureServe, 2015). Alsinidendron trinerve typically grows on slopes in wet forest or the wetter portions of diverse mesic forest dominated by ohia and flex anomala (kawau) at an elevation of900 to 1,200 meters (3,000 to 4,000 feet) (USFWS 1995). Associated plants include Coprosma sp. (pilo), Gunnera (apeape), Melicope sp. (alani), Cibotium sp. (hapuu), Antidesma platyphylla (hame), and mamaki (USFWS 1995) (USFWS, 1998). USFWS (2013) notes that there is only one known population. Clumped spatial arrangement of the population, narrow environmental specificity, low tolerance ranges and high site fidelity and ecological integrity of the community are inferred based on the species unique habitat requirements and the low number of known populations (One).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found.

Population Information and Trends

Population Trends:

Increasing (USFWS, 2013)

Number of Populations:

1 (USFWS, 2019)

Population Size:

300-350 individuals (USFWS, 2019)

Population Narrative:

Currently there are approximately 300 mature and 350 immature individuals of Schiedea trinervis in one population (from East Makaleha to Puʻu Kalena) in the Waiʻanae mountains of Oʻahu. No observations have been made since 2015 (Army Natural Resources Program-Oʻahu (ANRP) 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Ungulates (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/loss of indivduals
Narrative: Trampling from feral animals (especially pigs) is listed as a threat to this species (USFWS, 2013)

Stressor: Military training activities (USFWS, 2013)

Exposure:
Response:
Consequence: Loss of habitat/loss of indivduals
Narrative: This species sole population is found on an army installation. Military training activities are a threat to this species (USFWS, 2013).

Stressor: Alien plant species (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Alien plant species are known to alter the ecosystem and are listed as a threat to this species (USFWS, 2013).

Stressor: Human trampling (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: Trampling by humans is listed as a threat to this species (USFWS, 2013).

Stressor: Over-collection (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: Collection by humans is listed as a threat to this species (USFWS, 2013).

Stressor: Slugs (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: Predation by slugs is listed as a threat to this species (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) funded climate modeling that will help resolve these spatial limitations. High spatial resolution climate outputs are expected in 2013 (USFWS, 2013).

Recovery

Reclassification Criteria:
For downlisting, a total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum

of300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:
A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:

- Surveys/inventories o Search for additional individuals of Schiedea trinervis in its historical range. o Continue mapping the entire range of populations (USFWS, 2013).
- Population biology research o Study Schiedea trinervis populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. o Determine if additional populations should be reintroduced or if this species can be recovered with one large population (USFWS, 2013).
- Genetic research - Assess genetic variability within the one extant population (USFWS, 2013).
- Existing population management and restoration o Protect, manage within current wild populations o Manage all individuals of Schiedea trinervis (USFWS, 2013).
- Alliance and partnership development - Alliance and partnership development - Continue planning and contribute to implementation of ecosystem-level management and restoration to benefit this species with the U.S. Army Garrison, Hawaii Division of Forestry and Wildlife, and other landowners (USFWS, 2013).
- Captive propagation for genetic storage and reintroduction: Complete collection of fruit from wild individuals; augment these collections with seed from reintroduced individuals to add genetic diversity of ex situ seed storage (USFWS, 2013).
- Ecosystem-altering invasive plant species control: Control introduced invasive plant species around wild and reintroduced plants (USFWS, 2013).
- Ungulate exclosures - Construct large-scale fences to control feral ungulates around entire population and reintroduced individuals (USFWS, 2013).
- Reintroduction / translocation - Continue reintroducing individuals into protected suitable habitat within historical range (USFWS, 2013).
- Threats research - Investigate techniques to improve natural recruitment, including the development of an effective slug control method (USFWS, 2013).

Conservation Measures and Best Management Practices:

- New Management Actions: • Ungulate control—The ANRP reports ungulates are controlled by fencing at East Makaleha to Puʻu Kalena (ANRP 2018). • Nonnative invasive plant control—The ANRP reports nonnative plant control is ongoing at East Makaleha to Puʻu Kalena (ANRP 2018). • Captive propagation for genetic storage and reintroduction— o The ANRP reports that the population from East Makaleha to Puʻu Kalena has met its goals of genetic representation in collections with 90 wild plants represented in the ANRP seed bank (ANRP 2018). o Since the last 5-year review in 2013, the

Lyon Seed Micropropagation Laboratory reports 119 explants total representing both individuals at the Makaleha and Kaʻala subpopulations. The Lyon Seed Conservation Laboratory reports storage of more than 1,000 seeds representing at least one individual from Kaʻala. • Reintroductions—None (U.S. Army 2018). (USFWS, 2019)

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and inventories—Continue to survey geographical and historical range for a thorough assessment of the species' status. • Ungulate monitoring and control—Continue to fence and monitor wild and reintroduced populations to protect plants from impacts of feral ungulates. • Invasive plant monitoring and control—Continue to control established ecosystemaltering nonnative invasive plant species, and those that compete with Schiedea trinervis at all wild and reintroduced population. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Invertebrate control—Implement effective slug and nonnative snail control at all wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction—Continue seed collection for genetic storage and propagation for reintroduction. • Reintroduction—Continue to establish new populations and augment existing populations, keeping close track of maternal source used for ex situ propagation. • Population biology research— o Study populations of Schiedea trinervis with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. o Determine if additional populations should be established or if this species can be recovered as one large population. o Assess the genetic variability within the population. • Alliance and partnership development—Continue to work with the ANRP, the Hawaiʻi Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2019)

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U.S. Fish and Wildlife Service. 1998. Recovery Plan for Oahu Plants. U.S. Fish and Wildlife Service, Portland, Oregon. 207 pp., plus appendices.

USFWS. 2019. 5-YEAR REVIEW Short Form Summary Species Reviewed: Schiedea trinervis (no common name) Current Classification: Endangered. 9 pp.

SPECIES ACCOUNT: *Schoenocrambe argillacea* (Clay reed-mustard)

Species Taxonomic and Listing Information

Listing Status: Threatened; 01/14/1992; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

A perennial herbaceous plant in the mustard family, with sparsely leafed stems 15 to 30 cm (6 to 12 in) tall arising from a woody root crown. The leaves are very narrow with a smooth margin, 10 to 35 mm (0.4 to 1.4 in) long and, usually, less than 2 mm (0.1 inch) wide. The leaf blades are alternately arranged on the stem and, for the most part, are attached directly to the stem without a petiole. The narrow, fleshy leaves are covered with a white, waxy surface. The flowers of clay reed-mustard have petals that are pale lavender to whitish with prominent purple veins and measure 8 to 11 mm (0.3 to 0.4 inch) long and 3.5 to 4.5 mm (0.14 to 0.18 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of 3 to 20 flowers at the end of the plant's leafy stems. Flowers are pale lavender to whitish with conspicuous purple veins. Blooms in late April and early May. (USFWS, 2016; NatureServe, 2015)

Taxonomy

The species was first discovered and recorded by Dr. Duane Atwood in 1976. It was described as Thelypodium argillacea in 1977, moved to the genus Schoenocrambe in 1982, and most recently renamed Hesperidanthus argillaceus (Al-Shehbaz 2010). The latter is the name now accepted for this species by the Flora of North America and the integrated taxonomic information system (Al-Shehbaz 2010; ITIS 2017). (USFWS, 2019)

Current Range

Endemic to the Uinta Basin (Book Cliffs area) in Uintah County, northeast Utah. Known range is only about 24 km x 12 km, from the west side of the Green River to the east side of Willow Creek (USFWS 1994). Franklin (2005) describes the three population areas as follows: "along the east slopes of Big Pack Mountain and in Broome Canyon to the east; along the west slopes of Wild Horse Bench, from the vicinity of Kings Canyon and south nearly to The Wrinkles; and along the slopes of the canyons above Ray's Bottom, on the west side of the Green River." (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1994)

Breeding Season

Adult: April to May (USFWS, 1994)

Reproduction Narrative

Adult: Flowering occurs from April to May and fruiting occurs May to June in all three species. Reproduction in each of the three species is sexual. (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, barrens, desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1440 to 1765 meters (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (NatureServe, 2015)

Habitat Narrative

Adult: Occurs within shadscale, Indian ricegrass, pygmy sagebrush, and other mixed desert shrub communities on precipitous, typically north-facing slopes. On these slopes (elevations from 1440 to 1765 m), plants grow in both exposed and protected sites, with protected sites usually having the more robust plants. Substrates consist of at-the-surface bedrock, scree, and fine-textured soils, often clay soils rich in gypsum (shale barrens) overlain with sandstone talus. Occurs about the zone of contact between the Tertiary lower Uinta Formation and the Evacuation Creek Member of the upper Green River shale Formation. Commonly associated species include Eriogonum corymbosum, Ephedra torreyana, Atriplex confertifolia, Atriplex gardneri var. cuneata, Elymus salinus, Tetradymia nuttallii,and Amelanchier utahensis; other associates include Agropyron smithii, Arabis pendulina, Arabis pulchra, Artemisia nova, Astragalus chamaeleuce, Astragalus convallarius, Brickellia oblongifolia, Castilleja chromosa, Chrysothamnus viscidiflorus, Cryptantha rollinsii, Cymopterus fendleri, Eriogonum ovalifolium, Euphorbia fendleri, Leptodactylon pungens, Penstemon carnosus, Petradoria pumila, Cymopterus terebinthinus, Stipa hymenoides, Tetradymia spinosa, and Thelesperma subnudum. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

3 (USFWS, 2011)

Population Size:

~6,000 (USFWS, 2011)

Population Narrative:

Schoenocrambe argillacea occurs in six populations in Uintah County. In 1992, the Utah Natural Heritage Program completed an extensive survey of potential habitat for Schoenocrambe argillacea and estimated the total number of S. argillacea was 6,000 plants (Franklin 1992; Service 1994). (USFWS, 2011)

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Oil and gas development remains a significant threat to Schoenocrambe argillacea populations and habitat (Service 1990; 1994). All Federal lands on which known populations of S. argillacea occur are leased for oil and gas development (Utah Division of Oil, Gas, and Mining (UDOGM) 2011). To date, oil and gas development within known S. argillacea areas has been moderate. The Service does not know the actual ground disturbance at this point from oil and gas development, but the Service estimates approximately 5 acres (2 hectares) of total disturbance per well, including roads and infrastructure. After excluding directional wells (which are usually drilled from existing well pads), the Service calculated that at least 130 acres are disturbed within S. argillacea populations as mapped, and an additional 85 acres could be disturbed as currently approved oil and gas wells are drilled within the next 2 years (UDOGM 2011). Oil and gas development remains a significant threat to Schoenocrambe argillacea populations and habitat (Service 1990; 1994). All Federal lands on which known populations of S. argillacea occur are leased for oil and gas development (Utah Division of Oil, Gas, and Mining (UDOGM) 2011). To date, oil and gas development within known S. argillacea areas has been moderate. The Service does not know the actual ground disturbance at this point from oil and gas development, but the Service estimates approximately 5 acres (2 hectares) of total disturbance per well, including roads and infrastructure. After excluding directional wells (which are usually drilled from existing well pads), the Service calculated that at least 130 acres are disturbed within S. argillacea populations as mapped, and an additional 85 acres could be disturbed as currently approved oil and gas wells are drilled within the next 2 years (UDOGM 2011). (USFWS, 2011)

Stressor: Habitat fragmentation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Schoenocrambe argillacea exists in small, low-density populations that are likely prone to negative effects from habitat fragmentation. For example, small plant populations fluctuate more widely over time and the smaller the remnant, the more susceptible the population is to extinction (Soulé et al. 1992; Forman and Alexander 1998; Menges 2002; Lienert 2004). Small plant populations can lose genetic variation and their population viability decreases (Ellstrand and Elam 1993; Lienert 2004; Kolb 2008). Fruit set, germination rate, offspring survival, and total numbers of flowers per plant are higher in large populations than in small populations (Paschke et al. 2002). Similarly, the number of capsules per plant and the number of seedlings per plant are positively correlated with population size (Schmidt and Jensen 2000). Roads associated with

energy exploration and development cause a high level of habitat fragmentation. Increased oil and gas developments result in more roads developed near and potentially in Schoenocrambe argillacea habitat. Ecological effects of roads to plants can extend more than 328 feet (100 meters) from the road (Angold 1997; Forman 2000; Forman and Deblinger 2000). Disturbance can occur directly from construction or indirectly from road dust, discussed further below (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Angold 1997; Sharifi et al. 1997; Trombulak and Frissell 2000; Hobbs 2001; Myers-Smith et al. 2006). There is a strong correlation between vegetation composition and health with distance from a road, although it may take decades for the full effects of road development to be realized (Auerbach et al. 1997; Myers-Smith et al. 2006). (USFWS, 2011)

Stressor: Road dust (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Schoenocrambe argillacea may be impacted by the indirect effects of road dust associated with oil and gas development. Road traffic mobilizes and spreads dust (Farmer 1993; Trombulak and Frissell 2000), and for every vehicle traveling 1 mile (1.6 kilometers) of unpaved roadway once a day, every day for a year, approximately 2.5 tons of dust are deposited along a 1,000-foot (~300-meter) corridor centered on the road (Sanders pers. comm. 2008). Dust deposition tends to be highest near the road and decreases with increasing distance from the road (Everett 1980; Spatt and Miller 1981; Walker and Everett 1987; Santelmann and Gorham 1988; Myers-Smith et al. 2006). For example, in one study, 97 percent of dust was deposited within 410 feet (125 meters) of the road (Walker and Everett 1987). The distance from a road at which dust can affect vegetation varies (see McCrea 1984; Myers-Smith et al. 2006), but negative impacts can occur up to 984 feet (300 meters) away from the road (Everett 1980). Using information from these studies, the BLM now implements a buffer of 300 feet (91 meters) for surface disturbance activities near S. argillacea occupied habitat and a requirement for monitoring plants where surface disturbance occurs within the 300-foot (91-meter) buffer. Dust negatively affects photosynthesis, respiration, transpiration, water use efficiency, leaf conductance, growth rate, plant vigor, gas exchange, and allows the penetration of phytotoxic gaseous pollutants (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Sharifi et al. 1997; Trombulak and Frissell 2000; Hobbs 2001). Dust comprised of finer particulates caused more improper functioning of the stomata than larger particles (Ricks and Williams 1974; Eller and Brunner 1975; Eveling and Bataille 1984; Rawson and Clarke 1988; Hirano et al. 1995). Improperly functioning stomata result in increased water loss in two ways: due to an increased transpiration rate because of increased leaf temperatures and due to clogged stomata that are unable to close at night (Hirano et al. 1995). Dust also can inhibit sunlight from reaching plant surfaces (Sharifi et al. 1997). Additionally, dusted leaves were 4 to 5°F (2 to 3°C) warmer (Sharifi et al. 1997) than undusted, control leaves (Hirano et al. 1995). Dust from roads also impacts soil quality and vegetation type. Soils near roads can have significantly lower nutrient levels, altered organic horizon depth, higher bulk density, and lower moisture (Auerbach et al. 1997). Furthermore, soil characteristics and plant community composition can remain significantly different up to 28 years after road development (Myers-Smith et al. 2006). (USFWS, 2011)

Stressor: Plant-pollinator interactions (USFWS, 2011)
Exposure:
Response:

Consequence:
Narrative: Many of the negative effects of habitat fragmentation to plants are due to effects on plant-pollinator interactions (Debinski and Holt 2000; Moody-Weis and Heywood 2001; Aizen et al. 2002; Gathmann and Tscharntke 2002; Lennartsson 2002; Kolb 2008). Fragmented plant populations appear to be less attractive to insect pollinators, which spend more time in larger, unfragmented plant habitats (Aizen et al. 2002; Goverde et al. 2002; Lennartsson 2002; Kolb 2008). Furthermore, insect pollinator diversity increases in larger populations (Mustajarvi et al. 2001) and decreases in isolated habitats with smaller plant population size (Steffan-Dewenter and Tscharntke 1999). Lower pollinator visitation rates were associated with lower seed sets and reproductive success in fragmented sites compared to intact sites (Jennersten 1988). Bumblebees visit more flowers on fewer flower stalks in sparser plant populations (Mustajarvi et al. 2001; Goverde et al. 2002). This leads to increased self-pollination or near-neighbor pollination and contributes to inbreeding (Goverde et al. 2002; Lennartsson 2002). Inbred plants produce fewer flowers and seeds, have smaller plant height and smaller leaf-size, and reduced reproductive success (Steffan-Dewenter and Tscharntke 1999; Lienert 2004; Kolb 2008). (USFWS, 2011)

Stressor: Erosion and sedimentation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Although oil and gas development may not occur directly on the steep habitat Schoenocrambe argillacea occupies, erosion or sedimentation could still impact this species, particularly if the plants are downslope of development activities. In fact, development-related erosion and sedimentation may be a particular concern to this species because it grows on precipitous hillsides. Because of this unique vulnerability, the BLM Vernal Field Office requires energy companies to get site-specific approval from both the BLM and the Service when disturbance will occur upslope of habitat (BLM 2008a). This conservation measure is in effect because the species is listed as threatened by the ESA. (USFWS, 2011)

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: When we listed Schoenocrambe argillacea, the Service believed sheep and cattle grazing may have had an historical impact on this species. However, by 1994 grazing was no longer expected to impact S. argillacea due to changes in grazing management, namely reduced numbers of sheep and cattle on the land (Service 1994). Grazing levels have not increased appreciably since then, and thus the Service still concludes that grazing is not impacting S. argillacea. Elk were reported in S. argillacea habitat, but the Service has not determined whether they browse on this species (Glisson 2005). Insect and small mammal herbivory occurs on S. argillacea fruits (Glisson 2005), but the Service does not have any information that this is occurring at a level that negatively impacts the species. (USFWS, 2011)

Stressor: Small populations (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: When Schoenocrambe argillacea was listed, it was known to occur in 2 general areas—around the Green River and Willow Creek—in 6 populations with fewer than 6,000 individuals, and most sites contained fewer than 200 individuals. Estimates for the Recovery Plan did not indicate significant changes, and the Service does not have more recent comprehensive data indicating changes in population size. Small populations and species with limited distributions are vulnerable to relatively minor environmental disturbances (Given 1994). Small populations also are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Lower genetic diversity may, in turn, lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Barrett and Kohn 1991; Newman and Pilson 1997). On the other hand, many naturally rare species have persisted for long periods within small geographic areas, and many naturally rare species exhibit traits that allow them to persist, despite their small population sizes. Species with limited climatic ranges and restricted habitat requirements are typically the most vulnerable to extinction (Intergovernmental Panel on Climate Change (IPCC) 2002; Machinski et al. 2006). The risk of extinction is expected to increase for species with low population numbers (IPCC 2002; Jump and Penuelas 2005). (USFWS, 2011)

Stressor: Invasive species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Invasive, exotic plant species can contribute to the extinction of native plants (Soulé et al. 1992). Exotic invasive species are common along highways because seeds are carried and deposited along roads by vehicles, and spread via vehicle-caused air turbulence (Forman and Alexander 1998). Roads often promote the spread of invasive species by altering soil characteristics, stressing native plant species, and providing easier movement by wild or human vectors (Trombulak and Frissell 2000). Spread of invasive species via roads coupled with increased road dust can exacerbate the impact on native species; an increase in fine dust particles can increase nonnative, exotic plant species (Reynolds et al. 2001). Cheatgrass (Bromus tectorum) occurs in S. argillacea habitat (Glisson 2005). Cheatgrass can out-compete native species for soil nutrients and water (Melgoza et al. 1990; Aguirre and Johnson 1991; Pyke and Novak 1994). If it establishes in sufficient density in native plant communities, cheatgrass increases flammability, leading to shortened fire return intervals that make it difficult for native plants to re-establish (D'antonio and Vitousek 1992). Halogeton (Halogeton glomeratus) is another invasive species that is found in the vicinity of S. argillacea habitat, but is not documented within occupied habitat (Brunson 2009; Buys & Associates 2009). Halogeton quickly infests areas that are either left barren from fire or are exposed to some type of soil disturbance (Pavek 1992). Halogeton tends to be a poor competitor, but it can accumulate sodium in the soil and alter soil microbiota to the disadvantage of native plants (Kitchen and Jorgensen 2001; Kitchen and Carlson 2008). Although invasive species are present in Schoenocrambe argillacea habitat, they have not been identified in high numbers or densities. Atmospheric levels of carbon dioxide are expected to double before the end of the 21st century (IPCC 2002), which is likely to increase biomass and seed production of invasive annuals (Mayeux et al. 1994; Smith et al. 2000; Ziska et al. 2005). This effect, if manifested, could facilitate the expansion of cheatgrass and other invasive plants that could compete with and further threaten S. argillacea. Regardless, the Service does not currently consider invasive species a threat to S. argillacea. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Climate change is likely to affect long-term survival or distribution of native species. In the southwestern United States, including Utah and Schoenocrambe argillacea habitat, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960-1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the Southwest (Karl et al. 2009). Hot extremes, heat waves, and heavy precipitation will increase in frequency, with the Southwest experiencing the greatest temperature increase in the continental United States (IPCC 2007). The Service does not know how changes in precipitation will affect Schoenocrambe argillacea. However, we do know that increased drought can be detrimental to many drought-tolerant species. Drought conditions led to a noticeable decline in survival, vigor, and reproductive output of rare plants in the Southwest during the drought years of 2001-2004 (Anderton 2002; Van Buren and Harper 2002, 2003; Hughes 2005; Clark and Clark 2007; Roth 2008a, 2008b). Effects related to climate change, such as persistent or prolonged drought conditions, may affect the long-term persistence of S. argillacea, but without further research or information, it is difficult to predict how. (USFWS, 2011)

Recovery

Reclassification Criteria:
1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 1994)

Delisting Criteria:
1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 1994)

Recovery Actions:
- Inventory suitable habitat for S. argillacea, S. barnebyl, and S. suffrutescens and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 1994)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 1994)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long-term protection on undisturbed habitat for each species. (USFWS, 1994)

- Control activities which affect the habitat of S. argillacea, S. barnebyi, and S. suffrutescens through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 1994)
- The Service recommends creating a better distribution map for Schoenocrambe argillacea. Because of the difficult terrain it inhabits and previous inaccuracies in habitat mapping, we also recommend developing alternative mapping techniques, such as using satellite imagery to map and ground-truth suitable habitat. (USFWS, 2011)
- The Service recommends developing a reliable comprehensive population estimate every 5 years. Populations that are accessible by foot should be resurveyed routinely. General estimates may be used for inaccessible areas. Should additional populations and higher numbers be identified, this may address the small population size and limited distributional concerns cited in section 2.3.2.5 and 2.4 above. Improved habitat mapping and better population counts should also be considered in land use decisions to minimize impacts to the species. Finally, improved habitat maps and population estimates should be used to help revise the Recovery Plan (as recommended below). (USFWS, 2011)
- The Service will work with the BLM to establish long-term demographic monitoring plots for Schoenocrambe argillacea. The Service will review available information (Glisson 2005) and coordinate with experts to identify appropriate monitoring plots. Data the Service collects on survival, reproduction, and habitat condition for the species will help us identify trends, threats, and whether conservation measures incorporated thus far are effective. (USFWS, 2011)
- We will work with the BIA and the Ute Tribe to map potential habitat and survey for new populations of Schoenocrambe argillacea, if discovered on Uintah and Ouray Indian Reservation lands. (USFWS, 2011)
- Approximately 11 percent of mapped Schoenocrambe argillacea populations occur on State and private lands. The Service should work with SITLA and private landowners to survey and conserve S. argillacea habitat and increase outreach efforts. (USFWS, 2011)
- Basic biological and ecological information should be obtained for this species, including determining pollination mechanisms and pollinators. The habitat also needs to be better defined by accurately characterizing parent material, soil, and landscape characteristics of occupied habitat. (USFWS, 2011)
- The Service should collect seeds to include this species in the Center for Plant Conservation collection. Seeds also should be tested for viability and longevity. (USFWS, 2011)
- Once habitat requirements are better understood and reliable suitable habitat maps are developed (see above actions), the Service recommends studying the feasibility of introducing Schoenocrambe argillacea into new areas of unoccupied suitable habitat near existing populations. (USFWS, 2011)
- On Federal lands, the Service should continue to avoid development in Schoenocrambe argillacea populations and suitable, unoccupied habitat to the extent possible, until we can complete research showing what level of development in S. argillacea habitat is tolerable. The Service should ensure that developers follow established conservation measures when disturbance occurs and that habitat fragmentation is reduced to the extent possible. (USFWS, 2011)
- Using better distribution maps and updated survey information, we should identify and establish core conservation areas in minimally-disturbed habitat (both occupied and unoccupied) for long-term protection of Schoenocrambe argillacea. The Service should work with the BLM to adopt these conservation areas under a long-term conservation

agreement. (USFWS, 2011)

- Use conservation area information to identify and establish an Area of Critical Environmental Concern (ACEC) on BLM land to protect Schoenocrambe argillacea and its habitat. The ACEC should include no surface occupancy stipulations for those areas where mineral rights are not yet leased. The ACEC can be formally recommended to the BLM and incorporated during their resource management planning process. (USFWS, 2011)
- Develop a habitat management plan, which the BLM incorporates into the RMP and implements. Ensure that all Schoenocrambe argillacea occurrences on public lands are within management areas where maintenance of the species is a primary management goal. (USFWS, 2011)
- Develop conservation agreements with those federal mineral leaseholders whose leases are not subject to the terms of BLM management plans protecting the plants (leases that predate the RMP/habitat management plan). Through implementation of these conservation agreements, companies would implement conservation measures necessary to protect the species from mineral extraction activities. (USFWS, 2011)
- Once the Service has new survey data and research data available, we recommend revising the Recovery Plan to explicitly address the relevant listing factors. Time and cost required to meet the criteria and recover the species should be included in the Recovery Plan. (USFWS, 2011)
- The Service will publish in the Federal Register a formal name change from Schoenocrambe argillacea to Hesperidanthus argillacea to reflect the best available science. (USFWS, 2011)
- The Service will formally request the name be changed from Schoenocrambe argillacea to Hesperidanthus argillacea in the ITIS and USDA plants databases. (USFWS, 2011)

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USFWS. 2011. Schoenocrambe argillacea (clay reed-mustard) 5-Year Review: Summary and Evaluation. Utah Field Office, – Ecological Services West Valley City, Utah

SPECIES ACCOUNT: *Schoenocrambe barnebyi* (Barneby reed-mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; 01/14/1992; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

Schoenocrambe barnebyi is a perennial herbaceous plant with sparsely leafed stems 22 to 35 cm (9 to 15 inches) tall arising from a woody root crown. The leaves are entire with a smooth margin, 1.5 to 5 cm (0.6 to 3 inches) long and 0.5 to 2.5 cm (0.2 to 1 inch) wide. The leaf blades are alternately arranged on the stem and are attached to the stem by a petiole. The flowers of S. barnebyi have petals that are light purple with prominent darker purple veins and measure about 12 mm (0.4 inch) long and 2.5 mm (0.1 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of, commonly, two to eight flowers at the end of the plant's leafy stems (Welsh and Atwood 1980, Rollins 1982, Welsh et al. 1987). Flowers (May-June) have pale purple petals, prominently veined with darker purple. (USFWS, 1994; NatureServe, 2015)

Taxonomy

Rollins (1982), in reevaluating the cruciferous genera of Schoenocrambe and Thelypodiopsis, moved T. argillacea and T. barnebyi from Thelypodiopsis to Schoenocranibe as S. argillacea and S. barnebyi. Welsh and Chatterley (1985) moved Glaucocarpuni suffrutescens to the genus Schoenocranibe to complete what morphologically appears to be a discrete phylogenetic unit among the Brassicaceae. The genus Schoenocrambe currently includes five known species, two (S. linearifolia and S. linifolia) are abundant wide—ranging species from the dry lower elevations of the interior western Cordilleras. S. Iinearifolia occurs from southern Colorado and northern Arizona southward to western Texas and Durango and Sonora, Mexico. S. linifolia occurs from southeastern British Columbia, Canada, and western Montana southward to eastern Nevada and northern New Mexico. The remaining three, S. argillacea, S. barnebyl, and S. suffrutescens, are rare endemic species from low elevations of the northern and western portions of the Colorado Plateau in the State of Utah (Rollins 1982, Welsh et al. 1987). (USFWS, 1994)

Current Range

Endemic to the Canyonlands of south-central Utah, where known from two distinct clusters of occurrences: one in the southern portion of the San Rafael Swell near Muddy Creek in southern Emery County and the other in Capitol Reef National Park in the Fremont River drainage west of Fruita in central Wayne County. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1994)

Breeding Season

Adult: April to May (USFWS, 1994)

Reproduction Narrative

Adult: We have little information on the biology and life history of Barneby reed-mustard. Plants reproduce sexually and flower from late April to mid or late May (Welsh and Neese 1984). (USFWS, 1994)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bare rock/talus/scree, desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1460 and 1985 meters on sparsely vegetated sites (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Mixed desert shrub communities (shadscale, Eriogonum, Ephedra), in sparsely vegetated sites on steep, eroding north to northeast facing slopes (elevations between 1460 and 1985 meters). Grows in xeric, fine-textured red clay soils rich in selenium and gypsum of the Moenkopi Formation, and, rarely, on soils eroded from it that now overlie the Chinle Formation and on the Carmel Formation. Associated species include Abronia fragrans, Amelanchier utahensis, Artemisia dracunculus, Astragalus brandegeei, Atriplex confertifolia, Chrysothamnus nauseosus, Ephedra torreyana, Ephedra viridis, Eriogonum corymbosum, Erioneuron pulchellum, Erioneuron pilosum, Hilaria jamesii, Monolepis nuttalliana, Opuntia polyacantha, Phacelia rafaelensis, Sporobolus sp., Stanleya pinnata, and Townsendia incana. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Gravity, wind and rain are thought to be the primary dispersal agent of seeds (Welsh and Neese 1984). (USFWS, 1994)

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

4 (USFWS, 2021)

Population Size:

<3,000 (USFWS, 2021)

Population Narrative:

The species has the same number of populations (four) and estimated total population size (less than 3,000 plants) that we reported in our last status review (Table 1; USFWS 2011). (USFWS, 2021)

Threats and Stressors

Stressor: Mining (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The primary threat to Schoenocrambe barnebyi identified at the time of listing and in the Recovery Plan was habitat loss and degradation associated with future uranium mining on BLM lands (57 FR 1398, January 14, 1992; USFWS 1994). Mining related activities may result in increased surface disturbances, increased foot and vehicle traffic, reduced air quality, vegetation disturbance, and removal of top soil and overburden. Surface disturbances may impact the species by crushing or trampling plants, causing soil erosion and compaction, degrading suitable habitat, losing pollinator populations and habitat, reducing plant vigor and reproductive potential, reducing seed bank quantity and quality, and increasing invasive plant occurrences thereby increasing fire risk (Brock and Green 2003; BLM 2008a). All of the known individuals on BLM land occur in areas that are open to mineral exploration or development (BLM 2008a). Six mining claims occur near the Sy's Butte/Hidden Splendor Mine and mining activities may have extirpated a portion of this population during the 1950s and 1960s (Anderson 1985; USFWS 1994). Mining shafts from this time period are currently being closed (Conrad pers. comm. 2009; Ivory pers. comm. 2009). With the exception of the Lucky Strike Mine, there has been no mining since the 1960s (Conrad pers. comm. 2009; Ivory pers. comm. 2009). Because BLM lands remain open to mineral exploration and development and there are existing mining claims near the Sy's Butte/Hidden Splendor Mine population that may recommence at any time (Conrad pers. comm. 2009), future uranium mining continues to be a threat on BLM lands. The Service considers this threat to be currently low because it has been over 40 years since active mining occurred, and we are not aware of any current mining proposals in this area. (USFWS, 2011)

Stressor: Grazing (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Livestock grazing may result in the direct loss or damage to plants and their habitat through trampling, soil compaction, increased soil erosion, invasion of noxious weeds, and disturbance to pollinators (Kauffman et al. 1983; Fleischner 1994; Kearns et al. 1998; DiTomaso 2000). Sheep and cattle grazing were identified as possible historic threats to populations of Schoenocrambe barnebyi (57 FR 1398, January 14, 1992; USFWS 1994). At the time of listing, the intensity of grazing at known S. barnebyi populations was not expected to significantly impact the species. Grazing intensity has not increased since we finalized the Recovery Plan (BLM 2009). However, the Service does not have any monitoring data that evaluates the effects of grazing on S. barnebyi populations. (USFWS, 2011)

Stressor: Off-highway vehicle use (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The Services did not identify off-highway vehicle (OHV) activities as threats to Schoenocrambe barnebyi when we listed the species in 1992, nor in the Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). The OHV use may result in the direct loss or damage to plants and their habitat through soil compaction, increased soil erosion, reduced air quality, invasion of noxious weeds, and disturbance to pollinators and their habitat (Eckert et al. 1979; Lovich and Bainbridge 1999; Ouren et al. 2007; Wilson et al. 2009). The use of OHVs in Utah has exploded in popularity over the past several decades (Burr et al. 2008). From 1998-2006, the number of registered OHVs in Utah has increased by 233% (Burr et al. 2008). The known Schoenocrambe barnebyi population on BLM lands (Sy's Butte/Hidden Splendor Mine) occurs in an area that is open to OHV traffic along designated routes only (BLM 2008a). Although illegal OHV use occurs within the vicinity (BLM 2011), to date, no direct or indirect impacts to the population or individual plants have been documented (Ivory 2009). Due to the remoteness of the population and the steepness of the terrain, the Service expects the overall scope of the threat to be low. (USFWS, 2011)

Stressor: Erosion (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Erosion was not considered a threat at the time of listing or in the recovery plan (57 FR 1398, January 14, 1992; USFWS 1994). However, natural erosion of Schoenocrambe barnebyi habitat was listed as a potential threat in a 1992 survey report for the BLM (Ecosphere 1992). Schoenocrambe barnebyi grows in very steep habitats with sparse vegetation. Plants may be uprooted, damaged or destroyed by gullying, slumping or rockslides. Under natural circumstances, the Service presumes the species has adapted to living on a highly erodible substrate. However, erosion may increase as climate changes. Climate change will likely increase heavy precipitation events which can increase soil erosion (Nearing et al. 2004; IPCC 2007; see section 2.3.2.5 below).In addition, erosion may be accelerated through surface disturbing activities. As previously described, OHV use and grazing occur in the habitat of Schoenocrambe barnebyi on BLM lands. Although the Service believes the overall threat level of these activities to be currently low, the Service does not have monitoring data to adequately evaluate the effects, including erosion, of these uses to the plants. (USFWS, 2011)

Stressor: Trampling (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: At the time of listing and in our Recovery Plan, we identified trampling by Capitol Reef visitors as the primary impact on the Schoenocrambe barnebyi population at Sulphur Creek (57 FR 1398, January 14, 1992; USFWS 1994). However, trampling from hiking activities was later evaluated and determined to be unlikely (Clark 1997). Visitors tend to remain along the trail in the creek bottom, away from the plants and the habitat due to the steepness of the terrain. An historic livestock trail through the population is no longer in use but is occasionally used by deer (Clark pers. comm. 2009a). All other sites within Capitol Reef were evaluated for potential

impacts caused by hiking trails but none were documented (Clark 2005b). For these reasons, we no longer consider trampling a threat. (USFWS, 2011)

Stressor: Invasive species and fire (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Invasive species and fire were not considered threats at the time of listing or in the species' Recovery Plan (57 FR 1398, January 14, 1992; USFWS 1994). However, the spread of nonnative invasive species is considered the second largest threat to imperiled plants in the United States (Wilcove et al. 1998). Invasive plants—specifically exotic annuals—negatively affect native vegetation, including rare plants. One of the most substantial effects is the change in vegetation fuel properties that, in turn, alter fire frequency, intensity, extent, type, and seasonality (Menakis et al. 2003; Brooks et al. 2004; McKenzie et al. 2004). Shortened fire return intervals make it difficult for native plants to reestablish or compete with invasive plants (D'Antonio and Vitousek 1992). Mining, grazing, and unauthorized OHV use are activities that disturb soil surfaces within Schoenocrambe barnebyi habitat on BLM lands. In general, B. tectorum is known to invade areas in response to these types of surface disturbing activities (Hobbs 1989; Rejmanek 1989; Hobbs and Huenneke 1992; Evans et al. 2001). These types of surface disturbing activities do not occur on the populations in Capitol Reef. Currently wildland fires are considered unlikely to occur in S. barnebyi's habitat due to the sparseness of vegetation associated with the species (Borthwick pers. comm. 2009c; Ivory pers. comm. 2009). (USFWS, 2011)

Stressor: Herbivory (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Schoenocrambe barnebyi appears to be highly palatable to deer (Clark 2005b). The Service expects browsing to be localized and only affect a small portion of the populations. However, we do not have any information that browsing is occurring at a level that negatively impacts the species as a whole (Clark 2005b; Ivory 2009). For these reasons, this factor has the potential to affect the species. (USFWS, 2011)

Stressor: Small populations (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The original listing decision cited the limited distribution and low population numbers as a factor affecting the species (57 FR 1398, January 14, 1992). The species' rarity and limited distribution make it highly vulnerable to localized stochastic extinction events. While more sites have been found since the species was listed, it remains narrowly distributed in few populations and may be in decline (Clark 1997; Anderton 2002). Half of the sites have fewer than 100 plants (Clark 2005b; see Table 2). Although small population size is an intrinsic vulnerability of the species, some sites may hold so few plants that they are not demographically stable in the medium to long term and some may be lost as a result of natural variation in population numbers in the short term. Population genetics studies have not been undertaken for Schoenocrambe barnebyi, but despite the overall lack of information on the population ecology of the species,

the Service does know that small populations are at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Only the larger sites of S. barnebyi may have sufficient genetic variability to provide for long-term adaptation to natural or manmade changes in their environment. Small population size in and of itself is not considered a threat; however, it may increase the species' vulnerability if other threats discussed in this analysis are impacting the species. Even a small localized disturbance such as mining, OHV-related activities, or fire could result in the extirpation of a site. The Service determined the threat of climate change (see discussion below) has an overall threat level of moderate. Therefore, the Service considers the overall threat level for small population size to be moderate. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Species with limited ranges and restricted habitat requirements also are more vulnerable to the effects of global climate change (IPCC 2002; Jump and Penuelas 2005; Machinski et al. 2006; Krause 2010). Climate change was not discussed in the original rule to list the species or in the Recovery Plan. Over the past 50 years, the frequency of cold days, cold nights, and frosts have become less frequent over most land areas, and hot days and hot nights have become more frequent (IPCC 2007). Changes in the global climate system during the 21st century are hypothesized to be larger than those observed during the 20th century (IPCC 2007). For the next two decades, a warming of about 0.2°C (0.4°F) per decade is projected (IPCC 2007). Afterward, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase of 0.6 to 4.0°C (1.1 to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest may experience the greatest temperature increase of any area in the lower 48 States (IPCC 2007). Effects related to climate change, such as persistent or prolonged drought conditions, increased invasions of exotic species and pests, and increased heavy rainfall events, may affect the long-term persistence of S. barnebyi. Climate change could potentially reduce the overall abundance of Schoenocrambe barnebyi. However, a large degree of uncertainty exists regarding the extent of such effects. For these reasons, this factor has the potential to affect the species. Further studies should be conducted to monitor and minimize the effects of this potential threat. (USFWS, 2011)

Stressor: Lack of scientific knowledge/monitoring (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: The lack of scientific knowledge of Schoenocrambe barnebyi may cause the species to be managed below optimal levels. While not a threat in and of itself, this factor affects our ability to manage and recover the species. We lack scientific knowledge and monitoring data throughout the range of the species. We know little about S. barnebyi--its pollinators, range, habitat, and population trends. For example, we do not know why the original population estimate for BLM population was 2,000 individuals but surveys since have counted less than 200 plants. We do not know whether this represents a reduction in plant numbers or is an artifact of survey effort, making it difficult to analyze overall threat levels for the species. Because of this lack of scientific knowledge, opportunities for better management of the species could

potentially be missed. Based on our current limited understanding of the species, we consider the overall threat levels for threats discussed in sections 2.3.2.1, 2.3.2.4, and 2.3.2.5 are all low. We could potentially move the species toward downlisting, recovery, and eventual delisting if we could better quantify the degree of threat the species faces and work toward alleviating those threats. However, the only site that has longer, albeit irregular, monitoring data shows the plant may be in decline, potentially negatively impacted by drought (Clark 1997; Anderton 2002), and potentially able to recover (Clark pers. comm. 2009b). The lack of trend data following the drought makes it difficult to determine to what degree drought may be a threat to the species. (USFWS, 2011)

Recovery

Reclassification Criteria:
1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 2011)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 2011)

Delisting Criteria:
1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 2011)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 2011)

Recovery Actions:
- Inventory suitable habitat for S. argillacea, S. barnebyl, and S. suffrutescens and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 2011)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 2011)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for each species. (USFWS, 2011)
- Control activities which affect the habitat of S. argillacea, S. barnebyi, and S. suffrutescens through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 2011)
- The BLM and Capitol Reef should establish long-term trend monitoring to provide base line demographic data for the species. In addition to collecting baseline demographic data, BLM and Capitol Reef should collect data on the species' response to habitat conditions including how the factors considered in this 5-year review are affecting the species. (USFWS, 2011)

- Determine pollinators or pollination mechanisms including the identification of pollinators, pollinator availability, and their habitat requirements. (USFWS, 2011)
- Asses seedbank viability, including seed viability and dispersal mechanisms and determining germination requirements. (USFWS, 2011)
- Analyze population genetics to assess potential impacts from inbreeding depression. (USFWS, 2011)
- Determine the species' vulnerability to prolonged drought and the potential impacts of climate change. (USFWS, 2011)
- Determine the species response to invading nonnative species and its response to increased fire frequencies. (USFWS, 2011)
- Determine habitat requirements, including soils, aspects, and climatic variables. (USFWS, 2011)
- Determine the effects livestock grazing has on the species and its habitat. (USFWS, 2011)
- Determine the effects OHV use has on the species and its habitat. (USFWS, 2011)
- Determine the effects mining has on the species and its habitat. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Recommended future actions: Based on recent discussions with other Federal agencies and partners, we recommend the following future actions: (1) avoid and minimize impacts from mineral exploration and development and other activities in occupied habitat; (2) develop a habitat suitability model for the species; (3) survey potential suitable habitat for occupancy; (3) establish demographic and population trend monitoring within all populations; (4) provide habitat protections through regulatory mechanisms or conservation plans; (5) evaluate reproductive success and pollinator limitations; (6) collect seeds and implement propagation efforts in horticulture facilities; (7) establish new populations; and (8) develop public awareness and appreciation for the species' conservation (USFWS 2020). (USFWS, 2021)

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SPECIES ACCOUNT: *Schoenocrambe suffrutescens* (Shrubby reed-mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/06/1987; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

Shrubby reed-mustard is a perennial herb in the mustard family, with clumped stems 10 to 25 cm (4 to 12 inches) tall arising from a branching woody root crown. The leaves are entire with a smooth margin, 1.0 to 2.5 cm (0.4 to 1 inch) long and 0.3 to 1.0 cm (0.12 to 0.4 inch) wide. The leaf blades are alternately arranged on the stem and are subsessile or attached to the stem by a short petiole. The flowers of Shrubby reed-mustard have petals that are light yellow or greenish yellow and spatulately shaped measuring about 10 mm (0.4 inch) long and 3 mm (0.12 inch) wide. The entire flowers are about 1 cm (0.4 inch) across in full anthesis and are displayed in a raceme of, commonly, 5 to 20 flowers at the end of the plant's leafy stems. This herb produces yellow flowers May through June. (USFWS, 1994; NatureServe, 2015)

Taxonomy

The species was first discovered in 1935 by Edward Graham, described by Reed Rollins as Thelypodium suffrutescens (Graham 1937), and, in 1938, renamed Glaucocarpum suffrutescens (Rollins 1938; 52 FR 37416; October 6, 1987). The species was listed under the latter name (52 FR 37416; October 6, 1987). Since then, its genus was changed to Schoenocrambe (57 FR 1398; January 14, 1992), Glaucocarpum (Al-Shehbaz 2005), and most recently Hesperidanthus (AlShehbaz 2010). This last taxonomic change is currently accepted in the Flora of North America and the integrated taxonomic information system (ITIS) (Al-Shehbaz 2010; ITIS 2017). However, The Service will still use Schoenocrambe suffrutescens until a formal change in the Federal Register is completed. (USFWS, 2019)

Current Range

The species is endemic to the Uinta Basin region in northeastern Utah, and found exclusively within the Lower Green-Desolation Canyon and Willow Creek watersheds. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 1994)

Dependency on Other Individuals or Species

Adult: The following native bee species may be Schoenocrambe suffrutescens pollinators: Dialictus perdifficilis, D. sedi, Evylaeus pulveris, Andrena walleye, A. prunorum and Halictus rubicundus (USFWS 1994; Tepedino 2000; Lewis 2010). (USFWS, 2010)

Breeding Season

Adult: April to May (USFWS, 2010)

Other Reproductive Information

Adult: Shrubby reed-mustard could be pollinator limited if adequate and appropriate insect pollinators are not available (Lewis and Schupp 2014). Seed set is significantly lower in individuals that self-pollinate compared to individuals that are fertilized by cross-pollination (pollen from another plant; Lewis and Schupp 2014). These results also indicate that cross-pollination is critical for maximizing reproduction of the species. A related study of road dust impacts to shrubby reed-mustard found that increases in dust deposition reduced reproduction in the species by significantly decreasing the numbers of mature seeds produced, and showed trends of decreased seed numbers and weight (Lewis 2017). Mean stomatal conductance also significantly decreased with increasing dust presence on leaves, which may impact the overall health and reproductive capacity of the species (Lewis 2017). (USFWS 2019)

Reproduction Narrative

Adult: Reproduction is sexual (USFWS 1994), and the species is capable of self-pollination (Tepedino 2000). Flowering for this species occurs in April to May and fruiting occurs May to June. The following native bee species may be Schoenocrambe suffrutescens pollinators: Dialictus perdifficilis, D. sedi, Evylaeus pulveris, Andrena walleye, A. prunorum and Halictus rubicundus (USFWS 1994; Tepedino 2000; Lewis 2010). (USFWS, 2010)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, forest/woodland, woodland - conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1555 and 1981 meters. (NatureServe, 2015)

Environmental Specificity

Adult: Broad (inferred from NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: Commonly on level to moderately sloping ground surfaces. Soils are dry, shallow, and fine-textured, and are usually overlain by shale fragments. (NatureServe, 2015)

Habitat Narrative

Adult: Mixed desert shrub communities and, at some locations, in pinyon -juniper and desert shrub, on semi-barren, white-shale layers of the Evacuation Creek Member of the Green River Formation. Commonly on level to moderately sloping ground surfaces. Soils are dry, shallow, and fine-textured, and are usually overlain by shale fragments. 1555-1981 m elevation. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Decline (NatureServe, 2015)

Species Trends:

Decline (NatureServe, 2015)

Number of Populations:

7 (USFWS, 2019)

Population Size:

3,161 (USFWS, 2019)

Additional Population-level Information:

Range-wide population trend monitoring plots were established by the BLM in 2017. Preliminary findings suggest that open interspaces are important habitat components for the species (BLM 2017). Species monitoring provided a laseline density of 1.9 shrubby reedmustard plants per one-meter squared for monitoring plots; however, subsequent consecutive surveys are needed to refine our understanding of species density (BLM 2017). It is too early to determine demographic and population trends from this monitoring effort. (USFWS, 2019)

Population Narrative:

In 2019, the Service estimated shrubby reed-mustard was limited to 3,161 individuals within three geographic areas and seven populations. The range of the Bad Land Cliffs population has been extended from the 2010 estimate after the discovery of 232 new individuals in an area that was previously unsurveyed (BLM 2017). (USFWS, 2019)

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Oil and gas resource development operations pose a significant threat to Schoenocrambe suffrutescens populations and habitat (USFWS 1990; 1994). All known populations of S. suffrutescens that occur on Federal lands are leased for oil and gas development (USFWS 1994). In addition, an ongoing natural gas project (currently in the first phase of development) overlaps the entire range of three of the known seven S. suffrutescens populations. These populations account for over 40 percent of the species' known suitable habitat and over 80 percent of all known individuals (USFWS 2008a). Development continues in unoccupied suitable habitat, thereby limiting potential expansion and recovery of the species. Furthermore, development continues to occur in habitats immediately adjacent to occupied habitats. While steps have been taken to minimize these indirect effects, it is unknown if this adjacent development is adversely impacting the viability of S. suffrutescens populations. These

indirect effects, and the protections currently provided, are discussed below. (USFWS, 2010)

Stressor: Habitat fragmentation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Schoenocrambe suffrutescens exists in small, low-density populations that might be prone to negative effects from habitat fragmentation. For example, small plant populations fluctuate more widely over time and the smaller the remnant, the more susceptible the population is to extinction (Soulé et al. 1992; Forman and Alexander 1998; Menges 2002; Lienert 2004). Small plant populations can lose genetic variation and their population viability decreases (Ellstrand and Elam 1993; Lienert 2004; Kolb 2008). Fruit set, germination rate, offspring survival, and total numbers of flowers per plant are higher in larger populations than in small populations (Paschke et al. 2002). Similarly, the number of capsules per plant and the number of seedlings per plant are positively correlated with population size (Schmidt and Jensen 2000). Roads associated with energy exploration and development cause a high level of habitat fragmentation. Increased oil and gas developments result in more roads developed in and near S. suffrutescens habitat. Ecological effects of roads to plants can extend more than 328 feet (100 meters) from the road (Angold 1997; Forman 2000; Forman and Deblinger 2000). Disturbance can occur directly from construction or indirectly from road dust, discussed further below (Farmer 1993; Angold 1997; Trombulak and Frissel 2000). There is a strong correlation between vegetation composition and health with distance from a road, although it may take decades for the full effects of road development to be realized (Auerbach et al. 1997; Myers-Smith et al. 2006). (USFWS, 2010)

Stressor: Road dust (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Schoenocrambe suffrutescens may be impacted by the indirect effects of road dust associated with oil and gas development. Road traffic mobilizes and spreads dust (Farmer 1993; Trombulak and Frissell 2000), and for every vehicle traveling 1 mile (1.6 kilometers) of unpaved roadway once a day, every day for a year, approximately 2.5 tons of dust are deposited along a 1,000-foot (~300-meter) corridor centered on the road (Sanders pers. comm. 2008). Dust deposition tends to be highest near the road and decreases with increasing distance from the road (Spatt and Miller 1981; Everett 1980; Walker and Everett 1987; Santelmann and Gorham 1988; Myers-Smith et al. 2006). For example, in one study 97 percent of dust was deposited within 410 feet (125 meters) of the road (Walker and Everett 1987). The distance from a road at which dust can affect vegetation varies (see McCrea 1984; Myers-Smith et al. 2006), but negative impacts can occur up to 984 feet (300 meters) away from the road (Everett 1980). Dust negatively affects photosynthesis, respiration, transpiration, water use efficiency, leaf conductance, growth rate, plant vigor, gas exchange, and allows the penetration of phytotoxic gaseous pollutants (Eller 1977; Spatt and Miller 1981; Thompson et al. 1984; Farmer 1993; Sharifi 1997; Trombulak and Frissell 2000; Hobbs 2001). Dust comprised of finer particulates was shown to cause more improper functioning of the stomata than larger particles (Ricks and Williams 1974; Eller and Brunner 1975; Eveling and Bataille 1984; Rawson and Clarke 1988; Hirano et al. 1995). Clogged stomata result in increased water loss in two ways: due to an increased transpiration rate because of increased temperatures and due to clogged stomata that are

unable to close at night (Hirano et al. 1995). Other dust effects include inhibiting sunlight from reaching the surfaces of dusted plants (Sharifi et al. 1997). Additionally, a decrease in infra-red light reflectance can result in dusted leaves with a 4 to 5°F (2 to 3°C) higher temperature (Sharifi et al. 1997) compared to undusted leaves (Hirano et al. 1995). Soils near roads can have significantly lower nutrient levels, altered organic horizon depth, higher bulk density, and lower moisture (Auerbach et al. 1997). Furthermore, soil characteristics and plant community composition can remain significantly different up to 28 years after road development (Myers-Smith et al. 2006). We do not know if dust negatively affects plant pollinators. (USFWS, 2010)

Stressor: Plant-pollinator interactions (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Many of the negative effects of habitat fragmentation to plants are due to effects on plant-pollinator interactions (Debinski and Holt 2000; Moody-Weis and Heywood 2001; Aizen et al. 2002; Gathmann and Tscharntke 2002; Lennartsson 2002; Kolb 2008). Fragmented plant populations appear to be less attractive to insect pollinators, which spend more time in larger, unfragmented plant habitats (Aizen et al. 2002; Lennartsson 2002; Kolb 2008; Goverde et al. 2002). Furthermore, insect pollinator diversity increases in larger populations (Mustajarvi et al. 2001) and decreases in isolated habitats with smaller plant population sizes (Steffan-Dewenter and Tscharntke 1999). Lower pollinator visitation rates are associated with lower seed sets and reproductive success in fragmented sites compared to intact sites (Jennersten 1988).Bumblebees were observed visiting more flowers on fewer flower stalks in sparser plant populations (Mustajarvi et al. 2001; Goverde et al. 2002). This led to increased self-pollination or near-neighbor pollination contributing to inbreeding (Goverde et al. 2002; Lennartsson 2002). Inbred plants produce fewer flowers and seeds, have smaller plant height and smaller leaf-size, and reduced reproductive success (Steffan-Dewenter and Tscharntke 1999; Lienert 2004; Kolb 2008). Overall, we believe energy related development can cause serious impacts to Schoenocrambe suffrutescens through habitat fragmentation, increased road dust, and disruption of plant-pollinator interactions. Current 300 feet (91 meters) buffers are likely adequate to minimize impacts to the species. Nevertheless, in 2009, the Service initiated studies to quantify the effects of continued energy development related to these factors. (USFWS, 2010)

Stressor: Building stone mining (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Schoenocrambe suffrutescens habitat is associated with commercially valuable building stone. Building stone mining can directly disturb individual plants and their habitat, with other effects similar to oil and gas development, including habitat fragmentation, increased dust, and pollinator disturbance. Building stone mining was a significant historical threat to the species. Previous commercial stone excavation caused the extirpation of a portion of the species' population in the vicinity of Big and Little Pack Mountains (USFWS 1994). Today, this factor is only a substantive issue on private land. Although approximately 57 percent of mapped Schoenocrambe suffrutescens populations on BLM lands are open to leasing (BLM GIS data, September 2009), building stone mining does not currently occur in occupied habitat on BLM land (Hansen pers. comm. 2009). On private lands, building stone is currently mined in Schoenocrambe suffrutescens occupied habitat. At one site, seven individual plants and

occupied habitat were destroyed (Brunson 2010). We do not know how widespread this impact is across S. suffrutescens habitat on private lands. With so few individuals of this species, we believe that the loss of any individuals could significantly impact the species. Therefore, based on recently documented disturbance on private lands, the Service believes that building stone mining remains a threat to this species. (USFWS, 2010)

Stressor: Small populations (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: When Schoenocrambe suffrutescens was listed, it was known to occur in only nine populations with fewer than 3,000 individuals total, including three populations of fewer than 30 plants each. Recent estimates do not indicate significant changes. Small populations and species with limited distributions are vulnerable to relatively minor environmental disturbances (Given 1994). Small populations are also at an increased risk of extinction due to the potential for inbreeding depression, loss of genetic diversity, and lower sexual reproduction rates (Ellstrand and Elam 1993; Wilcock and Neiland 2002). Lower genetic diversity may, in turn, lead to even smaller populations by decreasing the species' ability to adapt, thereby increasing the probability of population extinction (Barrett and Kohn 1991; Newman and Pilson 1997). Species with limited climatic ranges and restricted habitat requirements are typically the most vulnerable to extinction (Intergovernmental Panel on Climate Change [IPCC] 2002; Machinski et al. 2006). The risk of extinction is expected to increase for species with low population numbers (IPCC 2002; Jump and Penuelas 2005). The Service lacks information on the population genetics of Schoenocrambe suffrutescens. Recent observations indicate this species produces more seed when it is outcrossed (Lewis 2010). Therefore, the fewer plants are located at a site, the less chance for cross-fertilization. Because population numbers are very low for this species, we consider small population size a threat to S. suffrutescens, but without further research or information, the Service cannot predict the magnitude of this threat. (USFWS, 2010)

Stressor: Invasive species (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Exotic species are common along highways because seeds are carried and deposited along roads by vehicles, and spread via vehicle-caused air turbulence (Forman and Alexander 1998). Roads promote the spread of invasive species by altering soil characteristics, stressing native vegetation, and providing easier movement by wild or human vectors (Trombulak and Frissell 2000). Spread of invasive species via roads coupled with increased road dust can exacerbate the impact on native species: an increase in fine dust particles can increase nonnative, exotic plant species (Reynolds et al. 2001). Invasive, exotic plant species can contribute to the extinction of native plants (Soulé et al. 1992). Cheatgrass (Bromus tectorum) was documented in Schoenocrambe argillacea habitat (Glisson 2005), in the vicinity of the Big Pack Mountain S. suffrutescens population. Cheatgrass can out-compete native species for soil nutrients and water (Melgoza et al. 1990; Aguirre and Johnson 1991; Pyke and Novak 1994). If it establishes in sufficient density in native plant communities, cheatgrass increases flammability, leading to shortened fire return intervals that make it difficult for native plants to re-establish (D'antonio and Vitousek 1992). Halogeton (Halogeton glomeratus) has been documented growing in S. suffrutescens occupied habitat (Brunson 2009; Buys and Associates 2009, Lewis

2010). Halogeton quickly infests areas that are either left barren from fire or disturbed from mechanical or land management means (Pavek 1992). Halogeton tends to be a poor competitor, but it can accumulate sodium in the soil and alter soil microbiota to the disadvantage of native plants (Kitchen and Jorgensen 2001; Kitchen and Carlson 2008). Although invasive species are present in Schoenocrambe suffrutescens habitat, they have not been noted at high levels. Their distribution is likely to increase over time as invasive annuals increase biomass and seed production at elevated levels of carbon dioxide (Mayeux et al. 1994; Smith et al. 2000; Ziska et al. 2005). Regardless, we do not consider invasive species a threat to S. suffrutescens now or for the foreseeable future. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Climate change is likely to affect long-term survival or distribution of native species. In the southwestern United States, including Utah and Schoenocrambe suffrutescens habitat, average temperatures have increased ~1.5°F (0.8°C) compared to a 1960-1979 baseline (Karl et al. 2009). By the end of this century, temperatures are expected to warm a total of 4 to 10°F (2 to 5°C) in the Southwest (Karl et al. 2009). Hot extremes, heat waves, and heavy precipitation will increase in frequency, with the Southwest experiencing the greatest temperature increase in the continental United States (IPCC 2007). We do not know how changes in precipitation will affect Schoenocrambe suffrutescens. However, we do know that increased drought can be detrimental to many drought-tolerant species. Drought conditions led to a noticeable decline in survival, vigor and reproductive output of rare plants in the southwest during the drought years of 2001-2004 (Roth 2008a, 2008b; Clark and Clark 2007; Hughes 2005; Anderton 2002; Van Buren and Harper 2002, 2003). On the other hand, there is some indication that high-stress areas may contain plants that are adapted to that stressor, and drought-adapted species may experience lower mortality during severe droughts (Gitlin et al. 2006). Effects related to climate change, such as persistent or prolonged drought conditions, may affect the long-term persistence of Schoenocrambe suffrutescens, but without further research or information, it is difficult to predict how. (USFWS, 2010)

Recovery

Reclassification Criteria:
1. Discover or establish a minimum of five separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above five populations of each species. (USFWS, 1994)

Delisting Criteria:
1. Discovery or establishment of a minimum of 10 separate populations with 2,000 or more individuals per population for each species. These populations must be demonstrated to be at or above minimum viable population levels. (USFWS, 1994)

2. Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for the above 10 populations of each species. (USFWS, 1994)

Recovery Actions:

- Inventory suitable habitat for S. argillacea, S. barnebyl, and S. suffrutescens and determine with a reasonable degree of accuracy the population and distribution of each species. (USFWS, 2011)
- Establish and conduct at least three minimum viable population studies on each of at least three different populations of each species. (USFWS, 2011)
- Document the presence of or, if necessary, establish formal land management designations which would provide for long—term protection on undisturbed habitat for each species. (USFWS, 2011)
- Control activities which affect the habitat of S. argillacea, S. barnebyi, and S. suffrutescens through sections 7 and 9 of the Endangered Species Act and other relevant laws and regulations. (USFWS, 2011)
- We recommend conducting range-wide, comprehensive surveys for Schoenocrambe suffrutescens within the next year, especially in the Gray Knolls area on tribal land. These data should be used to define and delineate populations, and to help revise the Recovery Plan. (USFWS, 2010)
- Monitoring plots were established for testing plant response to disturbance, and basic demographic data are being collected. We recommend continuing to collect data from at least a portion of these plots indefinitely, even past the need for the disturbance study, to be able to answer basic demographic questions and to monitor reproduction. (USFWS, 2010)
- The previous geological nomenclature that was commonly used to identify potential Schoenocrambe suffrutescens habitat was discarded (Weiss 1990), thus complicating an already difficult search for this species. The Service needs to accurately characterize parent material, soil, and landscape characteristics for S. suffrutescens. This research would allow us to more accurately identify unoccupied but potentially important habitat, areas for focused surveys and reintroduction, and areas where oil and gas development are unlikely to harm the species. (USFWS, 2010)
- Schoenocrambe suffrutescens should be reintroduced to new areas of suitable but unoccupied habitat near existing populations. (USFWS, 2010)
- Basic biological and ecological information should be obtained for this species, including pollination mechanisms and pollinators. This research began in 2010. (USFWS, 2010)
- Studies to quantify the effects of dust, invasive species, and disturbance from continued energy development were initiated in 2009. These studies should be continued until the Service has enough data to draw conclusions. (USFWS, 2010)
- The Service should consider collecting seeds to include this species in the Center for Plant Conservation collection. Seeds should also be tested for viability and longevity. (USFWS, 2010)
- Nearly 40 percent of the mapped Schoenocrambe suffrutescens populations occur on non-Federal lands. We should continue to work with the Uintah and Ouray Indian Reservation, SITLA, and private landowners to survey and conserve S. suffrutescens habitat and increase outreach efforts. (USFWS, 2010)

- On Federal lands, the Service should continue to avoid development in Schoenocrambe suffrutescens populations and suitable, unoccupied habitat as much as possible, unless research becomes available to indicate that S. suffrutescens is unaffected by development. The Service should ensure that developers follow established conservation measures when disturbance occurs and that habitat fragmentation is reduced as much as possible. (USFWS, 2010)
- Using research collected on soil characteristics and response to disturbance, the Service should identify and establish core conservation areas in minimally-disturbed habitat (both occupied and unoccupied) for long-term protection of S. suffrutescens. (USFWS, 2010)
- Once the Service has new survey data and research data available, the Service recommends revising the Recovery Plan to explicitly address the relevant listing factors. Time and cost required to meet the criteria and recover the species should be included in the Recovery Plan. (USFWS, 2010)
- The Service will continue to monitor the acceptance of Hesperidanthus as the correct genus for this species and will officially change this species' name through an FR notice as needed. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- Recommended future actions: We recommend increased surveys of potential suitable habitat on all landowner types to better estimate total number of individuals, delineate populations, identify important connectivity corridors, and allow planning for landscape level protections. Additional research that provides a better understanding of current population demographics, population trends, and impact of threats is also necessary to evaluate the effectiveness of current protections and identify when recovery criteria are met. The designation and management of protected areas that reduce impacts from identified threats remains necessary to facilitate this species' recovery. Additionally, we recommend revising the recovery plan and specifically reevaluating the recovery goals and criteria based on new population numbers, habitat requirements, connectivity analysis, and potential changes in threat type and intensity. (USFWS, 2019a)

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USFWS. 2019a. 5- Year Review Short Form Species Reviewed: Shrubby reed-mustard (Schoencrambe suffrutescense also known as Hesperidanthus suffrutescens). 3 pp.

SPECIES ACCOUNT: *Schoepfia arenaria* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (Region 4) (USFWS, 2015) 4/19/1991

Physical Description

An evergreen shrub or small tree up to 20 feet or 6 meters (in) tall and with several trunks from the base reaching 4 inches or 10 centimeters (cm) in diameter. The leaves are simple, alternate, without stipules, with petioles one—eighth of an inch or 4 millimeters (mm) long; the upper surface is green and slightly shiny, and the lower surface is light green. Schoepfia arenaria has been observed with flowers mainly in spring and fall, and with fruits in summer and winter. Usually two or three light yellow tubular—shaped flowers are borne on the end of the stalk at the leaf bases. The fruit is elliptic, one-seeded, shiny red, and one—half inch or 12 millimeters (mm) in diameter. The wood is light brown and hard (USFWS, 1991).

Historical Range

At the time the recovery plan was signed (1992), less than 200 individuals of S. arenaria were known within five areas: (A) Municipality of Isabela - approximately 100 individuals of all size classes; (B) Río Abajo Commonwealth Forest (RACF) - one individual; (C) Tortuguero Lagoon Natural Reserve (TLNR) - no population estimate; (D) Municipality of Loíza in the area of Punta Maldonado, Piñones - 30 mature plants and numerous saplings and seedlings; and (E) Municipality of Fajardo at El Convento - approximately 50 individuals. (USFWS, 2016).

Current Range

known from four sites in Puerto Rico: Isabela, Pinones, Fajardo, and the Rio Abajo Commonwealth Forest. (USFWS, 1991). 2016 location refinements: Less than 200 individuals of S. arenaria were known back then from four sites: Isabela, Loíza (Punta Maldonado, Piñones), Fajardo (El Convento), and the Río Abajo Commonwealth Forest. A fifth location is also mentioned in the recovery plan from the Tortuguero Lagoon Natural Reserve. (USFWS, 2016).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: This species has been observed with flowers mainly in spring and fall, and with fruits in summer and winter (USFWS, 1991).

Other Reproductive Information

Adult: Santiago-Valentín and Rojas-Vázquez (2001) recorded leaf, flower and fruit phenology for a period of one year. Their results demonstrate that although flowers and fruits can be found throughout the year, flowering and fruiting is seasonal, with production peaks during the first months of the year (February to May, dry season of Puerto Rico). Production of new leaves occurred continuously during the year. Santiago (2011) collected seeds of S. arenaria during the

dry season (March) and he designed an experiment to determine if mechanical scarification of the seed has a difference in the germination time. He reported that the average germination time of scarified seeds is shorter (about 20 days earlier) than non-scarified (control) seeds. Furthermore, he reported that the germination success was significantly higher in scarified seeds than control, 95% and 68%, respectively. Unfortunately, longterm seed storage does not seem to be a viable option for this species, as the seeds that were air-dried and stored over a year showed less than 10 percent germination success (Santiago 2011). Additionally, he found that growth rate of seedlings of this species is very low and suggested that S. arenaria is hemiparasitic (seedlings need to establish connections with a host plant to absorb the nutrients and water for survival). The author mentioned that seedlings started to become yellow and their development decreased after a year and a half, and eventually all died. (USFWS, 2016).

Reproduction Narrative

Adult: Little information is currently available concerning the life history and reproductive biology of Schoepfia arenaria. This species has been observed with flowers mainly in spring and fall, and with fruits in summer and winter. Usually two or three light yellow tubular-shaped flowers are borne on the end of the stalk in the leaf bases. Many seedlings have been observed under mature trees, and plants of all size classes have been observed. Pollinization mechanisms, seed production and dispersal, seed viability and germination requirements, and seedling establishment and growth should be studied. Other species in this genus are considered as hemiparasitic, due to their root interconnections with other woody species (hosts) nearby, from which they obtain soil minerals (Quevedo, pers. comm.). Future research should document interspecific relations with other native taxa in order to determine whether or not Schoepfia arenaria is also a hemiparasite (USFWS, 1991).

Habitat Type

Adult: Evergreen and semi-evergreen forest (USFWS, 1991)

Spatial Arrangements of the Population

Adult: Clumped (inferred from USFWS, 1991)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1991)

Site Fidelity

Adult: High (inferred from USFWS, 1991)

Habitat Narrative

Adult: Schoepfia arenaria, an evergreen shrub or small tree, occurs in low elevation evergreen and semi—evergreen forests of the limestone hills of northern Puerto Rico. Deforestation and limestone hill destruction for industrial, urban, and tourist expansion have restricted this species to its present locations. It is threatened by development projects in Isabela, and by illegal land acquisition in Pinones (USFWS, 1991). Low tolerance range, high site fidelity and ecological integrity of the community are inferred based on specific habitat needs and relatively low number of populations and individuals. Clumped spatial arrangement is also inferred based on habitat needs and distribution of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal and migration has not yet been assessed (USFWS, 1992).

Population Information and Trends

Number of Populations:

9 (USFWS, 2021)

Population Size:

>200 (USFWS, 2021)

Population Narrative:

As of 1991 there were four known populations totaling approxiamately 190 individuals. Since the 2016 5-year status review, new location has been reported with 12 individuals of S. arenaria in a private property in the municipality of Camuy. Also, 2 additional individuals were found near to Guajataca Commonwealth Forest at Isabela, increasing the total number of known individuals to over 200. However, these new locations currently show no indication of reproduction, so its viability is unknown at this time. With these new locations, this species currently occurs in 9 isolated populations (municipalities) along the north side of Puerto Rico. No new specific information was obtained about the status of the S. arenaria populations described in the 2016 5-year status review, but the information available suggests that S. arenaria stills threatened by habitat modification in the form of deforestation for urban development and impacts on the habitat by cattle (Factor A). Land use change in the vicinity of some populations since 2016, indicating that habitat modification is still significant and potentially an increasing concern related to the viability of the species. Also, based on the 2016 findings, we still consider Factor E to be a threat to S. arenaria. Thus, the Service considers that S. arenaria still meets the definition of a threatened species. (USFWS, 2021)

Threats and Stressors

Stressor: Deforestation (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: The species has become threatened as a result of deforestation in the coastal forests and limestone hills for urban, industrial, and tourist expansion in northern Puerto Rico (USFWS, 1991).

Stressor: Agriculture (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Among the factors which have historically limited the distribution of Schoepfia arenaria include deforestation and limestone hills destruction for agriculture, grazing, and more recently for urban, industrial and tourist developments, and associated roads and service facilities (USFWS, 1991).

Stressor: Grazing (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Among the factors which have historically limited the distribution of Schoepfia arenaria include deforestation and limestone hills destruction for agriculture, grazing, and more recently for urban, industrial and tourist developments, and associated roads and service facilities (USFWS, 1991).

Stressor: Urban, industrial and tourist development (USFWS, 1991)
Exposure:
Response:
Consequence:
Narrative: Among the factors which have historically limited the distribution of Schoepfia arenaria include deforestation and limestone hills destruction for agriculture, grazing, and more recently for urban, industrial and tourist developments, and associated roads and service facilities (USFWS, 1991).

Recovery

Delisting Criteria:
Delisting of Schoepfia arenaria will be considered when the privately-owned population sites are given protected status, and at least two self-sustaining populations in Commonwealth Forest units or other protected lands have been established (USFWS, 1991).

Recovery Actions:

- Monitor and protect existing populations to prevent further habitat loss and population decline. The known populations and habitat should be monitored and protected by both public agencies and private conservation organizations in order that the decline of individuals does not continue and that the complete extinction of the species does not occur. It is essential as well to maintain a source of material for propagation (USFWS, 1991).
- Continue to gather information on the distribution and abundance of Schoepfia arenaria. Additional information concerning the distribution and abundance of the species will affect future management decisions and the establishment of recovery priorities (USFWS, 1991).
- Research. Basic biological information is currently needed on Schoepfia arenaria. Studies should focus on aspects of life history, methods of propagation, and evaluation of possible introduction sites. These studies may be critical in the recovery of the species (USFWS, 1991).
- Refine recovery goals. As additional information on the biology, ecology, propagation, and management of Schoepfia arenaria is gathered, it will be necessary to better define, and possible modify, recovery goals (USFWS, 1991).
- 2016 recommended actions - 1: Conduct comprehensive surveys to determine status of the species. (USFWS, 2016).
- 2016 - 2: Develop appropriate propagation techniques to enhance existing populations and to establish new ones. (USFWS, 2016).
- 2016 - 3: Conduct studies on the pollination and seed dispersal strategies in order to asses if any of these are limiting population growth and expansion. (USFWS, 2016).

- 2016 - 4: Efforts should continue to protect populations in privately-owned lands by reducing habitat deterioration and promoting sustainable land use practices. (USFWS, 2016).
- 2016 - 5: Continue working and foster partnership with regulatory agencies to address and minimize potential adverse effects of development projects on the species and its habitat. (USFWS, 2016).
- 2016 - 6: Monitor known populations to determine its long-term status. (USFWS, 2016).
- 2016 - 7: Model potential suitable habitat using GIS tools to search for possible reintroduction sites and other potential populations that may exist. (USFWS, 2016).
- 2016 - 8: Conduct studies to determine intra and inter-population genetic diversity. (USFWS, 2016).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Recommendations included in the 2016 5-years status review still apply. Additionally, the Service recommends conducting assessments of the species to determine status of individuals and habitat condition after hurricanes Irma and María. (USFWS, 2021)

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SPECIES ACCOUNT: *Schwalbea americana* (American chaffseed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1992; Southeast Region (Region 4)

Physical Description

Schwalbea is an erect herb with unbranched stems or stems branched only at the base, growing to a height of3.0 to 6.0 dm (12 to 24 in). The plant is densely albeit minutely hairy throughout, including the flowers. The leaves are alternate, lance-shaped to elliptic, stalkless, 2.5 to 5.0 cm (0.8 to 2 in) long, and entire; the upper leaves are reduced to narrow bracts. The large, purplish-yellow, tubular flowers, 3.0 to 3.5 cm long (1.2 to 1.4 in) are borne singly on short stalks in the axils of the uppermost, reduced leaves (bracts) and form a many flowered, spike-like raceme. The showy flowers have a high degree of bilateral symmetry elaborated for pollination by bees (Pennell 1935). The fruit is a narrow capsule approximately 10 to 12 mm (0.4 to 0.5 in) long, with a septicidal dehiscence. The numerous seeds are pale greenish brown or yellowish-tan, narrowly linear, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting, sac-like structure that provides the basis for the common name, chaffseed (Musselman and Mann 1978). Flowering occurs from April to June in the southern part of the species' range, and from June to mid-July in the northern part of its range. Fruits mature from early summer in the South to October in the North (Johnson 1988). (USFWS, 1995)

Taxonomy

Pennell (1935) recognized a northern and southern species of Schwalbea, Schwalbea americana L. and Schwalbea australis Pennell, respectively. He distinguished Schwalbea americana by mostly recurved hairs and leaves up to 1.0 cm (0.4 in) wide or less, and Schwalbea australis by a pubescence of mostly upcurved hairs and leaves up to 1.5 cm (0.6 in) wide. Schwalbea americana was known from Massachusetts southward to Virginia, and Schwalbea australis was known from North Carolina to Kentucky and southward to Florida and Louisiana. Fernald (1937) found characters of the leaves and calyx lobes to vary over the total range so that recognition of two species was unwarranted. Following an examination of herbarium material, Musselman and Mann (1977) concurred that there was little taxonomic merit in recognizing more than a single species. Therefore, the U.S. Fish and Wildlife Service accepts the more recent treatments of Fernald (1937) and Musselman and Mann (1977), which recognize Schwalbea americana and Schwalbea australis as one species, Schwalbea americana. In this plan, Schwalbea americana will be henceforth referred to as the monotypic genus Schwalbea. (USFWS, 1995)

Historical Range

Historically known from Massachusetts and New York south along the East Coast to Florida and west along the Gulf Coast states to Texas. (NatureServe, 2015)

Current Range

Currently found in the following states: Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, Alabama, Florida, and Louisiana. (USFWS, 2019a)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual and sexual (outcrossing) (NatureServe, 2015)

Dependency on Other Individuals or Species

Adult: Schwalbea produces showy, insect-pollinated flowers with a high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). (USFWS, 1995)

Breeding Season

Adult: April to June (USFWS, 1995)

Other Reproductive Information

Adult: The germination rates of collected Schwulbea seeds are high. Kirkman (1993) reported that the germination rate of seeds placed in petri dishes, with and without cold stratification, was approximately 90 percent. (USFWS, 1995)

Reproduction Narrative

Adult: This species produces showy, insect-pollinated flowers; the high degree of zygomorphy elaborated for pollination by bees (Pennell 1935). Reproduction primarily occurs via outcrossing (sexual) but can also reproduce asexually. Flowers bloom between April and June. (USFWS, 1995; NatureServe, 2015)

Habitat Type

Adult: Palustrine and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, forest/woodland, savanna, woodland - mixed (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny open areas (NatureServe, 2015)

Environmental Specificity

Adult: Sunny areas (NatureServe, 2015)

Dependency on Other Individuals or Species for Habitat

Adult: The root parasitic behavior of Schwalbea has been known since 1856 (Musselman and Mann 1977). Schwalbea is considered the rarest root parasitic plant in the South, and, like most parasitic Scrophulariacese, it is not host-specific. (USFWS, 1995)

Habitat Narrative

Adult: Characteristically, Schwalbea occurs in sandy (sandy peat, sandy loam), acidic, seasonally moist to dry soils. The species is generally found in habitats described as pine flatwoods, fire-maintained savannas, ecotonal areas between peaty wetlands and xeric sandy soils, and other open grass-sedge systems (Kral 1983). Schwalbea appears to be shade intolerant and, therefore, occurs in areas maintained in an open to partially open condition. In Georgia, Scwalbea occurs in

ecotonal areas between freshwater wetlands and upland pine forests. In North Carolina, the species occurs in moist to dryish pine flatwoods, longleaf pine/wiregrass savannas, and on longleaf pine/oak sandhills composed of Upper Cretaceous deep, white sands, at the western edge of the coastal plain. In South Carolina, the predominant habitat is described as fire-maintained (or mowed, as under power lines), dry, well-drained, longleaf pine flatwoods. The soil is generally a sandy loam. In New Jersey, Schwalbea occurs in open areas that have been maintained by mowing within a pitch pine community. The site is next to a roadcut through a cedar swamp. (USFWS, 1995)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The structure of the Schwalbea seed, somewhat flattened or compressed, slightly curved, and enclosed in a loose-fitting sac-like structure, suggests wind dispersal; however, no information is available to support this hypothesis. Information is lacking on both the mechanism and distance of seed dispersal. (USFWS, 1995)

Population Information and Trends

Population Trends:

Long-term trends indicate population declines from 50 to 90%, whereas short-term trends suggest declines of 10 to 30% (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

43 (USFWS, 2019a)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Adaptability:

Moderate (NatureServe, 2015)

Population Narrative:

When Schwalbea was listed as an endangered species in 1992, 19 extant occurrences were known from the following States: New Jersey (1), North Carolina (1), South Carolina (11), Georgia (4), Florida (1), and Mississippi (1). At the completion of the recovery plan in 1995, extensive searches for this species that occurred in the Southeast, namely North and South Carolina, increased the number of extant occurrences to 72: New Jersey Pleasantville, New Jersey(1), North Carolina (18), South Carolina (42), Georgia (10), and Florida (1). The last comprehensive review of this species status occurred in 2008. At that time, 53 occurrences were extant (30% of sites extant) in 2008: New Jersey (2), North Carolina (11), South Carolina (33), Georgia (4), Alabama (1), Florida (1), and Louisiana (1). It is important to note that in the 1995 recovery plan and 2008 5-year review, the terms population and occurrence were used interchangeably. Since some Schwalbea populations have multiple element occurrences or sites per population, the number of populations across the species range was over-reported in some

cases. In order to standardize population numbers across state boundaries, NatureServe's (2018) population delimitation guidelines were used for all extant populations across Schwalbeas' range in this five-year review. Historic and unknown occurrences were not delimited. Currently, there are 43 extant populations across the species range: Massachusetts (1), New Jersey (2), North Carolina (6), South Carolina (18), Georgia (9), Alabama (2), Florida (3), and Louisiana (2). (USFWS, 2019a)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Habitat destruction and adverse modification of suitable habitat for Schwalbea continue to be major threats for this species. Development along the coast continues to threaten Schwalbea by (1) direct loss of habitat and (2) indirect threats due to urbanization resulting in fire suppression from either local air pollution regulations or safety concerns. Fire suppression continues to threaten this species on both private and public lands. Conversion of longleaf flatwoods and savannas to commercial pine plantations and agriculture fields continue to threaten this species. Although new Schwalbea populations are being discovered, the number of extant populations declined by approximately 25% since the last 2008-five year review. (USFWS, 2019a)

Stressor: Herbivory (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Herbivory continues to serve as a minor threat to the species, herbivores include the striped leaf beetle (Kuschelina sp.), Chrysomelid leaf beetle sp., and Buckeye caterpillar (Junonia coenia) larvae (M. Jenkins, Florida Department of Agriculture and Consumer Resources, pers. comm. 2017; Bob Dellinger, U.S. Forest Service, pers. comm. 2017). The Lethcoe, FMNF population suffered from herbivory when fresh new growth sprouted following a prescribed fire. (USFWS, 2019a)

Stressor: Small population size (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Small population size was noted as a threat in the last 2008 five-year review and remains a threat today. Populations that appear stable throughout time contain at least 100 individuals. Currently, 20 populations contain 100 or more individuals. Small populations are highly vulnerable to extirpation, especially in the absence of prescribed fire. Small populations may be less resilient to environmental changes related to climate change. (USFWS, 2019a)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2019a)
Exposure:
Response:
Consequence:

Narrative: Because the Act only grants protection to plants when a Federal nexus is involved (e.g., federal permit required, federally funded projects), existing regulatory mechanisms are inadequate to protect Schwalbea. Schwalbea receives protection from state rare plant protection laws in Massachusetts, New Jersey, North Carolina, South Carolina, Georgia, and Florida. (USFWS, 2019a)

Stressor: Drought (USFWS, 2019a)
Exposure:
Response:
Consequence:
Narrative: Since Schwalbea is mostly (can occur outside of ecotone areas in longleaf flatwoods) an ecotone species occurring in transitional areas between uplands and freshwater wetlands, an increase in drought frequency and decrease in precipitation events could threaten smaller, less resilient populations. (USFWS, 2019a)

Recovery

Reclassification Criteria:
1. Long-term protection is achieved for 50 geographically distinct, self-sustaining populations. The population sites must be protected from development and other anthropogenic threats that may interfere with the species' survival. Protection of populations on private lands will be evidenced through landowner agreements or conservation easements. Protection of Schwalbea on public lands will be secured through agreements that ensure the long-range protection, management, and monitoring ofSchi4.ulbea. Protected sites will be distributed to include, at a minimum, all of the States currently supporting Schwalbea, with at least four populations in the northern portion of the species' range. Site protection agreements will cover the immediate occurrence site and, where possible, enough contiguous unoccupied habitat to allow for dispersal and natural colonization and expansion of the species. (USFWS, 1995)

2. Management agreements or plans are developed for the 5O protected occurrence sites with the primary objective of ensuring that an ecosystem capable of supporting viable populations of Schwalbea will be permanently maintained. In the case ofprivate ownership, these management agreements could be part of the conservation easement or landowner agreement. (USFWS, 1995)

3. Viable populations of Schwalbea are established at four sites in the northern portion of the species' range (Massachusetts to Virginia), preferably with genetic material from the only remaining northern population in New Jersey. (USFWS, 1995)

4. Biennial monitoring shows that the 50 protected populations are viable as well as stable or increasing over a 10-year period. Demographic population data will be required to meet this condition. (USFWS, 1995)

5. Life history and ecological requirements are understood sufficiently to reliably predict the effectiveness of protection, management, and monitoring. (USFWS, 1995)

Delisting Criteria:

1. Protection via a conservation mechanism is achieved for 50 geographically distinct, self-sustaining populations (Addresses listing factors A, D, and E). (USFWS, 2019b)

2. Protected populations will be distributed to include all of the states currently supporting Schwalbea, and at least four populations in the northern portion of the species range (Massachusetts to Virginia) (Addresses listing factors A, D, and E). (USFWS, 2019b)

3. The land management plans or agreements for the 50 protected Schwalbea populations must include management objectives that abate threats to Schwalbea such as fire suppression, hog damage, and/or silviculture practices (Addresses listing factors A, D, and E). (USFWS, 2019b)

Recovery Actions:

- Protect extant populations and manage habitat. Identify ownership of all known populations. Establish contact with landowners and negotiate landowner agreements or conservation easements. Ensure that activities and management on public lands are consistent with the protection and management of Schwalbea. Use existing regulatory mechanisms to protect Schwalbea. Conduct additional surveys. (USFWS, 1995)
- Expand the extent of Schwalbea In the northern portion of the current range. The New Jersey occurrence of Schwalbea, which is critical to maintaining the northern range of the species, will receive continued protection. In addition, populations should be established in New Jersey, Delaware, Maryland, New York, Connecticut, and Massachusetts to guard against the extirpation of the species from the northern portion of its range. Data are not currently available that indicate the genetic significance of the remaining northern population; however, Pennell (1935) considered the northern and southern populations of Schwalbea trlbea to be distinct species, with the southern species occurring as far north as Virginia (Reveal and Broome 1981). Genetic analyses (Recovery Task 6 below) may further support the significance of maintaining viable populations from the northern gene pool. (USFWS, 1995)
- Investigate best management techniques. ContInue experiments to determine the effects of fire. Conduct experiments to determine the effects of other disturbances. (USFWS, 1995)
- Investigate the species' biology. Conduct research to obtain more comprehensive information on life history and population demography. Determine minimum viable population size. (USFWS, 1995)
- Investigate genetic variability. Genetic analyses should be conducted to determine inter and intra-genetic variability of populations. Differences in the genetic composition of populations may influence site protection and reintroduction priorities. Ongoing genetic analyses may be sufficient to determine if significant variability exists. (USFWS, 1995)
- Monitor populations. Meeting the recovery objectives is contingent upon the stabilization of viable populations over time. Consistent monitoring will provide population data necessary to determine if the recovery objectives are being met. (USFWS, 1995)
- Review recovery progress and revise recovery plan as necessary. The overall success of the recovery program should be periodically assessed, and recommendations regarding appropriate changes in recovery objectives or tasks as suggested by research, studies, or monitoring should be implemented. (USFWS, 1995)
- Research and determine if in situ recruitment and reintroduction can occur under different levels of soil disturbance and watering regimes. (USFWS, 2019a)

- Continually search for new populations in areas managed for quail and/or red-cockaded woodpeckers or any areas with a 1-2 year fire return interval within the species' historic range. (USFWS, 2019a)
- Survey unknown and historic populations and if present negotiate landowner agreements or conservation easements. (USFWS, 2019a)
- Develop an easy and repeatable Schwalbea survey form and methodology for range-wide use in order to tract/monitor recovery populations annually. (USFWS, 2019a)
- Research the germination ecology of Schwalbea in regards to moisture and light requirements and seedling recruitment / host attachment to understand Schwalbea's regeneration strategy. (USFWS, 2019a)
- Research fire seasonality effects, especially early April and late July/August fires, in conjunction with rainfall patterns/climatic fluctuations. (USFWS, 2019a)
- Continue population reintroductions within the historic range and introductions into protected areas with 1-3 year fire return intervals. (USFWS, 2019a)
- Expand the extent of Schwalbea in the northern portion of the current range. (USFWS, 2019a)

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SPECIES ACCOUNT: *Sclerocactus brevihamatus ssp. tobuschii* (Tobusch fishhook cactus)

Species Taxonomic and Listing Information

Commonly-used Acronym: SCLTOB

Listing Status: Endangered; 12/08/1979; Southwest Region (Region 2)

Physical Description

A cactus armed with fishhook-shaped spines. The hemispheric or short-columnar stems of mature plants are 3 to 10 centimeters (cm) (1.2 to 3.9 inches (in)) tall and 1 to 10 cm (0.4 to 3.9 in) in diameter; however, although the largest recorded individuals are as much as 10 cm (3.9 in) in diameter, few wild plants are greater than 5 cm (2.0 in) in diameter (Poole and Janssen 2002, p. 7). The stems are supported on short, conical taproots from which emerge numerous fibrous roots that typically grow horizontally along the surfaces and fissures of rock strata. The stems bear tubercles (podaria) up to 12 millimeters (mm) (0.5 in) long that have a groove (sulca) along their upper surfaces. The tubercles are arranged in 5 to 8 ribs (Marshall 1952, p. 79), or from 8 to 12 ribs (Poole et al. 2007, p.442). However, we note that the tubercles within each rib are nearly distinct from each other; the ribs, which may spiral, are difficult to discern, especially in smaller individuals, and the tubercles appear to alternate. Spines arise from areoles at the apex of each tubercle. The spines are of two types: Radial spines are fine, straight, from 1 to 2 cm (0.4 to 0.8 in) long, spreading at right angles to the tubercle from the edges of the areoles. From 3 to 5 thicker, flattened central spines, 2 to 4 cm (0.8 to 1.6 in) in length, arise from nearer the center of the areoles and project more or less outward from the stem; one of the central spines is abruptly recurved, and may reach 180° of curvature in older individuals. Spines are yellowish at first, and may have reddish tips, turning gray with age. Flowers emerge from the bases of young tubercles near the stem apex, and have numerous yellow tepals. Fruits are spineless, elongate, from 2.5 to 3 cm (1 to 1.2 in) long, turning reddish-green and usually splitting open along 1 or more lines when mature. (USFWS, 2017)

Taxonomy

The genus Ancistrocactus, which means "fishhook", contains four species, three occurring in the region of the Rio Grande River in southern Texas and adjacent Mexico, and one occurring farther south (Benson, 1982). According to Benson (1982) this genus is mostly closely related to Coryphantha and Neolloydia, all three genera being in the vast complex group of plants intermediate between Mammillaria and Echinocactus. Systematics of the Cactaceae has always been controversial. No single treatment is universally accepted, and the steady accumulation of phylogenetic analyses has forced continual revisions. In particular, there is no consensus among cactus authorities regarding the taxa pertaining to the related genera of Ancistrocactus, Sclerocactus, and Ferocactus. The following sources provide a brief review of the prevailing classifications. A number of synonyms have been applied to this taxon, including Ancistrocactus tobuschii (W.T. Marshall) W.T. Marshall ex Backeb, Echinocactus tobuschii (W.T. Marshall) Weniger and Ferocactus tobuschii (W.T. Marshall) N.P. Taylor. (USFWS, 1987; USFWS, 2010). An extensive discussion of the taxonomy is provided in the Species Status Assessment of 2017 (USFWS, 2017).

Historical Range

Endemic to the Edwards Plateau of Texas. (USFWS, 2017)

Current Range

In the following central counties in Texas: Bandera, Edwards, Kerr, Kimble, kinney, Real, Uvalde, and Val Verde. (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2017)

Lifespan

Adult: >10 years (USFWS, 2017)

Dependency on Other Individuals or Species

Adult: Pollinators; most common were several species of halictid bees (USFWS, 2017)

Breeding Season

Adult: Late January to mid-March (USFWS, 2017)

Other Reproductive Information

Adult: Tobusch fishhook cactus plants begin reproducing when they have grown to a diameter of about 2 cm (occasionally less); this is estimated to require 9 years of growth in the wild. Flowering occurs between late January and mid-March, depending on locality, and lasts a few weeks in each population. Honey bees and halictid bees are effective pollinators, although the latter group may be more active later in the flowering season. The breeding system is primarily by outcrossing, although self-fertilization occurs rarely. Fruits ripen around mid-May. (USFWS, 2017)

Reproduction Narrative

Adult: Tobusch fishhook cactus grows slowly, reaching a reproductive size of about 2 centimeters (0.8 inches) in diameter after 9 years. It flowers between late January and mid-March, and its major pollinators are honey bees and halictid bees. The breeding system is primarily out-crossing, but the species is capable of self-fertilization. Reproductive individuals produce an average of 112 seeds per year. Ants may be seed predators, dispersers, or both. Mammals or birds may also accomplish longer-distance seed dispersal. We have little evidence of a persistent soil seed bank. (USFWS, 2017)

Habitat Type

Adult: Terrestrial (USFWS, 2017)

Habitat Vegetation or Surface Water Classification

Adult: Shortgrass grasslands, oak-juniper woodlands, semi-desert shrublands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Full sunlight (USFWS, 2017)

Spatial Arrangements of the Population

Adult: Discontinuous patches (USFWS, 2018)

Environmental Specificity

Adult: Moderate, with some key requirements (USFWS, 2017)

Habitat Narrative

Adult: The riparian habitats described in the original status report are atypical. The great majority of documented populations occur in upland sites dominated by Ashe juniper-live oak woodlands and savannas on outcrops of early Cretaceous limestone. Soils are classified in the Tarrant, Ector, Eckrant, and similar series. Within a matrix of woodland and savanna, the species occurs in discontinuous patches of very shallow, gravelly soils where bare limestone rock and rock fragments comprise a large proportion of the surface cover. Associated vegetation includes small bunch grasses and forbs. The species' distribution within habitat patches is clumped and tends to be further from woody plant cover. The presence of spikemosses (Selaginella spp.), and perhaps other cryptogams, may be useful indicators of fine-scale habitat suitability. Wildfire (including prescribed burning) causes negligible damage to Tobusch fishhook cactus populations. The species probably does not require fire for germination, establishment, or reproduction, but periodic burning may be necessary to prevent the encroachment of woody plants into its habitats. (USFWS, 2017)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Ants remove a large proportion of seeds, pulp, and funiculi, but whether the ants consume the seeds, or effectively disperse them, is not known. Mammals or birds also consume fruits and may accomplish longer-distance seed dispersal. Moderate numbers of viable seeds have been found in the soil near live plants, but the extent and longevity of soil seed banks is unknown. (USFWS, 2017)

Population Information and Trends

Population Trends:

Increasing (USFWS, 2017)

Resiliency:

It is likely that Tobusch fishhook cactus has multiple, resilient populations (USFWS, 2017). 'Resilience and Redundancy. Resilience refers to the population size necessary to endure stochastic environmental variation (Shaffer and Stein 2000, pp. 308-310). Redundancy refers to the number and geographic distribution of populations or sites necessary to endure catastrophic events (Shaffer and Stein 2000, pp. 308-310). The recovery plan (USFWS 1987, p. 14) established a recovery criterion of 4 protected populations with at least 3,000 individuals, but did not show

how this level was determined. However, we now understand that insect parasites are able to devastate large, dense populations. We conclude that few large populations are much more vulnerable than many small populations, and that this recovery criterion should be amended. Poole and Birnbaum (2003, p. 1), using the surrogate species method of Pavlik (1996, pp. 136-137), estimated a MVP for Tobusch fishhook cactus of 1,200 individuals (Section II.7.5). Since few individual colonies reach this size, and since large colonies are more vulnerable to insect parasites, we recommend that the MVP of 1,200 individuals be applied to metapopulations that consist of multiple colonies distributed at a landscape scale. The resilience of Tobusch fishhook cactus derives not merely from the size of metapopulations, but also their density. Colonies that are too small or too isolated may incur loss of genetic diversity and inbreeding; Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8 populations, which he attributed to mating of close relatives within small, isolated populations. Conversely, vulnerability to insect parasitism increases when metapopulations become too dense, or when colonies become too large. Therefore, we believe that there must be some optimal range of metapopulation density and colony size, although we do not currently know what those optima are. These concepts of metapopulation size and density depend on how metapopulation boundaries are delimited. The EO concept is a good starting point, but may have to be revised for Tobusch fishhook cactus considering its specific population dynamics. The determination of Tobusch fishhook cactus viability is more challenging, since few surveys have been conducted on the roughly 95 percent of the potential habitat that is privately owned. Furthermore, since the populations are small and widely distributed, there is a low probability of detecting populations on any fixed area, such as a state park. It is likely that metapopulations are distributed over areas that are larger than individual parks and natural areas. We can speculate that the population densities found on the small number of areas that have been quantitatively surveyed are representative of the entire global distribution of this subspecies. Since 2009, several new quantitative surveys were conducted for highway, pipeline, and power line developments. These surveys provided data from transects that cross the subspecies' range and provide more evidence for its range of densities. Based on all available evidence, we provisionally estimate that the global population size is about 480,000 individuals (Appendix 2). Regardless of how this number is divided into metapopulations, we believe that it is likely that Tobusch fishhook cactus has multiple, resilient populations' (USFWS, 2017).

Representation:

Tobusch fishhook cactus currently possesses sufficient genetic diversity to conserve long-term adaptive capability. However, habitat fragmentation and disruption of gene flow among populations may have occurred too recently to be detected through genetic analyses. Considering the naturally low densities of Tobusch fishhook cactus populations, gene flow among them may be easily disrupted. (USFWS, 2017). Representation. Representation refers to the genetic diversity, both within and among populations, necessary to conserve long-term adaptive capability (Shaffer and Stein 2000, pp. 307-308). Rayamajhi (2015, (pp. 53, 54, 65, 66, 79, 80) found relatively low levels of genetic differentiation among 9 populations of Tobusch fishhook cactus (low pairwise FST and GST levels, discussed in II.2), regardless of the distance between populations. He found evidence of substantial gene flow among populations, suggesting that the documented populations may interact with additional (undocumented) populations (at least in the recent past) (p. 67). However, recently isolated populations may not yet show genetic differentiation, in part because individuals can live and contribute to the local gene pool at least for several decades. Most of the populations studied had healthy levels of outbreeding, but 3 populations were at relatively higher risk of inbreeding effects and may have

suffered recent genetic bottlenecks through population declines (P. 97). Based on controlled pollination experiments, Emmett (1995) found effective fertilization (fruit set, seed production, and seed viability) within isolated colonies in his study area (p. 87). This affirms empirically that at least some isolated colonies still possess a sufficient level of genetic diversity. The low level of genetic differentiation among populations is not unusual for endemic taxa, and may also indicate a fairly recent divergence of subspecies tobuschii from subspecies brevihamatus. There is evidence of gene flow throughout the subspecies' range and possible interaction of the monitored populations with undocumented populations on surrounding private lands. Genetic differentiation within most, but not all populations, is sufficiently high for effective fertilization and out-crossing. We conclude that Tobusch fishhook cactus currently possesses sufficient genetic diversity to conserve long-term adaptive capability. However, habitat fragmentation and disruption of gene flow among populations may have occurred too recently to be detected through genetic analyses. Considering the naturally low densities of Tobusch fishhook cactus populations, gene flow among them may be easily disrupted. Therefore, maintaining the continuity of potential habitats throughout the subspecies range should have a high conservation priority. We recommend that viability monitoring should be continued long enough to determine population dynamics and demographic trends at the metapopulation and subspecies levels (USFWS, 2017).

Redundancy:

It is likely that Tobusch fishhook cactus has multiple, resilient populations (USFWS, 2017). 'Resilience and Redundancy. Resilience refers to the population size necessary to endure stochastic environmental variation (Shaffer and Stein 2000, pp. 308-310). Redundancy refers to the number and geographic distribution of populations or sites necessary to endure catastrophic events (Shaffer and Stein 2000, pp. 308-310). The recovery plan (USFWS 1987, p. 14) established a recovery criterion of 4 protected populations with at least 3,000 individuals, but did not show how this level was determined. However, we now understand that insect parasites are able to devastate large, dense populations. We conclude that few large populations are much more vulnerable than many small populations, and that this recovery criterion should be amended. Poole and Birnbaum (2003, p. 1), using the surrogate species method of Pavlik (1996, pp. 136-137), estimated a MVP for Tobusch fishhook cactus of 1,200 individuals (Section II.7.5). Since few individual colonies reach this size, and since large colonies are more vulnerable to insect parasites, we recommend that the MVP of 1,200 individuals be applied to metapopulations that consist of multiple colonies distributed at a landscape scale. The resilience of Tobusch fishhook cactus derives not merely from the size of metapopulations, but also their density. Colonies that are too small or too isolated may incur loss of genetic diversity and inbreeding; Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8 populations, which he attributed to mating of close relatives within small, isolated populations. Conversely, vulnerability to insect parasitism increases when metapopulations become too dense, or when colonies become too large. Therefore, we believe that there must be some optimal range of metapopulation density and colony size, although we do not currently know what those optima are. These concepts of metapopulation size and density depend on how metapopulation boundaries are delimited. The EO concept is a good starting point, but may have to be revised for Tobusch fishhook cactus considering its specific population dynamics. The determination of Tobusch fishhook cactus viability is more challenging, since few surveys have been conducted on the roughly 95 percent of the potential habitat that is privately owned. Furthermore, since the populations are small and widely distributed, there is a low probability of detecting populations on any fixed area, such as a state park. It is likely that metapopulations are distributed over

areas that are larger than individual parks and natural areas. We can speculate that the population densities found on the small number of areas that have been quantitatively surveyed are representative of the entire global distribution of this subspecies. Since 2009, several new quantitative surveys were conducted for highway, pipeline, and power line developments. These surveys provided data from transects that cross the subspecies' range and provide more evidence for its range of densities. Based on all available evidence, we provisionally estimate that the global population size is about 480,000 individuals (Appendix 2). Regardless of how this number is divided into metapopulations, we believe that it is likely that Tobusch fishhook cactus has multiple, resilient populations' (USFWS, 2017).

Number of Populations:

511 sites (USFWS, 2017)

Population Size:

Globally about 480,000 individuals (USFWS, 2017)

Population Narrative:

The TXNDD (2016) lists 97 EOs, totaling 3,336 individuals in 8 counties of the Edwards Plateau of Texas. • From 2009 to 2016 we received additional sources of population data, primarily from surveys conducted for development projects. • A total of 118 permanent plots at 12 protected natural areas have been monitored from 1991 through 2013. Plot data reveals that mortality is often very high, and consistently exceeds recruitment; however, the known population sizes have steadily increased, due to the discovery of previously undetected individuals and colonies. • The probability of detecting live Tobusch fishhook cactus individuals during a single survey is highly variable; Reemts (2014) calculated an overall detection rate of 50 percent. The inability to detect all living members of a population confounds determinations of population size and demographic trends. • Demographic population viability analyses of monitored populations, using integral projection models, predicted stable or increasing trends for 2 or 3 populations, moderate declines for 2 populations, and large to precipitous declines in 5 populations over the next 50 years. When expected climate changes were included in the analyses, 4 populations responded negatively to climate changes and 6 populations responded positively (compared to PVA without climate changes). We estimate that the global population size for Tobusch fishhook cactus is about 473,000 individuals distributed over an area of over 2 million ha (5 million ac). (USFWS, 2017)

Threats and Stressors

Stressor: Land Use Changes (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Relatively little urban and industrial development is occurring within the semi-arid, sparsely populated eight-county known range of Tobusch fishhook cactus. However, a significant ongoing trend throughout the species' range is the subdivision of large ranches into many small "ranchettes," leading to a proliferation of roads, fences, power lines, and residential development, all of which contribute incrementally to habitat loss and fragmentation. Land subdivision also engenders changes in land use and management which may be both beneficial and detrimental to Tobusch fishhook cactus. For example, the predominant, historic land use

throughout the Edwards Plateau has been grazing of livestock, including goats, cattle, sheep, and horses. In many cases, poor rangeland management during the last century has caused the depletion of herbaceous vegetation, cessation of the natural wildfire cycle, proliferation of dense juniper stands, soil erosion, and reduced infiltration and storage of rainwater in the soil profile; all of these changes are likely to have harmed Tobusch fishhook cactus populations. The change to a primarily recreational land use often entails continued grazing, in order to obtain agricultural tax exemptions, but at a sustainable stocking density (landowners may subsequently convert an agricultural exemption to a wildlife exemption). Currently, both large and small landowners are more aware of and concerned with conservation issues than during the last century. Prescribed burning may be one of the most important vegetation management tools for sustaining Tobusch fishhook cactus populations; the proliferation of residential development within the species' habitat makes this tool more challenging for natural resource managers to use. The subdivision of privately-owned land and associated threats are likely to continue. (USFWS, 2017)

Stressor: Changes in vegetation and wildfire frequency. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Bray (1904, pp. 14–15, 23–24) documented the rapid transition of grasslands to woodlands in the Edwards Plateau occurring more than a century ago; he attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. Fonteyn et al. (1988, p. 79) state that savannas covered portions of the pre-settlement Edwards Plateau, and since 1850 were transformed to shrubland or woodland "primarily by suppression of recurring natural and anthropogenic fires and the introduction of livestock." They list the fire-sensitive Ashe Juniper as the most successful of many woody plants that have invaded grasslands. Reemts (2014 p. 1). lists the encroachment of woody plants into the rocky, open habitat as one of several habitatrelated threats to Tobusch fishhook cactus. However, the historic extent of grasslands in the Edwards Plateau is an area of active scientific debate. It is likely that woodlands were most abundant on slopes in the Balcones Escarpment (which includes the southern and eastern portion of the Tobusch fishhook cactus range) and that grasslands were more abundant on flatter, deeper soils in the western Edwards Plateau (Diamond et al. 1995, pp. 191-193; Diamond and True 2008, pp. 53-54; Murray et al. 2013, pp. 298, 302). (USFWS, 2017)

Stressor: Livestock grazing. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The recovery plan stated "Ancistrocactus tobuschii plants have been observed that were either uprooted or had apical meristem injuries from livestock trampling." Nevertheless, livestock trampling and herbivory have not subsequently been identified as significant causes of mortality or damage to Tobusch fishhook cactus plants. The recurved spines and small size probably discourage herbivory of Tobusch fishhook cactus plants. Livestock are not attracted to the sparsely vegetated outcrops where Tobusch fishhook cactus plants typically occur, and the plants are protected to some degree by surrounding rocks. While livestock trampling probably occurs in grazed habitats, particular where animals are concentrated, we have no evidence that it represents a significant threat to the species. A number of healthy Tobusch fishhook cactus populations occur on well-managed rangeland. We conclude that livestock grazing, especially where juniper thinning and prescribed burning are used to manage rangeland, is generally

compatible with conservation of this cactus. (USFWS, 2017)

Stressor: Illicit collection. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Many rare cactus populations have been depleted by overzealous collectors. The recovery plan lists collection by unscrupulous cactus and succulent fanciers as a threat to the species. Westlund (1991, pp. 2, 35, 39) found six specimens of Tobusch fishhook cactus, grown legally from seed, for sale in commercial nurseries. Poole and Janssen (2002, p.9) noted that one population of Tobusch fishhook cactus was heavily depleted by collection, but concluded that "collection is not currently perceived to be a grave threat." Although illicit collection has not significantly impacted the species, the wild populations openly accessed by the public remain vulnerable. The potential threat of illicit collection might be diminished if seeds and plants of legally-propagated Tobusch fishhook cactus are easier and less expensive to obtain than wilddug specimens. (USFWS, 2017)

Stressor: Parasites. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The Tobusch fishhook cactus weevil (Gerstaeckeria sp. nov.) and cactus longhorn beetle (Moneilema spp.) parasitize and kill Tobusch fishhook cactus plants and have contributed significantly to drastic declines in many of the known populations (Calvert 2003, all). Considering that the weevil (Gerstaeckeria sp. nov.) is a new species, and that it may be an obligate parasite of Tobusch fishhook cactus (Calvert 2003, p. 12), the weevil itself may be no less endangered than its host. Periodic outbreaks of insect parasitism appear to be an unavoidable natural cycle. For this reason, the recovery criterion of 3,000 individuals per population may be unattainable or unsustainable, as such large cactus populations would eventually host very large parasite populations, leading to their collapse. The most appropriate conservation strategy may be to protect larger numbers of small, widely-spaced populations, rather than fewer large populations that are more vulnerable to parasites; however, we do not currently know what the optimal parameters of size and spacing should be..(USFWS, 2017)

Stressor: Other herbivory. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Poole and Birnbaum (2003, pp. 11-12) report that jackrabbits browse the cactus, but in most sites cause less than 2 percent mortality. If the root systems are not too badly damaged, they may regenerate one or more new stems. Feral hogs have uprooted plants in many sites (also observed by Reemts (2015, p. 1)). An unidentified ant species has also caused 1 percent mortality at some sites by creating mounds on top of the stems. Federally-listed plants occurring on private lands have limited protection under the ESA, unless also protected by State laws; the State of Texas also provides very little protection to listed plant species on private lands. Approximately 95 percent of Texas land area is privately-owned. It is reasonable to assume that the vast majority of existing Tobusch fishhook cactus habitat, including sites that have not been documented, occurs on private land. Therefore, most of the species' populations and habitats

are not subject to Federal or State protection unless there is a Federal nexus, such as provisions of the Clean Water Act or a federally-funded project. The ESA does provide some protection for listed plants on land under Federal jurisdiction. However, Tobusch fishhook cactus populations have not been documented on Federal land. International trade of Tobusch fishhook cactus (as Sclerocactus brevihamatus ssp. tobuschii) is regulated under CITES Appendix I (Convention on International Trade in Endangered Species of Wild Fauna and Flora 2009). (USFWS, 2017)

Stressor: Demographic consequences of small population size and density. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Poole and Birnbaum (2003, p. 1) estimated an MVP of 1,200 individuals (Section II.7.5). Small populations are less able to recover from losses caused by random environmental changes (Shaffer and Stein 2000, pp. 308-310), such as fluctuations in recruitment (demographic stochasticity), variations in rainfall (environmental stochasticity), or changes in the frequency of wildfires. Tobusch fishhook cactus has a predominantly out-crossing breeding system. The probability of successful fertilization between unrelated individuals is reduced in small, isolated populations. The remaining plants would produce fewer viable seeds, further reducing population recruitment and engendering a downward spiral toward extirpation. The demographic consequences of small population size are compounded by genetic consequences (discussed below), since reduced out-crossing corresponds to increased inbreeding. In addition to population size, it is likely that population density also influences population viability; density must be high enough for gene flow within metapopulations, but low enough to minimize parasite infestations. (USFWS, 2017)

Stressor: Genetic consequences of small population sizes. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Small, reproductively isolated populations are susceptible to the loss of genetic diversity, to genetic drift, and to inbreeding. The loss of genetic diversity may reduce the ability of a species or population to resist pathogens and parasites, to adapt to changing environmental conditions, or to colonize new habitats. Conversely, populations that pass through a “genetic bottleneck” may subsequently benefit through the elimination of harmful alleles. Nevertheless, the net result of loss of the genetic diversity is likely to be a loss of fitness and lower chance of survival of populations and of the subspecies. Genetic drift is a change in the frequencies of alleles in a population over time. Genetic drift can arise from random differences in founder populations and the random loss of rare alleles in small isolated populations. Genetic drift may have a neutral effect on fitness, but is also a cause of the loss of genetic diversity in small populations. Genetic drift may also result in the adaptation of an isolated population to the climates and soils of specific sites, leading to the development of distinct ecotypes and to speciation. For example, the genetic divergence of Sclerocactus brevihamatus subspecies brevihamatus and tobuschii (Section II.2; Rayamajhi 2015, pp. 67, 98) may have resulted when populations of the species brevihamatus migrated into separate geographic regions, and once separated, each population adapted to different soils, climate, and pollinator species. Inbreeding depression is the loss of fitness among offspring of closely related individuals. While most animal species are susceptible to inbreeding depression, plant species vary greatly in response to inbreeding. Rayamajhi (2015, pp. 63-64) found relatively high inbreeding coefficients in 3 of 8

populations, which he attributed to mating of close relatives within small, isolated populations. Nevertheless, we do not know to what extent inbreeding has reduced fitness of these populations. (USFWS, 2017)

Stressor: Private land ownership. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: A large portion of the known individuals and populations of Tobusch fishhook cactus occurs on privately owned land. This does not constitute a threat to the subspecies, and in fact many landowners have demonstrated interest and enthusiasm for its conservation. However, private ownership makes conservation more challenging for several reasons. Access to populations and habitats is subject to the interests of hundreds of individual landowners. Consequently, our knowledge of the subspecies' actual status is far from complete. Establishing and maintaining cooperative relationships with large numbers of private landowners is time-consuming, and these important relationships may lapse when personnel of conservation organizations retire or pursue other career choices. The ownership of private lands changes hands over time, and future owners may choose not to continue conservation efforts that were supported by previous owners. Hence, it is difficult to assure permanent conservation on private lands. These challenges underscore the importance of effective landowner outreach in the conservation of Tobusch fishhook cactus. (USFWS, 2017)

Stressor: Climate change. (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; it is very likely that the frequency, intensity, and/or amount of heavy precipitation will increase in mid-latitude land masses; it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. We do not know how Tobusch fishhook cactus responded to prior climate changes, nor can we determine how these projected climate changes, forecast by the range of models and emissions scenarios, will affect the synecology of Tobusch fishhook cactus and its habitat. Warmer winters could extend the growing season and improve reproduction and survival of Tobusch fishhook cactus, but might also increase survival of parasite larvae. Heavier, less frequent rainfall could reduce establishment of Tobusch fishhook cactus seedlings, but perhaps less so than the bunch grasses that it competes with. Zaya et al. (2014, pp. 37-38) projected that expected climate changes will be detrimental to 4 populations and beneficial to 6 others. Thus, although it is likely that the projected climate changes will affect the survival of Tobusch fishhook cactus in infinitely complex ways, we do not currently know what the net result of beneficial and detrimental effects will be. (USFWS, 2017)

Recovery

Reclassification Criteria:
No longer applicable due to revision to Threatened status. (USFWS, 2018)

Delisting Criteria:
1. Populations or portions of metapopulations occur within 10 or more protected natural areas. Protected natural areas include lands owned by federal, state, or local government agencies, or by private landowners, that are legally protected for the purpose of conserving native plants and animals and their habitats. Examples include, but are not limited to, state parks, state natural areas, and state wildlife management areas, conservation easements on private lands, lands owned and managed for conservation by non-profit organizations, and legally-binding long-term management agreements with other public agencies or private landowners. To be considered under this criterion, the potential habitats of Tobusch fishhook cactus must be managed in a manner that promotes the continued survival of the subspecies. (USFWS, 2019)

2. The 10 or more protected natural areas described in the previous criterion must conserve the full geographic and ecological range of the subspecies. To meet this criterion, one or more protected natural areas must occur within each of four equal-area quadrants (northeast, northwest, southeast, and southwest) of the subspecies' natural range. (USFWS, 2019)

3. Populations or portions of metapopulations within each protected natural area have 1,200 or more mature individuals. This criterion may be met by combining multiple protected areas that occur within the same metapopulation, as defined above. (USFWS, 2019)

4. Periodic monitoring indicates that the minimum viable population level of 1,200 mature individuals within each protected natural area has remained stable or has increased over a period of 45 years. Monitoring (censuses) of each protected natural area must be conducted at least once every 5 years. The size of large populations may be estimated through statistically valid sampling methods. (USFWS, 2019)

Recovery Actions:
- 1. Remove immediate human threats to Ancistrocactus tobuschii by protecting known populations from collecting and habitat destruction. (USFWS, 1987)
- 2. Establish a permanent living collection at a botanical garden or university. Even though plants in a living collection can not substitute for healthy populations in natural habitats, a living collection would still contribute significantly to the overall recovery effort. Much information on ecological requirements and reproductive potential could be obtained most easily from a living collection. In addition, a permanent well documented and accessible living collection, together with appropriate seed banking, could provide an important source of material for non-destructive research, maintenance of wild popula- tions, and public awareness. An adequate living collection would remove the necessity of repeatedly returning to wild populations to collect plants for various recovery projects. (USFWS, 1987)
- 3. Minimize long-range threats to Ancistrocactus tobuschii by development of biological information relevant to recovery. A better understanding of the demography of populations and the life history and ecological requirements of the species would provide information useful to management. (USFWS, 1987)
- 4. Establish a long-term (five year) survey program to more precisely determine the true distribution of the species. Surveys for this cactus will be difficult because it is easily overlooked, particularly in the summer and fall when it is hidden by perennial grasses.

(USFWS, 1987)

- 5. Develop a comprehensive trade management plan for all cacti. Studies are needed to determine what species are in trade, the overall trend of trade in listed cacti, and the feasibility of reducing collecting pressure on wild populations by promoting a commercial artificial propagation program. These studies should be national in scope and address all cacti. The results will be used to develop policy and a comprehensive trade management plan for all cacti. Strategies for effective implementation of law enforcement responsibilities under ESA, CITES, Lacey Act, and State laws need to be developed. (USFWS, 1987)
- 6. Develop a program to provide propagated plants and seeds to the commercial market. If information from task 5 indicates that artificial propagation will reduce collecting from the wild, an effort should be made to see that adequate sources of propagated plants are commercially available. This may be particularly helpful for Ancistrocactus tobuschii because several of the historic sites are easily accessible and already well known from the literature. (USFWS, 1987)
- 7. Develop public awareness, appreciation, and support for preservation of the species. Public education is extremely important to this species' successful recovery. Landowners usually do not realize that this species exists and most will support protection and conservation efforts if they learn that a unique plant grows on their land. (USFWS, 1987)
- Recommended Future Actions from 2010 5-Year Review: 1. Continue monitoring and surveying the established protected reserves. 2. Conduct surveys of high-potential habitat within the known range of the species, focusing on sites that have not previously been surveyed. 3. Establish new reserves, using the LBJWC conservation fund and other resources. 4. Conduct public outreach efforts to encourage conservation of the species and its habitat on private lands; establish a private landowner support group, similar to the group now actively working to conserve Texas snowbells (Styrax platanifolius ssp. texanus). 5. Continue to investigate ecology and management, with special emphasis on woody plant control and prescribed burning; compare effects of prescribed burning conducted at different times of the year. 6. Investigate the factors influencing reproduction and dispersal in the wild, with emphasis on the fate of seeds collected by ants. 7. Apply sound management, as needed, to protected sites. 8. Investigate the phylogenetic and taxonomic relationship between Sclerocactus brevihamatus ssp. brevihamatus, S. brevihamatus ssp. tobuschii, S. scheeri, and other closely related taxa of Sclerocactus and/or Ancistrocactus. 9. Collect seeds of representative populations for propagation and seed banking, establish germ-plasm (live plant) refugia, and develop techniques for successful propagation and reintroduction. 10. Revise the 1987 recovery plan. (USFWS, 2010)

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SPECIES ACCOUNT: *Sclerocactus brevispinus* (Pariette cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/15/2009; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Small cactus with very short (2 mm) central hooked or straight spines. (NatureServe, 2015)

Taxonomy

The original listing rule for S. glaucus (44 FR 58868, October 11, 1979) included all hookless (straight central spines) Sclerocactus populations in western Colorado and northeastern Utah, and referred to them as S. glaucus per Benson (1966, pp. 50-57; 1982, pp. 728-729). This taxonomic classification is not supported by the results of more recent research. Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993; Welsh et al. 2003), and a reevaluation of the morphological characteristics of S. glaucus, led to separating this species into three distinct species: S. brevispinus, S. glaucus, and S. wetlandicus (Hochstätter 1993; Heil and Porter 2004). We recognized these three distinct species as threatened on September 15, 2009 (74 FR 47112). The Flora of North America recognizes 15 species in the genus Sclerocactus, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between S. brevispinus and S. wetlandicus, but infer S. glaucus is more closely related to S. parviflorus (Devil's claw cactus) and S. whipplei (Whipple's fishhook cactus). The common name for S. glaucus was changed to Colorado hookless cactus as the species is endemic to western Colorado. S. wetlandicus is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. S. brevispinus is now known as the Pariette cactus as it is limited to the Pariette Draw of the central Uinta Basin. The Uinta Basin hookless cactus complex will be used to refer to the combination of all three species previously listed as a single entity (USFWS, 2010)

Current Range

Known only from a single area a few miles across in the Pariette Draw region of Duchesne County, Utah, U.S.A.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominately insect pollinated (surrogate S. glaucus information) (USFWS, 2007)

Breeding Season

Adult: Flowering occurs in April-May, and fruits mature in May-June (surrogate S. glaucus information) (NatureServe, 2015).

Reproduction Narrative

Adult: Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantely outcrossing but is marginally self-compatible. Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of Sclerocactus glaucus (NatureServe, 2015). Information from S. glaucus is being used a surrogate information for S. wetlandicus due to the species similiarities and based on the following quote 'Because we lack life history data specific to S. wetlandicus, we have included life history data for S. glaucus, which should correlate to characteristics for S. wetlandicus' USFWS, 2010. Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015). The species' life history is poorly known, but it is thought to be a longlived perennial usually flowering after 3 or 4 years. A broad assemblage of native bees, and possibly other insects including ants and beetles, pollinates S. brevispinus (USFWS 1990, p. 7) (USFWS, 2007).

Habitat Type

Adult: Clay badlands (NautreServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species is endemic to highly saline and alkaline soils, restricted to clay badlands within a single geologic formation in Utah. Occurs on exposed clay hills and in saltbush and sagebrush flats, 1400-1500 m. (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species habitat requirements of the species and the relatively small geographic area this species inhabits.

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown

Population Size:

between 30,500 and 42,281 individuals (USFWS, 2020)

Population Narrative:

Cumulative survey data represents the best scientific information available regarding the number of individuals for Sclerocactus. The known range-wide population size for Uinta Basin hookless cactus is between 83,408 and 110,815 individuals, and the known range-wide population size for Pariette cactus is between 30,500 and 42,281 individuals (USFWS 2019).

(USFWS, 2020)

Threats and Stressors

Stressor: Oil and Gas Development and Associated Impacts (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The BLM is monitoring S. brevispinus populations and neighboring Sclerocactus species, including impacts associated with oil and gas development. Initial results show potential effects of oil and gas development (i.e., roads and well pads) on the survival and reproductive success of S. brevispinus (72 FR 53215, September 18, 2007) (USFWS, 2010.

Stressor: Collection (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Illegal collection is a significant threat to S. brevispinus. The original listing of S. glaucus concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductive population. As of 2006, approximately 96 percent of the known range of S. brevispinus (at the time, 5,733 ha or 14,166 ac) was within 400 m (1,312 ft) of a well (Service 2006). Such development facilitates human access and discovery by illegal collectors (72 FR 53216, September 18, 2007) (USFWS, 2010).

Stressor: Livestock Grazing and Trampling (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Nearly all S. brevispinus potential habitat on BLM land is leased for grazing. The species range overlaps four BLM grazing allotments. Most of the area is grazed by sheep, either continuously or on a deferred rotation, with some cattle grazing on the western and eastern edges of S. brevispinus potential habitat. Livestock grazing results in S. brevispinus mortality when livestock trample individual cacti (Service 1990; Utah Natural Heritage Program 2006; BLM 2008; 72 FR 53215, September 18, 2007). Overgrazing—the continued heavy grazing beyond the recovery capacity of forage plants (Vallentine 1990)—by domestic livestock degrades western ecosystem functions and structures (Fleischner 1994). Overgrazing can facilitate the establishment of invasive species like cheatgrass (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. Invasive weeds (including Bromus tectorum and Halogeton glomeratus) are prevalent on BLM lands in the range of S. brevispinus cactus and less so on tribal lands where grazing has been concentrated in areas outside of suitable cactus habitat (72 FR 53214, September 18, 2007) (USFWS, 2010).

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals

Narrative: Parasitism by the cactus-borer beetle (Moneilema semipunctatum) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 72 FR 53216, September 18, 2007). Parasitism is identified as a threat to Sclerocactus plants, however additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to S. brevispinus. Another source of mortality is lagomorph and rodent browsing. While there have been numerous observations of Sclerocactus being removed by desert cottontail rabbits (Sylvilagus audubonii) and unknown rodents (CNHP 2010b; BioLogic 2008; Clayton 2006), in subsequent years some of these plants have re-sprouted (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat (USFWS, 2010)

Stressor: Climate Change, Drought, and Impacts to the Vegetative Community (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change is likely to affect long-term survival of native species, including S. brevispinus, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., such as persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of S. brevispinus. While the potential impacts of climate change could be serious, improved projections are needed to better understand this potential threat. S. brevispinus mortality due to drought is well documented (Service 1990; 72 FR 53217, September 18, 2007). Many dead S. brevispinus individuals were observed in the Uinta Basin after the severe drought of 1976 to 1977 (Service 1990). In addition, noxious weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM's efforts to control noxious weeds and restore native vegetation, which is already difficult due to the extreme environment of the Uinta Basin (Service 1990; BLM 2005, 2008) (USFWS, 2010).

Stressor: Pesticides (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: S. brevispinus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as noxious weeds and insect pests (Service 1990). Individual cacti are likely to be directly affected by these chemicals, and indirectly by effects on pollinators or by movement of contaminated soils (Service 1990). However, specifics of the species' pollination biology are currently unquantified (USFWS, 2010)

Stressor: Vulnerability Related to Population Size and Distribution (USFWS, 2010)
Exposure:
Response:
Consequence: Extinction
Narrative: S. brevispinus' small population size and restricted distribution means the species is vulnerable to extinction by natural processes or human disturbance (Ellestrand and Elam 1993; Levin et al. 1996). For example, random events causing population fluctuations or population extirpations become a serious concern when the number of individuals or the geographic distribution of the species is very limited. Similarly, a single human-caused or natural environmental disturbance could destroy the entire population. The species' slow reproductive rate also increases the risk of effects of stochastic events as it is unlikely that the species will be able to rebound quickly (e.g., exhibit a high rate of population growth), even if environmental conditions improved after such an event. Other issues related to this factor include loss of genetic variability, which may reduce a species ability to respond to changing environmental conditions, (Godt et al. 1996) and inbreeding depression, which can decrease fertility and survival rates (Levin et al. 1996). No information exists to indicate that the species' range and population numbers have been significantly larger than they are currently, except for recent documented losses due to oil and gas development and illegal collection (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: We are not aware of any city, county or state laws, ordinances or zoning that provide for protection or conservation of the S. brevispinus or its habitat. Removal, damage, or destruction of plants on private lands is can be allowed through consultation with the Service. Conservation needs of S. brevispinus are addressed through interagency consultation (section 7 requirements) typically between the Service, BLM, and Bureau of Indian Affairs (BIA). Through this process, conservation measures are implemented on a project-by-project basis to minimize the loss of individual cacti from oil and gas activities. These measures include preconstruction cactus surveys and a required buffer around individual cacti. For example, the Castle Peak/Eightmile Flat Oil and Gas Expansion Project Final Environmental Impact Statement included conservation measures to specifically protect S. brevispinus and its habitat (BLM 2005). The BLM also has attempted to establish protected areas for S. brevispinus. The Pariette Wetlands Area of Critical Environmental Concern (ACEC) was established in 1994. The ACEC, intended to provide protection for this species, contains approximately 1,250 ha (3,086 ac) or 8 percent of the potential habitat of S. brevispinus. Management prescriptions for the ACEC state that the BLM will authorize no action in suitable habitat for threatened and endangered species if it would jeopardize the continued existence of the species or result in severe modification of the habitat (BLM 2008). Although the BLM Vernal Field Office Resource Management Plan designated the Pariette Wetlands ACEC as "no surface occupancy" for oil and gas development (BLM 2008), pre-existing lease rights still allow surface disturbance from oil and gas development within the ACEC (BLM 2005). As of November 2009, the ACEC contains one well for approximately every 30 ha (74 ac), with more development planned. The BLM is currently deferring approval of new wells and ancillary facilities located within the Pariette Wetlands ACEC until a master development plan is completed. In addition to the ACEC and project-specific protections such as cactus surveys, we need to establish consistent guidance and Resource

Management Plan designations that provide adequate regulatory mechanisms over the longer term to protect large portions of the range of the S. brevispinus (USFWS, 2010).

Stressor: Invasive and Noxious Weeds (USFWS, 2020)
Exposure:
Response:
Consequence:
Narrative: Invasive species were not considered a threat to Sclerocactus at the time of the listing (44 FR 58868, October 11, 1979), but were identified as a threat in 2010 (USFWS 2010a, b). Increased disturbance from land use activities (oil and gas development, grazing, ORV use) and climate change are likely to facilitate the invasion and spread of invasive species such as cheatgrass (Bromus tectorum), halogeton (Halogeton glomeratus) and Russian thistle (Salsola tragus; Brooks 2003, Masters and Sheley 2001, Brooks and Pyke 2001). Invasive species compete with native plants for resources such as sunlight, soil nutrients, water, pollinators, and space. Invasive species alter plant composition and density in a variety of habitats from forested to desert ecosystems (Di Tomaso 1998, Young et al. 1998, Wilcove et al. 1998, Mack et al. 2000, Levine et al. 2003, Trombulak and Frissell 2000). This competition for resources may indirectly impact Sclerocactus by reducing individual fitness and reproduction, as well as the population by reducing seedling recruitment and population size (Di Tomaso 1998, Young et al. 1998, Wilcove et al. 1998, Mack et al. 2000, Levine et al. 2003, Trombulak and Frissell 2000). The most frequently observed invasive species occurring in Sclerocactus habitat are cheatgrass and flatspine stickseed (Lappula occidentalis; Hornbeck 2018). Monitoring plots recorded cheatgrass in 25 and 57 percent of plots for Pariette cactus and Uinta Basin hookless cactus, respectively (Hornbeck 2018). Flatspine stickseed was recorded in 35 and 22 percent of plots for Pariette cactus and Uinta Basin hookless cactus, respectively (Hornbeck 2018). (USFWS, 2020)

Recovery

Reclassification Criteria:
Recovery Priority Number: 5C

Delisting Criteria:
For Pariette cactus – All four core 2 areas have a stable or increasing growth trend (average lambda (λ) ≥ 0.095) over a minimum period of 10 consecutive years and predictive modeling (using data from a minimum of a 10-year monitoring period) indicates that the likelihood for long-term survival of the metapopulation is at least 95 percent over a 100-year period (USFWS, 2023).

For Pariette cactus – The metapopulation maintains a size distribution that contains individuals in all size classes over a 5-year minimum period and where the largest size class maintains a stasis rate no less than 0.85. Size classes for Pariette cactus are defined as: class 1:<19.7 mm; class 2: 19.7–40 mm; class 3: 40.1–75 mm; and class 4: >75 mm (Hornbeck 2020) (USFWS, 2023).

For Pariette cactus – Genetic diversity across the metapopulation is maintained at levels such that there is a high probability (95 percent) of two core 1 populations persisting over the long term (100 years) within each core 2 area (USFWS, 2023).

For Pariette cactus – Disturbance that contributes to the degradation and loss of habitat (e.g., roads, recreation, livestock) does not exceed established tolerance thresholds for each core 2 area (percent of habitat) (USFWS, 2023).

For Pariette cactus – Protected areas will be formally established by land managers for at least one genetically important population and at least one connectivity corridor (as identified using connectivity analysis) to provide long-term protection from anthropogenic threats. Methods may include but are not limited to ACECs, Resource Management Plan special designations, Tribal resolutions, conservation agreements, and conservation easements (USFWS, 2023).

Recovery Actions:

- Priority 1 Actions 1. Monitor two core 1 areas within each core 2 area for Pariette cactus and eight core 2 areas for Uinta Basin hookless cactus to evaluate short- and long-term population trends across the metapopulation and support predictive modeling. Monitoring should be conducted for a minimum of 10 years (Recovery Criteria 1 and 2). 2. Reduce impacts from livestock, feral horses, and herbivores on a landscape scale (in all subpopulations) through herd management, grazing rotations and rest, and habitat improvements (Recovery Criterion 1). 3. Develop disturbance tolerance thresholds for each core 2 area (Recovery Criterion 4). 4. Formalize conservation measures with partners to be implemented with, and prior to, all surface disturbing projects. Conservation measures may be documented in a memorandum of understanding, resource management plan, conservation agreement, recreation management plan, travel management plan, or similar document (Recovery Criteria 1, 2, 3, 4, and 5). 5. Restore disturbed areas within core habitat so that new surface disturbance is less than the tolerated threshold identified in Recovery Action 3 (Recovery Criteria 1, 2, and 3). 6. Resurvey subsampled areas (targeted and repeat) to update abundance and population estimates (Recovery Criteria 1, 2, 3, 4, and 5) (USFWS, 2023).
- Priority 2 Actions 7. Evaluate current genetic diversity across the species range to identify subpopulations at risk, those needing protections, and those of high importance (Recovery Criterion 2). 8. Conduct a connectivity analysis to identify important gene flow corridors (Recovery Criterion 2). 9. Restore or improve connectivity corridors between core 1 and core 2 areas that are important for maintaining gene flow across the species range and limit new surface disturbance in important existing connectivity corridors (Recovery Criteria 2 and 3) (USFWS, 2023).
- Priority 3 Actions 10. Update disturbance calculations on an annual basis for each core area (Recovery Criterion 3). 11. Develop a predictive model to evaluate the long-term trend and projected survival probability of each species under likely future scenarios, including climate change (Recovery Criteria 1, 2, 3, 4, and 5). 12. Reestablish Sclerocactus individuals on restored sites and monitor effectiveness (Recovery Criteria 1, 2, and 4). 13. Establish areas for permanent protections that provide the greatest benefit towards maintaining the redundancy, representation, and resiliency of the species (Recovery Criteria 1, 2, 3, and 5). 14. Develop and implement management plans for each protected area (Criterion 5) (USFWS, 2023).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We recommend that objective and quantifiable recovery criteria be established for each species, so that concrete goals can be established and progress towards recovery can be quantified. The recovery plans for these species should be

completed in FY2021 as budgets allow. Based on ongoing actions and preliminary results, we recommend the continuation of the range-wide Sclerocactus monitoring program in order to track population trend over a long period of time. Management actions which result in preserving or improving intact habitat, population size class diversity, seedling recruitment, gene flow, and pollinator movement should be a high priority for both species. (USFWS, 2020)

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SPECIES ACCOUNT: *Sclerocactus glaucus* (Colorado hookless Cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/11/1979; Mountain-Prairie Region (Region 6) (USFWS, 2016)

Physical Description

A squat, globular, spiny succulent. Each mature stem is 3-12 cm tall, 4-9 cm wide, although during the driest part of the year the stem may shrink to below ground-level. Central spines are straight (hookless). The plants are inconspicuous except when in flower (April-May), when showy, fragrant, pink to magenta flowers appear at the top of the stem. (NatureServe, 2015)

Taxonomy

The original listing rule for S. glaucus (44 FR 58868, October 11, 1979) included all hookless (straight central spines) Sclerocactus populations in western Colorado and northeastern Utah, and referred to them as S. glaucus per Benson (1966, pp. 50-57; 1982, pp. 728-729). Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993; Welsh et al. 2003), and a reevaluation of the morphological characteristics of S. glaucus have led to separating this species into three distinct species: S. brevispinus, S. glaucus, and S. wetlandicus (Hochstätter 1993; Heil and Porter 2004). The Flora of North America recognizes 15 species in the genus Sclerocactus, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between S. brevispinus and S. wetlandicus, but infer S. glaucus is more closely related to S. parviflorus (Devil's claw cactus) and S. whipplei (Whipple's fishhook cactus). The common name for S. glaucus was changed to Colorado hookless cactus as the species is endemic to western Colorado. S. wetlandicus is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. S. brevispinus is now known as the Pariette cactus as it is limited to the Pariette Draw of the Central Uinta Basin. (USFWS, 2010)

Current Range

Colorado hookless cactus is an endemic plant found in Delta, Montrose, Mesa, and Garfield Counties, Colorado. There are two population centers of Colorado hookless cactus: (1) on alluvial river terraces of the Gunnison River from near Delta, Colorado, to southern Mesa County, Colorado; and (2) on alluvial river terraces of the Colorado River and in the Plateau and Roan Creek drainages in the vicinity of DeBeque, Colorado (Service 1990). (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominately sexual (outcrossing) but can reproduce asexually (NatureServe, 2015)

Lifespan

Adult: 10-20 years (NatureServe, 2010)

Breeding Season

Adult: April to May (NatureServe, 2015)

Reproduction Narrative

Adult: Reproduction is predominately sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantely outcrossing but is marginally self-compatible. Although no long-term demographic data is available, field observations suggest that plants may live for 10-20 years in good conditions (Ellen Mayo, Peggy Lyon pers. comm.) Population size may vary widely between years (Jim Ferguson, pers. comm.). Plants are typically sparsely distributed even in larger populations. Stems may fluctuate in size according to seasonal moisture availability, shrinking below the soil surface in dry times. Predation by a cactus borer beetle has been observed in Colorado populations, and may be very heavy in a localized area. Some herbivory by rodents has also been observed. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert, forest/woodland, shrubland/chaparral, woodland - conifer (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 1200 and 2000 m (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The Colorado hookless catcus is found on exposed, gravel-covered, clay hills, saltbush or sagebrush flats, or pinyon-juniper woodlands at elevations from 1400 to 2000 m (Flora of North America Editorial Committee 2003). Populations occur primarily on alluvial benches along the Colorado and Gunnison Rivers and their tributaries. Sclerocactus glaucus generally occurs on gravelly, or rocky surfaces on river terrace deposits and lower mesa slopes. Exposures vary, but S. glaucus is more abundant on south-facing slopes. Soils are usually coarse, gravelly river alluvium above the river flood plains usually consisting of Mancos shale with volcanic cobbles and pebbles on the surface. Elevations range from 1200-2000 m. Associated vegetation is typically desert scrub dominated by shadscale (Atriplex confertifolia), galleta (Hilaria jamesii), black-sage (Artemisia nova), and Indian rice grass (Stipa hymenoides). Other important species include two similar spherical or cylindrical cactus species, strawberry hedgehog cactus (Echinocereus triglochidiatus var. melanacanthus) and Simpson's pincushion cactus (Pediocactus simpsonii). Other important species in the plant community include the prickly pear cactus (Opuntia polyacantha), winterfat (Krascheninnikovia lanata), yucca (Yucca harrimaniae), snakeweed (Gutierrezia sarothrae), low rabbitbrush (Chrysothamnus viscidiflorus), sand dropseed (Sporobolus cryptandrus), and Salina wildrye (Elymus salinus) (USFWS 1990, Scheck 1994). Fire is not typically characteristic of S. glaucus habitat, but areas with large infestations of cheatgrass (Bromus tectorum) may build up sufficient fuel to carry fire into S. glaucus populations. (NatureServe, 2015). S. glaucus and S. dawsonii are endemic cactus species found

in the Colorado and Gunnison River basins and their tributary canyons in Garfield, Mesa, Montrose, and Delta Counties in western Colorado. The species occur on alluvial benches and colluvial slopes from 4,500 to 7,200 feet (1,372 to 2,195 meters) in semi-arid high elevation desert. S. glaucus occurs in eight analytical units (AUs) in a range that extends from the Grand Valley, through the high desert at the foot of the Grand Mesa, and along the alluvial terraces of the Gunnison River and the Dominguez and Escalante Creek drainages to near Montrose. S. dawsonii occurs in two AUs along the Colorado River from DeBeque downstream toward the Grand Valley and along the Roan and Plateau Creek drainages (USFWS, 2022).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of Sclerocactus glaucus. (NatureServe, 2015)

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Resiliency:

To be resilient, AUs of both species require survivorship and recruitment at rates that are able to sustain AUs with pollinator connectivity between individuals and clusters of plants within the AU. Resilient AUs also contain enough individuals across each life stage (seed, seedling, and mature reproductive adult) to bounce back after experiencing environmental stressors such as intermediate disturbance, occasional drought, or grazing. Finally, individuals in both species of Colorado hookless cactus need certain habitat factors for resiliency. These include shallow exposed sandy or shale soils of sedimentary parent material or gravelly deposits of river alluvium; a semi-arid, high elevation desert climate (1,372-2,195 m) with 8-12 inches rain per year; and a period of deep cold during winter months to facilitate germination the following spring. (USFWS, 2022)

Representation:

Individuals and AUs inhabiting diverse ecological settings and exhibiting genetic or phenological variation add to the level of representation across the species' range. The greater diversity observed in Colorado hookless cactus genetics, habitats, and morphology, the more likely it is to be able to adapt to change over time. (USFWS, 2022)

Redundancy:

Colorado hookless cactus redundancy is influenced by the number of AUs across the landscape. More AUs across the range of Colorado hookless cactus increase the species' ability to withstand catastrophic events. (USFWS, 2022)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

98 (USFWS, 2010). 8 AUs (USFWS, 2022)

Population Size:

>= 103,086 (USFWS, 2022)

Population Narrative:

The species has been documented at 98 element occurrences (EOs) totaling approximately 13,300 individuals (CNHP 2010b). Forty-two of the EOs have not been observed in over 20 years. Over 6,000 additional individuals were located recently in field surveys for a proposed electric transmission line and a proposed oil and gas wastewater evaporation facility north of Delta, Colorado (Bio-Logic 2008; 2009). These newly discovered individuals have not yet been incorporated into the CNHP database. Therefore, by combining the new survey data and the CNHP data, we estimate the total known population of Colorado hookless cactus at over 19,000 plants. (USFWS, 2010). Currently, S. dawsonii has a minimum of 31,867 plants distributed across two highly resilient AUs with a high survival rate and moderate to high habitat conditions across the range of the species. S. glaucus currently has a minimum of 103,086 plants distributed across eight AUs. Seven of the eight AUs are highly resilient; one is ranked moderate. Across their limited ranges, both species of Colorado hookless cactus are relatively abundant, which contribute to the high levels of resiliency in all but one AU. Redundancy for narrow endemic species is inherently limited; however, S. glaucus plants are distributed broadly across the range of the species in eight AUs, providing redundancy throughout its relatively small geographic range. With only two AUs located within a smaller range than S. glaucus, redundancy of S. dawsonii is much lower than that of S. glaucus. S. glaucus's relatively broad distribution and multiple highly resilient AUs make it better able to withstand catastrophic events than S. dawsonii. Representation is comparable among S. glaucus and S. dawsonii (USFWS, 2022).

Threats and Stressors

Stressor: Mineral and energy development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The 1990 Recovery Plan identified threats associated with mineral and energy development including: oil and gas, oil shale and tar sands, sand and gravel quarrying, gold dredging, and building stone collecting and quarrying. A gravel mining project proposed near Whitewater, Colorado, poses a threat to several Colorado hookless cactus individuals (BLM 2010). The BLM recently closed an area where recreational gold panners were causing disturbance in close proximity to a Colorado hookless cactus occurrence (BLM 2009b). Oil and gas development remains a meaningful factor in the long-term conservation of the Colorado hookless cactus. Thirty-six percent of the federally-owned potential habitat approximately 164,000 ac (66,000 ha) is leased for oil and gas development (Service 2010b). Increased surface disturbance from wells, roads and pipelines for oil and gas projects can result in the following impacts to S. and habitat. Oil and gas development fragments and destroys S. habitat (BLM 2005, 2008a). Each well disturbs approximately 1.5 ac (0.6 ha) of surface area (74 FR 47112, September 15, 2009). Increased erosion, soil compaction, and sedimentation can kill cacti (BLM 2005). Cactus seeds can be buried and lost due to erosion runoff from well-field facilities (BLM 2005). Increased surface disturbance increases airborne dust. Dust accumulation on cacti increases tissue temperature and reduces photosynthesis, thus decreasing plant growth, vigor,

and water use efficiency (Farmer 1993; Sharifi et al. 1997). Dust effects can extend up to 300 m from roads (Everett 1980). Energy development requires the addition of access roads in previously undeveloped areas. In most cases, these access roads are open to the public. The ORV trail use increases erosion, fugitive dust, soil compaction, sedimentation, and can crush cactus (Service 1990; BLM 2008a). Human access can result in illegal collection and the direct loss of individual plants (Service 1990; BLM 2005). Oil and gas development increases weed invasions because of the associated surface disturbance. Increased invasive weeds alter the ecological characteristics of cactus habitat, making it less suitable for the species (Service 1990; BLM 2008a).

Stressor: Utility corridors (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: A BLM and Department of Energy designated Westwide Energy Corridor covers 70,142 ac (28,385 ha) of BLM land that is potential habitat for Colorado hookless cactus (Service 2010b; BLM 2008b). The BLM identified preferred corridors to limit the proliferation of additional rights-of-way across the landscape, but utilities are not limited to these corridors (BLM 2008b). Twenty-nine of the species' 98 occurrences are at least partially located within this energy corridor (Service 2010b; BLM 2008b). Specific pipeline and transmission line routes within the energy corridor are not yet identified. The TransColorado (TransCO) gas pipeline resides in this corridor. Many of the 29 aforementioned occurrences were discovered during surveys for this project. The TransCO project resulted in transplantation of approximately 1,200 Colorado hookless cactus individuals. Monitoring documented a 19-percent mortality rate for the 129 monitored individuals between 1999 and 2003 (Bio-Logic 2008). Surveys for a new powerline north of Delta, Colorado (not in the designated energy corridor), located approximately 5,200 Colorado hookless cactus individuals (Bio-Logic 2008). Up to 100 individuals may be transplanted or destroyed during construction of this powerline in 2010 (Bio-Logic 2008). (USFWS, 2010)

Stressor: Invasive species (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Invasive weeds, including Bromus tectorum (cheatgrass) and Halogeton glomeratus (halogeton), are prevalent on BLM and private lands within the range of Colorado hookless cactus (CNHP 2010b). Invasive weeds alter the ecological characteristics of cactus habitat, making it less suitable for the species (Service 1990; BLM 2008a). In addition, invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Several EO records include cheatgrass invasion as a threat, and BLM attributes downward trend at several locations to cheatgrass invasion (CNHP 2010b; BLM 2009a). (USFWS, 2010)

Stressor: Off road vehicle use (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Despite ORV use being common within Colorado hookless cactus habitat, there have been few documented impacts to the plants. Observers documented ORV use as a threat to 3 of the 98 EOs (CNHP 2010b). Additionally, illegal off road driving damaged Colorado hookless

cactus individuals during construction of the Collbran pipeline (WestWater Engineering 2009). The ORV use is expected to increase along with expected human population increases in the region in which Colorado hookless cactus is native and with increasing popularity and availability of improved ORVs. This is expected to result in an increase in damage to Colorado hookless cactus individuals and habitat (Service 1990). (USFWS, 2010)

Stressor: Water development (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The 1990 Recovery Plan identified water development as a threat to the species. It is likely that reservoir and irrigation canal development have impacted Colorado hookless cactus occurrences in the past; however, we have no documentation of those impacts. Two water reservoir projects known as Roan Creek and Sulphur Gulch have been proposed within potential and occupied habitat of Colorado hookless cactus. These potential reservoirs could permanently destroy plants and their habitat through project construction and inundation. After evaluation of numerous alternatives, the Roan Creek and Sulphur Gulch projects are no longer being considered (Bray and Drager pers. comm. 2008; Grand River Consulting Corporation 2009). Since the proposals have been withdrawn, these threats are not imminent. (USFWS, 2010)

Stressor: Collection (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The original listing of the Uinta Basin hookless cactus complex concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age individuals, leaving behind a younger, less reproductively fit population. We are not aware of illegal removal of Sclerocactus in Colorado prior to 2009. Three Colorado hookless cactus individuals were removed illegally in 2009 from sites proposed for a natural gas pipeline and a sewer pipeline in Mesa County, Colorado (Service 2010a; Glenne 2009). It did not appear that these plants were removed by collectors, but rather these were acts of vandalism. Additional damage to cacti occurred during project construction on the same natural gas pipeline (WestWater Engineering 2009). These incidents show that additional development increases risk to cacti of vandalism and removal by increasing human presence in areas previously rarely visited by humans. (USFWS, 2010)

Stressor: Livestock grazing and trampling (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Of the 450,000 ac (182,000 ha) of Colorado hookless cactus potential habitat on Federal lands, approximately 94 percent, 424,000 ac (172,000 ha) falls within grazing allotments. Moderate to heavy domestic livestock grazing has been observed to cause physical damage to Sclerocactus plants through trampling, but we have no evidence to suggest that cattle browse on individual Sclerocactus plants (Service 1990). A study on another federally listed cactus, S. wrightiae, found that cacti density increased more rapidly in a fenced plot excluded from cattle grazing than in an unfenced plot with a reduced cattle stocking rate (Clark and Clark 2007). Overgrazing (the continued heavy grazing beyond the recovery capacity of forage plants) by

domestic livestock can have a negative impact on North American xeric ecosystems (Jones 2000; Vallentine 1990). For example, overgrazing can facilitate the establishment of invasive species like Bromus tectorum (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. (USFWS, 2010)

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Another source of mortality is lagomorph and rodent browsing on Colorado hookless cactus. While there have been numerous observations of S. glaucus individuals being removed by desert cottontail rabbits (Sylvilagus audubonii) and unknown rodents (CNHP 2010b; BioLogic 2008; Clayton 2006), some of these plants have re-sprouted in subsequent years (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat. Parasitism by the cactus-borer beetle (Moneilema semipunctatum) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 74 FR 47112, September 15, 2009). Additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to Colorado hookless cactus. (USFWS, 2010)

Stressor: Herbicides and pesticides (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Colorado hookless cactus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as cheatgrass and crop harming insects (Service 1990). Individual cacti are likely to be directly affected by herbicide use, and indirectly by effects of pesticides on pollinators (Service 1990). However, we cannot fully assess the magnitude of this threat, since the specific species that pollinate Colorado hookless cactus are currently unknown. (USFWS, 2010)

Stressor: Hybridizations (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Extinction due to hybridization, both natural and human influenced, can be a major concern for rare and endangered species (Denver Botanic Gardens 2009b). Colorado hookless cactus may hybridize with S. parviflorus (Heil & Porter 1987; Woodruff 2009; CNHP 2010b). The extent to which hybridization is occurring is unknown. Genetic research investigating this issue is essential for planning management and recovery efforts. The Denver Botanic Gardens has begun collecting floral tissue to examine the population genetic structure within and among the two population centers of Colorado hookless cactus and investigate the potential threat of introgression with S. parviflorus (Denver Botanic Gardens 2009b). (USFWS, 2010)

Stressor: Climate change, drought, and impacts to the vegetative community (USFWS, 2010)
Exposure:
Response:

Consequence:
Narrative: Climate change is likely to affect long-term survival of native species, including Sclerocactus, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979 baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of Colorado hookless cactus. While the potential impacts of climate change could be significant, improved localized projections are needed to better understand this potential threat. In addition, invasive weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM's efforts to control invasive weeds and restore native vegetation, which is already difficult due to the extreme environment of the Colorado and Gunnison River basins (Service 1990; BLM 2005, 2008a). (USFWS, 2010)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:
- Completion of a comprehensive survey throughout the species' range. (USFWS, 2010)
- Surveys also should more accurately delineate the Colorado hookless cactus range relative to other Sclerocactus species. (USFWS, 2010)
- Locate possible population connectivity corridors. (USFWS, 2010)
- Continue ongoing monitoring efforts and expand monitoring to include a larger and more representative sample of occupied sites. (USFWS, 2010)
- Identify sites in urgent need of habitat protection, set protection priorities, and implement protective measures. In the long run, land management agencies should establish formal land management designations to provide for long-term protection of important populations and habitat. (USFWS, 2010)
- Oil and gas leasing and other mineral extraction activities should avoid occupied sites and other important habitat. (USFWS, 2010)
- Develop and implement standard conservation measures to minimize future project and use impacts. (USFWS, 2010)
- Coordinate with land management agencies, project proponents, and other partners early in the planning process to limit direct and indirect impacts of planned activities. (USFWS, 2010)

- Prevent the collection of Colorado hookless cactus plants from natural populations. (USFWS, 2010)
- Resolve the taxonomic status of Colorado hookless cactus regarding the species relationship with S. parviflorus. Secondarily, this study would assess genetic differences between Colorado hookless cactus populations. (USFWS, 2010)
- Continue research into Colorado hookless cactus life history and ecology, including pollinators. (USFWS, 2010)
- Study population dynamics and conduct a population viability analysis. (USFWS, 2010)
- Encourage investigations that project Sclerocactus species' vulnerability and response to climate change. (USFWS, 2010)
- Improve our understanding of livestock and native (e.g., rodent) grazing impacts. (USFWS, 2010)
- Monitor cactus-borer beetle (Moneilema semipunctatum) infestations, and study the relationship of episodic infestations with drought and other environmental factors. (USFWS, 2010)
- Monitor changes in invasive species prevalence and impacts on Colorado hookless cactus. Additionally, continue to explore approaches to minimize the risk posed by invasives and associated remediation actions. (USFWS, 2010)
- Make a final determination on the proposed the taxonomic revision splitting Sclerocactus glaucus into S. brevispinus, S. glaucus, and S. wetlandicus. We expect to make a final determination on this proposal in 2008. (USFWS, 2008)
- Issue a proposed and final rulemaking to reclassify S. brevispinus from threatened to endangered as described in our recent 12-month finding (72 FR 53211, September 18, 2007). (USFWS, 2008)
- Develop a recovery plan for each of the three species. As required by Section 4(f)(1)(B), each recovery plan should incorporate: (i) a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species; (ii) objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this section, that the species be removed from the list; and (iii) estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal. (USFWS, 2008)
- Conduct range-wide inventories for each species. Once completed, continue and improve population monitoring for each species. (USFWS, 2008)

Conservation Measures and Best Management Practices:

- STATUS RECOMMENDATION Standard for Review Section 4 of the Act (16 U.S.C. Section 1533) and its implementing regulations (50 CFR part 424) set forth the procedures for determining whether a species meets the definition of "endangered species" or "threatened species." The Act defines an "endangered species" as a species that is "in danger of extinction throughout all or a significant portion of its range," and a "threatened species" as a species that is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." The Act requires that we determine whether a species meets the definition of an "endangered species" or a "threatened species" because of any of the following factors: (A) The present or threatened destruction, modification, or curtailment of its habitat or range; (B) Overutilization for commercial, recreational, scientific, or educational purposes; (C) Disease or predation; (D) The inadequacy of existing regulatory mechanisms; or (E) Other natural or manmade

factors affecting its continued existence. (USFWS, 2021)

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SPECIES ACCOUNT: *Sclerocactus mesae-verdae* (Mesa Verde cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/29/1979; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

The Mesa Verde cactus stems are usually singular, globose, 3.2-6.5 cm tall (1.5 - 3 in) and of equal diameter; central spine 0 (possibly 1-4); radial spines 8-11, 6-13 mm long (1/4-1/2 in), white, tan, straw or gray; flowers 2 cm in diameter (3/4 in), cream to yellow; fruit green, becoming brown with age and splitting open horizontally; seeds black. In late April a yellow or cream-colored flower blooms on top of the stem. (USFWS, 1984)

Taxonomy

Sclerocactus mesae-verdae and S. wrightiae have several morphological features in common: stem size, shape and color; flower shape and color; fruit dehiscence (not bearing scale leaves); and the ability to retract into the soil during periods of drought. S. mesae-verdae has 0-1 central spines, 8-11 radial spines, cream to yellow flowers with no fragrance, brownish-black seeds, while S. wrightiae has 4-6 central spines, 5-10 radial spines, cream to pink flowers with fragrance, and black seeds. (USFWS, 1984)

Current Range

Occurs only in parts of Montezuma County, Colorado and San Juan County, New Mexico. Mostly on Navajo Indian Reservation lands (Roth, pers. comm., 1998). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 2010)

Lifespan

Adult: ~50 years (USFWS, 2023)

Dependency on Other Individuals or Species

Adult: Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Other common visitors included pleasing fungus beetles (Tritoma sp.) and blister beetles (Epicauta sp.), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993). (USFWS, 2010)

Breeding Season

Adult: Late April to early May (USFWS, 2010)

Key Resources Needed for Breeding

Adult: Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). (USFWS, 2010)

Reproduction Narrative

Adult: Sclerocactus mesae-verdae is a perennial desert plant that grows slowly and has a lifespan of approximately 20 years (Colorado Natural Areas Program 2005). Stems begin producing flowers when they are about 2 cm (0.8 in) in diameter or about 8 years old and begin to flower each year after reaching 4 cm (1.6 in) in diameter (New Mexico State Forestry Division 2007). Flowers are diurnal, bloom from late April into early May, and open daily for up to five days (Heil and Porter 1994). Flowers possess both male and female organs (hermaphroditic) indicating self-compatibility, yet Heil and Porter (1994) suggest that self-fertilization rarely is found in the genus Sclerocactus. Tepedino (1998) found that a single plant can self-fertilize (selfing) using pollen from another flower on the same plant (geitonogamy) and produce viable seed, but not pollen from the same flower (autogamy). However, 50 percent less seed is produced from self-compatible fertilization when compared to the pollen donor coming from a flower on a nearby plant (xenogamy or outcrossing) (Tepedino 1998). Pollen grain collected from the field averaged 91 percent viability (Cully et al. 1993) and the most frequent visitors and potential pollinators were small, solitary bees of the family Halictidae (Cully et al. 1993; Heil and Porter 1994; Colorado Natural Areas Program 2005; Navajo Nation Heritage Program 2004). Other common visitors included pleasing fungus beetles (Tritoma sp.) and blister beetles (Epicauta sp.), but it is still not known which insects are the effective pollinators for this cactus (Cully et al. 1993). Repeated freezing and thawing (vernalization), seed coat scarification, and the proper temperature and moisture are required for successful germination (Service 1984). Seed dispersal distance and seed bank sampling found a total seed load around mature plants averaging 200 seeds within a 1 meter (m) (3.3 feet [ft]) radius with 80 percent of the seeds 0 - 3 cm (0 - 1 in) deep in the soil (Cully et al. 1993). Mesa Verde cactus, or Whoosh Diikoozih (O'Kane et al. 2022, p. 5), is a perennial desert plant that grows slowly and has an estimated lifespan of at least 50 years (Coles et al. 2012, p. 313). Mesa Verde cactus can reach maturity within 2 to 3 years and can reach a reproductive size in 7 to 11 years (Coles et al. 2012, p. 313). The Navajo Natural Heritage Program found during monitoring that stems lived an average of 4.33 years, however 27 stems (out of 270 stems) survived the entire study (2008-2019; 11 years) (USFWS, 2023)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Open sunny areas (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Restricted to dry exposed hills and mesas at elevations about 1,400 to 2,000 m; sparsely vegetated areas (USFWS, 2010; NatureServe, 2015)

Environmental Specificity

Adult: Medium (USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Moderate (USFWS, 2010)

Habitat Narrative

Adult: Sclerocactus mesae-verdae are restricted to sparsely vegetated badlands of clay loam soils derived from upper Cretaceous Mancos shale in Colorado, and Mancos and Fruitland shale in New Mexico (Service 1984). Populations are located in a narrow strip of land between Cortez, Colorado, and Sheep Springs, New Mexico, at elevations ranging from 1,400 to 2,000 m (4,600 - 6,560 ft) (Heil and Porter 1994; Coles and Naumann 2003). These formations erode easily, forming low, rolling hills where plants are found on hilltops and benches, but less so in basins or swales (Cully et al. 1993; Coles and Naumann 2003). The soils are sodic (high alkalinity; pH 7.5 to 8), gypsiferous (poor permeability), and have shrink-swell tendencies which make harsh sites for plant growth (Potter et al. 1985). However, during severe hot or cold dry periods, individual plants shrink and retract back into soils which can minimize desiccation or dehydration (Heil and Porter 1994). Colorado State University soil lab results on Colorado Natural Areas Program plots (2001) revealed clay and silty clay loams in texture, with low water permeability. Sodium, calcium, selenium and iron levels are elevated, while organic matter, phosphate and nitrate levels are low. Cracks in the clay soil, where the seeds fall and may germinate, are apparently an important part of the plant's microhabitat. Soils are typically high in selenite. Vegetative associates, though low in total percent ground cover (5 to 18 percent), include Atriplex cuneata (valley saltbush) and A. corrugata (mat saltbush) in New Mexico, and A. corrugata, A. confertifolia (shadscale saltbush), A. gardneri (Gardner's saltbush), and Artemisia spinescens (bud sagebrush) in Colorado (Cully et al. 1993; Coles and Naumann 2003). In both states, A. corrugata was consistently found to be the dominant shrub.(USFWS, 2010; NatureServe, 2015)

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2010)

Dispersal/Migration Narrative

Adult: Harvester ants (Pogonomyrmex sp.) and erosional processes (rain) are the most effective short-range seed dispersers; whereas, wind may be more important to long-range dispersal (Cully et al. 1993; Rojas-Arechiga and Vasquez-Yanes 2000). Seed predation is well known in desert areas with frugivores (fruit eaters) being another type of important dispersal agent. Mainly rodents, but also birds, lizards, and some mammals prey on fruits and seeds (Rojas-Arechiga and Vasquez-Yanes 2000). No long-range dispersal was observed by rodents or birds for this species (Cully et al. 1993; Colorado Natural Areas Program 2005; Navajo Natural Heritage Program 2005). (USFWS, 2010)

Population Information and Trends

Population Trends:

Long-term trends are unknown but short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Population Growth Rate:

Slow growth and reproduce success rate (NatureServe, 2015)

Number of Populations:

78 (NatureServe, 2015)

Population Size:

10,000 individuals (NatureServe, 2015)

Population Narrative:

Slow growth and low reproductive success rate; the taking of a few plants can deplete/extirpate a population. There is insufficient data to characterize long-term population trends but short-term trends indicate a decline of 10-30%. Approximately 2000 individuals have been documented in element occurrence records (CNHP 2012, NHNM 2003), although the species is estimated to be represented by as many as 10,000 individuals (Coles 2003). A total of 78 occurrences have been documented, 22 in Colorado and 56 in New Mexico (CNHP 2012, NHNM 2003). Twenty of the occurrences report less than 10 individuals each. (NatureServe, 2015). Mesa Verde cactus is not distributed continuously throughout its range, distribution is instead sporadic and widely scattered. Mesa Verde cactus density within populations is low, rarely exceeding one plant per 10 square meters (108 square feet) (Coles et al. 2012, p. 312). Of the known Mesa Verde cactus populations, at least 80 percent of these occur on Navajo Nation lands, 15 percent on Ute Mountain Ute lands, and 5 percent on small blocks of Bureau of Land Management and New Mexico State trust lands (NMSFD 2020b, p. 2). Mesa Verde cactus are now known to occupy private land (BOR 2022, p. 18). At this time, not all potentially suitable habitat for Mesa Verde cactus has been surveyed (USFWS, 2023).

Threats and Stressors

Stressor: Highway construction and right-of-ways for transmission lines (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The Navajo Nation and BLM have consulted with the Service for various projects that have taken place or are planned to occur in areas with occupied or suitable habitat for S. mesae-verdae. We provide a list of consultations in order to convey the number and diversity of projects and to acknowledge the continuing compliance of the Navajo Nation and BLM with accounting for rare species. In each case, however, after the Service provided non-jeopardy opinions, we did not receive any further information regarding implementation of conservation measures, including post-construction surveys or progress reports. To ensure that the conservation measures are implemented and effective, and to apply adaptive management, if needed, to modify measures to assist the cactus, providing documentation of the outcome of these projects and other monitoring data would be very beneficial to the Service. By sharing information about the effects of projects, all parties managing S. mesae-verdae can be informed of what conditions are most favorable for this cactus and what conservation measures are the most worthwhile for promoting this species' recovery and moving toward delisting. There is a

need for a S. mesae-verdae multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. (USFWS, 2010)

Stressor: Off-highway vehicles (OHVs) (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The 1984 recovery plan correctly anticipated that OHV use would be one of the greatest human-caused threats to S. mesae-verdae. The use of OHVs appears to have increased within the Navajo Nation (Roth 2009, pers. comm.) and on BLM lands ((Jamison 2009, pers. comm.). This increase is most likely due to the recent energy boom and the resultant population boom within San Juan County; a 55 percent increase in population from 1980 to 2006 (http://wrdc.usu.edu/htm/publications/). National all-terrain and off-highway vehicles retail sales from 1993-2003 show a dramatic increase from 2,920 total vehicles sold in 1993 to a total of 8,010 vehicles sold by 2003 (Cordell et al. 2005). However, the perception of increased OHV traffic may be more of an issue of unmanaged/unregulated use where one vehicle could cause extensive and severe habitat damage with one trip through closed areas. When a vehicle runs over a cactus, the growing tip is often damaged resulting in a failure to flower and set seed as well as an increased vulnerability to desiccation, herbivory, and pathogens. Cacti can also be directly uprooted or irreversibly damaged from OHVs or any other form of forceful contact. In addition to these direct impacts to the cactus, indirect effects from OHV riding also occur such as damage or destruction of annual and perennial plants, destruction of fragile soil crusts, soil erosion and compaction, alteration of drainage patterns, formation of dust, and proliferation of weeds (Brooks 2009; Lei 2009). Erosion and denuding of plants on dry soils from unauthorized OHV use changes soil properties and alters the hydrological dynamics of an area, with impacts spanning from the microhabitat to the landscape scale. These factors increase run-off and decrease the infiltration of precipitation into soils, further diminishing water storage and accessibility to plant roots. Off-highway vehicle activity can also disturb fragile cyanobacterial-lichen soil crusts, a dominant source of nitrogen in desert ecosystems (Belnap 1996). Belnap (1996) showed that anthropogenic surface disturbances may have serious implications for nitrogen budgets in cold-desert ecosystems similar to those occupied by S. mesae-verdae. Soil crusts also appear to be an important source of water for plants, as crusts were shown to have 53 percent greater volumetric water content than bare soils during the late fall when winter annuals are becoming established (DeFalco et al. 2001). Once the soil crusts are disturbed, non-native plants may colonize, become established, and outcompete native perennial and annual plant species (DeFalco et al. 2001). Surface disturbance from OHV activity can cause erosion and large amounts of dust to be discharged into the air. Recent studies addressing surface dust impacts on gas exchanges of desert shrubs showed that plants encrusted by dust have reduced photosynthesis and decreased water-use efficiency, which may decrease primary production during seasons when photosynthesis occurs (Wijayratne et al. 2005; Sharifi et al. 1997). Sharifi et al. (1997) also showed reduction in maximum leaf conductance, transpiration, and water-use efficiency due to dust. These effects may impact desert plants including S. mesae-verdae. Impacts from constant OHV use, causing soil, vegetation, and hydrological disturbances, have the capacity to compound over time, particularly if the source of OHV impacts is located high in a drainage (Brooks and Lair 2005). Repeated OHV trail use leads to new routes that are not included in road databases (Brooks and Lair 2009). As a result, continual unauthorized OHV use, especially off-trail riding, can create conditions less and less supportive for a habitat specialist such as this cactus species. Furthermore, reduced moisture availability and ground cover from

OHV use can interact with other variables such as climate change or grazing, exacerbating drying conditions an already arid system. (USFWS, 2010)

Stressor: Coal mining (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: About 90 percent of known S. mesae-verdae habitat occurs in areas that lack coal reserves (Parker et al. 1977). The 1984 recovery plan reported that no coal mining was being actively pursued within occupied habitat, although several strip mining operations were within a few miles of the Waterflow cactus population (Service 1984). This cactus population was the only one known growing on the coal-bearing Fruitland formation (Service 1984). We are not aware of any effects resulting from coal mining on this species (Sivinski 2000). Thus, we believe that coal mining is not currently a threat and is not likely to threaten the species in the foreseeable future. (USFWS, 2010)

Stressor: Oil and gas exploration and production (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: About 70 percent of the known occupied S. mesae-verdae habitat is located on Navajo Nation lands. Navajo Nation lands contain significant deposits of coal, oil, and natural gas. Development of energy resources in the Four Corners Basin continues to increase (Energy, Minerals, and Natural Resources Department 2008). The Fruitland Coal formation of the San Juan Basin is the largest coal bed methane producer in the United States (Energy, Minerals, and Natural Resources Department 2008). These resources occur subsurface in ancient marine shale layers, primarily Fruitland and Mancos layers, which coincide with S. mesae-verdae habitat. Nearly all known cactus habitat has the potential to be affected by natural gas or oil exploration and development. Another mineral, a decomposed type of coal (humate), is also found under much of S. mesae-verdae habitat (Colorado Natural Areas Program 2004). Humate is used as a soil conditioner and additive to drilling mud which increases the potential for development. About 12.1 billion tons of humate occur within the San Juan Basin (McLemore et al. 2002). Ground disturbing impacts from these activities include the construction and maintenance of pipelines, power lines, and associated roads; the total clearing of all vegetation on an average of three acres for every oil or gas well pad and associated facilities; and associated commercial and residential development. These activities lead to long-term degradation, fragmentation, or loss of habitat, with impacts to S. mesae-verdae similar to those described above in the OHV section. Most S. mesae-verdae habitat occurs on the Mancos Formation, with the Rattlesnake, Shiprock-Gallup, Horseshoe-Gallup, and Hogback oil fields located within high quality habitat. Destruction of cactus habitat from these oil fields appears to be extensive (Roth 2008, pers. comm.); however, data quantifying the size of each oil field, number of cactus mortalities, and leasing of other areas for associated activities are not available. (USFWS, 2010)

Stressor: Commercial and residential development (USFWS, 2010)
Exposure:
Response:
Consequence:

Narrative: Commercial and residential development threatens S. mesae-verdae on private and Tribal lands (Service 2009). Since the species was listed, cactus habitat has been increasingly impacted from urban development on Navajo Nation lands (Navajo Natural Heritage Program 2004). Urban development is not allowed within a BLM ACEC or on New Mexico State trust lands. The status of urban development on Ute Mountain Ute lands regarding this cactus is unknown at this time. Impacts from urban development include habitat loss, fragmentation, and degradation, along with other factors relating to soil, vegetation, and hydrologic disturbances described in more detail in the off-highway vehicles section above. These impacts not only directly damage cacti, but also can make occupied and potentially usable habitat inhospitable to S. mesae-verdae and result in the decline of individuals and populations. Urban development, including homes, roads, power lines, pipelines, and waterlines; increased recreational activities, including use of OHVs; and commercial facilities have expanded in the proximity of Shiprock. In an effort to off-set the Navajo fairground project interfacing with the cactus, the Northern Navajo Fairground Conservation Area was established in 2001 to use for transplanting cacti that otherwise would be destroyed by the construction of the fairground. However, it is unknown at this time if signs and fences are in place to protect this area. (USFWS, 2010)

Stressor: Livestock grazing and trampling (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: The 1984 Recovery Plan (Service) stated that livestock grazing was not believed to be a significant threat. Since that time, nearly all monitoring has documented disturbance of S. mesae-verdae by livestock. Livestock grazing occurs throughout the range of the cactus, and impacts from trampling, such as uprooted cacti, partially or entirely crushed cacti, and soil disturbance immediately adjacent to cactus individuals are regularly observed (Ecosphere Environmental Services 1985). Cattle have also been observed eating S. mesae-verdae (Service 1984; Ecosphere Environmental Services 1985). Livestock grazing continues to be permitted by the BLM within the Hogback ACEC (Bureau of Land Management 2003b). Navajo Nation staff noted heavy sheep and cattle grazing at the Sheep Springs population that historically supported S. mesae-verdae prior to 2004 (Navajo Natural Heritage Program 2004), but now appears to be extirpated (Roth 2008, pers. comm.). Three additional occupied areas on Tribal land were observed to have extensive livestock damage (Navajo Natural Heritage Program 2004). In Colorado, livestock trampling was also documented and believed to be the primary source of cactus mortality in 2005 (Colorado Natural Areas Program 2005). The 1984 Recovery Plan reported that when livestock are fenced in cactus habitat, trampling of the species could occur. High intensity grazing associated with fenced private or Tribal residences is likely to result in the permanent loss of cacti through trampling and soil compaction (Service 2009). On larger fenced acres, ranchers drive their trucks and OHVs off-road, tracking or herding their livestock (Jamison 2009, pers. comm.). Likewise, during capture of feral horse herds on the Navajo Nation, soils have become compacted within S. mesae-verdae habitat (Service 2009). Based on the increase in habitat degradation due to livestock trampling, whether it be compacted soils or vegetation displacement resulting in increased soil erosion and dust formation, we believe that livestock grazing and trampling has become a moderate threat to this species for the foreseeable future. (USFWS, 2010)

Stressor: Collectors (USFWS, 2010)
Exposure:

Response:
Consequence:
Narrative: Cacti are desirable plants whose wild populations in the U.S. and Mexico have been subject to illegal collection and trade (Robbins 2003). Some cactus hobbyists, known as cactophiles, are well known for their passion and interest in rare cacti. Many of these collectors have illegally obtained certain species for their private collections (Robbins 2003). In summary, illegal collection leads to the direct loss of plants and has threatened some S. mesae-verdae populations. Cactus collecting will probably continue at some level into the foreseeable future, but such activities are difficult to document and we have not discovered any new information to suggest that cactus theft is increasing (CITES 2000; Robbins 2003; Martin 2009). Although illegal collection of S. mesae-verdae was considered a significant threat at the time of listing and during the development of the Recovery Plan, as evidenced by the second recovery criterion which directly addresses this threat, collecting appears to have decreased since the publishing of the Recovery Plan and is now considered a minor threat to the species for the foreseeable future. (USFWS, 2010)

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: All Sclerocactus are susceptible to disease and predation, but only predation has been observed in this species. The longhorn cactus beetle (Moneilema semipunctatum) normally feeds upon Opuntia spp. However, during the 20022003 period of severe drought, the longhorn cactus beetle fed upon S. mesaeverdae and substantially reduced all of the monitored populations. Although the longhorn cactus beetle is a native species and S. mesae-verdae has likely evolved with it, this beetle has the potential to cause serious mortality in the foreseeable future with periodic atypical population eruptions. Native to the Great Plains and Intermountain West, a migratory, noctuid moth, the army cutworm (Euxoa spp), destroyed many S. mesae-verdae in the BLM Hogback ACEC study area during the drought of 2002-2003 (Bureau of Land Management 2003b). Numerous cacti also were reported killed by the army cutworm on Navajo Nation land (Roth 2008, pers. comm.). Since this insect is generally associated with agricultural crops which are found nearby BLM and Navajo Nation lands, but will also consume native plants, particularly grasses, the threat is still substantial. In 2003, a third type of cactus predator was observed in the Colorado (Navajo Natural Heritage Program 2004). Unfortunately, the identity of the predator was not determined, but the effects to the plant appear to be similar to those from the longhorn cactus beetle (Navajo Natural Heritage Program 2004). The Service believes that insect predators can be an ongoing, yet minor threat to S. mesae-verdae. However, during atypical drought episodes, the threat from these predators can be severe into the foreseeable future. (USFWS, 2010)

Stressor: Pesticide use (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Pesticides are considered a potential threat because they could directly harm a plant, but also could indirectly kill pollinators of S. mesae-verdae or their host plants (Service 1984). Herbicides are commonly used for noxious weed control, but no documentation has been provided on herbicide application occurring, and whether any S. mesae-verdae populations have

been directly or indirectly affected. On the other hand, agricultural use of pesticides has been reported on nearby BLM lands. Pesticides, particularly insecticides, are linked to bee declines (Kearns et al 1998; Kremen et al. 2002; National Academy of Sciences 2007), with the abundance and diversity of wild bee communities negatively correlated with increasingly intensive chemical applications of pesticides (Tuell and Isaacs 2010). Although the toxicity of pesticides to pollinators is challenging to quantify in a field setting and varies depending on the chemistry, quantity applied, degree of contact, area treated, and seasonal timing (Mineau et al. 2008; Tuell and Isaacs 2010), some pesticides cause immediate mortality to bees if applied upon crops while bees are actively foraging (Johansen 1977). Both wild and honey bee (Apis mellifera) declines have been found in areas adjacent to sprayed fields, suggesting a wider spatial impact to the pollinator community than just a targeted area (Kevan 1975; Kevan et al. 1990). Furthermore, depending on the seasonal timing of pesticide application, effects to pollinator communities may be chronic and cumulative, yet difficult to assess due to the different phenologies and nesting situations of pollinator species (Desneaux et al. 2007; Tuell and Isaacs 2010). Pesticide application, particularly aerial spraying, occurs in the local agricultural areas to control crop pests, including army cutworms (Euxoa spp). Most of the S. mesae-verdae populations are miles away and would not be impacted by drift (Sivinski 2000). However, a few cactus populations are situated near agricultural areas, such as the Waterflow population, which is close to an apple orchard and alfalfa field, yet it has been successfully setting fruit until the severe drought of 2002-2003. Due to the lack of information, we are uncertain whether pesticides directly or indirectly affect the survival of S. mesae-verdae. Thus, we do not consider pesticides to be a threat to this species in the foreseeable future. (USFWS, 2010)

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Based on the unequivocal evidence of warming of the earth's climate from observations of increases in average global air and ocean temperatures, widespread melting of glaciers and polar ice caps, and rising sea levels recorded in the Intergovernmental Panel on Climate Change Report (IPCC 2007), climate change is now a consideration for Federal agency analysis (GAO 2007). The earth's surface has warmed by an average of 0.74 º C (1.3 º F) during the 20th century (IPCC 2007). The IPCC (2007) projects that there will very likely be an increase in the frequency of hot extremes, heat waves, and heavy precipitation events as a result of climate change. Increases in predatory insects are also predicted with climate change (Enquist and Gori 2008). This was documented for S. mesae-verdae during the drought of 2002-2003 with the unusual and extensive invasion of the longhorn cactus beetle and the army cutworm. The drought combined with concurrent insect infestations significantly reduced S. mesae-verdae populations and recovery has been extremely slow. Sclerocactus mesae-verdae is likely to have experienced and rebounded from periods of drought and cycles of insect predation in the past. However, should substantial climate change materialize with increased severity and frequency of drought, it would likely reduce the long-term survivorship of this species. Since the documented decline of S. mesae-verdae was concurrent with the drought of the early 2000s, the Service believes that climate change is a severe threat to this species in the foreseeable future. (USFWS, 2010)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 11C

Delisting Criteria:
1. Establish at least two restricted use areas for selected portions of S. mesaeverdae habitat on the Navajo Indian Reservation and on Bureau of Land Management (BLM) administered lands. (USFWS, 2010)

2. Provide S. mesae-verdae stock to trade outlets to help relieve the black market demand through the addition of 10,000 plants per year to commercial nurseries for 5 years. (USFWS, 2010)

Recovery Actions:
- Major actions listed in the recovery plan include species monitoring, management, and protection of the five known populations; establishment of at least two (additional) areas of restricted use; surveys of all potential species' habitat; development of a commercial artificial propagation program; and research into the distribution, population biology, and ecology of this species. (USFWS, 2010)
- Revise the recovery plan for this species to incorporate new information on biology, ecology, threats, and management recommendations. Objective and measurable recovery criteria for down and delisting of the species should be developed which addresses all listing factors relevant to this species. (USFWS, 2010)
- Recommend more stringent off-highway vehicle use restrictions and stronger enforcement of OHV laws in known and potential cacti habitat. (USFWS, 2010)
- Develop a S. mesae-verdae multi-agency working group to share and disseminate information regarding this listed species to promote education, protection, and recovery. (USFWS, 2010)
- Develop standardized survey and monitoring protocols for this species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. (USFWS, 2010)
- Develop a mitigation banking requirement (a system whereby project proponents pay for plants to be preserved in an area suitable for their preservation as mitigation for losses incurred during projects). (USFWS, 2010)
- Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. (USFWS, 2010)
- Provide legally grown seeds and plants of S. mesae-verdae to the commercial succulent trade, but law enforcement must remain vigilant against the theft of cacti throughout its range. (USFWS, 2010)
- Provide viable S. mesae-verdae seeds to a seed bank operating under the Center for Plant Conservation guidelines. (USFWS, 2010)
- Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to more clearly define the vulnerable life history stages of this species. (USFWS, 2010)

- Determine microhabitat needs of this species (“nurse” plants, pollinators, precipitation needs - amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. (USFWS, 2010)
- Collect data on the biology, demographics, ecology, and movements of the longhorn cactus beetle and the army cutworm to determine their long-term significance as predators of this species. (USFWS, 2010)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • If possible given workloads, conduct a Species Status Assessment to inform the next fiveyear review and to guide the development of a revised recovery plan to reflect current number of populations, population status and demographics, and status of threats. • We recommend stronger enforcement of off-highway vehicle laws in known and potential cacti habitat. • Conduct additional research on taxonomy and genetics of the Mesa Verde cactus across the range of the species. • Finalize species range map and continue to survey areas within the species’ revised range to verify the presence or absence of individuals and suitable habitat. • Develop a Mesa Verde cactus multi-agency working group to improve collaboration, discuss annual monitoring results, and to promote protection and recovery. • Develop or adopt standardized survey and monitoring protocols range-wide for this species to be conducted annually by well trained personnel. Continue monitoring of known sites as well as adding new sites to provide a robust dataset for long-term trend analysis. • Implement and monitor new transplant projects with experimental manipulations (watering, shading, planting depth, etc.) and controls to determine required establishment needs. • Collect data on seed dispersal and growth past the germination stage, timing of seed set, and seedling establishment to clearly define the vulnerable life history stages of this species. • Determine microhabitat needs of this species (“nurse” plants, pollinators, precipitation needs - amount and timing, slope and aspect requirements, disturbance patterns, etc.) to further quantify potential habitat for a transplant and mitigation site. • Collect data on the biology, demographics, ecology, and movements of the longhorn cactus beetle and the army cutworm to determine their long-term significance as predators of this species. • Establish additional conservation areas for the Mesa Verde cactus. • Establish an off-site conservation program to develop captive propagation techniques that follow the Center for Plant Conservation best management practices. Conduct studies to evaluate the effectiveness of seed germination and seedling establishment. • Conduct studies on the reproductive biology of Mesa Verde cactus, including pollination, seed development, seed dispersal, and inbreeding depression. • Conduct additional studies on predation, impacts of invasive species to different life stages, and other emerging threats (USFWS, 2023).

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SPECIES ACCOUNT: *Sclerocactus wetlandicus* (Uinta Basin hookless cactus)

Species Taxonomic and Listing Information

Listing Status: Threatened; 09/15/2009; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

S. wetlandicus is a barrel-shaped cactus that ranges from 4 to 18 centimeters (cm) (1.5 to 7 inches (in.)) tall, with exceptional plants up to 30 cm (12 in.) tall. The stems have typically 12 to 15 ribs that extend from the ground to the tip of the plant. Along the ribs are areoles (small, cushion-like areas) with hooked spines radiating out (Heil and Porter 2004). There are two types of spines, radial and central, defined by the size and position on the plant (see Figure 1) (74 FR 47112, September 15, 2009). The 6 to 14 radial spines are located around the margin of the areole, extending in a plane parallel to the body of the plant. The radial spines are white or gray to light brown, and are 6 to 20 mm (0.24 to 0.8 in.) long. The one to five central spines (usually three) are 15 to 30 mm (0.5 to 2.0 in.) long, are generally longer than radial spines, and extend from the center of the areole. The central spines include abaxial and lateral forms. Abaxial spines are typically single and are noticeably bent at an angle usually less than 90 degrees. Lateral spines are usually present in pairs on either side of the abaxial spine, but are more or less straight and diverge from the abaxial spine at an acute angle (usually 20 to 50 degrees). The funnel-shaped flowers usually have pink to violet tepals (petal-like flower parts not differentiated into petals and sepals) with yellow stamens (the male reproductive organ of the flower), and are 2 to 5 cm (0.8 to 2 in.) long and 2 to 5 cm (0.8 to 2 in.) in diameter (74 FR 47112, September 15, 2009). The fruit is short, barrel-shaped, reddish or reddish grey when ripe, 7 to 12 mm (0.3 to 0.5 in.) wide, and 9 to 25 mm (0.35 to 1.0 in.) long (USFWS, 2010).

Taxonomy

The original listing rule for S. glaucus (44 FR 58868, October 11, 1979) included all hookless (straight central spines) Sclerocactus populations in western Colorado and northeastern Utah, and referred to them as S. glaucus per Benson (1966, pp. 50-57; 1982, pp. 728-729). This taxonomic classification is not supported by the results of more recent genetic and morphological research. Genetic studies (Porter et al. 2000), common garden experiments (Hochstätter 1993b; Welsh et al. 2003), and a reevaluation of the morphological characteristics of S. glaucus have led to separating this species into three distinct species: S. brevispinus, S. glaucus, and S. wetlandicus (Hochstätter 1993b; Heil and Porter 2004). The Flora of North America recognizes 15 species in the genus Sclerocactus, including these 3 species (Heil and Porter 2004). Comparative DNA sequences (Porter et al. 2000) infer common ancestry between S. brevispinus and S. wetlandicus, but infer S. glaucus is more closely related to S. parviflorus (Devil's claw cactus) and S. whipplei (Whipple's fishhook cactus). The common name for S. glaucus was changed to Colorado hookless cactus as the species is endemic to western Colorado. S. wetlandicus is now known as the Uinta Basin hookless cactus as this species occurs across Utah's Uinta Basin. S. brevispinus is now known as the Pariette cactus as it is limited to the Pariette Draw of the central Uinta Basin. The Uinta Basin hookless cactus complex will be used to refer to the combination of all three species previously listed as a single entity (USFWS, 2010).

Current Range

Known only from Duchesne and Uintah counties, Utah (Flora of North America Editorial Committee (2003).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Predominately insect pollinated (surrogate S. glaucus information) (USFWS, 2007)

Breeding Season

Adult: Flowering occurs in April-May, and fruits mature in May-June (surrogate S. glaucus information) (NatureServe, 2015).

Reproduction Narrative

Adult: Reproduction is predominantly sexual, although individuals may sprout multiple stems. Flowering occurs in April-May, and fruits mature in May-June. The species appears to be predominantely outcrossing but is marginally self-compatible. Ants and gravity appear to be the primary dispersal mechanisms (Peggy Lyon pers comm. 1998). Seed dispersal may be a limiting factor in the distribution of Sclerocactus glaucus (NatureServe, 2015). Information from S. glaucus is being used a surrogate information for S. wetlandicus due to the species similiarities and based on the following quote 'Because we lack life history data specific to S. wetlandicus, we have included life history data for S. glaucus, which should correlate to characteristics for S. wetlandicus' USFWS, 2010. Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015). The species' life history is poorly known, but it is thought to be a longlived perennial usually flowering after 3 or 4 years. A broad assemblage of native bees, and possibly other insects including ants and beetles, pollinates S. brevispinus (USFWS 1990, p. 7) (USFWS, 2007).

Habitat Type

Adult: Salt desert shrub (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred form NatureServe, 2015)

Site Fidelity

Adult: High (inferred form NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits salt desert shrub communities and pinon-juniper woodlands on river benches, valley slopes, and rolling hills (Franklin 2005). Gravel-covered clay hills, desert

grasslands, saltbush, and rabbitbrush flats (Flora of North America Editorial Committee 2003). (NatureServe, 2015). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the species habitat requirements of the species and the relatively small geographic area this species inhabits.

Dispersal/Migration

Dispersal

Adult: Believed to be dispersed by heavy down-pours (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Believed to be dispersed by heavy down-pours (Tepedino et al. 2010).; ABIOTIC; Water; (NatureServe, 2015)

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

6 - 80 (NatureServe, 2015)

Population Narrative:

Approximately 8 occurrences observed since 1989 and 17 others last observed earlier (UTNHP 2009). (NatureServe, 2015). We do not have long-term status or trend population (USFWS, 2010). Low resiliency, redundancy and representation are inferred based on the relatively low number of known populations and the small geographic area this species is known to inhabit. data for S. wetlandicus (USFWS, 2010).

Threats and Stressors

Stressor: Oil and Gas Development and Associated Impacts (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The BLM is monitoring S. wetlandicus and neighboring Sclerocactus species, including impacts associated with oil and gas development. Initial results show that there may be impacts from oil and gas development (i.e., roads and well pads) on the survival and reproductive success of S. brevispinus (72 FR 53215, September 18, 2007), and similar effects could be expected for S. wetlandicus (USFWS, 2010).

Stressor: Collection (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Illegal collection is a significant threat to S. wetlandicus. The original listing of S. glaucus concluded that the cactus is prized among collectors and threatened by unregulated commercial trade (44 FR 58869, October 11, 1979). Collectors prefer larger, reproductive age

individuals, leaving behind a younger, less reproductive population. Approximately 40 percent of the potential habitat of S. wetlandicus is within 400 meters (1,312 feet) of a well (Service 2009). Such development facilitates human access and discovery by illegal collectors (72 FR 53216, September 18, 2007) (USFWS, 2010).

Stressor: Livestock Grazing and Trampling (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: A majority of S. wetlandicus potential habitat on BLM land is leased for grazing. At least 28 grazing allotments overlap with S. wetlandicus potential habitat, with both cattle and sheep grazing continuously and on deferred rotation. Livestock grazing results in S. wetlandicus mortality when livestock trample individual cacti (Service 1990; Utah Natural Heritage Program 2006; BLM 2008; 72 FR 53215, September 18, 2007). Overgrazing—the continued heavy grazing beyond the recovery capacity of forage plants (Vallentine 1990) - by domestic livestock degrades western ecosystem functions and structures (Fleischner 1994). Overgrazing can facilitate the establishment of invasive species like cheatgrass (Masters and Sheley 2001), which are difficult to eradicate and tend to outcompete native vegetation, including cacti. Invasive weeds (including Bromus tectorum and Halogeton glomeratus) are prevalent on BLM lands in the range of S. wetlandicus cactus and less so on tribal lands where grazing has been concentrated in areas outside of suitable cactus habitat (72 FR 53214, September 18, 2007) (USFWS, 2010).

Stressor: Predation (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Parasitism by the cactus-borer beetle (Moneilema semipunctatum) is a significant but localized source of mortality to all Sclerocactus species on the Colorado Plateau, especially in larger, mature, reproducing individuals (Service 1990; 72 FR 53216, September 18, 2007). Parasitism is identified as a threat to Sclerocactus plants; however, additional studies are needed to determine the long-term, population-level effects of the cactus-borer beetle to S. wetlandicus. Another source of mortality is lagomorph and rodent browsing. While there have been numerous observations Sclerocactus being removed by desert cottontail rabbits (Sylvilagus audubonii) and unknown rodents (Colorado Natural Heritage Program 2010b; BioLogic 2008; Clayton 2006), in subsequent years some of these plants have re-sprouted (Clayton 2010). Browsing likely goes unnoticed unless a marked individual is revisited within a 1- to 2-year period. We know very little about the magnitude of this threat (USFWS, 2010).

Stressor: Climate Change, Drought, and Impacts to the Vegetative Community (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change is likely to affect long-term survival of native species, including S. wetlandicus, especially if longer or more frequent droughts occur. For the southwestern region of the United States, warming is occurring more rapidly than elsewhere in the country with an increase of 1.5°F (0.8°C) since 1979 (Karl et al. 2009). Under lower emission scenarios temperature is expected to increase 5°F (2.8°C) and under higher emission scenarios temperature is expected to increase 10°F (5.6°C) by the end of the century, from the 1979

baseline (Karl et al. 2009). Other future projections for the southwest include more intense and longer-lasting heat waves, an increased probability of droughts that are worsened by higher temperatures, heavier downpours, increased flooding, and increased erosion (Karl et al. 2009, pp. 129-134). The levels of aridity of recent drought conditions and perhaps those of the 1950s drought years may become the new climatology for the southwestern United States (Seager et al. 2007). Effects related to climate change (e.g., persistent or prolonged drought conditions, changes in community assemblages and the ability of nonnative species to succeed) may affect long-term persistence of S. wetlandicus. While the potential impacts of climate change could be serious, improved projections are needed to better understand this potential threat. S. wetlandicus mortality due to drought is well documented (Service 1990; 72 FR 53217, September 18, 2007). Many dead S. wetlandicus individuals were observed in the Uinta Basin after the severe drought of 1976 to 1977 (Service 1990). In addition, noxious weeds are often able to out-compete native species under drought conditions (Everard et al. 2010). Drought conditions could further hinder BLM's efforts to control noxious weeds and restore native vegetation, which is already difficult due to the extreme environment of the Uinta Basin (Service 1990; BLM 2005, 2008) (USFWS, 2010).

Stressor: Herbicides and Pesticides (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: S. wetlandicus lives in or near areas that receive herbicide and pesticide treatments to remove undesirable species, such as noxious weeds and insect pests (Service 1990). Individual cacti are likely to be directly affected by these chemicals, and indirectly by effects on pollinators or by movement of contaminated soils (Service 1990). However, specifics of the species' pollination biology are currently unquantified (USFWS, 2010).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: We are not aware of any city, county, or State laws, ordinances, or zone that provide for protection or conservation of the S. wetlandicus or its habitat. Removal, damage, or destruction of plants on private lands is not prohibited under the Act. Removal from Federal lands is prohibited without a permit, but can be allowed through consultation with the Service. The BLM sometimes authorizes adverse effects to the S. wetlandicus if it will not jeopardize the continued existence of the species. Conservation needs of S. wetlandicus are addressed through interagency consultation (section 7 requirements) typically between the Service, BLM, and Bureau of Indian Affairs. Through this process, conservation measures are implemented on a project-by-project basis to minimize the loss of individual cacti from oil and gas activities. These measures include preconstruction cactus surveys and a required buffer around individual cacti. For example, the Castle Peak/Eightmile Flat Oil and Gas Expansion Project Final Environmental Impact Statement included conservation measures to specifically protect S. wetlandicus and its habitat (BLM 2005). In addition to these project-specific protections, we need to establish consistent guidance and Resource Management Plan designations that provide adequate regulatory mechanisms over the longer term to protect large portions of the range of the S. wetlandicus (USFWS, 2010).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

For Uinta Basin hookless cactus – The metapopulation has a stable or increasing growth trend (average lambda (λ) ≥ 0.95) over a minimum period of 10 consecutive years and predictive modeling (using data from the same 10-year monitoring period) indicates that the likelihood for long-term survival of the metapopulation is at least 95 percent over a 100-year period. In addition: a. At least 8 of the 11 core 2 areas have a stable or increasing growth trend (average lambda (λ) ≥ 0.95) over a minimum period of 10 years to demonstrate metapopulation stability. b. The eight core 2 areas evaluated should incorporate the principles of redundancy and representation by including core areas that represent the full distribution of the species (i.e., core areas from the furthest north, south, east, and west boundaries, representation from all habitat types, and range of elevation) (USFWS, 2023).

For Uinta Basin hookless cactus – The metapopulation maintains a size distribution that contains individuals in all size classes over a 5-year minimum period and where the largest size class maintains a stasis rate no less than 0.90. Size classes for Uinta Basin hookless cactus are defined as: class 1:< 21.2 mm; class 2: 21.2–51 mm; class 3: 51.1–80 mm; and class 4: >80 mm (Hornbeck 2020) (USFWS, 2023).

For Uinta Basin hookless cactus – Genetic diversity across the metapopulation is maintained at levels such that there is a high probability (95 percent) of two core 1 populations persisting over the long term (100 years) within each core 2 area (USFWS, 2023).

For Uinta Basin hookless cactus – Disturbance that contributes to the degradation and loss of habitat (e.g., roads, recreation, livestock) does not exceed established tolerance thresholds for each core 2 area (percent of habitat) (USFWS, 2023).

For Uinta Basin hookless cactus – Protected areas will be formally established by land managers for at least one genetically important population and at least one connectivity corridor (as identified using connectivity analysis) to provide long-term protection from anthropogenic threats. Methods may include but are not limited to Areas of Critical Environmental Concern (ACECs), Resource Management Plan special designations, Tribal resolutions, conservation agreements, and conservation easements (USFWS, 2023).

Recovery Actions:

- Priority 1 Actions 1. Monitor two core 1 areas within each core 2 area for Pariette cactus and eight core 2 areas for Uinta Basin hookless cactus to evaluate short- and long-term population trends across the metapopulation and support predictive modeling. Monitoring should be conducted for a minimum of 10 years (Recovery Criteria 1 and 2). 2. Reduce impacts from livestock, feral horses, and herbivores on a landscape scale (in all subpopulations) through herd management, grazing rotations and rest, and habitat improvements (Recovery Criterion 1). 3. Develop disturbance tolerance thresholds for each core 2 area (Recovery Criterion 4). 4. Formalize conservation measures with partners to be implemented with, and prior to, all surface disturbing projects. Conservation measures may be documented in a memorandum of understanding, resource management plan,

conservation agreement, recreation management plan, travel management plan, or similar document (Recovery Criteria 1, 2, 3, 4, and 5). 5. Restore disturbed areas within core habitat so that new surface disturbance is less than the tolerated threshold identified in Recovery Action 3 (Recovery Criteria 1, 2, and 3). 6. Resurvey subsampled areas (targeted and repeat) to update abundance and population estimates (Recovery Criteria 1, 2, 3, 4, and 5) (USFWS, 2023).

- A Recovery Plan has not been published for this species.
- Priority 2 Actions 7. Evaluate current genetic diversity across the species range to identify subpopulations at risk, those needing protections, and those of high importance (Recovery Criterion 2). 8. Conduct a connectivity analysis to identify important gene flow corridors (Recovery Criterion 2). 9. Restore or improve connectivity corridors between core 1 and core 2 areas that are important for maintaining gene flow across the species range and limit new surface disturbance in important existing connectivity corridors (Recovery Criteria 2 and 3) (USFWS, 2023).
- Priority 3 Actions 10. Update disturbance calculations on an annual basis for each core area (Recovery Criterion 3). 11. Develop a predictive model to evaluate the long-term trend and projected survival probability of each species under likely future scenarios, including climate change (Recovery Criteria 1, 2, 3, 4, and 5). 12. Reestablish Sclerocactus individuals on restored sites and monitor effectiveness (Recovery Criteria 1, 2, and 4). 13. Establish areas for permanent protections that provide the greatest benefit towards maintaining the redundancy, representation, and resiliency of the species (Recovery Criteria 1, 2, 3, and 5). 14. Develop and implement management plans for each protected area (Criterion 5) (USFWS, 2023).

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SPECIES ACCOUNT: *Sclerocactus wrightiae* (Wright fishhook cactus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/11/1979; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Wright fishhook cactus (Sclerocactus wrightiae) is named for Dorde Wright Woodruff who discovered Wright fishhook cactus (L. Benson) in Emery County in 1961 (Benson 1982). The species is endemic to south-central Utah occurring in scattered clusters in Wayne, Emery, and Sevier counties. Wright fishhook cactus is a small, perennial globose shaped cactus mainly 6 – 12 cm long and 4 - 8 cm in diameter growing as a single plant with a branched taproot (Welsh et al. 2008). If damaged, the cactus may form multiple stems. Spines, both lateral and central, emerge from warty protuberances called tubercles. The large, lower central spine is hooked, a noticeable character that gives the cactus its common name of "fishhook." The flower is 3 to 4 cm in diameter, 3 to 4 cm long, white to cream or pink and fragrant. Sepaloids are green or green tinged with red or brown. Flowering occurs from late April through May and fruits are set in June. Fruits are barrel shaped and borne on the top of the cactus. Seeds are black, 2 mm long and 3.5 mm broad (Heil and Porter 1994). A distinguishing characteristic of the Wright fishhook cactus is the presence of magenta filaments with yellow anthers. Short spine length, round spines, early flowering time, small flower size, and magenta filaments help distinguish this species from other similar cacti (Heil and Porter 1994, Benson 1982).

Current Range

The known range of Wright fishhook cactus extends across approximately 696,099 acres (ac) (281,701 hectares (ha)) of Utah's western Emery County, southeastern Sevier County, and central Wayne County.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Almost completely self-incompatible and pollination is accomplished mostly by native sweat bees

Reproduction Narrative

Adult: Wright fishhook cactus is almost completely self-incompatible and pollination is accomplished mostly by native sweat bees (Halictidae) (Tepedino 2000). Eight species of bees from one family (halictid bees) and two genera (Dialictus and Agapostemon) are known to visit Wright fishhook cactus (Tepedino 2000). Pollination is limited by the foraging distance of the ground nesting bees, which is strongly correlated to body size (Greenleaf 2005). The distance that ground nesting bees travel from their nests is difficult to determine but it is believed that they do not travel far; the maximum travel distance reported for the two genera that pollinate Wright fishhook cactus is approximately a quarter mile (400 m) (Tepedino 2000). Cross

pollination is essential for Wright fishhook cactus to produce viable seeds; self-pollination would result in production of non-viable seeds. Little is known about the species' seed banks, seed viability, germination, dispersal, dormancy and establishment in the wild. Seeds fall directly from the base of the dry fruit onto the ground and most are believed to remain near the parent plant (USFWS 1985). Possible dispersal vectors include gravity, wind and water erosion, as well as insects and rodents (USFWS 1985, Kass 1990).

Habitat Type

Adult: Flat areas, low ridges and slopes

Environmental Specificity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: Wright fishhook cactus occurs on semi-barren sites on flat areas, low ridges and slopes in sparsely vegetated arid desert environments. They occur in a variety of vegetation types including desert scrub, desert grasslands, and open pinyon-juniper woodland communities. Wright fishhook cacti are generally found between 1,290 and 2,300 m (4,230 and 7,545 ft) and occur on a variety of geologic formations including Curtis, Mancos Shale, Morrison, Summerville, Dakota, Carmel, Entrada, and Moenkopi. Soils where the species is found include a broad range of textures, including clays, sandy silts, fine sands, loam and loamy sand. Soils generally have an overlying layer of fine and medium sized gravels or a cryptobiotic soil surface crust (USFWS 1985, Kass 1990). The overall range of the species has not changed significantly since the publication of the 1985 Recovery Plan. However, survey and inventory efforts have greatly expanded our knowledge of the distribution of the species across its range. We now know of more occupied sites and in some cases, more continuous populations than at the time of listing. The known range of Wright fishhook cactus extends across approximately 696,099 acres (ac) (281,701 hectares (ha)) of Utah's western Emery County, southeastern Sevier County, and central Wayne County. Wright fishhook cactus occurs primarily on lands managed by the BLM's Price and Richfield Field Offices and by the NPS at CRNP. More than 300 localities of Wright fishhook cactus have been documented from BLM and CRNP lands. A cactus locality consists of one or more individual cacti. There are 22 localities on lands managed by the BLM's Price Field Office, 256 localities on lands managed by the Richfield field office, and 55 localities on CRNP lands. Ninety-five percent of the Wright fishhook cactus range occurs within 22 active grazing allotments, including BLM, CRNP, SITLA, and private lands. Grazing is not permitted on the BLM North Caineville Mesa (2,200 ac (890 ha)) and a small section of the Factory Butte SRMA (approximately 1,300 acres (526 ha)). Although grazing is not permitted at Goblin Valley State Park, portions of the park are not fenced and are therefore accessible to livestock from adjacent lands. The CRNP section of the Cathedral grazing allotment was retired in 1999; however, livestock trail through the area each fall when moving between their summer and winter ranges. Our most recent range-wide population estimate is 4,500 - 21,000 individuals (USFWS 2008). Inventory efforts within CRNP during 2011 – 2013 documented 2,551 live individuals in 55 localities (CRNP 2014b). This should be considered a conservative number as counting and mapping efforts at each locality were limited to four person-hours, and therefore not all cacti at a locality were counted. Potential habitat is widely available in the vicinity of known localities of the species throughout its range, and because the species is a relative generalist, abundance of habitat is not considered a limiting factor in the conservation or survival of the species. Much of this additional potential habitat has yet to be surveyed. During the 2014 field season CRNP staff

conducted 106 belt transects to gather presence/absence data on Wright fishhook cacti and Winkler cacti within suitable habitat that has not been previously inventoried (Clark 2014). These efforts located 546 previously unmapped Wright fishhook cacti. Although additional Wright fishhook cactus localities have been found since the species was listed, we cannot determine a trend. Previous surveys are not comparable because we do not have a measure of acreage surveyed or effort spent searching. The earliest estimates of 50,000 to 100,000 (Neese 1987, Kass 1990, Kass 2001a) are most likely not accurate because subsequent surveys do not support this estimate. In recent inventories conducted from 2011 and 2012, BLM and CRNP (BLM 2012a, CRNP 2012, CRNP 2013) found 10,724 individual cacti in 157 localities with the majority on BLM land. This number is likely to increase as inventories of the remaining known localities are made.

Dispersal/Migration

Population Information and Trends

Number of Populations:

130

Population Size:

2,348

Population Narrative:

Wright fishhook cactus is a long-lived species that is slow to reach reproductive maturity. Individual cacti begin flowering when around 4 to 5 years old, producing flowers generally less than 50 percent of the time (Kass 2001a, Clark and Clark 2007). The highest reproductive rates are associated with large adult plants (>3.5 in [9.0 cm] in diameter), which flower between 75 and 100 percent of the time producing a disproportionately large amount of seeds (Kass 2001a, Clark and Clark 2007). Depending on environmental conditions, Wright fishhook cactus is estimated to grow an average of 0.2 ± 0.1 in (0.5 ±0.25 cm) in diameter within one year (Clark and Clark 2007) with seedlings growing at a faster rate than adults (Kass 2001a). Because of slow growth rates, the highest reproductive individuals may be at least 18 years old. Size class distribution of a population indicates its structure and stability, and can help to show vulnerabilities in each life stage. Between 1999 and 2008, Clark (2008a) collected size class data on Wright fishhook cactus collected at 130 of 151 sites surveyed. During these surveys, 2,348 cacti in the four size classes (excluding multiple stemmed plants) were recorded as follows: 10 percent seedlings, 37 percent juveniles, 52 percent young adults, and 2 percent old adults. Although it is likely that some seedlings were missed during this inventory effort, the percentage of old adults is likely accurate (Clark 2008a). Similar population structure results were reported from three demographic monitoring sites on BLM lands over a seven year period with most of the population in the young adult size class (Kass 2001a). Monitoring initiated at Factory Butte in 2009 also showed low numbers of seedlings (5 percent), higher numbers of juveniles (21 percent) and young adults (68 percent), and low numbers of older adults >8 cm in diameter (6 percent) (Clark 2009a). Overall, the majority of Wright fishhook cactus plants occur in the juvenile to young adult size classes throughout the range of the species (Kass 2001a, Clark and Clark 2007, Clark 2008a, Clark 2009a) with the largest and smallest size classes poorly represented. Low frequency in the occurrence in the smallest size classes indicates low levels of recruitment into the population. Demographic monitoring over a seven year period at three

BLM Wright fishhook cactus monitoring plots reported a mortality to recruitment ratio of 2.5:1 in all plots (Kass 2001a). Low levels of recruitment are also reported in the Factory Butte area, where overall mortality was 8.9 percent between 2009 and 2010, and 6 percent between 2010 and 2011 (BLM 2012a). The mortality to recruitment ratio for both years was reported at 6:1 and 5:1, respectively (BLM 2012a). Low recruitment patterns and the small number of large older reproductive individuals may constitute a species wide pattern (Kass 2001a). For populations to persist in their environment, recruitment into the population must exceed mortality. Populations with a low percentage of seedlings or a low percentage of the highly reproductive individuals are potentially declining populations (Elzinga et al. 1998).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: Threats to the species include damage to the habitat during mineral and gas exploration and the mining of coal, gypsum, bentonite and bentonite clay, uranium, vanadium, building stone and gravel. Livestock activity, such as trampling and uprooting of plants, is a threat. Off-road vehicle use causes damage. Illegal collecting is still a problem. The cactus apparently suffers from predation by the beetle Moneilema semipunctatum and perhaps other beetles. Small mammals such as Ord's kangaroo rat (Dipodomys ordii) and white-tailed antelope squirrel (Ammospermophilus leucurus) may eat the cactus. (NatureServe, 2015)

Recovery

References

USFWS 2016. Status of the Species and Critical Habitat: Sclerocactus wrightiae (Wright fishhook cactus). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

NatureServe. 2015. NatureServe Central Databases. Arlington, Virginia, U.S.A.

SPECIES ACCOUNT: *Scutellaria floridana* (Florida skullcap)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) (USFWS, 2015) 5/8/1992

Physical Description

A perennial herb, up to 4 dm tall. Stems are solitary or few, mostly erect or ascending. Leaves are opposite, narrowly linear, 2-4 mm long, the margins strongly rolled. Flowers are solitary in the axils of leaves and are bright lavender-blue with a whitish throat. (Based on Kral 1983.) (NatureServe, 2015)

Taxonomy

The rarest of several southeastern species in this genus. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known from the Apalachicola region of the Florida panhandle from Liberty, Franklin and Gulf counties. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: Perrenial (USFWS, 2009)

Breeding Season

Adult: Flowering is in May and June (Kral 1983) (USFWS, 2009).

Reproduction Narrative

Adult: The Florida skullcap is a perennial herb with quadrangular stems and opposite leaves. The flowers are solitary, with a bell shaped calyx and bright lavender-blue corolla. The corolla has two lips, the lower one being white in the middle. The stigma sticks out from under the flower hood with the anthers residing inside. Bumblebees, megachilids and halictids are probably important pollinators. Plants flower from mid-April through early July and are most prolific after a fire UUSFWS, 2009).

Habitat Type

Adult: Pine-palmetto flatwoods, wet prairies (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015)

Site Fidelity

Adult: High (Inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dark, humus rich sands of pine-palmetto flatwoods, wet prairies, and savannahs. (Based on Kral 1983) Seepage slopes. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from NatureServe, 2015)

Dispersal

Adult: Low (inferred from NatureServe, 2015)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

19 protected populations (USFWS, 2024)

Population Size:

>100,000 total (USFWS, 2024)

Population Narrative:

Reported to respond positively to fire by sprouting and blooming. They stop flowering if not burned at least once every three years. Pollinator visits were infrequent in one study that examined who and when pollinators visited Scutellaria floridana. In addition, native bees were the primary pollinator, and factors that effect bee density could affect S. floridana density. Based on recent surveys within range and habitat of the species (NatureServe, 2015). Moderate resiliency, representation and redundancy are inferred based on number of populations and individuals as well as relatively large area in which this species is known to occur. Florida Natural Areas Inventory had estimated hundreds of thousands of flowering stems for multiple occurrences (Florida Natural Areas Inventory 2017-2023, A. Johnson, 2023, pers. comm). However, because of the clonal system for this species, stem counts alone are an imperfect proxy for abundance in S. floridana populations as one individual can be composed of dozens of stems with no clearly delineated shape or arrangement across the landscape (Hanko et al. 2023); clonal diversity in 12 studied populations showed that one to 16 clones were present in a single population. Scutellaria floridana is a perennial mint endemic to four counties in the Florida panhandle (Figure 1). It grows in fire-dependent habitats such as longleaf pine wet

forests and wet meadows and has a strong response to fire (Negron-Ortiz 2023). It can also occur in appropriate habitats within road/transportation and/or transmission rights-of-ways that are maintained. There were originally 40 historically documented occurrences throughout this species range (Service 2009, 2019). Since points within 1 km are all considered part of one occurrence (NatureServe 2020), the 40 historical occurrences represent 29 Element Occurrences (hereafter EOs or occurrences; Service 2009, 2019). Currently, there are 19 extant, protected EOs. These EOs continue to be threatened by urban development, timber farming, and fire suppression (USFWS, 2024)

Threats and Stressors

Stressor: Logging (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Pulpwood production in the outer Coastal Plain in the Apalachicola Basin The timber industry in North Florida became well established in the 1850s (FNAI 2005). It started in Franklin County in the 1870s and continued to be a prominent industry until the mid-1990s (Howell and Hartsell 1995). The St. Joe Timberland Company had close to a million acres in timber in the eastern region of the panhandle and they plan to continue to harvest and replant indefinitely. The Company also owned a paper mill in Port St. Joe until it was sold and shut down in 1999. According to J. Huffman (2009, pers. comm. to Negron-Ortiz) tree farming, i.e., privately owned forest managed (clearcutting, mechanical site preparation, and pine plantations) for timber production, is a primary threat since there still is a mill in Panama City (Bay County) and there are many thousands of acres of tree farms that are smothering out S. floridana (as in around the SJBSBP). Therefore, tree farming is a threat to this species (USFWS, 2009).

Stressor: Real estate development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Urban development continues to threaten Florida skullcap. The St. Joe Timberland Company still owns the former extensive timber land in Northwest Florida, and now focuses on commercial and residential development along roadways and near or within business districts in the region. Urbanized land in Florida, statewide, is projected to double by 2060 along with doubling of the population to 36 million (http://www.1000friendsofflorida.org/PUBS/2060/01-Northwest-Florida). Several S. floridana's locations are found along U.S. and state roads. Construction activity may directly kill individual plants or convert habitat to unsuitable space; widening may convert native habitat to managed roadside; and culvert modification may change drainage patterns, which may change seasonal hydrology. Therefore, development, road widening and new roads continue to pose a threat to the species from direct habitat loss to severe habitat modification. As explained under C.1.e, this plant has unique habitat characteristics. Working together with partners on road maintenance activities, we can find possible alternatives that will support or maintain S. floridana (USFWS, 2009).

Stressor: Fire suppression (USFWS, 2009)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: Suppression of fire continues to threaten the pineland and savanna's flora since fire is essential for the maintenance of flatwoods (Abrahamson and Hartnett 1990). Fire influences community structure and composition (Abrahamson and Hartnett 1990), and with insufficient frequency in longleaf pine communities, a woody midstory quickly develops (Glitzenstein et al. 1995), negatively affecting the understory diversity. Thus, fire suppression continues to be a threat to S. floridana. Lack of fire, and subsequent growth of shrubs (particularly encroachment of Cyrilla racemiflora L., commonly known as swamp titi) and saplings in the understory, in addition to shading by planted pines, inhibits this species emergence (Negrón-Ortiz, 2008, pers. observ.; FNAI 2008). Declining fire frequency reduces S. floridana abundance in areas where it was previously observed in great quantities (FNAI 2008). In recently burned areas, however, plant emergence is prolific within one year of the fire event (L. Keppner, 2008, pers. comm.). Several studies have shown that frequent prescribed fire regimes are important for maintenance of flatwoods diversity (Hiers et al. 2007). Therefore, frequent prescribed burnings, i.e., 1-3 yr interval, are needed to maintain optimal S. floridana populations. At present, the ANF utilizes a 3-5 yr interval burn rotation, Lathrop Bayou uses a 2-7 yr interval, and SJBSBP uses a 2-5 yr interval (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:
For delisting the species, the goal is to adequately protect and manage 15 populations distributed throughout the species' historical range for 10 years. The plan states that these goals are by necessity only preliminary, and they will be refined (USFWS, 2009).

Recovery Actions:

- Protect and manage these plants outside Apalachicola National Forest (USFWS, 1994).
- Protect populations in Apalachicola National Forest and on other public lands (USFWS, 1994).
- Perform systematic and other studies (USFWS, 1994).
- Garden propagation and reintroduction (USFWS, 1994).
- Manage rights-of-way (USFWS, 1994).
- Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range (USFWS, 2009).
- Determine the levels and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices. For example, the identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations (USFWS, 2009).
- Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with

subsequent validation or inspection of the sites for plants (USFWS, 2009).

- Conduct population studies. a. Studies on the viability of dry-stored seeds, the timing of germination, and whether a persistent seed bank is present should be addressed. b. Establish and implement monitoring to address demography. Plants should be monitored several times during the first 12-month period to assess the best monitoring schedule (e.g. annually, biannually). Data from monitoring should be evaluated through 5-year reviews. • Establish permanent plots on protected locations throughout the species' historical range. Priority for populations should include those sites that can be managed with fire. For each plot: o Estimate the density, and abundance of individuals. If possible, investigate basic ecological questions (e.g., pollinators; flowering period; annual variability in flowering; seed production). o Monitor the effect of fire (if the areas are burned) on density, fecundity, and size structure (USFWS, 2009).
- Manage ROWs Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and USFWS; a management plan should be developed and implemented (USFWS, 2009).
- The recovery plan should be updated to define objective measurable criteria and better address the five factors (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Estimate the levels of clonality and distribution of genetic diversity. Knowledge of the levels and distribution of genetic variation in species of conservation concern can be important for the development of efficient and effective conservation practices. Sampling should involve the established monitoring plots (see page 3 Recovery action 1) • By understanding clonality, the Service will be able to determine what is an individual and evaluate abundance. Specifically, we will be able to 1) relate flowering stems (both vegetative and flowering) to number of individuals in a given area, and 2) infer the effect of fire on flowering stems/individuals. • The identification of populations with rare alleles or with elevated levels of genetic diversity may lead to greater efforts for their preservation relative to less genetically unique populations. 2. Complete a comprehensive census (e.g., the total number of individuals, number of flowering vs. non-flowering plants, and whether seedling recruitment is occurring) throughout the present distribution including all the historical locations to determine the population numbers and range. Given the cryptic nature of this plant when it is not flowering, the density of surrounding vegetation and the number of locations, surveys are best recommended a ~5 weeks post-fire, if the fire is in the growing season; or in April or May if the fire was in Dec-Mar time period (A. Jonhnson, FNAI, 7/06/2019). A consistent and repeatable method should be employed. • Censuses are most critical for populations outside ANF. Surveys that have been accomplished following fire in the ANF (in the past 10 years by FNAI, Ann Johnson, and local botanists) have been extensive and thorough (A. Jenkins, FNAI, 6/27/2019). 3. Monitoring. It is recommended to set up more subplots and monitor both flowering and nonflowering individuals over time. • Population census data [e.g., the total number of individuals (flowering and nonflowering plants), and whether seedling recruitment is occurring] will help predict extinction risks and the smallest size at which a population can exist without facing extinction by using computer simulations known as population viability analyses. Emphasis should be given to clones and individuals with unique profiles identified by genetic study. If possible, investigate basic ecological questions [e.g., pollinators; flowering period; annual variability in flowering; seed production; and the effect of fire (if the areas are burned) on density, fecundity, and size structure]. See page 3 for details of ongoing investigations in the ANF. • A repeatable method should be employed. If the target population is small (e.g., 200 m2), it is recommended to walk the entire area and count each individual. If the target population covers a

large area, then permanent marked transects should be established in key selected areas that reflect the larger area. 4. Conduct surveys/inventories on potentially new sites. This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. • FNAI developed occurrence-based suitable habitat model for S. floridana in 2011, and many new locations have been discovered since that time. Recommendation: Update the current model with most recent survey data (A. Jenkins, FNAI, 6/27/2019) and validate the model. 5. Manage ROWs Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Talquin Electric, FDOT, and the Service; a management plan should be developed and implemented. 6. The recovery plan should be updated to define objective measurable criteria and better address the five factors. (USFWS, 2019)

- RECOMMENDED FUTURE ACTIVITIES 1. Address continued monitoring and management. a. Continue the long-term monitoring in the Apalachicola National Forest sites and set up plots in other sites such as St. Joseph Bay State Buffer Preserve, Tate's Hell State Forest, and Lathrop Bayou. b. As sea levels rise, saltwater intrusion increases in duration, frequency, and spatial extent. To assess the effect of salinity on S. floridana, sites where intrusion of salt water occurs should be considered for long-term monitoring. c. Develop a stand-alone plan for managing listed plants at the Apalachicola National Forest and Tate's Hell State Forest and integrate it to their Management Plans. 2. Conduct surveys/inventories on targeted sites. Based on Hanko et al. (2023), the genetic study showed that stem counts alone may not accurately reflect abundance in populations with low clonal richness; one individual can be composed of dozens of stems. It appears that on average, ten adjacent stems generally represent 1–2 unique individuals, suggesting that stem counts are usually equivalent to ten times the true population size. a. Gulf County. Thorough surveying of populations located on private lands (North Gulf Co., Fig. 1, sites with yellow and black symbols) is recommended to determine whether S. floridana and corresponding habitat are still present. This action is a priority for this species. b. In-depth investigation of clonal reproduction and management history of the four populations on public lands (Box-R Wildlife Management Area 1, Apalachicola National Forest 5, Tate's Hell State Forest 1, and St. Joseph Bay State Buffer Preserve 1; Fig. 1) that possess very low genetic diversity and evidence of inbreeding. 3. Conduct surveys/inventories on potentially new sites (targeting recently burned sites). This action can include the use of species distribution modeling methods to initially determine potential sites, with subsequent validation or inspection of the sites for plants. 4. Manage Right-of-ways (ROWs) Continue fostering conservation practices for utility and highway ROWs with the Forest Service, Florida Department of Transportation, and the Service; a management plan should be developed and implemented. 5. Establish (or continue) frequent growing-season fire regimes (i.e., 3- to 5-year interval) on selected areas such as the Apalachicola National Forest, St. Joseph Bay State Buffer Preserve, Tate's Hell State Forest, and Lathrop Bayou to maintain optimal conditions of populations. Re-visit sites shortly after a burn event, and mark and count individual ramets. Populations tend to be more evident after a fire event (Negron-Ortiz 2023) (USFWS, 2024).

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SPECIES ACCOUNT: *Scutellaria montana* (Large-flowered skullcap)

Species Taxonomic and Listing Information

Listing Status: Threatened (effective 2/13/2002; originally listed as Endangered (effective 7/21/1986); Southeast Region (R4)

Physical Description

A perennial herb with solitary, erect, square stems, usually from 30 to 50 centimeters (cm) tall (Figure 1). The leaves are lanceolate to ovate, on 1 to 2 cm petioles, with blades 5 to 8 cm long and 3 to 5 cm wide, crenate to serrate margins, and hairy on both surfaces. The inflorescence is a terminal, leafy-bracted raceme, with or without paired lateral racemes at the base. The calyx is two-lobed (characteristic of the genus Scutellaria). The corolla is relatively large, 2.6 to 3.5 cm long, blue and white, and lacking a fleshy ridge (annulus) within the corolla tube near the top of the calyx. Flowering occurs from mid-May to early June and fruits mature in June and early July. Bridges (1 984b) stated, "The genus Scutellaria can be easily recognized by its distinctive calyx, with a protrusion, or 'cap' on the upper lobe." Within the genus there are other species with which Scutellaria montana could be confused. Bridges (1984b) listed some important characters that a specimen must have to be characterized as Scutellaria montana: (1) a terminal inflorescence; (2) a large corolla (at least 2.5 cm long); (3) tapering or truncate leaf bases, never cordate; (4) a midstem with at least some stipitate glandular hairs; (5) no sessile glands on the upper leaf surface, (6) a fairly densely pubescent lower leaf surface, often with glandular hairs; and, (7) a corolla tube lacking an annulus within. (USFWS, 1996)

Historical Range

See Current Range.

Current Range

Ridge and Valley and Cumberland Plateau physiographic provinces in Georgia and Tennessee. This includes the following counties: Georgia Counties: Bartow, Catoosa, Chattooga, Dade, Floyd, Gordon, Murray, Walker, Whitfield; Tennessee Counties: Bledsoe, Hamilton, Marion, Sequatchie. (USFWS, 1996)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (NatureServe, 2015)

Lifespan

Adult: 8+ years (USFWS, 1996)

Dependency on Other Individuals or Species

Adult: Pollination is principally or exclusively by Hymenoptera of the superfamily Apoidea (bees) (NatureServe, 2015).

Breeding Season

Adult: Collins (unpublished manuscript) summarizes the general life cycle as follows. "Nutlets are released from late June through early July (mid-June to mid-July?), overwinter, and apparently germinate in late March. Mature individuals that have perennated as rootstocks begin shoot growth in late March. By early April, plants are 5-10 cm tall and are pushing through the leaf litter. Anthesis typically begins during mid-May and continues through early June (NatureServe, 2015).

Reproduction Narrative

Adult: The nutlets have a smooth exterior and do not appear to be adapted for any means of long-distance dispersal; they most likely fall a short distance (<= 5 m) from the parent plant due to explosion of mint capsule. They could be washed downslope by water, or carried by small animals, but have only remote chances of extra-population dispersal (Collins, unpublished manuscript).; The life history of Scutellaria montana has not been specifically studied, and relatively little of it is known. Mature nutlets were not even seen until about 1983 by workers at Shorter College, thus indicating the early stage of work on the biology of the species. Collins (unpublished manuscript) summarizes the general life cycle as follows. "Nutlets are released from late June through early July (mid-June to mid-July?), overwinter, and apparently germinate in late March. Mature individuals that have perennated as rootstocks begin shoot growth in late March. By early April, plants are 5-10 cm tall and are pushing through the leaf litter. Anthesis typically begins during mid-May and continues through early June. Pollination is principally or exclusively by Hymenoptera of the superfamily Apoidea (bees). The corolla shrivels somewhat and falls from the calyx one or two days after pollination, presumably within 24 hours of fertilization. The calyx closes around the developing fruit immediately after corolla abscission. During the next two to four weeks, the calyx and the enclosed nutlets enlarge and mature. The calyx then dehisces by the loss of the upper lip, and the nutlets are released...A different course is followed if fertilization does not occur. The corolla shrivels markedly and may or may not remain united to the calyx. The entire calyx, still open at the mouth, falls leaving the pedicel bare." Workers at Shorter College are apparently conducting demographic and autecological studies on S. montana. Preliminary results indicate that less than 40 % of the flowers produce mature nutlets. Collins (1976) found that in other species of this group of Scutellaria studied, 76 to 93% of the flowers form nutlets. This lowered rate of fruit production, and the often few-flowered inflorescences, combine to give S. montana a reproductive capacity less than many of its relatives. The nutlets have a smooth exterior and do not appear to be adapted for any means of long-distance dispersal; they most likely fall a short distance (<= 5 m) from the parent plant due to explosion of mint capsule. They could be washed downslope by water, or carried by small animals, but have only remote chances of extra-population dispersal. However, as Collins (unpublished manuscript) notes, this cannot alone explain its rarity, in that all of its more widespread relatives have virtually identical seed dispersal. Conditions necessary for germination and establishment are still unknown, although the Marshall Forest population has variously been described as from 500 to 1300 plants. This may represent actual population fluctuations. Scutellaria species in the group to which S. montana belongs generally occur at fairly low density, scattered seemingly at random over fairly large areas of forest. Large colonies are seldom found, and individual plants are usually widely spaced and easily distinguishable. S. montana may sometimes occur in tighter colonies than many of its relatives, as indicated by its

clumped distribution at Marshall Forest. In the largest Tennessee population (ca. 5000 individuals), the plants are spaced at approximately 6" intervals (Hawks 1985b), giving a density of 4/sq ft, or ca. 40/sq meter. In the smaller Tennessee populations, however, density is 1 plant per sq meter or less, and individuals can be separated by 50m or more from the nearest S. montana (Bridges 1983, 1984; Bridges and Hawks 1984) Collins (unpublished manuscript) indicates that S. montana was only known to occur in minimally disturbed sites with a stable habitat. This would indicate it to be a plant of late-successional or climax forests. In Tennessee, some of the sites have clearly younger trees and more recent disturbances than the above would suggest. One site has trees generally 30-40 years old; most sites average trees less than 60 years old. The largest site is in a relatively old (50-60 yrs ?) forest, but is unique in that there had been a gentle ground fire about three years before the discovery of S. montana at the site. While S. montana will not, or has not been observed, to grow in early successional pine stands, it will occupy relatively mature stands with varying degrees of disturbances. Thus it can be considered a mid-to-late successional species which probably persists in, but is not restricted to, mature or climax forests. This is the typical situation for most forest herbs of the region.; BIOTIC; Hymenoptera (NatureServe, 2015). USFWS (1996) notes that this species can live for more than eight years.

Habitat Type

Adult: Oak-pine forests (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common (NatureServe, 2015).

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: Moderate (NatureServe, 2015)

Habitat Narrative

Adult: SUMMARY: Scutellaria montana is typically found in rocky, shallow soils, and on submesic to xeric, well-drained, slightly acidic oak-pine forests in the Ridge and Valley and Cumberland Plateau provinces of Northwestern Georgia and adjacent southeastern Tennessee. In Georgia, it has been reported from elevations of 189 to 265 m on steep, lower slopes of all aspects. In Tennessee, the elevation range of the species is much greater, with one concentration of sites at 200 to 320 m on slightly sloping to steep lower to mid-slopes on the Upper Mississippian Pennington Formation. The other concentration is at 400 to 540 m on gentle to somewhat steep slopes of small ravines near the escarpment on the Cumberland Plateau, on Lower Pennsylvanian sandstone and shale (Bridges 1984). The soil is always rocky and somewhat shallow, with plants rooted in deeper soil between boulders, or on as little as 3 cm of soil over rocks (Collins, unpublished manuscript). The species appears to have little specific habitat preference, occurring in localized areas within its known range. It is unclear what limits the northern edge of its distribution (NatureServe, 2015).

Dispersal/Migration

Motility/Mobility

Adult: Low (NatureServe, 2015)

Dispersal

Adult: Low (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: The nutlets have a smooth exterior and do not appear to be adapted for any means of long-distance dispersal; they most likely fall a short distance (= 5 m) from the parent plant due to explosion of mint capsule. They could be washed downslope by water, or carried by small animals, but have only remote chances of extra population dispersal (Collins, unpublished manuscript) (NatureServe, 2015).

Population Information and Trends

Population Trends:

Short-term trend: Declining (NatureServe, 2015).

Number of Populations:

TN: 28 populations (164 occurrences). GA: 52 occurrences (population distribution is under evaluation) (USFWS, 2015)

Population Size:

10,000 - 100,000 total individuals (NatureServe, 2015)

Population Narrative:

Appears to be self-maintaining in mature forests. However, at some sites, it is unclear whether the species is reproducing, as seedlings are infrequently detected. More than 50,000 individuals known (Fish and Wildlife Service 2002). Plants are fairly widely scattered, even within occurrences; often, additional search effort at the same site results in the discovery of additional plants. Some occurrences contain over 500 plants, but others have only 5 or 6. Many of the Georgia occurrences are small. Suitable habitat is abundant on the escarpment of the Cumberland Plateau in forests that are no longer logged or converted to pine monoculture. Suitable habitat also exists in Northern Alabama. 205 occurrences are currently mapped and considered extant, but delineating separate occurrences for this species is challenging because it occurs as small clumps that are relatively close together. Efforts are now underway to re-delineate occurrences, resulting in many closely-spaced small occurrences being lumped into fewer large occurrences with better viability ranks. Nevertheless, additional search effort for this species continues to result in the discovery of additional occurrences. Short-term Trend Comments: Areas containing two subpopulations that were declining were closed to the public (USFWS 2009). Transplantation was done at one of these subpopulations but has not yet been evaluated (USFWS 2009). Long-term Trend Comments: Three historical populations were extirpated by extensive recreational and residential development. Moderate resiliency, redundancy and representation are based on numbers of populations and individuals as well as its relatively wide-spread geography (NatureServe, 2015).

Threats and Stressors

Stressor: Logging (USFWS, 2015)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: A recent status survey for S. montana in Tennessee identified the following potential threats to the species and its habitat: 1. Removal of mature forest by logging or development on private lands (USFWS, 2015).

Stressor: ORV traffic (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 2. ORV traffic on undesignated trails (USFWS, 2015)

Stressor: Invasive exotic plants (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 3. Invasive exotic plants (USFWS, 2015).

Stressor: Trail construction (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 4. Trail construction and maintenance on public and conservation lands (USFWS, 2015).

Stressor: Power line maintenance (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 5. Power line maintenance including the use of herbicide, manual, and mechanical treatments for vegetation management (USFWS, 2015).

Stressor: Wildfire suppression (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 6. Wildfire suppression involving construction of large fire lines (USFWS, 2015).

Stressor: Recreational impacts (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: 7. Recreational impacts including unauthorized hiking, camping and picnicking on public and conservation lands (USFWS, 2015).

Stressor: Mineral mining (USFWS, 2015)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: 8. Mineral mining and quarrying

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
Scutellaria montana (large-flowered skullcap) will be considered for delisting when there are 15 adequately protected and managed self-sustaining populations. Populations must be distributed throughout the range and must be maintained for 10 years. A population will be considered adequately protected when it is legally protected and all needed active management is provided. A population will be considered "self-sustaining" if monitoring data support the conclusion that it is reproducing successfully and is stable or increasing in size. The minimum number of individuals necessary for a self-sustaining population should be considered to be at least 100 until otherwise determined by demographic studies (USFWS, 1996).

Recovery Actions:
- Search for additional populations of Scutellaria montana and prioritize sites for protection. Since the species was listed, several additional populations have been discovered through thorough inventories of specific areas. Without a focused effort, the potential for increasing the known number of populations is slim. The ability to prioritize and protect the highest-quality sites will depend on having complete information on extant populations of the species. (USFWS, 1996)
- Protect known populations. Of the 17 populations currently known, eight are protected though public ownership or by the Tennessee River Gorge Trust and The Nature Conservancy. Eight populations, including the second and third largest, are privately owned. One population in Hamilton County, Tennessee, occurs on public and private land. The protected sites need management plans in order to effectively protect Scutellaria montana. (USFWS, 1996)
- Conduct long-term monitoring of known populations. All populations should be monitored annually for the first 5 years to check the number of individuals and to determine threats to the populations. For the larger protected populations, this should include permanent plots. (USFWS, 1996)
- Determine the effects of potential management techniques. Observations by individuals in the field can help direct studies to document the effects of potential management techniques on populations of S. montana. This work should incorporate knowledge about site management, disturbance history, and forest composition. (USFWS, 1996)
- Examine genetic diversity within and between populations. A study of the species' genetic diversity should be conducted, and populations that are genetically diverse should be identified. This information should then be used to help set priorities for the preservation of genetic diversity. Information on genetic variability will help determine the number of populations and population size necessary to successfully maintain the species. (USFWS, 1996)

- Maintain plants and seeds ex situ. To protect against the loss of a population, attempts at propagation, using cuttings, should be attempted. In addition, seeds should be maintained at a long-term seed storage facility. (USFWS, 1996)
- Recommendation for Future Action from 2015 5-Year Review: Continue long-term monitoring using standardized protocols across the geographic range of S. montana to provide a basis for establishing whether populations exhibit cyclical patterns of demographic variability and for assessing population responses to local and regional environmental conditions. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Work with TDEC, TVA, UT-Chattanooga, TNARNG, TN River Gorge Trust, TDF, NPS, and others to develop plan for collecting current census data, where needed in Tennessee, to evaluate long-term persistence and stability of populations for which recent data are lacking. Appendix B includes a draft list of EOs where census data should be collected. Georgia DNR will be collecting census data from populations in Georgia during 2014. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Establish cooperative management agreements with landowners for protected occurrences and populations to ensure that conservation efforts for the species would continue following delisting of the species. (USFWS, 2015)
- Recommendation for Future Action from 2015 5-Year Review: Develop a post-delisting monitoring plan. (USFWS, 2015)

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SPECIES ACCOUNT: *Senecio layneae* (Layne's butterweed (=Packera))

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/18/1996; Pacific Southwest (R8)

Physical Description

A perennial herb of the aster family (Asteraceae) that sprouts from a rootstock. Its mostly basal lance-shaped leaves are 8 to 24 centimeters (3 to 10 inches) long. The several flower heads are 4 to 6 centimeters (2 to 3 inches) wide. Each flower head has 5 to 8 orange-yellow ray flowers (the flowers usually located on the edge of the inflorescence of members of the aster family) and numerous yellow disk flowers (flowers in the center portion of an inflorescence of a member of the aster family). Senecio aronicoides (rayless groundsel), S. flaccidus var. douglasii (Douglas' groundsel), and S. vulgaris (common groundsel) also occur on gabbro-derived soils in the Pine Hill area (Wilson 1986). These Senecio species can variously be differentiated from S. layneae by a combination of life form, type of flower, number of flower heads, flower color, and pubescence. (USFWS, 2002)

Taxonomy

Kate Layne-Curran collected the type specimen for Senecio layneae in May 1883 from El Dorado County, California, on Sweetwater Creek, not far from Folsom. Edward L. Greene first described S. layneae in 1883 (Greene 1883). Although Asa Gray (1884) reduced S. layneae to a variety of S. fastigiatus, it currently is known as S. layneae (Barkley 1993). Senecio layneae is a member of the aureoid group of Senecio that is united by most of the following characters: perennial herbs arising from creeping rootstocks or a stout caudex; well developed basal leaves with cauline (arising from the upper part of the stem) leaves progressively reduced upward; leaf margins without callose denticles (hard teeth); thin branching fibrous roots; and haploid chromosome numbers 22 or 23, or derived from these numbers (Barkley 1988). The aureoid group of Senecio is now known by some as the genus Packera. The type population of S. layneae is now thought to be extirpated due to inundation by Folsom Lake. (USFWS, 2002) In the second edition of the Jepson Manual, the genus to which Layne's butterweed belongs was changed from Senecio to Packera (Baldwin et al. 2012). (USFWS, 2019)

Historical Range

In western El Dorado County that includes the Pine Hill formation and adjacent serpentine; a few other colonies occur in the Eldorado National Forest in El Dorado County, California. (USFWS, 2002)

Current Range

On the Pine Hill formation in western El Dorado County, California; a few known isolated occurrences in El Dorado, Nevada and/or Tuolumne Counties. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2002)

Breeding Season

Adult: Senecio layneae is a perennial herb that flowers from April to July (USFWS, 2019).

Other Reproductive Information

Adult: It is unclear whether the species has the ability to resprout from its caudex after disturbance (Marsh and Ayres 2002). Although the seed of this species seems to germinate in a wide range of soil conditions and adult plants grow in a wide range of slope, aspect, light and elevation levels (Williams 2014), it appears to have little or no persistent seedbank, a short seed dispersal distance (Williams 2014), and is also shade intolerant (Baad and Hanna 1987). It is likely the species functions as a fugitive species, depending on a short fire return interval to create a regeneration niche and a supply of the short-lived seed from a nearby reproducing population to colonize the patch (Marsh and Ayres 2002). Little else is known about reproductive biology, ecology, and demography of the species. (USFWS, 2019)

Reproduction Narrative

Adult: Senecio layneae is a perennial herb that flowers from April to July (California Native Plant Society 1994). Twenty-two plants from Cameron Park were used to determine whether the predominant breeding system was self-fertilizing or outcrossing (mating not involving inbreeding). Pollinators were excluded from the flower heads with fine mesh fabric. Open pollinated flower heads had an 8-fold increase in potentially viable seeds over flower heads where the pollinators had been excluded, indicating that the predominant breeding system for Senecio layneae is outcrossing (Marsh 2000) (USFWS, 2002).

Habitat Type

Adult: Chapparral (NatureServe, 2015)

Environmental Specificity

Adult: Moderate (inferred from USFWS, 2019)

Habitat Narrative

Adult: In addition to occurring on gabbro soils, Layne's butterweed is also known to occur on serpentine soils.All serpentine sites, with the possible exception of the one in Shingle Springs, continue to support Layne's butterweed. Persistence in at least two separate habitat/soil types benefits these species by increasing their degree of representation. (USFWS, 2019)

Dispersal/Migration

Population Information and Trends

Population Trends:

Stable to increasing (USFWS, 2019)

Number of Populations:

45 populations; 6 extant; 36 presumed extant; 3 possibly extirpated (USFWS, 2019)

Population Size:

Greater than 9,100 individuals (USFWS, 2019)

Population Narrative:

In general, a direct comparison of species abundance now versus at the time of listing is not possible due mainly to lack of abundance data at the time of listing. Contributing to that challenge is that there is not consistent current abundance data for many of the populations, especially those on private lands. However, given the increase in the number of populations of Layne's butterweed since listing, it is likely that overall abundance has increased for those species (CNDDB 2018). (USFWS, 2019)

Threats and Stressors

Stressor: Habitat loss and fragmentation (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: Historically, gold rush activities and clearing for agriculture reduced and fragmented habitat in western El Dorado County. More recently, vegetation on the Pine Hill formation has changed significantly due to commercial and residential development, road construction, and fragmentation. Commercial or residential developments have partially or completely destroyed occurrences of the species (California Natural Diversity Data Base 1998; California Department of Fish and Game 1990a, 1990b; G. Clark in litt. 1993). Proposed residential or commercial development within the Pine Hill formation threatens most of the remaining sites within the Pine Hill formation and adjacent serpentine in western El Dorado County, and either directly or indirectly will adversely affect most of the range of this species. Additionally, habitat fragments may be too small to support viable populations of animals serving as pollinators or seed dispersal agents for the species. Edge effects, which occur at the interfaces of any two or more habitat types, typically increase with habitat fragmentation and are more pronounced for natural communities bordered by human disturbances (USFWS, 2002).

Stressor: Altered fire regime (USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: The primary overall threat is encroachment of native vegetation due to succession, even on lands in conservation ownership, in the absence of the natural fire regime. The long fire return interval due to fire suppression is preventing the formation of necessary clearings for Layne's butterweed establishment and possibly the scarification of seeds needed for germination. (USFWS, 2019a)

Stressor: Land use activities USFWS, 2002)
Exposure:
Response:
Consequence:
Narrative: The increasing number of people and changes in land uses will continue to place an increasing strain on undeveloped areas through activities such as off-road vehicle traffic,

unauthorized garbage dumping, and changes in the pattern of wildfires. Horse paddocking in rural residential areas within the central and northern portions of the Pine Hill formation threatens this species. The horses, when confined, severely graze or trample most available vegetation. The herbaceous gabbro plants are especially likely to be grazed (J. Van Ess pers. comm. 1993). (USFWS, 2002)

Stressor: Invasive nonnative plants (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Invasive plants continue to present a minor threat to gabbro plant species. Populations within the Pine Hill Preserve are not significantly threatened by invasive plants and any small infestations identified are largely reduced or eliminated by mechanical means (BLM 2008). However, a population of Layne's butterweed at BLM's Red Hills Kanaka Point property in Tuolumne County is threatened by yellow starthistle (Centaurea solstitialis) and distaff thistle (Carthamus lanatus) (B. Brenneman, in litt. 2018b). (USFWS, 2019)

Recovery

Reclassification Criteria:
Not applicable.

Delisting Criteria:
1. Secure and protect specified recovery areas from incompatible uses: Populations representing the range of the species including: (a) Cameron Park preserve south of Highway 50, (b)Cameron Park preserve north of Highway 50, (c) Pine Hill preserve, (d) Penny Lane preserve, (e) Salmon Falls/Martel Creek preserve, (f) occupied habitat on BLM lands in Yuba and Tuolumne Counties, and (g) occupied habitat on the Eldorado National Forest; along with adjacent unoccupied habitat and a 150-meter (500-foot) buffer. (USFWS, 2002)

2. Management plan approved and implemented for recovery areas, including survival and recovery of the species as the objective: For all populations and any occupied or unoccupied habitat identified as necessary for survival and recovery (see previous column) (USFWS, 2002).

3. Monitoring in all recommended preserves shows: (a) Stable or increasing with evidence of natural recruitment for a period of 60 years that includes normal disturbance. (b) Habitat monitoring of recommended preserves shows a mosaic of multiage class stands and habitat fragmentation has not appreciably increased (less than 5 percent) within any preserves over current (2000) conditions. (c) Spatially and temporally, the establishment of occurrences must be at least 10 percent greater than the extirpation of occurrences. (USFWS, 2002)

4. Other actions: (a) Ameliorate or eliminate threats (see Appendix H); (aa) Study importance of fire for management; (b) seeds of disjunct populations stored in at least two Center for Plant Conservation certified facilities. (c) Maintain metapopulation dynamics of at least 1 very large, 1 large, 7 medium, and 24 small occurrences throughout the Pine Hill formation; of at least 1 large, 2 medium and 5 small in western El Dorado County; of at least 2 medium and 4 small in Tuolumne County; and of at least 2 small in Yuba County. (USFWS, 2002)

Recovery Actions:

- 1. Develop and implement a cooperative program and participation plan. A cooperative program is needed to coordinate local public and private land use planning with State and Federal land use and recovery planning for gabbro species. A cooperative program needs to be developed focusing on western El Dorado County. A participation plan produced from this program will increase the chances of recovery for listed species. (USFWS, 2002)
- 2. Protect and secure existing populations. Natural lands that contain this species need to be protected in perpetuity. Protection of these lands includes identification and minimization of threats in perpetuity and application of appropriate and adaptive management (see Task 3) to ensure species survival and recovery. Natural lands that need protection can be categorized into two types: (1) blocks of land that contain occupied or potential habitat for two or more this species and (2) blocks of land that contain occupied or potential habitat for one this species. All potential preserve areas should be evaluated based on current mapping information and ground-truthed prior to purchase to confirm their value for recovery. (USFWS, 2002)
- 3. Manage Habitat Managing habitat is essential to the recovery of the listed species. Habitat management includes preparation and implementation of management plans for all areas inhabited by special status species being proposed for preservation, and periodic monitoring of populations in each of these areas. Within western El Dorado County, a multi-constituent committee should be formed to oversee the management of preserves located on the Pine Hill formation. The preserve management committee should include, at a minimum, representatives from the California Department of Fish and Game, U.S. Fish and Wildlife Service, Bureau of Land Management, El Dorado County, California Department of Forestry and Fire Protection, California Native Plant Society, American River Conservancy, and a private landowner representative. (USFWS, 2002)
- 4. Survey historical locations and other potential habitat where this species may occur. Recovery of listed species may often require relocating historic populations or locating new populations of these species. Historical locations should be surveyed to determine whether suitable habitat remains, the species persists at the sites, and/or the sites may be suitable for repatriation. Suitability of historical locations for repatriation would depend upon: (1) whether potential habitat exists, (2) the presence and magnitude of threats, and (3) whether the sites can be secured and managed for the long-term protection of the species. Surveys should also include other potential gabbro or serpentine habitat to determine whether undiscovered populations may exist. If new populations are discovered, they need to be protected and managed as discussed above. During the surveys, potential introduction sites should also be identified. (USFWS, 2002)
- 5. Conduct necessary biological research and use results to guide recovery/conservation efforts. - Develop propagation techniques for listed plant species for which enhancement, repatriation, or introductions would be appropriate. Geographic area research is outlined in the Recovery Plan. Species-specific research is described as follows: Habitat Survey Research: Serpentine soil areas off the Pine Hill formation in El Dorado County; Serpentine and Gabbro areas in Nevada County; Serpentine near Red Hills in Tuolumne . Reproduction and Demography Research: Including determining limiting life stages, seed production and survival in soil to determine appropriate fire return period, reproductive studies identifying pollinators, seed germination studies. . Genetics research. . Other Research Needs: Influence of disturbance and fire on seedling establishment; effects of grazing; metapopulation analysis; effects of fire; fire management techniques; determine efficacy of other types of disturbance regimes for species and habitat management; feasibility of

habitat restoration/ enhancement. . Management Actions Needed: Disturbance/ burning; general surveys; baseline monitoring; monitoring for trends of populations, success of management actions and threats at all populations identified for protection; monitoring for habitat fragmentation, major shifts in vegetation type, and tracking of occurrence establishment, and extirpation; seed banking for disjunct populations. (USFWS, 2002)

- 6. Undertake artificial enhancement, repatriation, or introduction efforts where necessary. Where it is deemed necessary, artificial enhancement, repatriation, or introduction efforts for sensitive plants should be undertaken. Prior to repatriation or introduction of sensitive plants, genetics studies are needed (see Task 5) to ensure that new populations will not disrupt unique local gene complexes. Plant repatriation or introduction efforts should be undertaken using collected seeds or plant propagules. (USFWS, 2002)
- 7. Determine possible prescribed burning management strategies and incorporate the strategies into the management plans (Priority 1). Possible prescribed burning management strategies need to be evaluated, peer reviewed, and incorporated into management plans. (USFWS, 2002)
- 8. Perform metapopulation-type analyses for this species (Priority 2). The results of a metapopulation-type analysis may be useful in clarifying uncertainties, data needs, and research, management priorities, and delisting criteria. Metapopulation-type analyses should be based on the results of monitoring and research. (USFWS, 2002)
- Dedicate more resources toward the investigation of best management approaches for the Pine Hill listed plant species, even at the cost of a temporary hiatus in land acquisition efforts. Investigation should be made into fire-related and non-fire related methods of disturbance to maintain listed plant species habitat. (USFWS, 2019)
- Once the best management strategy (in terms of technique, frequency, timing, and intensity) is determined at each site, implement these management practices to achieve and maintain a habitat mosaic that enables the attainment of recovery criteria for the species.

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SPECIES ACCOUNT: *Serianthes nelsonii* (Hayun lagu (=(Guam), Tronkon guafi (Rota)))

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/18/1987; Pacific Region (R1) (USFWS, 2016)

Physical Description

Serianthes nelsonii is a large tree in the pea family (Fabaceae, subfamily Mimosoideae). Adult trees can reach heights over 30 m (98 ft) and diameters over 1.5 m (4 ft) (USFWS 1994, p. 11). Its bark is smooth and light brown in color. Fine rusty hairs cover the flowers, seed pods, and newer vegetation growth. Leaves are doubly pinnate with many pairs of leaflets. Flowers are brush-like with pink and white coloration, and fruits are hard, dry, brown pods (Stone 1970, p. 304). Seedlings closely resemble those of a small introduced tree, Leucaena leucocephala (tangantangan), but can be discerned by the fine pubescence on new leaf buds (USFWS 1994, p. 6).

Current Range

Serianthes nelsonii is endemic to the islands of Guam and Rota (USFWS 1987, p. 4907). Recorded specimens on Guam were mostly from northern limestone forests, but a few trees were recorded in southern clay soils (USFWS 1994, p. 8).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: What little is known about pollination, seed dispersal, phenology, flowering, and fruiting for this species comes mainly from incidental reports (USFWS 1994, p. 11). Fruiting occurs throughout the year, as seed pods have been observed during all months of the year (USFWS 1994, pp. 11-13). Similarly, flowering has been recorded during all months of the year, with one report (Schreiner and Nafus 1991, as cited in USFWS 1994, p. 11) reporting the highest proportion of branches with flowers in May and June. This report also indicated leaf production throughout the year with declines during the dry season from January to June. Age of reproduction in the wild is also unknown, but flowers and pods have been observed on cultivated trees as young as 10 years old (USFWS 1994, p. 13). Serianthes nelsonii, being a large, canopy tree species, provides habitat for a number of smaller species. This species supports a diverse community of arthropods including predator species such as spiders and mantids that may control other potentially problematic insect populations (Wiles et al. 1996, p. 233). S. nelsonii also hosts a variety of epiphytes including ferns, orchids, and other plants such as Ficus sp., and Freycinetia reineckei (Wiles et al. 1996, p. 233-234).

Habitat Type

Adult: Limestone forests

Habitat Narrative

Adult: Serianthes nelsonii is endemic to the islands of Guam and Rota (USFWS 1987, p. 4907). Recorded specimens on Guam were mostly from northern limestone forests, but a few trees were recorded in southern clay soils (USFWS 1994, p. 8). Currently, the last remaining wild adult tree on Guam is located at NWF, AAFB in northern Guam. A new fence was constructed to exclude ungulates in 2012 by AAFB, the Serianthes tree and seedlings are monitored monthly by DoD. DoD has conducted research on limiting factors for seedlings, fallen seeds collected and stored for future use. In 2014, 31 S. nelsonii seedlings supplied to the Service by JRM were planted at the GNWR in northern Guam (Demeulenaere et al. 2015, p. 4). The 31 seedlings are maintained with 2 previously outplanted saplings on the GNWR. On AAFB, one outplanted sapling is located in the Tarague Basin. The history of S. nelsonii's abundance and distribution on Rota is poorly known (USFWS 1994, p. 7), but surveys in 1994 estimated 121 adult trees with very little regeneration (Wiles et al. 1996, p. 232). Current estimates for Rota are 40 to 50 wild adult trees with little to no regeneration (J. Manglona, CNMI DLNR, pers. comm. 2015). Serianthes nelsonii is recorded mainly from limestone soils, with a few historical occurrences in clay soils in Guam (USFWS 1994, p. 8). Most of the adult trees in Rota occur on or near steep limestone cliffsides, and the last wild adult tree in Guam is located in rugged limestone karst habitat at NWF.

Dispersal/Migration

Population Information and Trends

Population Size:

48 on Rota, 1 on Guam (USFWS, 2020)

Population Narrative:

The total wild population of Serianthes nelsonii is estimated to be 50 adult trees, with almost all of the population occurring in Rota, and a single wild adult tree in Guam. In addition, there are outplanted occurrences on each island, all younger than 20 years of age. Seedling propagation and outplanting on Rota have been ongoing with limited success over the past 20 years, mainly in the Isang area in southern Rota, and between the main villages of Songsong and Sinapalo. Approximately 10 outplanted individuals in Rota have survived to a reproductive age (J. Manglona, CNMI DLNR, pers. comm. 2015). Twenty seedlings were outplanted in 1999 in the Tarague Basin, on AAFB in Guam (M. Marutani, University of Guam, pers. comm. 2015). To date, only one of these saplings has survived (AAFB 2015), but has not produced any seed pods (A. Gawel, USFWS, pers. obs. 2014). In 2009, approximately 30 seedlings were planted at the GNWR; all but 5 have survived (J. Cruce, USFWS, pers. comm. 2015). In 2014, 31 seedlings were donated to GNWR by JRM and outplanted and are being maintained by the Guam Plant Extinction Prevention Program (Demeulenaere 2015, p. 4) and GNWR staff. Recent Serianthes nelsonii recovery efforts on Guam and Rota have been dependent on funding, the amount of available propagated seedlings in nurseries, and the seedling to adult survival rates in the wild. In early 2015, the total number of nursery seedlings and saplings in Guam and Rota was estimated at 300 individuals, with approximately 200 in Guam nurseries. However, this estimation may change rapidly if outplanting seedling survival is low. Recent studies from AAFB indicated that although many seeds fall from the Guam adult tree and many of the seeds germinate, there is very limited survival under the mother tree (AAFB 2015). Both islands'

populations have constant regeneration of wild seedlings that are several days to several months old. However, these seedlings experience incredibly high turn-over, and in recent decades, none have been known to survive to adulthood in the wild (J. Manglona, CNMI DLNR, pers. comm. 2015; AAFB 2015, pp. 4-5). Although wild seedling survival is bleak, progress has been made on increasing the likelihood of survival of outplanted individuals with new methods of insect control and exclusion, given insect herbivory and damage are the major cause of outplanted seedling early mortality (E. Demeulenare, GPEPP, pers. comm. 2015). Continued demographic decline of wild population on Rota. The decline anticipated by Wiles (1998) continues. Recent field reviews on Rota (AnnMarie Gawel, USFWS, pers. comm. 2016a & 2016b) confirmed an apparent large dieoff among the historic adult trees, relative to the approximately 120 adult trees inventoried in 1992 (Wiles et al 1996). Also, there was no regeneration (no seedlings recorded). The following is a more specific breakdown, organized by Wiles' original subpopulation numbers, all from Ann Marie Gawel, USFWS (pers. comm. 2016a & 2016b), except for subpopulations 1, 6, and 14. o Subpopulation 1: Of the 15 adult trees recorded in 1992, 11 remain alive (McBride field notes and GPS points, October 2016). o Subpopulations 2-5 and 7-10: Of the 63 adult trees in this area in 1992, only 19 were found alive in June 2016, while another 20+ large stumps and down logs (none recent) may represent some of the prior Serianthes lost there. o Subpopulation 6: Of the 4 adult trees recorded in 1992, none were found alive in this area; a large diameter snag and larger down log may represent two of the prior trees recorded here (McBride field notes and GPS points, January 2017). o Subpopulations 11-13: One live tree, with a full crown, was observed from the road in January 2017; Rota Forestry indicated that the rest of the 28 live trees in this area in 1992 had previously died (McBride field notes and GPS points, January 2017). o Subpopulation 14: Of the 8 adult trees recorded in 1992, one remains alive as of October 2016. However, this last survivor is in very poor condition, with less than 5% live crown (McBride field notes, October 2016). o Subpopulations 15-16: Rota Forestry observed that the 3 live Serianthes recorded here in 1992 have all subsequently died. 3 Rangewide demographic decline. In aggregate, including the one surviving adult Serianthes on Guam, the current numbers represent a 73% decline among these wild Serianthes trees from the 1992 baseline— from the 122 documented then to 33 currently known (USFWS, 2017). Reduction in geographic range of wild population on Rota. Along with the demographic decline, there has also been significant reduction in the known range of the wild population. At the time of the 1992 inventory, the species range on Rota could be described as largely surrounding the Mount Sabana massif, which dominates the west half of the island— a distance of nearly 8 km. Following the loss of Wiles' 1992 subpopulations in the Palii area (#'s 15 & 16), that distance has already been reduced by half to just under 4 km. Other outlying subpopulations (#14, in Lupok area, and #'s11-13, in the Isang area) have greatly declined, down to a single surviving individual in each location at last report — representing a 93% reduction of the 36 total individuals recorded among these subpopulations in 1992. If these outlying populations are lost, the Rota population will be restricted to a 1.6 km area on the southwestern flank of Mount Sabana. Whether or not such continuing collapse transpires, 94% of today's remaining known wild Serianthes population on Rota survive within an area of less than 100 hectares. With this reduced range, the remaining population is highly vulnerable to large- to mid-scale disturbance events, whether of anthropogenic, climatic, or other origin (USFWS, 2017). On Guam, the lone adult tree at Ritidian continues to survive in a deteriorated condition, with no persisting natural regeneration to sustain a wild population. The one remaining mature Serianthes tree survives, despite evidence of its compromised condition (reduced crown volume; conks and visibly decayed wood showing development of Ganoderma fungus). This tree, including its flowers, fruits, seeds, and surrounding seedlings, were monitored

on a monthly basis through 2016. The prevalence of the fungus Phellinus noxious in other trees in close proximity this tree is a concern. While it is not established if the Phellinus noxious directly affects Serianthes, the fungus can be a lethal pathogen for several native forest tree species (AAFB 2016). Several researchers have monitored and studied the fate of seedlings under the crown. Marler and Cascasan (2015) studied the survival of seedlings germinating beneath this tree, documenting both their high recruitment potential (an average of >1 seedling emerging per day throughout 2013) and inability to survive to the juvenile stage. Over half the seedlings died within the first month after sprouting, while essentially all had died by 200 days post-emergence. During 2014-15, Marler and Musser (2015) monitored the survival and fate of 488 seedlings under the Ritidian tree, evaluating four different treatments as mitigations for potential seedling stressors. While insecticide, fertilizer, and supplemental lighting treatments did not meaningfully extend the longevity of test seedlings, those treated with a fungicide (Ridomil Gold) survived more than twice as long as the untreated control seedlings. This suggests that root pathogens may be significant agents of mortality, in addition to the previously-recognized problems of insect and ungulate herbivory. The capacity for Serianthes to regulate the soil's 4 biogeochemistry beneath its canopy was also studied; in contrast to more distant samples, those taken from within the litterfall area beneath the tree had significantly more nitrogen, carbon, calcium, magnesium, copper, and zinc; and less iron (Naval Facilities Marianas 2015). At the Guam National Wildlife Refuge, Deregnier (USFWS, pers. comm. 2016a) observed a range of insect herbivory agents, among which mealybugs have been the most problematic; their attacks on both foliage and (particularly) roots of Serianthes have caused 10 of 12 seedling deaths to date. Also on the Refuge, Deregnier found that outplanted trees seemed to do best in forest-gap settings: that is, with relatively high light and humidity, but low wind exposure (Ryan Deregnier, USFWS, pers. comm. 2016a). On both Guam and Rota, the high rate of loss of the remaining wild trees — together with the failure of seedlings to persist — emphasizes the importance both of studies of the mechanisms of decline in the wild populations, as well as into propagation methods to sustain the species through the near to mid-term (USFWS, 2017). In addition to these in situ studies, off-site research on Guam has contributed knowledge toward successful propagation practices and establishment of horticultural protocols. Marler et al. (2015) evaluated seedling emergence in varying shade conditions, finding that both percentage and velocity of seedling emergence for Serianthes were maximized in deep shade. They also found that seeds of Serianthes are not very short-lived, with germination observed after nine months of storage at ambient temperature and relative humidity. The University of Guam's Guam Plant Extinction Prevention Program (GPEPP) worked on in vitro seedling propagation, including tissue culture from seedling meristematic tissues to mitigate limited seed availability (GPEPP 2015) (USFWS, 2017). Other field observations: On Rota, during the June 2016 field reviews it was observed that the root masses of mature Serianthes trees extend laterally from the trunks 6 m or more above ground (and perhaps further sub-surface), which may provide the trees greater stability and water-uptake (AnnMarie Gawel, USFWS, pers. comm. 2016a). Older outplanted Serianthes became reproductive after 18-23 years (McBride, field observations August 2016), and may be capable of doing so as young as ages 12-15 (Manglona, pers. comm. 2016a & 2016b). On Guam, two trees less than 4 years old (outplanted in Nov. 2014) have produced flowers, but fruit has not yet been confirmed; these trees were known to be substantially stressed by mealybug infestations at the time (Ryan Deregnier, USFWS, pers. comm. 2016b) (USFWS, 2017). Distribution of recovered populations (future). Considering the delisting objective for Rota of having four populations separated by at least 1 km, some of these older outplanted trees may become the locations for those eventual recovery populations. Since the distribution of the currently known wild subpopulations would

only provide for two or three of the required recovery populations, it is evident that additional reintroduced (outplanted) populations may be essential to attain the delisting objective (USFWS, 2017). Anticipated: An upcoming study by E. Demeulenaere at the University of Guam on phylogenetics of Serianthes, which should clarify the degree of genetic similarity between the Guam and Rota populations. One objective of this study is to develop genetically-informed strategies for conservation of the species (USFWS, 2017). Anticipated: A study by GPEPP funded by McIntire Stennis to determine the genetic make-up of the Serianthes taxa, which will analyze the phylogenetic relationship of Serianthes nelsonii to other members of the Serianthes genus in the region. This project aims to confirm that Serianthes nelsonii is a valid species differing from congenerics in the region (USFWS, 2017). Recent surveys and population estimates indicate several more trees on Rota than previously known, and a total estimate of 49 trees, 48 which are found on Rota, and the single tree on Guam with on-site recruitment (Table 1) (Bamba in litt 2020; AAFB, 2020; GNWR 2020). Seedling survival, however, is very low. Monitoring, collection, propagation, and reintroduction efforts are ongoing. Some threat control, such as fencing to protect individuals from ungulate damage and research to control insect herbivory, is ongoing. (USFWS< 2020)

Threats and Stressors

Stressor: • Loss and degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Development from construction and military training has decreased the total recovery habitat for this species. Serianthes nelsonii habitat continues to be degraded by ungulates (Wiles et al. 1996, p. 234; DON 2013c), i.e. feral pigs and Philippine deer (Rusa mariannae), and by encroachment of invasive plants. In addition, declines in pollinators, seed dispersers, and insectivores have contributed to habitat loss (Wiles et al. 1996 p. 230).

Stressor: • Introduced predators and herbivores
Exposure:
Response:
Consequence:
Narrative: Introduced deer and pigs feed on Serianthes nelsonii (Wiles et al. 1996, p.234; Morton et al. 2000, p. 230). A number of invertebrate predators and herbivores also have been reported on this species: mealybugs (Dysmococcus brevipes, D. neobrevipes, Ferrisia virgate, and Planococcus sp.), caterpillars of Eurema blanda, termites (USFWS 2012b), and katydids (A. Moore, University of Guam, pers. comm. 2014). In addition, insect predation occurs on seed pods in Rota, but the insect is unknown (USFWS 2012b).

Stressor: • Stochastic events
Exposure:
Response:
Consequence:
Narrative: Typhoons have resulted in damage and mortality to this species as well as damage to habitat (USFWS 2012b).

Recovery

Delisting Criteria:
For Serianthes nelsonii to be considered for delisting, the Service proposes that at least four populations be established on each island – Guam and Rota – each with a 10-year average of 500 or more reproductive plants (USFWS 1994, p. 26). The populations should have age structures comprised of a large proportion of adult trees as well as seedlings and immature trees (USFWS 1994, p. 26). In addition, the Service recommends that the populations on Rota be separated by at least 1 km (0.621 mi), and that at least one of the populations in Guam should be in the southern part of the island (USFWS 1994, p. 26).

Recovery Actions:
- To achieve recovery needs, the Service outlines the following recovery actions (adapted from USFWS 1994, pp. 27-37):
- • Additional surveys are needed on both islands since the last surveys for this tree were in 1994. To prevent ungulate degradation and herbivory, subpopulations should be fenced wherever possible. Methodology to control insect pests should be developed and implemented. Existing individuals need to be monitored for survivorship, new threats, and any possible evidence of regeneration. Public education and community involvement should also be encouraged and developed.
- • Conduct research important to the management of Serianthes nelsonii. The ecology, life history, and habitat requirements of S. nelsonii are poorly understood and should be studied. Although a number of insect pests have been identified, many remain unidentified, and their ecology, specific effects, abundance, and especially control methods need to be investigated. The Service also recommends genetic studies, especially on the variation between Guam and Rota populations, as well as any effects from small population size and inbreeding.
- • Augment current populations and reintroduce to historical range. Plans for augmentation and reintroduction should be developed for both Guam and Rota. Areas for outplanting should be identified and secured, and plants should be propagated and transplanted to the identified areas.
- • Prevent clearing of forest next to S. nelsonii. Maintenance of an intact forest canopy next to S. nelsonii will reduce the potential of edge effects and for high winds during typhoons to break tree limbs and trunks.
- • Implement standardized control procedures for insect pests after research on insect control determines appropriate methodology.
- Propagation and outplanting programs on Guam: the Guam Plant Extinction Prevention Program propagated seedlings (seeds from the Ritidian tree) in their Rare Plant Nursery during FY2014-15; these were outplanted at the Guam National Wildlife Refuge, in partnership with Anderson AFB, USFWS, and LMS Landscape Services (Marler 2014, GPEPP 2015). From Nov. 2014 to Dec. 2016 at the Guam NWR, 68 young Serianthes nelsonii were outplanted, with 48 of those two- to four-year-old trees surviving as of December 13, 2016. Also, there are five surviving older (five to nine years old) outplanted Serianthes, planted during 2009-2012. All 73 seedlings were propagated by the University of Guam's Guam Plant Extinction Program, from seed from the last surviving adult Serianthes tree on Guam. These outplantings are distributed in four clusters throughout the Refuge. GPEPP recently planted 10 Serianthes seedlings at the University of Guam (UOG), 10 at the UOG Yigo Agricultural Research Station, and 15 at the Cotal Conservation area (USFWS, 2017).

- Outplanting sites are fenced to exclude ungulates, with individual trees enclosed in netting to prevent defoliation or other damage by insects, including mealybugs, ants, scale insects, whiteflies, psyllids, butterfly and looper caterpillars, and katydids and cerambycid beetles. Insecticidal treatment against mealybugs was conducted both directly (insecticidal soap on mealybugs themselves), and indirectly through bait poisons for their tending ants. Concern about potential negative effects of soil-borne pathogens on seeds led to the proposed usage of hanging seed collectors to capture some of the seedfall above the ground (AAFB 2016; Ryan Deregnier, USFWS, pers. comm. 2016a & 2016b). Finally, recent reports including monthly monitoring detail the condition, through September 2016, of the one older juvenile Serianthes persisting in the Tarague Basin. This is the lone survivor of 67 outplanted in 1999-2000; three had been alive as recently as 2013 (Naval Facilities Marianas 2015; AAFB 2016) (USFWS, 2017).
- Propagation and outplanting programs on Rota: from 2015-2016, 62 young Serianthes have been outplanted; these plants are protected by fenced enclosures and are currently two to three years old (Manglona 2016). Also, there are 10 older outplanted Serianthes (18-23 years old; identified as “mature” in Table 1) planted in four different locations (James Manglona, pers. comm. 2016b), among which at 6 least 6 of 9 observed trees are currently producing flowers and seedpods (McBride, personal observation). Susceptibility of these outplants to scale insects and other pathogens necessitates their active management until reaching at least three meters in height to ensure their survival—and even larger trees are still visibly affected, if not lethally (James Manglona, pers. comm. 2016c). Some of the older outplantings are farther northeast and in lower elevations (100-125m) than the historical range of the species on Rota (above 150m, Mount Sabana massif only). This expansion of the species range on Rota through propagation could prove beneficial in the event of large-scale disturbances (USFWS, 2017).
- Also on Rota, in 2016 Lainie Berry of CNMI Department of Lands and Natural Resources began work on surveys and propagation of Serianthes, under a USFWS Section 6 grant (F16AP00687). In addition to surveys for new individuals as well as all previously-known trees, efforts to propagate the species will also be undertaken. Anticipated propagation activities include seed and cutting collection, propagation via established techniques, outplanting in conservation areas, and initial monitoring. Existing fencing will be restored as needed, new fencing and signage established, and invasive plants hand-cleared where necessary to protect individual trees. This work is scheduled to conclude in 2018. Ongoing fence maintenance will be carried out by Rota Forestry, as well as longer-term monitoring if additional federal funding is secured (USFWS 2016) (USFWS, 2017).
- In addition to the previously-described monitoring and propagation activities being conducted by Anderson AFB, in accord with the terms of their recovery permit, they have convened a Serianthes Strategy Team. The purpose of this team is to develop, in cooperation with AAFB, GPEPP, USFWS, and other recovery collaborators, a long-term conservation strategy for propagation and outplanting of Serianthes nelsonii, to replace the initial one-year strategy outlined in the permit by July 2017 (AAFB 2016) (USFWS, 2017).
- Anticipated: The Department of Navy’s proposed relocation of the U.S. Marine Corps from Okinawa to Guam, as well as the associated activities on Guam, has been evaluated by the Service (USFWS 2015). In that Biological Opinion, the Service concluded that this project, including the construction and operation of a Live-Fire Training Range Complex (LFTRC) in close proximity to the lone surviving wild adult Serianthes on Guam, would likely have a number of effects on that mature tree, nearby seedlings, outplanted saplings, and the species’ recovery habitat on Guam. These anticipated effects include, but are not limited to,

clearing of 948 acres of recovery habitat—including 65 acres of primary limestone karst forest, to within 100 feet of the surviving tree; increased exposure to wind loading and its potential for damage or injury to that adult tree; other abiotic and biotic edge effects, including microclimate alterations and increased invasibility by non-native species; potentially increased fire risk; potential disruption of ecological relationships such as pollination and seed dispersal; and reduced accessibility to the wild tree/seedling area and the outplanted saplings for both research and management purposes. In that Opinion, the Service concluded 7 that the proposed action will adversely affect the last remaining adult Serianthes nelsonii tree in Guam, will negatively impact that wild tree and seedlings around it, and the outplanted saplings at the Refuge, and will result in the loss of 948 acres of recovery habitat. The Service further concluded that if the Department of Navy fully implements its proposed conservation measures and best management practices—including but not limited to the outplanting of 30 Serianthes nelsonii trees in a protected area, and their successful maintenance into adulthood—then it is unlikely that this project will preclude the recovery and survival of S. nelsonii. However, the Opinion also states that if new information suggests that the Guam population is distinct from S. nelsonii in Rota, or if the baseline for this species experiences an unforeseen major decline, this determination will need to be revisited. (For further details, see full Biological Opinion, USFWS 2015). Since S. nelsonii has undergone a major decline, the Navy has been notified of this status update and the Service is anticipating re-consultation (USFWS, 2017).

- Preserve the remaining genetic and geographic diversity of the species. Maintain presence of existing reproductive individuals on both islands. This will best assure continuity of seed sourcing for propagation efforts while safeguarding what remains of the species genetic diversity, and retaining some geographic distribution to mitigate the risk of catastrophic loss from disturbance events (USFWS, 2017).
- Similarly, research and other recommended actions below need be conducted in recognition that the populations between the two islands may be distinct in various ways: genetically, ecologically, or with regard to threats, and other survival or recovery issues. Original studies on each population may be necessary to inform effective management on the two islands (USFWS, 2017).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of military training activities, agricultural and urban development, and hurricanes (typhoons) (USFWS, 2017).
- Fire protection – Develop and implement a fire management plan for all populations (USFWS, 2017).
- Implement fencing plans for both outplanted trees and wild subpopulations as described in the recovery plan; this fencing should be designed to exclude ungulates and allow greater chance for successful establishment of seedling regeneration. As one example, the Aplalago “grove” (subpopulation #1) of 11 live adult trees could be enclosed with as little as 120-200 m of fencing, using the nearby cliff rim as a natural barrier along one side (USFWS, 2017).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species within fenced enclosures (USFWS, 2017).
- Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist (USFWS, 2017).
- Continue propagation and outplanting programs on both islands to establish Serianthes in a range of locations, particularly within the known historic distribution around the Mount Sabana massif on Rota (USFWS, 2017).

- Captive propagation for genetic storage and reintroduction: o Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation. o Augment the species with specimens from Rota to encourage genetic mixing of the Guam population (USFWS, 2017).
- Captive propagation protocol development – Protect seed pods with a fine mesh covering to prevent predation by arthropods before seeds mature (USFWS, 2017).
- On Rota, collect seed stock at the Aplalago subpopulation (#1), to broaden the genetic diversity of current propagation material, and thus potentially augment its characteristics for survival (USFWS, 2017).
- On Rota, conduct studies of the subpopulations (#1, #7) with better recent-term survival, to identify any characteristics potentially favoring enhanced survival (USFWS, 2017).
- Invertebrate herbivory research – continue studies to identify the effects of invertebrate predation on seeds and seedlings of S. nelsonii. If determined to be a limiting factor, develop and implement control measures to protect the species (USFWS, 2017).
- Root pathogen research – Develop studies to identify specific root pathogens that influence the survival of S. nelsonii seedlings, and the mechanisms by which this occurs. If determined to be a limiting factor, develop and implement control measures to protect the species (USFWS, 2017).
- Population biology research – Research the use of hand pollination to enhance outbreeding of the species (USFWS, 2017).
- Threats research: o Research what factors are limiting the natural recruitment of individuals in each population--both on Guam, and on Rota. o Assess the modeled effects of climate change on this species, and use results to determine future landscape needed for the recovery of the species (USFWS, 2017).
- Alliance and partnership development – Continue to work with Guam National Wildlife Refuge, Guam Plant Extinction and Prevention Program, the CNMI's Department of Lands and Natural Resources and both its Forestry Division and Fish and Wildlife Division, the Guam Department of Agriculture's Forestry and Soil Resources and Aquatics and Wildlife Divisions and other land managers to further their implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2017).
- Review the recovery plan (USFWS 1994) to determine if any new information suggests a need to update the plan to more effectively attain recovery goals (USFWS, 2017).
- New management actions that have occurred in the last five years include: Since Serianthes nelsonii was listed in 1987, outplanting of individuals have been attempted with limited success. However, several recovery projects aimed at understanding and improving outplanting efforts and management of individuals have begun since 2012: • The last remaining adult tree in Guam is fenced to prevent access by ungulates. The Air Force has funded research to look at ecology, seedling survival, propagation methods, and health and life history of the adult tree (AAFB 2015). • The Service has funded a project with the CNMI Division of Forestry in Rota to outplant and maintain Serianthes nelsonii in fenced plots on private property. • The Service has funded a multi-year project for Serianthes nelsonii recovery on the GNWR to be managed by a full-time biologist. This person will work with the Guam Plant Extinction Prevention Program to maintain the S. nelsonii seedlings that were outplanted at the GNWR in 2014. The Service is collaborating with Guam Department of Agriculture, DoD, the University of Guam, and the Guam Plant Extinction Prevention Program.

- Recommendations for Future Actions (adapted from USFWS 2012b, pp. 17-18) • Captive propagation for genetic storage and reintroduction: o Continue to collect seeds from all existing populations and propagate at multiple locations to increase success. o Perform genetic studies to determine if Guam and Rota populations are distinct. • Captive propagation protocol development – Protect seed pods with a fine mesh covering to prevent predation by arthropods before seeds mature. • Reintroduction / translocation implementation: o Propagate and maintain all outplanted individuals on the GNWR to a size where insect herbivory is less likely to cause mortality. This will likely be when plants produce multiple branches and the main stem achieves a girth sufficient enough to withstand damage from Eurema blanda butterflies laying eggs in the plant's tissue. • Ungulate control – Continue to protect all populations against disturbances from feral ungulates. • Invertebrate control research – Research and identify the effects of invertebrate predation on seeds and seedlings of S. nelsonii. If determined to be a limiting factor, develop and implement control measures to protect the species. • Population biology research – Research the use of mechanical pollination to enhance outbreeding of the species. • Surveys / inventories – Resurvey the historical range of the species to determine if previously unknown or newly reestablished populations exist. • Threats research: o Research what factors are limiting the natural recruitment of individuals in Guam. o Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. • Ecosystem-altering invasive plant species control – Control invasive introduced plant species within fenced exclosures. • Site / area / habitat protection – Develop and implement effective measures to reduce the impacts of agricultural and urban development and hurricanes (typhoons). • Fire protection – Develop and implement a fire management plan for all populations. • Alliance and partnership development – Continue to work with GNWR, Guam Rare Plant Restoration Group, and other land managers to continue implementation of ecosystem-level restoration and management to benefit this species.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: • Surveys/inventories—Continue to monitor wild and reintroduced populations Serianthes nelsonii, including assessment of impact of threats on individuals and the populations. • Population Biology—Continue molecular studies to better understand the genetic structure of Serianthes nelsonii and apply results to a conservation strategy. • Ungulate control—Continue to improve and refine ungulate-exclusion techniques to protect individuals. • Captive propagation for genetic storage and reintroduction—continue to collect from unrepresented founders to maintain collections ex situ and propagation for reintroduction • Reintroduction and translocation—Identify suitable reintroduction sites and continue to establish new populations and augment wild populations on Guam and Rota. • Alliance and partnership development—Continue to work with the local governments, University of Guam, military, and other partners and land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. o Habitat and natural process management and restoration— o Continue habitat management in areas where the species currently exists (USFWS 2006). o Fortify fences and netting that are already established around the species. o Remove ungulates from within the fences. o Develop effective techniques against defoliating insects. (USFWS, 2020)
- New management actions: • Molecular studies continue to understand the genetic diversity among populations (AAFB 2020). • The Rota Forestry Nursery has 184 trees in their inventory, as well as 173 seedlings in propagation (Bamba 2020, in litt.). • Water bladders have been put at the base of

the outplanted trees at Guam National Wildlife Refuge (GNWR) in order to reduce the threat of drought and increase survivorship. Staff observed the importance of maintaining water in the bladders in order to avoid increased soil temperatures below the bladders once they become empty (GNWR 2020, pers.comm.). (USFWS, 2020)

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SPECIES ACCOUNT: *Sibara filifolia* (Santa Cruz Island rockcress)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/8/1997; Pacific Southwest (R8)

Physical Description

An annual herb, usually with a single, slender, branching stem, 1.5-3 dm tall. Leaves are finely divided into many linear lobes. Flowers (March-May) have pink or purple, spoon-shaped petals. Fruit is a long slender pod. (NatureServe, 2015)

Taxonomy

Sibara filifolia (E. Greene) was first collected by Greene in 1886 and described as Cardamine filifolia (Greene 1887a, p. 30). Greene later transferred it to Arabis filifolia (1887b, p. 390). In 1896, Greene proposed the new genus Sibara to accommodate the species (Greene 1896, pp. 10– 12). Sibara filifolia has been maintained by all subsequent floristic and systematic treatments (Munz 1974, pp. 300–301; Rollins 1993, pp. 435–436; Al-Shehbaz 2012, p. 562). There have been no changes in the nomenclature or taxonomic classification of Sibara filifolia since it was listed (USFWS, 2012).

Historical Range

See current range/distribution.

Current Range

California endemic, currently known only from San Clemente Island (possibly still be extant on Santa Catalina Island, although not seen there since 1973); formerly collected on distant Santa Cruz Island, so thought to have been more widespread in the past (USFWS 1997). (NatureServe, 2015)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollination (USFWS, 2012)

Breeding Season

Adult: Flowers in April (USFWS, 2012)

Reproduction Narrative

Adult: Sibara filifolia (Santa Cruz Island rock-cress) is a diminutive and slender annual herb in the Brassicaceae (mustard family) that flowers in April (Munz 1974, pp. 300–301). It is 13 to 38 centimeters (cm) (5 to 15 inches (in)) tall. The flowers are bisexual and are borne in small terminal unbranched flower stalks called racemes. Based on greenhouse observations, it appears that Sibara filifolia is self-compatible and capable of self-pollination or is possibly

apomictic (capable of producing seeds without pollination) (Wall, pers. comm., 2006; K. Helenurm, University of South Dakota, pers. comm., 2006). Under natural conditions, plants typically produce 2 to 10 fruits (Helenurm, pers. comm., 2006). Seed dispersal appears to be by gravity, with many seeds likely tumbling or washing downhill (Helenurm 2003, p. 184). Past germination trials at Rancho Santa Ana Botanic Garden have proven successful by simply placing S. filifolia seeds in the soil (Wall, pers. comm., 2006). As discussed in the 2006 5-year review, previous studies investigating the tolerance of S. filifolia seed to smoke and fire suggested that the plant is not well-adapted to fire (C. Ames, Rancho Santa Ana Botanic Garden, pers. comm., 2006; Wall, pers. comm., 2006). (USFWS, 2012).

Habitat Type

Adult: Volcanic scree (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species is currently known only from south-facing, sunny, volcanic screes but historical populations were apparently found in shady places (NatureServe, 2015).

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Seed dispersal appears to be by gravity, with many seeds likely tumbling or washing downhill (Helenurm 2003, p. 184). Past germination trials at Rancho Santa Ana Botanic Garden have proven successful by simply placing S. filifolia seeds in the soil (Wall, pers. comm., 2006). As discussed in the 2006 5-year review, previous studies investigating the tolerance of S. filifolia seed to smoke and fire suggested that the plant is not well-adapted to fire (C. Ames, Rancho Santa Ana Botanic Garden, pers. comm., 2006; Wall, pers. comm., 2006) (USFWS, 2012).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:

The taxon was only known from the Channel Islands, but is believed to be extirpated from at least one. Proper management may increase suitable habitat for this taxon. Decline of >70% (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2020)

Population Narrative:

At the time of the last 5-year review in 2012, three populations were considered extant, two on Santa Catalina Island and one on San Clemente Island (i.e., Cape Canyon and Wild Board Gully, and Pyramid Point, respectively). In this review, we consider just two populations to be extant; Cape Canyon on Santa Catalina Island has not been observed since 1973 and its status is currently unknown. (USFWS, 2020)

Threats and Stressors

Stressor: Nonnative plants (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasive nonnative plants represent a significant, ongoing, rangewide threat to Sibara filifolia. Vectors for their dispersal into habitat occupied by S. filifolia can include vehicles, humans, and other animals. Increased fire frequency, associated with nonnative plants, can also produce type conversion from shrub-dominated landscapes to those occupied by mainly invasive, nonnative, annual grasses. Nonnative invasive plant removal activities are being implemented on both islands where S. filifolia is known to be extant. The implementation and effectiveness of such programs may be limited to currently monitored occurrences (Wild Boar Gully (EO 7) on Santa Catalina Island), where site-specific monitoring and treatment actions are identified and implemented. The implementation is absent and effectiveness unknown for nonnative plant control at point localities associated with the occurrence at Pyramid Point (EO 2) on San Clemente Island; this area is closed due to the presence of UXO. The long-term threat to habitat occupied by S. filifolia may be significantly reduced if sources of invasive plant propagules and vectors that facilitate their spread are reduced or eliminated. Impacts of invasive nonnative plants on S. filifolia habitat will continue at significant levels in areas where these elements are not controlled (USFWS, 2012).

Stressor: Fire (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: In summary, fire remains an ongoing threat to Sibara filifolia habitat on Santa Catalina and San Clemente Islands. The vulnerability results from small populations and potential type conversion of habitat resulting from fire, particularly the invasion of nonnative invasive annual grasses. Fires on San Clemente and Santa Catalina Islands occur frequently and fire prevention measures and invasive plant control are necessary for the protection of S. filifolia habitat. Control of invasive nonnative grasses is necessary on Santa Catalina Island to prevent adverse fuel conditions that might impact S. filifolia habitat and seed bank. The FMP developed for San Clemente Island has identified measures to minimize the risk of fires spreading from the impact

areas to adjoining habitat where S. filifolia may occur; however, lack of access will likely limit or preclude site specific management actions, fire response measures, and post-fire assessments (USFWS, 2012).

Stressor: Erosion (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Erosion from training exercises on the island has resulted in the past. The likely extent of erosion has recently been evaluated for off-road Assault Vehicle Maneuver Areas, Artillery Firing Points, Artillery Maneuvering Points, and Infantry Operations Area (Navy 2008a, pp. G-1, G-2). The Navy has proposed an erosion control plan that would consider a variety of erosion control methods to promote sustainable land use in support of military operations in these areas) (Navy 2008a, p. G-22); however, there is no approved off-highway vehicle use until this plan comes into effect (Munson, pers. comm., 2011a). The erosion control projects developed in this plan will be implemented in ways that best avoid threatened and endangered species (Munson, pers. comm., 2011a). Erosion impacts to Sibara filifolia habitat do not appear to be significant at this time (USFWS, 2012).

Stressor: Trampling (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Although trampling of native vegetation was not discussed directly as a threat in the listing rule, it was described relative to grazing of large mammalian herbivores, which together have facilitated the spread of nonnative plants on the Channel Islands (USFWS 1997a, p. 42693). The threat of trampling from large mammalian herbivores has been reduced since listing due to the removal of goats and pigs from Santa Catalina Island and San Clemente Island. The fencing surrounding Wild Boar Gully (EO 7) on Santa Catalina Island has also substantially reduced this threat. At present, the potential threat of trampling from large grazing animals (blackbuck antelope (Antilope cervicapra), mule deer (Odocoileus hemionus), and American bison (Bison bison)) only exists near Cape Canyon (EO 6) (Appendix 1). Sibara filifolia is at risk from human trampling due to the small size of the populations, although human access is regulated on each of the Channel Islands. Due to its cryptic appearance, this may result from biologists surveying or otherwise conducting management activities on the islands (Kellogg, pers. comm., 2006). On Santa Catalina Island, work crews removing invasive plant species likely represent the primary threat, as the area where the plant occurs is fenced with restricted public access. On San Clemente Island, the potential threat of trampling can result from biologists' activities as well as any military training activities that could involve troop movements through the area where the plant is distributed. The Navy proposed to brief military units on maneuver area boundaries prior to conducting operations to minimize the potential of incidental foot traffic in S. filifolia habitat; the use of markers to aid in identification of range boundaries or sensitive areas is considered incompatible with training (USFWS 2008, p. 140). The potential for human traffic is high, because the plant is distributed on ridgetops and flat areas rather than within inaccessible steep terrain, (Kellogg, pers. comm., 2006). However, the incidence of impacts to S. filifolia is expected to be very low (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)

Exposure:
Response:
Consequence: Loss of genetic variability/extinction
Narrative: The listing rule discussed the vulnerabilities associated with few occurrences of small population sizes for Sibara filifolia (USFWS 1997a, p. 42699). Sibara filifolia is vulnerable to extirpation from a number of factors such as environmental stochasticity, genetic stochasticity, demographic stochasticity, and natural catastrophes, because it is an insular endemic species presumed to currently exist as three small, narrowly distributed occurrences (Shaffer 1981, p. 131). Small population size may be the result of several conditions, including local extirpations or ongoing natural or artificial factors limiting establishment and survival of the taxon. Stochastic events represent a significant threat to small occurrences. Given the extremely restricted distribution of this species, any natural catastrophe such as a fire, landslide, or prolonged drought on an island could lead to the extirpation of the species from one of the two islands currently known to support the species. On San Clemente Island, the known extant occurrence (EO 2) of Sibara filifolia could be affected by a single fire. The Santa Catalina Island occurrences (EOs 6, and 7) are also closely spaced and likely to be similarly affected by a single catastrophic event. However, the presence of S. filifolia on separate islands improves the prospects for continued survival of the species in the event of a natural catastrophe. The likelihood of maintaining genetic diversity decreases in smaller populations (Barrett and Kohn 1991, pp. 9, 10, and 13) and elevates concern for small, isolated populations of Sibara filifolia. The low genetic diversity and low differentiation observed from San Clemente Island may indicate a bottleneck or potentially nearly complete selfing lineages, or both for this population (McGlaughlin, pers. comm., 2011). Loss of genetic variation could limit the likelihood of this species maintaining tolerances suited to a changing environment (Helenurm 2003, p. 185). In contrast, the observed genetic diversity found within the Santa Catalina Island indicates the importance of those populations for seed banking and other conservation activities. The risk of extinction of Sibara filifolia from elements inherent in its small insular population size is lessened by the conservation seed bank established at RSABG since the listing (Wall, pers. comm., 2006). While seed banking, by itself, does not remove the systematic or stochastic threats facing natural populations of S. filifolia, these seeds can provide source material to reestablish populations in the wild should they become extirpated (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Impacts to Sibara filifolia under predicted future climate change remain unclear. While it appears reasonable to assume that this taxon may be affected, we lack sufficient certainty on knowing how and when climate change will affect the species, the extent of average temperature increases in California, or potential changes to the level of threat posed by fire on the Channel Islands. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to S. filifolia at this time (USFWS, 2012).

Recovery

Recovery Actions:

- No recovery plan or outline has been prepared for Sibara filifolia (USFWS, 2012).

- Based on recommendations and genetic diversity of occurrences, establish an adequate seed bank for Sibara filifolia with sampling emphasis on genetically highly diverse sites on Santa Catalina and a lesser emphasis on the less diverse sites on San Clemente Island (USFWS, 2012).
- Maintain and improve invasive nonnative plant control programs with a focus on sites where Sibara filifolia occurs or where habitat conditions may support reemergence of the species from a dormant seed bank (USFWS, 2012).
- Continue to collaborate with the Navy on ongoing projects to assist with conservation of listed species on the island to help facilitate effective management and monitoring of Sibara filifolia (USFWS. 2012).
- Determine soil and habitat preferences for Sibara filifolia and conduct additional surveys on all three islands where S. filifolia has been collected historically using this data to look for previously undetected occurrences as well as identify and characterize potential reintroduction sites (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The recommended actions listed below were identified in the 2012 status review. The actions were intended to reduce threats to Sibara filifolia and provide information to better understand the biological and physical factors limiting the population growth and distribution. We recognize that conservation of S. filifolia will require cooperation and coordination with partners (e.g., Federal, State, local agencies, and non-profit entities) to minimize impacts from current threats, aid future restoration, and maximize effectiveness of limited funding. Progress has been made on each of these actions, but they remain relevant to the recovery of S. filifolia. Minor updates to the actions from 2012 are underlined below. 1. Based on recommendations and genetic diversity of occurrences, establish an adequate seed bank for Sibara filifolia with sampling emphasis to capture genetic diversity of natural populations. 2. Maintain and improve invasive nonnative plant control programs with a focus on sites where Sibara filifolia occurs or where habitat conditions may support reemergence of the species from a dormant seed bank. 3. Continue to collaborate with the U.S. Navy and Catalina Island Conservancy on ongoing projects to assist with conservation of listed species on San Clemente and Santa Catalina islands to help facilitate effective management and monitoring of Sibara filifolia. 4. Determine soil and habitat preferences for Sibara filifolia and conduct additional surveys on all three islands where S. filifolia has been collected historically using this data to look for previously undetected occurrences as well as identify and characterize potential reintroduction sites. As part of this effort, conduct surveys at the Cape Canyon site on Santa Catalina Island to determine its status; Sibara filifolia has not been observed at Cape Canyon since 1973 and its status is currently unknown and possibly extirpated. We've identified the following additional recommendations to supplement those described above from 2012: 5. Investigate what may have caused Sibara filifolia to become extirpated on Santa Cruz Island. If those causes can be ameliorated, determine whether there is suitable habitat to sustain outplantings and conduct surveys for potential reintroduction sites. 6. Research the mating system of the species throughout its range, including the role of pollination to the genetic diversity of Sibara filifolia. Research the cause and effect of reproductive strategies expressed by both populations. Determine if restoration of pollinator communities is needed to improve population genetics, growth, and distribution. 7. Determine the role of soil moisture and germination cues for Sibara filifolia, and model the impact of various climate change models on the species needs. (USFWS, 2020)

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SPECIES ACCOUNT: *Sidalcea keckii* (Keck's Checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A slender, bristly-hairy, annual herb, 1.5-3.5 dm tall. A few deep pink flowers bloom April-May. (NatureServe, 2015)

Taxonomy

A distinct species in a genus of about 22 species of western North America. (NatureServe, 2015)

Historical Range

At the time of listing, the Mine Hill Sidalcea keckii population existed within a 0.73 acre area. The population occurred on a privately owned 700-acre parcel of land that was used for livestock 5 grazing. The occurrence of S. keckii at Mine Hill in Tulare County may have been extirpated when orange groves were planted on the property. (USFWS, 2012)

Current Range

Tulare and Fresno counties (NatureServe, 2015)

Critical Habitat Designated

Yes; 3/18/2003.

Legal Description

On March 18, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Sidalcea keckii (Keck's Checker-mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes three critical habitat units (CHUs), in California (68 FR 12863-12880).

Critical Habitat Designation

The critical habitat designation for Sidalcea keckii includes three CHUs in Fresno and Tulare counties, California. This species critical habitat encompasses approximately 1,085 acres (ac) (438 hectares (ha)) (68 FR 12863-12880).

Unit 1: Piedra: Unit 1 is on the western slopes of Tivy Mountain in the Piedra area of southern Fresno County. It contains 206 ha (510 ac), of which 203 ha (503 ac) are privately owned and 3 ha (7 ac) are managed by the BOR (R. Faubion, pers. comm., 2002). Of the privately owned land, 77 ha (189 ac) of proposed critical habitat is on the Tivy Mountain Reserve which is owned by SFC and established for the conservation of Sidalcea keckii and other rare plants. SFC uses managed grazing as a tool to reduce competing non-native grasses from S. keckii sites, and monitors the plant as well (SFC 2001). Another 6.5 ha (16 ac) of this unit occurs on a conservation easement held by SFC on privately owned land adjacent to the reserve. Recent surveys of the areas containing documented populations of Sidalcea keckii were conducted in 1998, 2000, and 2001. In 1998, surveys coordinated by the BOR found 500 to 1,000 plants in the area (Cypher 1998). Surveys conducted in 2000 and 2001 by the SFC found eight separate patches of S. keckii growing on both Fancher and Cibo soils (C. Peck, in litt., 2002). This unit is essential to the conservation of

the species because it is one of the two sites at which the species has been observed since the 1930s. When the number of populations or geographic distribution of a species are severely limited, as is the case when plants have only been observed recently at two locations, possible extinction or extirpation due to random events become a concern. Examples of random events that are a concern include fire and disease (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994). This unit is also essential because it includes the most northerly location known for S. keckii, and is the only location where above-ground plants with maroon-centered flowers have been documented (Cypher 1998).

Unit 2: Mine Hill: Unit 2 is about 3 km (2 mi) south of Success Dam and 5 km (3 mi) east of Porterville in Tulare County and contains 86 ha (213 ac), all of which are on privately owned land. Unit 2 encompasses a single known patch of Sidalcea keckii, which contained approximately 60 plants when last surveyed in 1992. At the request of the landowner, it has not been surveyed since that time. However, based on information from public comment, the standing population at Mine Hill may have been extirpated by conversion of the habitat to an orange grove. We currently do not know how much habitat may have been converted, although we believe that much of the habitat around the original population remains potentially viable and may contain a seed bank or standing plants. The Coarsegold rock outcrop soils of the area are best suited to rangeland (SCS 1982), which is the current use of the area where not converted to orchard. However the site is also zoned for mobile home development (R. Brady, Tulare County Planning Department, pers. comm., 1997). This unit is essential to the conservation of the species because it is presumably one of the two known locations where Sidalcea keckii plants have been observed since the 1930s. As is the case with Unit 1, when the number of populations or geographic distribution of a species are severely limited, possible extinction or extirpation due to random events become a concern. Examples of random events that are a concern include fire and disease (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994).

Unit 3: White River: Unit 3 is located near the town of White River in southern Tulare County. It contains 146 ha (362 ac), all of which is private land. Unit 3 contains the ‘‘type’’ location, specimens from which were used to first describe the species in 1940 (Wiggins 1940). This site is the only one not closely associated with serpentine rock, but contains the primary constituent elements that would support the species. This may be due to the presence of currently unknown and unmapped serpentine areas, or it may be due to an increased ability to compete on non-serpentine Cibo soils. As noted above, the White River site is one of the extremely few locations where Sidalcea keckii has ever been observed and may be occupied by a seed bank. Sidalcea keckii plants may still occur here, but none have been documented recently. Even if the species is not rediscovered at the White River site, we believe the site is essential to the conservation of the species. Because S. keckii has been observed at the site, it is the most appropriate site at which a reestablishment effort might be attempted. The combination of small range, few populations, and restricted habitat makes S. keckii susceptible to extinction or extirpation from a significant portion of its range due to random events, such as fire, disease, or other occurrences (Shaffer 1981, 1987; Primack 1993, Meffe and Carroll 1994). Such events are a concern when the number of populations or geographic distribution of a species are severely limited, as is the case with S. keckii. Establishment of a third location for S. keckii is likely to be an important component in reducing the risk of extinction due to such catastrophic events. This location also represents the southernmost extent of the known historical range of the species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Sidalcea keckii critical habitat consists of two components (68 FR 12863-12880):

(i) Minimally shaded annual grasslands in the foothills of the Sierra Nevada Mountains containing open patches in which competing vegetation is relatively sparse; and

(ii) Serpentine soils or other soils that tend to restrict competing vegetation.

Life History

Food/Nutrient Resources

Habitat Type

Adult: Gressy slopes (Natureserve, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine soils (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: High (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Found on grassy slopes from 120 to 425 m elevation. The extant population is in a sparsely vegetation annual grassland on red or white-colored clay soils with 2-40 percent slopes. The clay substrates are thought to be derived from serpentine. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Population Growth Rate:

Loss of populations because of development. Decline of 50-70% (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Loss of populations because of development. Decline of 50-70% Known historically from 3 populations in Tulare and Fresno counties, California, but the species has potentially been extirpated from each location. A new location discovered in 1998 had approximately. 900 individuals. Historical occurrence at White River near Glenville, Tulare County, California. (NatureServe, 2015). Low resiliency, representation and redundancy are based on the low number of known populations and restricted habitat requirements.

Threats and Stressors

Stressor: Agricultural conversion (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Agricultural development is listed as a threat to this species (USFWS, 2012).

Stressor: Potential development (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Critical Habitat Unit KECK-1 includes 205 acres of land protected by the Sierra Foothill Conservancy, federally managed lands, and some private land. There is a single unprotected parcel within the Piedra population that could potentially be developed (Stebbins 2004). However, there are no imminent plans for development at this time. The Service is not aware of any activities that would have caused destruction or modification habitat within Critical Habitat Unit KECK-1 since the last 5-Year Review in 2007 (USFWS, 2012).

Stressor: Grazing (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: At the time of listing, cattle (Bos taurus) grazing was discussed as a potential threat to the species; there has been no known change since the final listing. Cattle grazing may limit encroachment of non-native grasses (C. Peck, in litt., 2002; Weiss 1999). However, cattle have been observed to cause damage to S. keckii by eating or trampling it, although the damage was barely noticeable a week later (Cypher 1998). Increased grazing during months of flowering, seed-set, or seed maturation could potentially reduce local population viability and negatively affect long-term conservation of this species. Summary of Factor C: Diseases do not appear to be a threat at this time. Overgrazing by cattle may threaten the long-term conservation of this species (USFWS, 2012).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Summary of Factor D: In summary, the Endangered Species Act is the primary Federal law that has provided protection for this species since the dates of its listing as endangered in

2000. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent their status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)
Exposure:
Response:
Consequence: Threat of extinction/lack of genetic variability
Narrative: Small population size increases the susceptibility of a population to extirpation from random demographic, environmental, and/or genetic events, affecting survival and reproduction of individuals (Shaffer 1981, 1987; Lande 1988; Groom et al. 2006). Small populations of annual species, such as Sidalcea keckii, may be more vulnerable to random environmental events such as extreme weather, disease, fire, or insect infestations (Shaffer 1981, 1987; Menges 1991; Groom et al 2006). For example, if a fire should occur before plants bloom or during the blooming season, the fire could destroy the individual plants as well as deplete the seed bank. The threat from random natural events has increased since S. keckii was listed because the plant now is found only at one location (USFWS, 2012).

Stressor: Altered fire regime (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: he absence of Sidalcea keckii from dense grasslands, even those on serpentine clay soils, suggests that it is a poor competitor (Stebbins 1992; J. Stebbins, pers. comm. 2001). Thus, aggressive, nonnative grasses such as Bromus madritensis ssp. rubens, and Bromus hordeaceus could potentially outcompete S. keckii if conditions changed to favor these grasses. For example, soil disturbances, increased availability of soil nutrients (e.g., nitrogen deposition) from cattle feces and other sources, and absence of fire may provide ideal conditions that would allow these nonnative grasses to outcompete S. keckii. Non-native grasses may generate increased fuel sources that could increase intensity of fires above the normal range of variability in serpentine grasslands that support S. keckii (E. Cypher, California Department of Fish and Game, pers. comm. 2006). However, an appropriate fire regime may reduce the presence of nonnative grasses and benefit serpentine endemic species such as S. keckii (Harrison et al. 2003) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to

make accurate predictions regarding its effects to particular species at this time (USFWS, 2012).

Recovery

Recovery Actions:

- There is no approved final or draft recovery plan for the species (USFWS, 2012).
- Continue to protect property with suitable habitat for Sidalcea keckii. Acquisition of additional habitat through fee title or conservation easements is needed for the recovery of the species (USFWS, 2012).
- Survey additional serpentine and gabbro soil areas in Tulare and Fresno Counties to discover additional populations of Sidalcea keckii (USFWS, 2012).
- If additional populations of Sidalcea keckii are not discovered through systematic surveys, the species should be reintroduced into protected land within critical habitat units (USFWS, 2012).
- Continue monitoring the status and trend of Sidalcea keckii to determine whether this species is stable, increasing, or declining (USFWS, 2012).
- Continue genetic studies to confirm the species identity of plants preliminarily identified as Sidalcea keckii so that we can more accurately determine the actual number of populations, the geographic range, and types of habitats that support this species (USFWS, 2012).

Conservation Measures and Best Management Practices:

- The following recommendations for future actions are from the 2012 5-year review, scientific literature, and as a result of discussions with species experts. 1. Protect existing habitat in the San Joaquin Valley for Keck's checkermallow. 2. Conduct genetic evaluations to determine taxonomic status of Keck's checkermallow outside of the San Joaquin Valley. 3. Survey both extant and extirpated occurrences that have not been visited in the past few years to determine the status of these occurrences. Conduct yearly surveys at extant locations utilizing a standardized methodology to determine trends in the range-wide status as well as population/occurrence abundance. (USFWS, 2020)

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SPECIES ACCOUNT: *Sidalcea oregana ssp. valida* (Kenwood Marsh checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/21/1997; Pacific Southwest (R8)

Physical Description

A perennial herb in the mallow family (Malvaceae). The plants are 1 to 2 m (3 to 6 ft) tall. The leaves are rounded. Lower leaves have 5 to 7 shallow lobes; upper leaves are generally smaller and divided into 3 to 5 entire, lanceolate segments. The compound inflorescence consists of densely flowered, spike-like racemes 2 to 5 cm (0.8 to 2.0 in) long. Petals are 1.0 to 1.5 cm (0.4 to 0.6 in) long, notched at the apex, and deep pink-mauve. The flowers appear from late June to September. Sidalcea oregana ssp. valida differs from S. oregana ssp. eximia in having a hairless calyx. (USFWS, 1997)

Taxonomy

Edward L. Greene (1897) first described Sidalcea oregana ssp. valida in June, 1894, based on material he collected from Knight's Valley, Sonoma County, California. Since then, this taxon has been known as S. maxima (Baker), S. oregana var. spicata (Jepson), S. eximia (Baker) and S. spicata ssp. valida (Wiggins) (CNPS 1988b). C. L. Hitchcock (1957) studied the genus Sidalcea and recognized four subspecies, including S. oregana ssp. valida, a treatment accepted by Steven Hill (1993). (USFWS, 1997)

Historical Range

See current range/distribution.

Current Range

Freshwater marshes approximately 150 m (490 ft) in elevation, at Kenwood Marsh and Knight's Valley, Sonoma County, California. (USFWS, 1997)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Flowers appear from late June to September (USFWS, 2009).

Reproduction Narrative

Adult: Flowers appear from late June to September (USFWS, 2009).

Habitat Type

Adult: Marsh (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits the edges of freshwater marsh. (NatureServe, 2015). High ecological integrity of the communit and site fidelity as well as low tolerance ranges are inferred based on the specific habitat needs of this species and the low number of known populations.

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (USFWS, 2019)

Number of Populations:

2 (USFWS, 2019)

Population Size:

Varies from 24 to 500 per population (USFWS, 2019)

Additional Population-level Information:

At the time of listing, two occurrences of Kenwood Marsh checker-mallow were known to exist with 130 plants between them. In 2018, biologists observed a small population (less than 100 individuals) at Deerfield Ranch Winery but no abundance survey was done (K. Symonds, pers. comm. 2018). Based on new observations from scientists and volunteers the threats to Kenwood Marsh Checker-mallow have marginally increased since the last status review. However, there has been no change to our understanding of threats to the species, or its distribution. (USFWS, 2019)

Population Narrative:

There are two locations with extana populations: Kenwood Marsh and Deerfield Ranch Winery. During the previous status review (2009) there were two main sites within Kenwood Marsh where the Kenwood Marsh checker-mallow remained extant: at Deerfield Ranch Winery and on an adjacent property. Today, the only confirmed, extant population exists at the Deerfield Ranch Winery. Botanists have not surveyed the additional population at Kenwood Marsh for nearly 20 years (Service 2009) and the status of the plant remains unknown at this location. Likewise, no botanical surveys have been done at Knight's Valley in 30 years. In 2009, only three colonies existed at the Deerfield Ranch Winery (USFWS; A. Rex, in litt. 2017). Kenwood Marsh checker-

mallow abundance at this location has continued to decline in recent years (A. Rex, in litt. 2017; Appendix A). Over the past 25 years, the abundance at the winery has fluctuated from as many as 550 individuals, to as few as 24 (Appendix B; CNDDB 2018; USFWS 2009). (USFWS, 2019)

Threats and Stressors

Stressor: Grazing (USFWS, 1998)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: This species is adversely affected at both of its locations by reduced seed set resulting from cattle grazing (CNPS 1988b). Populations of Lilium pardalinum ssp. pitkinense have been enclosed with various types of wire fencing in an attempt to prevent grazing or browsing by cattle, horses, and deer, but most of the fences have failed to prevent grazing completely. The plants continue to suffer from herbivory by cattle, deer, and perhaps gophers and other herbivores, resulting in loss of flowers and seeds (L. Lozier, in litt. 1990). (USFWS, 1997)

Stressor: Water diversion (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Both permitted and unathorized water diversions are listed as a threat to this species (USFWS, 2009).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Regulatory mechanisms are deemed as inadequate to protect this species. Including those that require a 10-day advance notice to officials before private landowners change the land use in areas populated with this species. (USFWS, 2009).

Stressor: Small population size (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: The small population size of this plant species increases the susceptibility to extirpation from random events. Population sizes of 100 or fewer are known for one or more populations of Sidalcea oregana ssp. valida. This species may also be subject to increased genetic drift and inbreeding as a consequence of their small population sizes (Menges 1991, Ellstrand and Elam 1993). Increased homozygosity resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993). This species is threatened by potential loss of fitness and/or genetic variability associated with small population sizes. (USFWS, 1997)

Stressor: Naturally-occurring events (USFWS, 1997)

Exposure:
Response:
Consequence:
Narrative: The potential for loss of the only population of Sidalcea oregana ssp. valida from naturally occurring events, because of the small population size, is exacerbated by drought and water diversions. In addition, this population is being encroached upon by invasive weeds, including yellow star-thistle and blackberry (A. Howald, pers. comm. 1993). One of the subpopulations was damaged by an off-road vehicle during maintenance of a local aqueduct, which passes through the marsh. The maintenance activity occurred late in the season when the soil was relatively dry, resulting in minimal damage to the plants. If such maintenance activities occur during a time when the soil is saturated, they pose a threat to the plants (A. Howald, pers. comm. 1993). (USFWS, 1997)

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Climate change is listed as threat to this species. (USWS, 2009)

Recovery

Reclassification Criteria:
Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

Delisting Criteria:
Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)

Recovery Actions:
- Not defined. A Recovery Plan has not been prepared. (USFWS, 2019)
- Removing thatch and invasive species from exclosures: Kenwood Marsh checker-mallows grow in full sun on the margins of riparian areas (K. Symonds, pers. comm. 2018). The species is currently threatened by thatch buildup from annual sedges, as well as invasive plants, both of which shade habitat (K. Symonds, pers. comm. 2018; R. Rex, pers. comm. 2018). Manual removal of invasive plants and thatch might be necessary to increase Kenwood Marsh checker-mallow survival. In 2018, Deerfield Ranch Winery staff and volunteers removed thatch and invasive plants from browsing exclosures (A. Rex, pers. comm. 2018). These efforts should take place annually to ensure the survival of Kenwood Marsh checker-mallow. (USFWS, 2019)
- Locate appropriate areas for new colony establishment: The Kenwood Marsh checker-mallow probably once existed in riparian zones between Kenwood Marsh and Knight's Valley. Today, the dispersal of this species is restricted by land-use conversion to agriculture and urban areas. However, there might be areas within the historical range where the species could be re-established with seeding and outplanting. Private landowners should be contacted and, if landowners are willing, a management plan should be developed and implemented by the Service or CDFW. Research and public outreach would be needed to determine the feasibility of establishing new colonies in the area. (USFWS, 2019)
- Population monitoring: Population estimates of Kenwood Marsh checker-mallow are sporadic (CNDDB; Appendix B). Establishing a protocol for continual, annual population

monitoring would help us better understand the species needs and recovery potential. (USFWS, 2019)

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SPECIES ACCOUNT: *Sidalcea oregana var. calva* (Wenatchee Mountains checkermallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Plant has several stems, 2-15 dm tall; leaves thick and fleshy, without hairs; flowers light to deep pink. Flowers June through July. (NatureServe, 2015)

Taxonomy

The taxon was first recognized as a distinct variety named Sidalcea oregana ssp. oregana var. calva by Hitchcock and Kruckeberg (1957). Hitchcock and Cronquist (1973) later simplified the nomenclature by eliminating the subspecies oregana, and all subordinate taxa of S. oregana became varieties of the species. No further revisions have been made for S. oregana var. calva related to either taxonomy or relevant nomenclature for the species (USFWS, 2011).

Current Range

Occurs in a small area within Chelan County, Washington.

Critical Habitat Designated

Yes; 9/6/2001.

Legal Description

On September 6, 2001, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Sidalcea oregana var. calva (Wenatchee Mountains checkermallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Washington (66 FR 76536-76548).

Critical Habitat Designation

The critical habitat designation for Sidalcea oregana var. calva includes one CHU in Chelan County, Washington. This species critical habitat encompasses approximately 6,135 acres (ac) (2,484 hectares (ha)) (66 FR 76536-76548).

Washington, Chelan County. From USGS 7.5' quadrangle maps Peshastin and Tip Top, Washington. T. 23 N., R 18 E., beginning at a point on Camas Creek in the NW1/4 of NW1/4 of section 35 at approximately 47°26'52? N latitude and 120°38'57? W longitude proceeding downstream (northwesterly), expanding in all directions to include the entire wetland complex that comprises the Camas Meadow Natural Area Preserve, to a point approximately 0.4 km (0.25 mi) from the confluence of Pendleton Creek and Peshastin Creek, located at 47°31'06? and 120°37'18? W longitude. From this last point, the western boundary of the designated critical habitat parallels Peshastin Creek to a point at the southwest of the designated area located at 47°28'46? N latitude and 120°38'57? W longitude. The maximum elevation of the designated critical habitat is 1,000 m (3,300 ft) and the lowest elevation is 488 m (1,600 ft). Critical habitat within this area includes watercourses and wetland habitat out to the beginning of upland vegetation.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Sidalcea oregana var. calva critical habitat consists of three components (66 FR 76536-76548):

The known primary constituent elements of critical habitat for Sidalcea oregana var. calva include: surface water or saturated upper soil profiles; a wetland plant community dominated by native grasses and forbs, and generally free of woody shrubs and conifers that would produce shade and competition for Sidalcea oregana var. calva;

seeps and springs on fine-textured soils (clay loams and silt loams), which contribute to the maintenance of hydrologic processes necessary to support meadows that remain moist into the early summer;

and elevations of 488–1,000 m (1,600–3,300 ft).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (bee) pollinated. Other pollinators unknown (USFWS, 2004)

Breeding Season

Adult: Flowering begins in the middle of June and peaks in the middle to end of July, although some individuals may have flowers present in mid-August (USFWS, 2004).

Reproduction Narrative

Adult: Hymenoptera (NatureServe, 2015). Pollination of the species is not well understood. In her studies of S. oregana var. calva, Tara Goldsmith reported that the colonial ground-nesting bee Diadasia nigrifrons is most likely the dominant pollinating insect (Goldsmith 2003). Honey bees (Apis mellifera), although present, were not observed to visit S. oregana var. calva. Interestingly, Goldsmith found no significant difference in the rate of flower to fruit success (about 36 percent) between flowers that were excluded from insect pollination and those that were not, indicating that insects are not the sole vector for pollination. Goldsmith pointed to the need for further study of the pollination mechanisms of S. oregana var. calva to potentially improve the plant's reproductive output. The species likely reproduces only from seed and, based on examination of seed capsules, the production of seed appears to be high (Gamon 1987). The somewhat clumped distribution of mature S. oregana var. calva plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (Caplow 2002). Reproductive individuals produce flowers on one to several stems. Flowering begins in the middle of June and peaks in the middle to end of July, although some individuals may have flowers present in mid-August. Welldeveloped fruits are present by early August (Hitchcock et al. 1961; Washington Natural Heritage Program and U.S. Bureau of Land Management 1998). Investigations have suggested the species is not rhizomatous (D. Wilderman, pers. comm. 2004). The species likely reproduces only from seed and, based on examination of seed capsules, the production of seed appears to be high (Gamon

1987). The somewhat clumped distribution of mature S. oregana var. calva plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (Caplow 2002). (USFWS, 2004).

Habitat Type

Adult: Meadows (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: S. oregana var. calva is restricted to wetlands and moist meadows of the Wenatchee Mountains of central Washington on the east side of the Cascades. This species is found at midelevations, ranging from 488 to 1,000 meters (1,600 to 3,300 feet). Populations of S. oregana var. calva are generally concentrated in the wetter portions of open forest-moist meadow habitats, in slight topographic depressions. The plant may also be found in open conifer forests dominated by Pinus ponderosa (ponderosa pine) and Pseudotsuga menziesii (Douglas-fir), on the perimeter of shrub and hardwood thickets dominated by quaking aspen (Populus tremuloides), along permanent or intermittent streams in sparsely forested draws, and near seeps, springs, or small drainages. The presence of surface water or saturated upper soil profiles in the spring and early summer is the feature common to the variety of habitats where the species is found (USFWS, 2004). High ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the low number of known populations and the relatively restricted range.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The somewhat clumped distribution of mature S. oregana var. calva plants suggests that seed dispersal is restricted to the areas near mature plants, unless the seeds are moved by animals or transported by water (Caplow 2002) (USFWS, 2004).

Population Information and Trends

Population Trends:

Stable (USFWS, 2020)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

>13,000 (USFWS, 2020)

Population Narrative:

The status of Sidalcea oregana var. calva has remained stable since the publication of the 5-year review in 2011. Large populations that have been monitored have either increased (Camas Meadows) or remained relatively stable (Mountain Home) and monitoring does not indicate whether individuals within populations are increasing or decreasing in size or vigor. However, the status of small populations reveal a decline (Camas Creek Tributary) or are unknown (Pendleton and Forest Service). The population at Camas Meadows remains the largest with around 13,000 individuals while the Camas Creek Tributary remains the smallest population with zero plants. The Mountain Home population was discovered to be much larger than previously thought, which suggests that additional properties may contain undetected populations of Sidalcea oregana var. calva as demonstrated by the 2019 discovery of 43 additional individuals at a site north of the Mountain Home population. (USFWS, 2020)

Threats and Stressors

Stressor: Wetland conversion (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The primary threats to S. oregana var. calva include habitat fragmentation, degradation, or loss due to conversion of native wetlands to orchards and other agricultural uses and rural residential development (USFWS, 2004).

Stressor: Altered hydrology (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Altered hydrology is considered a major threat to this species (USFWS, 2004).

Stressor: Competition from native and nonnative plants (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition from native and nonnative plants is listed as a major threat to this species (USFWS, 2004).

Stressor: Recreational impacts (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Recreational impacts are considered a major threat to this species. Seeds of the full species Sidalcea oregana are collected by horticulturists. Some populations are small enough that even limited collecting pressure could have adverse impacts. S. oregana var. calva is an attractive plant and may be sought for collection. All perennial species in the genus are considered

attractive plants with horticultural potential (Hitchcock and Cronquist 1961; Gamon 1987). Wild-collected seed of the species S. oregana (no variety given) is available through a seed exchange program offered by the International Gardening Society, North American Rock Garden Society (North American Rock Garden Society 1996). Although seed collection does not pose a key threat to S. oregana var. calva currently, the potential of harm through such activity should be considered when developing management plans for the species (USFWS, 2004)

Stressor: Woody plant encroachment (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In the absence of fire woody plant encroachment can happen as part of natural succession and is considered a major threat to this species (USFWS, 2004).

Stressor: Seed predation (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Seed predation by weevils is considred a major threat to this species (USFWS, 2004).

Stressor: Fire suppression activities (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Mountain Home Meadow site was adversely impacted by fire suppression activities associated with the Rat Creek Fire during 1994 (Harrod 1995). A fire line was constructed in the drainage area supporting a population of S. oregana var. calva. Blading of the area by a bulldozer destroyed approximately 50 percent of the population (more than 100 plants), disturbed the soil, and altered the hydrology of this wet meadow. This types of activity is considered a major threat to this species (USFWS, 2004).

Stressor: Road construction (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Road construction may alter hydrology by modifying surface and subsurface runoff, changing water flows, and increasing the potential for erosion and sedimentation and is considered a threat to this species (USFWS, 2004).

Stressor: Timber harvest (USFWS, 2004)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Timber harvest may alter hydrology by modifying surface and subsurface runoff, changing water flows, and increasing the potential for erosion and sedimentation and is considered a threat to this species (USFWS, 2004).

Stressor: Naturally occurring events (flooding, land slides, etc.) (USFWS, 2004)

Exposure:
Response:
Consequence: Loss of haibtat/extinction
Narrative: The species is highly vulnerable to extirpation from demographic factors or random, naturally occurring events due to the small size of most of the remaining populations (USFWS, 2004).

Recovery

Reclassification Criteria:
There are at least four stable, self-sustaining populations in each of the 5th field watersheds (Peshastin Creek and Icicle Creek) where the species currently occurs. Alternatively, there could be three stable, self-sustaining populations in each of these two watersheds and at least three stable, selfsustaining populations in another drainage if additional populations are discovered in the future. Additional populations may be identified through surveys or established through reintroductions. To be considered separate, each population must be geographically and hydrologically separated, such that events resulting in the extinction of one population are not likely to result in the extinction of another population. To be considered stable and self-sustaining, a population should maintain a 5-year average of at least 500 adult plants, show evidence of positive or neutral population growth over the same 5-year period, and show evidence of natural reproduction and establishment (USFWS, 2004).

2. All of the stable, self-sustaining populations are on protected sites secure from threats. For a site to be considered protected, it must be owned or managed by a government agency or private conservation organization that identifies perpetual maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species (USFWS, 2004).

3. Genetic material is stored in a facility approved by the Center for Plant Conservation. The stored genetic material in the form of seeds must adequately represent the species' geographic distribution and genetic diversity (USFWS, 2004).

4. Adequate population and habitat monitoring has been established for all of the known populations. Population monitoring must be statistically sound and should be able to detect a 20 percent change in the population with a 90 percent degree of certainty. Habitat monitoring should include monitoring of shrub and tree cover, nonnative species, and hydrology (USFWS, 2004).

5. Management plans have been developed and implemented for all State and federally owned populations. Management plans will include provisions for monitoring, research, and habitat maintenance and restoration, including hydrologic restoration. These plans will also define actions designed to reduce or control threats to the species (USFWS, 2004).

Delisting Criteria:
Criteria for delisting the species remain the same as those for downlisting, with the following exceptions: 1. The populations that meet downlisting criterion #1 above will be naturally reproducing, stable or increasing in number with a minimum of 500 adult plants, secure from

threats, and will have persisted an additional 5 years, for a total of 10 years. All other details of criterion #1 remain unchanged (USFWS, 2004).

One additional criterion is added for delisting: 6. Post-delisting monitoring plans and agreements to continue post-delisting monitoring are in place and ready for implementation at the time of delisting. Monitoring of populations following delisting will verify the ongoing recovery of the species and provide a means of assessing the continuing effectiveness of management actions (USFWS, 2004).

Recovery Actions:

- Collect, distribute, and store seed in an approved Center for Plant Conservation Seed Bank facility for later grow-out and reintroduction The need for this action is considerable, given the current accessions are ageing, do not represent the Mountain Home population, and are located only in a single seed bank location, at the Berry Botanic Garden in Portland, Oregon. The currently stored collections date from 1986 to 1999. We would like to expand this to more than one seed bank location by adding the Miller Seed Vault at the University of Washington's Center for Urban Horticulture, Seattle, Washington (USFWS, 2011).
- Census and monitor all populations Despite the best of intentions by responsible agencies, monitoring has been somewhat inconsistent between populations since publishing of the recovery plan. There has not been a full species census conducted in a single year to serve as a baseline for future comparisons and to allow the detection of trends. It is important to design a census that is efficient and comprehensive, yet be flexible to continue into the future in the face of uncertain funding. Cooperative development of a new monitoring plan is a challenge for the Technical Team (USFWS, 2011).
- Continue research into insect predation Arnett and Birkhauser (2008) recommend repeating the proposed weevil protocol at several sites in order to develop an understanding of annual variation in level of insect infestation and to gain a better understand of the annual variation in phenology. Trial runs early and late in the season may yield a better understanding of the different behavior of the two weevil species. A single late season monitoring was also suggested, as it may give the best estimate of the total level of insect damage, if it is conducted before seed dispersal begins. Arnett and Birkhauser (2008) suggested conducting prescribed fire at one of the Sidalcea oregana var. calva populations. This offers an opportunity to use this methodology to measure the effects of this action as a management treatment as the plant and the weevil likely evolved together under conditions of a higher fire frequency than current. Because Sidalcea oregana var. calva is historically located in areas where late season, low-intensity burns occurred frequently (Caplow 2003, Goldsmith 2005), it could be predicted that the plant species would respond positively to fire, as it would reduce competition with encroaching shrubs and trees and increase plant vigor, as well as possibly keep populations of the weevil and other harmful insects in check (USFWS, 2011).
- Complete hydrologic restoration in Camas Meadows The success of a pilot hydrologic restoration project at Camas Meadows has improved wetland function and increased the amount of habitat in the largest population of Sidalcea oregana var. calva. In addition, the project was shown to improve native plant diversity and reduce the threat of altered hydrology within in the Camas Meadow population. This project demonstrated a successful method for restoring the hydrologic function to the wetland and provided benefits to the species. Several areas of headcutting still require attention in remnant drainage ditches and should be completed to help alleviate threats to Sidalcea oregana var. calva. Invasive species

control and native restoration planting should accompany any hydrologic restoration undertaken with S. oregana var. calva (USFWS, 2011).

- Reconsider value of Mountain Home population to survival and recovery With the discovery of a much larger, increasing and more stable Mountain Home population than previously thought, the Technical Team may reconsider the value of this population to the recovery of the species and we may elect to pursue a conservation agreement with the landowners. Such an action would allow the population to "count" toward recovery criteria # 1: a minimum of 500 plants, stable, and in a protected status; all for a period of at least five years. Additionally, this population is thought to represent a significant source of genetic variability for S. oregana var. calva, and therefore elevates its importance as a potential source of seed collection to propagate seedlings for reintroduction efforts or the species (USFWS, 2011).
- Complete and refine reintroduction planning In the Spotlight Species Action Plan (USFWS 2009) is a list of actions, that if implemented, would make substantial gains toward the recovery of Sidalcea oregana var. calva. The Technical Team should review this document, update it to reflect the new information and insight from this status review and use it to guide the reintroduction of the species. The Action Plan was developed primarily by using information and actions directly taken from the recovery plan (USFWS 2004), and would likely benefit from a revision (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS A comprehensive listing of actions such that, if implemented, are expected to lead to the downlisting or delisting of Sidalcea oregana var. calva is discussed in the recovery plan (Service 2004) and appendices, including the recovery implementation schedule. New or enhanced actions, including adaptive management actions created as a result of this review are recommended as follows (in order of priority): A. Census and monitor all populations There has not been a full species census conducted in a single year to serve as a baseline for future comparisons and to allow the detection of trends. It is important to design a census that is efficient and comprehensive yet flexible to continue into the future in the face of uncertain funding. In 2018, the Service provided funding to WDNR to complete this action in 2019 and 2020. B. Collect, distribute, and store seed in an approved Center for Plant Conservation Seed Bank facility Given that the majority of accessions are ageing and of low viability, this action remains a high priority. The seed stock should be refreshed in order to ensure seed collections are of high quality and viability. Seed stock should also contain accessions from all populations to ensure the genetic diversity of Sidalcea oregana var. calva is represented and preserved. In 2019, the Service funded Rare Care to expand the ex situ collection of seed accessions in 2020 to be held at the Miller Seed Vault. C. Establish seed production beds for reintroductions and augmentations Seed production beds should be established at a nursery to aid future recovery projects, such as reintroductions and augmentations. Seed production beds can yield much more seed than could be sustainably collected at natural populations, and it is vitally important that natural populations are allowed to maintain their seed bank for recruitment purposes. However with high seed predation levels from weevils and other insects, seed collecting for reintroductions and augmentations could potentially be another threat to recruitment if not balanced with seed production beds. Seed production should be setup to ensure the conservation and enhancement of the genetic diversity of Sidalcea oregana var. calva. D. Determine best management practices for suitable habitat Before augmenting or reintroducing populations in suitable habitat, it is imperative to determine how these habitats need to be managed for Sidalcea oregana var. calva. Management methods such as fire or overstory thinning should be tested at occupied sites with a sound experimental design to

determine causation to ensure accuracy of results. Additionally, climate change should be taken in to account for future management of sites and populations. Subsequently, management methods should be clarified for specific habitat conditions and land management types. E. Refine methods and complete reintroductions and augmentations The reintroduction project at Mountain Home Ridge was completed in 2015 by ChelanDouglas Land Trust where 161 Sidalcea oregana var. calva plants were outplanted at two sites. Microsite conditions resulted in low overall survival at one site and relatively high survival at the other site. Using lessons learned from this project, new reintroduction sites as well as augmentation sites for extant populations below 500 individuals should be identified and projects should be developed and implemented. Subsequent projects should identify whether outplanting or direct seeding is the best method for reintroductions and augmentations in addition to determining the most suitable habitat and microsite conditions for the preferred method. F. Reassess value of Mountain Home population to survival and recovery With the discovery in 2011 that the Mountain Home population was much larger than originally thought, the Technical Team may reassess the value of this population to the recovery of the species and the Service may pursue a conservation agreement with the current landowners. Securing a conservation agreement would allow the population to contribute toward recovery criteria #1, which is a minimum of 500 plants in a stable or increasing population on a protected site for a period of at least five years. Furthermore, this population may represent a significant source of genetic diversity for Sidalcea oregana var. calva, which elevates its importance for species persistence and reintroduction efforts as a seed source. In February 2019, the WDNR Natural Heritage Program advisory council recognized the Mountain Home landowners for their good stewardship by registering Mountain Home in the Register of Natural Areas. This voluntary agreement acknowledges the Mountain Home property as ecologically valuable for Sidalcea oregana var. calva and encourages conservation at this site. G. Continue research into insect predation and herbivory Arnett and Birkhauser (2008) recommend repeating the proposed weevil protocol at several sites in order to develop an understanding of the annual variation in insect infestation and phenology. Trial runs early and late in the season may yield a better understanding of the different behavior of the two weevil species and leaf beetles. A single late season monitoring was also suggested, as it may give the best estimate of the total level of insect damage as long as it is conducted before seed dispersal begins and the plant senesces. Arnett and Birkhauser (2008) also suggested conducting a prescribed fire at one of the Sidalcea oregana var. calva populations. The plant and weevil likely evolved together under conditions of a higher fire frequency than current, and Arnett and Birkhauser's (2008) suggestion offers an opportunity to measure the effects of prescribed fires as a management treatment. Because S. oregana var. calva is historically located in areas where late-season, low-intensity burns occurred frequently (Caplow 2003; Zimmerman and Reichard 2005), it could be predicted that the plant species would respond positively to fire. Fire would reduce competition with encroaching shrubs and trees and increase plant vigor as well as possibly keep populations of the weevil and other harmful insects in check. H. Complete hydrologic restoration in Camas Meadows The success of a hydrologic restoration project at Camas Meadows NAP has greatly improved the wetland function and increased the amount of suitable habitat for the largest population of Sidalcea oregana var. calva. The hydrologic restoration project also increased native plant diversity and reduced the threat of altered hydrology within in the Camas Meadows population. This project successfully demonstrated a technique for restoring the hydrologic function to wetlands benefiting S. oregana var. calva. However, there is still an area of deep headcutting that requires restoration in a remnant drainage ditch and should be addressed to help alleviate threats to S. oregana var. calva. Invasive species management and native plant restoration should accompany any hydrologic projects. (USFWS, 2020)

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SPECIES ACCOUNT: *Sidalcea pedata* (Pedate checker-mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from a fleshy taproot. The inflorescence is spike-like with deep rose-pink flowers; the upper flowers are crowded. (NatureServe, 2015)

Taxonomy

The genus Sidalcea, of the mallow (Malvaccae) family, comprises approximately 22 species located throughout western North America, mostly Oregon and California. A thorough description of the perennial members of this genus can be found in Hitchcock (1957). The perennial herb of interest. Sidalcea pedata A. Gray, was first described by Asa Gray (1887) based on a 1886 collection made by Samuel B. Parish from "Bear Valley in the San Bernardino Mountains, S. California" (Parish 1917). Jepson (1925) relegated the taxon to the variation Sidalcea spicata var. pedata. However, C. L. Hitchcock (1957) returned the taxon to full species status as Sidalcea pedata in his revision of the perennial species of the genus Sidalcea. Sidalcea pedata is distinguished from other sister species by its smooth carpels, mostly leafless stem, and the three- to five-lobed leaves that are then dissected into short, linear segments. Additional species of Sidalcea that occur in the San Bernardino Mountains include S. malvaeflora ssp. dolosa (distinguished by the presence of additional stem leaves, few-flowered racemes, and net-veined carpels), S. hicknianji ssp. parishii (shallowly-lobed leaves and coarse, gray pubescence), and S. neomexicana (fleshy leaves and netveined carpels). Colloquial names commonly used for this species are pedate checkermallow, bird-footed checkerbloom, bird-footed checkermallow, and Bear Valley checkermallow. Voucher specimens of Sidalcea pedata are held at the University of California, Riverside Herbarium; Jepson Herbarium at the University of California, Berkeley; Pomona College Herbarium; and in the Dudley Stanford collection of the California Academy of Sciences.

Historical Range

See current range/distribution.

Current Range

California endemic, occurs in the Big Bear Basin of San Bernardino County, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2011)

Reproduction Narrative

Adult: Sidalcea pedata is gynodioecious, meaning there are plants with both female and hermaphrodite flowers and plants with female flowers only. Research findings indicate that female and hermaphrodite plants differ substantially in their reproductive biology and pollination ecology (Leong 2006, p. 24). Hermaphrodites can produce seeds through outcrossing (pollen transfer between separate plants) and geitonogamy (pollen transfer between separate flowers on the same plant), whereas females appear to produce seeds solely through outcrossing. The most common visitors to S. pedata appear to be generalist bees, predominantly in the genus Osmia. Sidalcea pedata also attracts one specialist pollinator, the female of the bee species Diadasia nigrifrons (Anthrohoridae). Other visitors include flies, butterflies, and beetles. Bee visitors appear to distinguish between the two sex morphs and are more highly attracted to hermaphrodite flowers when initially flying to a new group of stems (Leong 2006, p. 24). Female plants also appear to be much more productive than hermaphrodites. Sidalcea pedata seeds are small and dispersal appears to be limited to the area surrounding the parent plant (USFS 2000a, p. 37). Research indicates that S. pedata does not reproduce in or near severely impacted areas and that noncompacted soils are important to the reproductive success and persistence of this species (Krantz 1981, p. VI) (USFWS, 2011).

Habitat Type

Adult: Meadows (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits loamy clay of annually-moist pebble plain meadows, and occasionally in dry meadows at 1600-2500 m (Pearson, 1989) (NatureServe, 2015). High ecological integrity of the community, site fidelity and low tolerance ranges are inferred based on the specific habitat needs of this species, the relatively small number of populations and its limited geographic range.

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Sidalcea pedata seeds are small and dispersal appears to be limited to the area surrounding the parent plant (USFS 2000a, p. 37) (USFWS, 2011).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

9 extant and 7 presumed extant (USFWS, 2021)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

In summary, monitoring for Sidalcea pedata has occurred at 10 occurrences since 2011 (Table 1), providing new information about the species' presence and abundance. We reassessed our 2011 occurrence status determinations and updated the status of nine occurrences (Table 1), based on monitoring data, the date since last survey, and information in the CNDDB. Finally, we have removed two occurrences (EOs 10 and 19) because they are now part of another EO. Based on those updates, there are 25 occurrences of Sidalcea pedata (Figure 1; Table 2). Nine are extant, seven are presumed extant, one is possibly extirpated, and eight are extirpated. We have no new information that changes our understanding of S. pedata biology or spatial distribution, and so that information in our 2011 review remains accurate. (USFWS, 2021)

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The threat of development remains high because the majority of Sidalcea pedata occurrences are on private land (10 of 16 EOs). Two of these occurrences are currently posted for sale: Metcalf Creek at the Drive-in and Flea market (EO 17) and the YMCA camp at Bluff Lake (EO 6) (Eliason, pers. obs. 2010). Impacts of development pressures on private land are evident at a number of occurrences: the east side of Baldwin Lake (EO 9, 30) has been highly developed to the extent that populations may become extirpated or too small to persist, and populations at Metcalf Creek (EO 17), Eagle Point (EOs 19, 21), and the south shore of Baldwin Lake (EO 8) have also been impacted by development. The only S. pedata occurrence that is considered fully protected is at the north shore of Baldwin Lake (EO 1) on the Baldwin Lake Ecological Reserve (managed by CDFG). The direct threat of development to S. pedata habitat therefore remains substantial and is currently impacting habitat at 10 of the 16 extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Off-Highway Vevicles (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The listing rule indicated that OHV activity eliminated colonies and damaged Sidalcea pedata habitat (USFWS 1984, p. 34499). In 2000, a review by the USFS found that approximately

1.1 miles (1.7 kilometers (1.3 ha (3.3 ac))) of unauthorized roads bisect or are adjacent to known occupied meadow plant occurrences and that the unauthorized network of roads allow for an "unknown, though likely high, level of random and on-going impacts to threatened/endangered meadow plant habitat (USFS 2000a, p. 99)." OHV use continues to impact moist meadow habitat by altering hydrology, compacting soil, and degrading habitat. Preventing OHV use within Sidalcea pedata habitat has been difficult because much of the activity is either on private land or is unauthorized. Occurrences at the north and south shores of Baldwin Lake (EOs 1, 6) are particularly vulnerable to OHV use. At the south shore of Baldwin Lake (EO 6), OHV trails bisect the S. pedata occurrence, connecting private land to the shoreline (USFS 2000, p. 62). Fencing that may provide protection to the occurrence at the north shore of Baldwin Lake (EO 1)—at the side of State Route 18, which could prevent unauthorized OHVs from entering—has been knocked down or has fallen down due to heavy snow drifts (Eliason, pers. obs. 2010). In 2010, the USFS placed boulders at the entrance of these roads to prevent illegal OHV activity, which appears successful in reducing impacts from this threat (Eliason, pers. obs. 2010) on USFS land. Currently 10 of the 16 known extant occurrences are subject to impacts from OHV activity (USFWS, 2011).

Stressor: Alteration of hydrology (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Alteration of soil hydrology or existing drainage patterns may have impacted several Sidalcea pedata occurrences including Eagle Point (EO 21) and the north shore of Baldwin Lake (EO 1). At each of these locations, efforts were made to prevent hydrology-related impacts to the habitat and to the species. For instance, CDFG's purchase of private lands containing the watershed for the north shore of the Baldwin Lake occurrence (EO 1; Baldwin Lake Ecological Reserve) in 1992 has helped to maintain natural hydrologic patterns. The Pan Hot Springs occurrence (EO 12) is found on deed restricted land; however, the water source for the habitat is not included in the deed restriction. Without control of water availability, the plants and their habitat at this occurrence remain threatened (USFS 2002, p. 25). While protection measures have lessened the threat of altered hydrology at several occurrences, it remains a rangewide threat to 14 of the 16 known extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Invasive nonnative plants (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Thinopyrum intermedium (previously Elytrigia intermedia) (intermediate wheatgrass) has been identified as a threat to occurrences at Baldwin Lake (EOs 1, 8, 9, 23, 24, 30), Eagle Point (EOs 19 and 21), and in the south of Pan Hot Springs (EO 12). An entire population at the northern end of the Pan Hot Springs occurrence (EO 12) has been extirpated from the meadow edge since the early 1990s by a dense invasion of T. intermedium (Krantz 2008, p. 11; Eliason, pers. comm. 2011). Thinopyrum intermedium invades Sidalcea pedata habitat and outcompetes it for space. It also produces a thatch that S. pedata seedlings cannot penetrate. Control methods such as burning or mowing have proven ineffective as both grasses are perennial and that returns in subsequent years (Eliason, pers. obs. 2010). Nonnative plants are a threat to 14 of the 16 known extant occurrences of S. pedata (Appendix 1) (USFWS, 2011).

Stressor: Predation (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Since the time of listing, horse grazing and pasturing activities have been identified as threats that are impacting occurrences at Pan Hot Springs (EO 12), Metcalf Creek (EO 17), and Bluff Lake (EO 6). Voluntary landowner agreements resulted in the relocation of equestrian activities away from rare plant habitat in the areas, and in 1987, horse corrals were removed from Pan Hot Springs. These efforts were successful and recovery of Sidalcea pedata populations has been observed at that location (USFS 2002, p. 19). Horse grazing and pasturing activities remains a threat to only 3 of 16 S. pedata occurrences at the east and south shores of Baldwin Lake (EOs 8, 9, 30). These occurrences are on private lands and there are no protective measures in place to reduce this threat (USFWS, 2011).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, the Act is the primary Federal law that has provided protection for Sidalcea pedata since its listing as endangered in 1984. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for S. pedata absent its status under the Act. One occurrence at Baldwin Lake (EO 1) is considered fully protected; however, even this population is impacted by recreational activities and illegal trespass. Two of the 16 extant S. pedata occurrences are afforded protection through local agencies by protecting land to conserve rare plant populations. There are also unresolved conflicts between State protections afforded under CESA and NPPA and county weed abatement provisions. Therefore, State and other Federal laws and regulations have limited ability to protect the species in absence of the Act. Inadequacies in provisions or implementation in regulatory mechanisms are not considered threats to the species, although these inadequacies may permit or precipitate actual threats that are described under Factors A, B, C, and E (USFWS, 2011).

Stressor: Recreational activities (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals/loss of habitat
Narrative: Impacts associated with recreational activities have been identified as a rangewide threat to Sidalcea pedata (Appendix 1). Recreational activities include but are not limited to: hiking, camping, fishing, horse riding, mountain biking, and dog walking. The primary impact from recreational activities is trampling that can crush and kill individual plants. Additional impacts include soil compaction, devegetation, escaped campfire threats, introduction or spread of nonnative species, and burial of plants with litter (USFS 2002, p. 23). Fencing and signage indicating the presence of sensitive species have proven effective at reducing the threat of recreational activities at the north and south shore of Baldwin Lake. Moderate success has also been made in educating the public and heightening the awareness of the need for the protection and recovery of S. pedata and numerous other listed and rare species near Big Bear Lake. The Big Bear Discovery Center at San Bernardino National Forest regularly presents public education programs on a variety of subjects, including threatened and endangered species (USFS 2000b, p.

80). Though recreational activities are a rangewide threat, the resulting impacts have been reduced at Pan Hot Springs (EO 12) and Bluff Lake (EO 6) through coordination with private landowners (USFS 2002, p. 23) (USFWS, 2011).

Stressor: Fire suppression measures (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Implementation of fire suppression measures has been identified as a threat at 11of 16 extant Sidalcea pedata occurrences. The San Bernardino County Land Use/Fire Hazard Abatement Division (see Factor D discussion) requires that owners must remove weeds and grasses in areas where this vegetation acts as fuel that may pose a fire threat. Weeds and grasses are described by the County of San Bernardino generally as annuals that grow and dry out each year, and thus removal activities do not discriminate for rare plants (County of San Bernardino 2010). Weed and grass removal generally involves mowing, which damages or destroys individual S. pedata plants. If removal activities are conducted before or during S. pedata flowering and fruit development, the plants reproductive output and germination may be significantly impacted. While S. pedata appears to be a robust species and has been observed in mowed, vacant lots (Eagle Point (EO 21), Metcalf Creek (EO 17)), these populations (or in many cases just individual perennial plants) may be “hanging on” and not reproducing (Eliason, pers. obs. 2010). If mowing is to continue, effort should be made to time this activity to avoid impacting S. pedata germination and the persistence of the populations (USFWS, 2011).

Stressor: Reduced populations (USFWS, 2011)
Exposure:
Response:
Consequence: Lack of genetic variability
Narrative: Fragmentation and isolation can adversely impact small populations of plants that are already reduced in distribution such as Sidalcea pedata resulting in increased vulnerability to extirpation (Barrett and Kohn 1991, pp. 3–30). These effects may be the result of several factors, including small areas of suitable habitat, local extirpations, or ongoing natural or artificial factors limiting establishment and survival of the taxon. The small numbers of Sidalcea pedata occurrences is a concern because it increases the possibility that impacts from urban development or other activities near moist meadow habitat could destroy all or a significant portion of the species’ population. Sidalcea pedata is distributed on less than 8.1 ha (20 ac) of moist meadow habitat (USFWS 1998, p. iii). Stochastic events outside the natural range of frequency and severity (such as floods, fires, contamination, or drought) can substantially reduce or eliminate species such as S. pedata with a restricted range and small population, and increase the likelihood of its extinction (Lande 1993, p. 912). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61). Allee (1931, pp. 17– 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi–216). Stephens et al. (1999, pp. 185–190), Dennis (2002, pp. 389–401) and Courchamp et al. (2008, pp. vi–216) suggest that the Allee effect is a density-dependent event that is inversely related to population size (USFWS, 2011).

Stressor: Climate change and drought (USFWS, 2011)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including Sidalcea pedata) or sites at this time. It seems likely that S. pedata, a species restricted to montane meadows in a single small portion of a mountain range found on clay soils with particular hydrological needs, would be threatened rangewide by any differences in climatic regimes brought on by changes to the climate. A changing climate with spatial and temporal shifting of temperature and precipitation may cause this speciesspecific adaptations to climate to work against its survival. A changing climate may also provide advantages to other native and nonnative plant species. Sharing information between scientists, land managers, and decision makers will increase our ability to address these threats. Increasing the success with which we address current threats to S. pedata will increase our success of handling the uncertain effects of future climate change (USFWS, 2011).

Recovery

Reclassification Criteria:
Populations of Sidalcea pedata and adjacent suitable habitat are fully protected through land management agreements, land ownership by resource agency or conservation organization, conservation easement, or other permanent means of protection (USFWS, 2011).

Populations are stable or increasing with allowances for natural fluctuations (USFWS, 2011).

Recovery Actions:

- Overall, while some steps have been made in achieving recovery, progress towards reclassifying and eventually delisting Sidalcea pedata has been largely unsuccessful and there are indications—such as two extirpations, and the significant habitat degradation at the east and south shores of Baldwin Lake (EOs 8, 9, 30), Metcalf Creek (EO 17) and Eagle Point (EO 21)— that S. pedata is facing an increasing threat of extirpation. The recovery plan was not threats based; consequently, action items necessary to meet the plan's recovery criteria are insufficient to reduce or eliminate the threats identified in the five-factor analysis and recover the species.
- Work with partners, in particular private landowners, to help conserve Sidalcea pedata. Identify opportunities through the Service's Partners for Fish and Wildlife Programs to implement conservation opportunities on private lands (USFWS, 2011).
- Conduct monitoring to inventory actual occurrences and update the status of Sidalcea pedata occurrences throughout the species range. While the occurrences on the east side of Baldwin Lake (EOs 9, 30) are presumed extant, surveys should occur because they have not been conducted at this species location for many years (USFWS, 2011).
- Establish a seed bank focusing first on small, isolated populations that have the greatest potential to become extirpated (USFWS, 2011).
- Work with the State and San Bernardino County to resolve conflicts with the weed abatement plan (USFWS, 2011).
- Develop a threats-based recovery plan or outline to guide conservation actions for the species (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Continue to collect additional seed from Sidalcea pedata occurrences to expand the ex situ conservation seed bank at the California Botanic Garden (formerly Rancho Santa Ana Botanic Garden) 2. Study Sidalcea pedata population genetics, including levels of genetic diversity and differentiation within and among occurrences, and levels of inbreeding, relatedness, and ploidy. This information will allow us to assess levels of current genetic diversity and gene flow, assess whether genetic management is needed, and assess appropriate seed sources for potential future reintroduction or augmentation activities. 3. Develop a propagation protocol for Sidalcea pedata. 4. Coordinate with landowners to identify opportunities for conservation on private lands. Work with private landowners, local governments, and conservation organizations to conserve, manage, and enhance habitat for Sidalcea pedata. 5. Continue to monitor Sidalcea pedata occurrences. (USFWS, 2021)

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SPECIES ACCOUNT: *Sideroxylon reclinatum ssp. austrofloridense* (Everglades bully)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/6/2017; Southeast Region (R4) (USFWS, 2017)

Physical Description

Everglades bully is a single to many-stemmed shrub, 3 to 6 feet (ft) (1 to 2 meters (m)) tall (Corogin and Judd 2014, pp. 410-412). The branches are smooth, slightly bent, and somewhat spiny. The leaves are thin, oval-shaped, 0.8 to 2 inches (in) (2 to 5 centimeters (cm)) long, evergreen, lance-shaped, and fuzzy on their undersides. The flowers are in axillary clusters. This subspecies is distinguished from the similar subspecies S. reclinatum ssp. reclinatum in Florida by its leaves, which are persistently pubescent (fuzzy) on their undersides, rather than smooth or pubescent only along the leaf midvein. In addition, the two subspecies are more reliably distinguished by differences in the micromorphology of the leaf epidermis. (USFWS, 2017)

Taxonomy

The genus Sideroxylon is represented by eight species in Florida. All of these plants were previously assigned to the genus Bumelia. Sideroxylon reclinatum, the Florida bully, is represented by three subspecies that range nearly throughout Florida and into neighboring states. The Everglades subspecies was first recognized by Whetstone (1985, pp. 544-547) as Bumelia reclinata var. austrofloridense, then transferred to the genus Sideroxylon (Kartesz and Gandhi 1990, pp. 421-427). Sideroxylon reclinatum ssp. austrofloridense was made a subspecies rather than a variety (Kartesz and Gandhi 1990, pp. 421-427); in plant nomenclature, the ranks of variety and subspecies are interchangeable. Sideroxylon reclinatum ssp. austrofloridense is used in the current treatment of the Florida flora (Wunderlin and Hansen 2016, p. 1). The online Atlas of Florida Vascular Plants (Wunderlin and Hansen 2016, p. 1), Integrated Taxonomic System (ITIS 2016, p. 1), NatureServe (2016, p. 1), and the Florida Department of Agriculture and Consumer Services (FDACS) (Coile and Garland 2003, p. 19) indicate that Sideroxylon reclinatum ssp. austrofloridense is the accepted taxonomic status. (USFWS, 2017)

Historical Range

The historical range of Sideroxlon reclinatum ssp. austrofloridense is limited to Collier, Miami-Dade, and Monroe Counties, Florida. In Miami-Dade County, the plant was known from central and southern Miami-Dade County along the Miami Rock Ridge, which extends from Long Pine Key in the Everglades northward through urban Miami to the Miami River. In Monroe County, the plant is known from Big Cypress National Preserve on the mainland, and was collected as far south as Key Largo, in the Florida Keys. In Collier County, the subspecies has been recorded only within Big Cypress National Preserve. The subspecies is apparently extirpated from Key Largo, and has not been found in surveys of pine rocklands on Key Largo, Big Pine Key, Cudjoe Key and Lower Sugarloaf Key. (USFWS, 2017)

Current Range

The current range of Sideroxylon reclinatum ssp. austrofloridense is in Miami-Dade and Monroe Counties, Florida, in Big Cypress National Preserve, the Long Pine Key region of Everglades National Park, and pine rocklands adjacent to Everglades National Park. The current range is

approximately 42 mi (67.5 km). (USFWS, 2017)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (USFWS, 2017)

Reproduction Narrative

Adult: Little is known about the life history of Sideroxylon reclinatum ssp. austrofloridense, including pollination biology, seed production, or dispersal. Reproduction is sexual, with new plants generated from seeds. The subspecies produces flowers from April to May, and fruit ripens from June to July. (USFWS, 2017)

Habitat Type

Adult: Pine rockland habitat, marl prairie habitat, and within the ecotone between both habitats (USFWS, 2017)

Dependencies on Specific Environmental Elements

Adult: Periodic fire is extremely important to maintaining habitat for this subspecies (USFWS, 2017)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2017)

Tolerance Ranges/Thresholds

Adult: The plants can stand partial inundation with fresh water for a portion of the year, but do not tolerate salinity. (USFWS, 2017)

Dependency on Other Individuals or Species for Habitat

Adult: The species frequently has numerous stem galls, but these galls do not appear to cause mortality to the plant and may in fact be an important part of the subspecies' natural history. In addition, the stem galls are often inhabited by acrobat ants. (USFWS, 2017)

Habitat Narrative

Adult: Sideroxylon reclinatum ssp. austrofloridense grows in pine rockland habitat, marl prairie habitat and within the ecotone between both habitats. These habitats are maintained by regular fire, and are prone, particularly marl prairie, to annual flooding for several months during the wet season. The species also grows on the sunny edges of rockland hammock habitat, which is fire-resistant. Everglades bully occurs in sparsely vegetated, well-lit, open areas that are maintained by disturbance. (USFWS, 2017)

Dispersal/Migration

Dispersal

Adult: Unknown (USFWS, 2017)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2023)

Number of Populations:

14 extant populations (USFWS, 2023)

Population Size:

10,000 to 100,000 plants, mostly occurring at Long Pine Key (USFWS, 2023)

Population Narrative:

The largest population occurs at Long Pine Key in Everglades National Park (ENP). The population at Long Pine Key is estimated at between 10,000-100,000 plants. Recent surveys of ENP have identified 14 occurrences of Sideroxylon reclinatum ssp. austrofloridense in Long Pine Key, expanding the known range in ENP. In Miami-Dade County, outside ENP, pine rocklands tracts are orders of magnitude smaller and exist in a matrix of agricultural, commercial, and residential development. Approximately 73 plants were observed at Larry and Penny Thompson Park, within the Richmond Pine Rocklands. Extant populations have been found at Quail Roost Pineland (two plants), Navy Wells Pineland Preserve (four plants), and Sunny Palms Pinelands (two plants). The subspecies has been observed in pine rocklands at Grant Hammock and Pine Ridge Sanctuary. The subspecies no longer occurs at the Nixon-Smiley Preserve. Surveys in the Gum Slough region of Lostmans Pines in Big Cypress National Park reported finding Sideroxylon reclinatum ssp. austrofloridense with limited distribution within the study area (USFWS, 2017). The Everglades bully currently has 14 extant populations on public and private lands in Miami-Dade and Monroe counties (Table 1). There is evidence that populations of Everglades bully are increasing within Everglades National Park (Bradley et al. 2013; Gann 2015; Lange, pers. comm. 2017), but insufficient survey data on private lands coupled with persistent threats to the species means it is unclear whether the overall species status is trending upwards (USFWS, 2023).

Threats and Stressors

Stressor: Present or Threatened Destruction, Modification, or Curtailment of Its Habitat or Range
Exposure:
Response:
Consequence:
Narrative: Habitat loss, fragmentation and degradation, and associated pressures from increased human population are major threats this species. These threats are expected to increase as remaining pine rocklands and other habitats are lost to development, placing these plants at greater risk. This species may be impacted when pine rocklands are converted to other uses or when lack of fire causes the conversion to hardwood hammocks or other unsuitable habitats. On public lands, including National Park Service lands and Miami-Dade County-owned lands, implementation of prescribed fire has not been sufficient because of legal constraints (permitting requirements) and inadequate funding. Any populations of this species found on private property

could be destroyed due to development. Although efforts are being made to conserve natural areas and apply prescribed fire, most pine rocklands remain in poor fire condition, and the long-term effects of large-scale and wide-ranging habitat modification, destruction, and curtailment will last into the future, while ongoing habitat loss due to population growth, development, and agricultural conversion continues to pose a threat to this species outside of conservation lands.

Stressor: Inadequacy of Existing Regulatory Mechanisms
Exposure:
Response:
Consequence:
Narrative: This species is found on Federal, State and County lands. NPS regulations provide protection at Everglades National Park and Big Cypress National Preserve. These two sites continue to support the largest and best managed populations. State regulations provide protection against trade, but allow private landowners or their agents to clear or remove species on the Florida Regulated Plant Index. State Park regulations provide protection for plants within Florida State Parks. The Natural Forest Communities program in Miami is designed to protect rare and important upland (non-wetlands) habitats in south Florida; however, this regulatory strategy has several limitations that reduce its ability to protect this plant and its habitat. Although many populations of this species are afforded some level of protection because they are on public conservation lands, especially Federal lands, existing regulatory mechanisms vary in strength and scope, and do not provide substantive protection of habitat at this time. They have not led to a sufficient reduction of threats posed to these plants by a wide array of sources. (USFWS, 2017)

Stressor: Other Natural or Manmade Factors Affecting Its Continued Existence
Exposure:
Response:
Consequence:
Narrative: Threats from other natural or manmade factors to this species include nonnative, invasive plants; management practices (such as mowing); recreation (including off-road vehicle use), effects from small population size and isolation; limited geographic range; and stochastic events including hurricanes, storm surges, and wildfires. Additionally, this plant is particularly vulnerable to the effects of climate change, including sea level rise, as changes in the water table, increased soil salinity from partial inundation, and storm surge will likely result in vegetation shifts in the decades prior to the fully anticipated sea level rise. Some of these threats (e.g., nonnative species) may be reduced on public lands due to active programs by Federal, State, and County land managers. Many of the remaining populations of this plant are small and geographically isolated, and genetic variability is likely low, increasing the inherent risk due to overall low resilience of these plants. The threats act together to impact populations of this species. (USFWS, 2017)

Recovery

Reclassification Criteria:
Not defined.

Recovery Priority Number: 9

Delisting Criteria:
Not defined.

Recovery Actions:

- Recovery actions have not been defined.
- Conserve pine rocklands and suitable habitat through purchase or conservation easements.
- Provide regular prescribed burns to maintain suitable habitat conditions.
- Remove exotic plants and hardwoods to restore understories.
- Monitor and manage remaining small populations in Miami-Dade County.
- Locate new occurrences within Everglades National Park through additional surveys.
- Establish the limits of this species habitat requirements through additional surveys within Everglades National Park.
- Determine effects (positive or negative) from Everglades restoration and other hydrologic manipulations and changes through monitoring at Long Pine Key.

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities Through the course of this species status review, we recommend the following potential recovery activities. Restoration and protection of the pine rocklands, marl prairies, and rockland hardwood hammock habitats is critical to maintain populations of the species. This will ideally include increased fire management coupled with physical removal of invasive species. Removal of dense, woody invasive flora will prevent heightened burn temperatures and longer burn times, both of which increase Everglades bully mortality. More frequent prescribed fires will prevent tree encroachment and the succession of pine rockland habitat into hardwood forest. Further, we recommend working with private landowners to prevent the destruction of Everglades bully plants and to reintroduction. Monitoring / Research Activities We recommend extensive surveys on public and private lands to better understand the population trends in those areas. Of 14 extant populations, only the ENP colony has been sufficiently surveyed. There have also been no genetic studies on the Everglades bully, presenting a gap in our understanding of the species and its allelic richness. Further research should be conducted on the species response to development and fragmentation, pesticide use, and stochastic events and sea level rise which are expected to increase in frequency with climate change (USFWS, 2023)

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SPECIES ACCOUNT: *Silene alexandri* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/08/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A subshrub 3-6 dm tall. Flowers are white. (NatureServe, 2015)

Taxonomy

Silene alexandri was described by Hillebrand (1888) based upon a specimen he discovered on Molokai (USFWS 1992) (USFWS, 1996).

Historical Range

See current range/distribution

Current Range

Current range: central Molokai; historically no additional range.

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Silene alexandri under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one detailed critical habitat unit (CHU), in Maui County in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Silene alexandri includes one CHU in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania

tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Silene alexandri critical habitat consists of one component. Lowland mesic (Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further

degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 1996)

Reproduction Narrative

Adult: Currently, no life history information is available for this species (USFWS, 1996).

Habitat Type

Adult: Shrubland/Dry forest (USFWS, 1996)

Habitat Narrative

Adult: Species inhabits moist shrublands on steep rocky slopes. (NatureServe, 2015). The two known populations are found in remnant dry forest and shrubland at an elevationbetween 610 and 760 meters (2,000 and 2,500 feet). Associated plant species include aalii, ohia, pukiawe, and uluhe (USFWS 1992) (USFWS, 1996).

Dispersal/Migration

Motility/Mobility

Adult: Unknown (USFWS, 1996)

Dispersal/Migration Narrative

Adult: Currently, no life history information is available for this species (USFWS, 1996).

Population Information and Trends

Population Trends:

Increasing (USFWS, 2014)

Number of Populations:

1 (USFWS, 2023)

Population Size:

6 adults, 30 seedlings (USFWS, 2023)

Population Narrative:

Fragility unknown. A total of fewer than 50 plants observed. 1 current (between 1982 and 1997) and 1 historical occurrence. (NatureServe, 2015). Surveys conducted by the Plant Extinction Prevention Program (2009) discovered four new individuals of Silene alexandri at Kewela in a population containing 17 individuals previously. In 2012, the single population contained 25 mature wild individuals of S. alexandri (PEPP 2012). Overall, the numbers of individuals have increased from approximately 6 individuals reported in the previous 5-year review to approximately 25 individuals in 2012 (PEPP 2012). The increase in numbers resulted from additional surveys (USFWS, 2014). Low resiliency, representation and redundancy are based on the species being kown from a single population with few individuals and its specific habitat requirements. • Currently, there is one population on Moloka‘i at Kawela gulch, with a total of

six mature individuals and 30 seedlings (Bakutis, pers. comm. 2023). • Currently, there are approximately 31 founder lines represented in ex situ storage and propagation collections, including seeds in seed banks, explants in micropropagation and plants in cultivation (Lyon Arboretum 2022; National Tropical Botanical Garden (NTBG) 2022) (USFWS, 2023).

Threats and Stressors

Stressor: Climate change (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change destruction or degradation of habitat – Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Silene alexandri is highly vulnerable to the impacts of climate change. Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2014).

Stressor: Feral deer (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Ungulate degradation of habitat – Axis deer (Axis axis) populations have increased on Molokai and are now found in areas occupied by S. alexandri (PEPP 2011, 2013) (USFWS, 2014).

Stressor: Landslides/flooding (USFWS, 2014)
Exposure:
Response:
Consequence: Extinction
Narrative: Landslides and flooding destruction or degradation of habitat – The single population is threatened by landslides and erosion (PEPP 2009, 2013) (USFWS, 2014).

Stressor: Stochastic events (USFWS, 2014)
Exposure:
Response:
Consequence: Extinction/loss of habitat
Narrative: Stochastic events – Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on S. alexandri (PEPP 2013). In addition, fire is a threat to the single known population of this speices (USFWS, 2014).

Stressor: Slug herbivory (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Slug herbivory – Herbivory by slugs (unidentified species) have been reported as a new threat to this species (PEPP 2012, 2013) (USFWS, 2014).

Stressor: Rodent predation and herbivory (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Rodent predation and herbivory – Rats (Rattus sp.) are considered a threat to S. alexandri (PEPP 2010, 2012) (USFWS, 2014).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that S. alexandri is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.991 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions, including potential for assisted translocations, are needed to conserve this taxon into the future (USFWS, 2018).

Recovery

Reclassification Criteria:
For downlisting, a total of at least five populations, with at least 300 plants each (a total of 1,500 mature plants) must be sustained for five years (USFWS, 1996).

Recovery Priority Number: 5

Delisting Criteria:
For delisting, a total of at least five populations, with at least 300 plants each (a total of 1,500 mature plants) must be sustained for ten years (USFWS, 1996).

Recovery Actions:
- Ungulate monitoring and control – Maintain fencing to exclude browsing by ungulates (USFWS, 2014).
- Invasive plant monitoring and control – Continue control of invasive introduced plant species within fenced areas (USFWS, 2014).
- Captive propagation for genetic storage and reintroduction o Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. o Evaluate genetic resources currently in storage to determine the need to place additional genetic resources in long-term storage due to this species' vulnerability to climate change (USFWS, 2014).
- Reintroduction/translocation – Augment populations as genetically appropriate individuals become available in nurseries and as habitat is protected (USFWS, 2014).
- Surveys / inventories – Survey the geographical and historical range of Silene alexandri for a thorough current assessment of the species' status (USFWS, 2014).

- Fire monitoring and control – Develop and implement a fire management plan at the existing exclosure (USFWS, 2014).
- Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change (USFWS, 2014).
- Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2014).
- New Management Actions: • Captive propagation for genetic storage and reintroduction— o The Lyon Arboretum Micropropagation Laboratory reported 164 containers of propagules representing seven individuals from Kawela. The Lyon Arboretum Seed Conservation Laboratory reported almost 22,000 seeds in storage representing 19 plants from one population at Kawela; almost 11,000 seeds in storage representing 11 plants from a second population at Kawela; and over 1,000 seeds representing crosses of individuals at Mākolelau (Lyon Arboretum 2017). o The University of California—Irvine (2014) reported six plants in storage representing three wild individuals. • Stochastic events—Build resiliency and redundancy—In 2015, the Plant Extinction Prevention Program (PEPP) outplanted 28 individuals at Kawela and 13 individuals at Mākolelau. In 2016, PEPP outplanted 358 individuals at Kawela (21 founders represented). In 2017, PEPP outplanted 321 individuals at Kawela and 20 individuals at Kamiloloa gulch (PEPP 2015, 2016, 2017a, 2017b) (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are updated and reiterated for the 5-year review for 2023. • Surveys and monitoring—Survey for additional populations of Silene alexandri at historical populations and areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Silene alexandri within and around all wild and reintroduced populations. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change, including increasing temperatures, periods between rain events, and frequency and intensity of hurricanes. Additional management actions may be needed, such as locating microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and implement effective methods for rodents and slugs around wild and reintroduced populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Build resiliency, redundancy, and representation — Increase species' viability through habitat restoration, threat control, and reintroduction and translocation. Continue attempts at reintroduction into suitable habitat that is being managed for known threats to this species to reduce impacts of erosion, treefall, flooding, and hurricanes. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2023).

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SPECIES ACCOUNT: *Silene polypetala* (Fringed campion)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/19/1991; Southeast Region (R4)

Physical Description

Fringed campion is a perennial herb that forms mats by spreading vegetatively, with long, slender stolon-like rhizomes and leafy offshoots, both of which terminate in overwintering clusters of leaves (rosettes). Leaves of the rosette and stem are opposite, widest toward the tip, mostly 1-4 inches long. Each rosette produces one to several erect flowering shoots, each of which is unbranched or sparingly branched, up to 16 inches tall. The flowers are arranged in groups of 3-5 at the top of the flowering shoot. The calyx is tubular and covered with long, weak hairs. The 5 separate petals are each divided into a lower part about as long as the calyx and a triangular upper part that extends 1-11/ 2 inch from the calyx. The wide apex of each petal is divided into slender segments, giving the flower a fringed appearance. The petals are pink or white. Flowering is from late March to May (Kral 1983, Hitchcock and Maguire 1947, Faust 1981). The plant is easily recognized by its distinctive flowers. (USFWS, 1996)

Taxonomy

Research by Ward (2006) proposed an official change in nomenclature for the species, from Silene polypetala to Silene catesbaei. Ward's (2006) historical research found that the name Silene polypetala, formed in 1948 by Fernald and Schubert, based on their assessment of Thomas Walter's 1788 Flora Caroliniana, was erroneously applied to a fragmentary herbarium specimen they believed to be labeled by Walter as Cucubalus polypetalus. Ward (2006) proposes that the species and fragmentary herbarium specimen Thomas Walter referred to as Cucubalus polypetalus was either of two introduced species, Silene cucubalaus or Lychnis alba--these two exotic species having been established in mountains of North Carolina by the eighteenth century. When Ward (2006) cross-referenced Thomas Walter's Latin prescriptions to specimen labels, he found a prescription for a new species termed by Walter as Silene catesbaei, a plant for which no herbarium specimen could be located in the Flora Caroliniana. Walter's Latin prescription appeared to Ward (2006) to be a better match to the species named by Fernald and Schubert and considered today as Silene polypetala. Since no type specimen matched Walter's prescription of Silene catesbaei, the International Code of Botanical Nomenclature guidelines allows for an author [Ward] to select a new type specimen, a neotype, to match the accepted name and prescription of Silene catesbaei, for which Ward (2006) did, selecting a specimen formerly and widely known as Silene polypetala. The neotype is a specimen of Silene catesbaei/Silene polypetala collected along Pobiddy Road in Talbot County, Georgia. USFWS accepts the name of Silene catesbaei for future documentation. However, to formally make this change in 50 CFR 17.12, it will require notice in the Federal Register (USFWS, 2015).

Historical Range

In six counties in Georgia: Bibb, Crawford, Decatur, Talbot, Taylor, and Upson Counties; in two counties in Florida: Gadsden and Jackson Counties. (USFWS, 1996)

Current Range

In eight counties in Georgia: Bibb, Crawford, Decatur, Houston, Talbot, Taylor, Twiggs, and Upson Counties; in two counties in Florida: Gadsden and Jackson Counties. (USFWS, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual and asexual (USFWS, 1996)

Breeding Season

Adult: Flowering begins in late March at the Florida locales, and ends sometime in May at the sites near the Fall Line in Georgia, with fruits maturing a month later (NatureServe, 2015).

Reproduction Narrative

Adult: Although no studies of the reproductive biology of Silene polypetala are known to the author, the large, showy, nectariferous flowers are indicative of a sexually reproducing species dependent on insects for pollination, perhaps supplemented by hummingbirds. In the genus Silene, the nectar is concealed at the base of the calyx tube, and the flowers are probed by larger bees and lepidoptera (Zomlefer 1994). Flowering begins in late March at the Florida locales, and ends sometime in May at the sites near the Fall Line in Georgia, with fruits maturing a month later. Some, if not all, plants in cultivation exhibit male sterility as evidenced by flattened anther sacs and the production of few, if any well-formed pollen grains. Lack of sexual reproduction may, therefore, be one reason for this species not persisting in cultivation. Sexual reproduction is supplemented by, and quite possibly exceeded by asexual reproduction. Silene polypetala produces runners, nearly leafless basal, procumbent stems terminating in rooted rosettes of leaves. In time, the rosettes produce flowering stems and the connection to the original plant decays. Thus a colony that appears to be composed of numerous individuals may, in fact, harbor only one or very few genetic individuals. The clonal nature of this species creates difficulties for monitoring its status and progress towards recovery. Counting individuals seems impossible without genetic testing. There is no clear reason to examine the genetic structures of the populations if they are stable. Possibly, the best approach for monitoring of populations is by detailed mapping using permanent stakes (metal stakes driven into the ground can be relocated with a metal detector) combined with geographic positioning systems, which are useful relocating populations. While plants can be mapped precisely, use of the mapping methods is limited by the need for trained individuals and costly equipment (USFWS, 1996). This species spreads vegetatively and the number of genotypes is far fewer than the number of clusters of plants at a site (USFWS 1991) (NatureServe, 2015).

Habitat Type

Adult: Deciduous woods

Environmental Specificity

Adult: Broad (USFWS, 2015)

Habitat Narrative

Adult: Silene polypetala occurs in various situations within hardwood forests. It is often on fairly steep slopes of deep ravines or north-facing hillsides, sometimes on nearly level ground, particularly in flatwoods developed on Iredell soils. The great majority of populations of Silene polypetala occur in the watershed of the Apalachicola River and its- tributary, the Flint River. One factor that the sites seem to have in common is a circumneutral soil reaction, due to the nature of the parent material. In the Coastal Plain occurrences (Florida and Decatur County, Georgia) the parent material is limestone. In the Piedmont localities the parent material is a magnesium-rich rock, hornblende gneiss. (USFWS, 1996)

Dispersal/Migration

Population Information and Trends

Population Trends:

Stable short term population trend (NatureServe, 2015)

Number of Populations:

44 (USFWS, 2021)

Population Size:

1500 - 2000 plants in Florida; no estimate for Georgia, but most sites are more extensive than the Florida sites (USFWS, 2015)

Resistance to Disease:

Plants in the wild appear to exhibit no apparent symptoms of disease. (USFWS, 2015)

Population Narrative:

Fringed campion continues to be threatened with extinction throughout its range. Few sites (12 of 44) occur on protected property (federal, state, or private owned conservation lands), three of these are considered extirpated, and no protected site is considered to have “very good to excellent” viability. The remaining protected sites have declined or have uncertain statuses. Since the last review three new sites were discovered and one safeguarding site was established, however, this increase was offset by three sites that were previously considered extant being placed in the extirpated or possibly extirpated categories. Across the range, the species continues to face serious threats from nonnative, invasive plant species and incompatible timber harvests. Several sites have been severely impacted by timber harvests within and adjacent to fringed campion habitat. Additionally, new and increasing threats include impacts from feral hogs, widespread severe storms (e.g., hurricanes), and fire. (USFWS, 2021)

Threats and Stressors

Stressor: Habitat loss and/or degradation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Habitat loss continues for Silene catesbaei as areas are clear-cut and other forested parcels suffer from infestation by exotic, invasive plant species that out-compete Silene catesbaei. The largest known site (40 acres) in the Ocmulgee River drainage (Piedmont area) is at

risk of losing Silene catesbaei, if English ivy continues to spread up the small stream courses where the species grows. Hundreds of acres of habitat in the Apalachicola River drainage are being impacted by invasive plants, many sites where other endangered plants occur, such as Torreya taxifolia. (USFWS, 2015).

Stressor: Predation by herbivores (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: One increased threat to the species is the burgeoning population of white-tailed deer (Odocoileus virginianus) that, on some sites, excessively browse the plants, preventing fruit development and seed set (Steve Bowling, pers. comm. 2004)(Wilbur Duncan, pers. comm. 2004)(Pete Pattavina, pers. obs. 2004). Steve Bowling observed an increase in deer pressure on Silene catesbaei populations, beginning in the early-to-mid 1980s. This observation is supported by data that shows rapid expansion of Georgia's white-tailed deer population since 1972, when the State deer herd expanded from 253,000 to approximately 990,000 in 2013, peaking in 1997 at 1,460,000 individuals (GDNR 2014). Although no data is available to prove that the increase in deer population has a negative effect on Silene catesbaei populations, deer modified population structure and plant robustness in other forest herbs (Anderson 1994)(Leege et al. 2010), caused declines in species richness in forests, evenness and species diversity (Rawinski 2008)(Webster et al. 2005). (USFWS, 2015)

Stressor: Inadequacy of existing regulation (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: State laws do not restrict private landowners from any lawful activity that would modify or destroy threatened or endangered plants. Therefore neither the Preservation of Native Plants of Florida Act nor the Georgia Wildflower Preservation Act has had a significant effect in minimizing habitat degradation or fragmentation on private lands, the primary threat to the listed species. Georgia's Wildflower Preservation Act of 1973 provides protection for this species, especially on state-owned land. Sites owned by the U.S. Army Corps of Engineers should be considered protected, although close communication with land managers is necessary to ensure Silene catesbaei's needs are included in approved management protocols. The Endangered Species Act prohibits deliberate removal of endangered plants from these areas, and all Federal agencies have a responsibility to conserve endangered plants. (USFWS, 2015)

Stressor: Climate change (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: : Climate change may also influence the long-term viability of fringed campion. Within mixed hardwood forests where the species occurs, drought conditions due to higher temperatures and variable precipitation could reduce the available resources required for plant survival, increase the risk of negative effects from flooding and erosion, and limit the ability of fringed campion to produce viable seed and persist over time. Despite the recognition of climate effects on ecosystem processes, there is uncertainty within climate models about what the exact climate future for the southeastern United States will be, and there is uncertainty in how the

ecosystems and species will respond. Although there are several potential risks associated with long-term climate change there is uncertainty regarding the how fringed campion will respond to these risks. (USFWS, 2021)

Stressor: Fire (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: The influence of fire on fringed campion is uncertain. Several sites have experienced incidental fire from prescribed fires that burned into fringed campion habitat. Where fire burned into fringed campion habitat, the density of fringed campion appears to have decreased post-fire. Fringed campion is a shallowly rooted plant and may not be resilient to the effects of fire. The long-term impacts of natural or prescribed fire still need to be assessed for the species. (USFWS, 2021)

Stressor: Severe storm events (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Severe storm events can alter forest structure where fringed campion occurs. The Coastal Plain of the southeastern United States is vulnerable to extreme storm events, especially due to tropical storms and hurricanes. Hurricane force winds can blow down trees and greatly alter forest structure. Most fringed campion sites are more than 300 km (186 mi) inland and are largely buffered from the widespread effects of tropical storms and hurricanes. However, 15 of the 44 fringed campion sites are located in the Florida Panhandle and southwest Georgia (Gadsden, Jackson, and Decatur counties) and are approximately 90 km (145 mi) inland. This distance may also buffer effects of most tropical storms and hurricanes. However, in October 2018 Hurricane Michael made landfall near Mexico Beach, Florida as a category 5 hurricane. The storm tracked across these 15 sites into southwest Georgia. Review of field surveys and aerial imagery shows considerable impacts to the forest habitat (downed trees) to all 15 sites. Reduction of the forest canopy at these sites may increase the vegetative competition for fringed campion and the long-term persistence for the species at these sites is unknown. The effect of this disturbance has not been examined. (USFWS, 2021)

Recovery

Reclassification Criteria:
1. Reclassification of Silene polypetala to Threatened will be considered if 10 viable and geographically distinct populations are protected from foreseeable threats (USFWS, 1996).

Delisting Criteria:
1. Delisting of Silene polypetala will be considered if 20 of the known populations (including at least 16 in Georgia and 4 in Florida) are protected. Population viability should be confirmed through periodic monitoring for at least a 10-year period (including at least 5 years of monitoring after delisting) (USFWS, 1996).

Recovery Actions:

- 1. Protect populations. Silene polypetala has an inherently narrow geographic and ecological distribution. In the absence of active conservation efforts, sites with this plant will gradually be lost or degraded for reasons described above. This plan emphasizes the conservation of existing populations rather than the creation of new ones. The plan assumes that most owners of sites with this plant are interested in its conservation and that they may be receptive to offers of biological monitoring and assistance with conservation measures such as honeysuckle control. Planning of exotic pest plant control is important enough to be a separate recovery task (4). (USFWS, 1996)
- 2. Preserve genetic stock from acutely threatened populations. Due to the scarcity of extant populations, conservation of the genetic diversity that remains in the species is a high priority. Therefore, some living material of the species should be moved from any population facing imminent local extinction (i.e., where protection is not feasible or cannot be initiated in time to prevent extirpation). At the time of writing, this is necessary for the Crawford County, Georgia population. It is not known whether seed can be stored, which would be less costly than maintaining plants in cultivation. (USFWS, 1996).
- 3. Monitor populations to determine trends and developing threats. All sites supporting Silene polypetala should be monitored, if landowners grant permission. Arrangements with landowners to allow monitoring are included in Task 1. (USFWS, 1996)
- 4. Plan control of exotic pest plants. - Assess threats. When sites are visited, the nature and extent of pest plant infestations must be noted. Information from Silene sites must be combined with information from similar habitats in central Georgia and the Apalachicola Bluffs region of Georgia, Florida, and Alabama. - Identify control methods. A great deal of information is available on exotics control, as well as practical experience by land managers. As threats are identified, possible control methods need to be sought and tried, then modified with experience. Herbicide treatments have the potential to destroy native forest species. (USFWS, 1996)
- 5. Search for additional populations. As indicated above, this species has been searched for previously. However, additional potential habitat exists which has not been checked. Just one example: areas in Monroe County, Georgia indicated on the state geological map as underlain by hornblende gneiss, the same mapping unit as nearby Bibb County localities for the species. (USFWS, 1996)
- 6. Reestablish populations and augment populations at protected locations, if deemed necessary. The feasibility of (re)introduction has not been demonstrated, nor will introductions be necessary if other recovery actions are successful. (USFWS, 1996).
- 7. Manage sites to maintain and/or enhance populations. As Silene polypetala is adapted to an environment in which successional change is relatively slow, maintenance of populations chiefly requires protection from disturbance. Results of the monitoring program (Task 3) should indicate whether human manipulation might benefit Silene polypetala in certain natural or experimental microhabitats. Because exotic pest plants can invade otherwise pristine habitats, controlling them may become the main management action. (USFWS, 1996)
- 8. Educate the public about the value and fragility of this species and its habitat. Since most of the landscape of the Piedmont and Coastal Plain is developed, in cultivation, or in a successional state, relatively undisturbed hardwood forest can provide an all-too-rare primeval experience. They also have the potential to serve as outdoor classrooms for studying important ecological and/or evolutionary concepts such as succession, competition, endemism, and ecotypic differentiation. (USFWS, 1996)

- 9. Apply laws protecting endangered plant species. Employ local, State, and Federal regulations when they are appropriate to protect the sites where this plant occurs. (USFWS, 1996)
- Update the most recent, draft recovery plan (USFWS 1996b), to incorporate genetic information and new populations (USFWS, 2015).
- Revisit and assess all known sites for viability and other population variables at least every two years (USFWS, 2015).
- Promote and/or fund long-term population and/or demographic monitoring projects through partnerships (USFWS, 2015).
- Acquire private forestry tracts and bring into public ownership for proper management of the species and its habitat. Land tracts in the Chattahoochee River basin should be given top priority for purchase because of the genetic and habitat diversity found there. Since the species generally occurs over small areas, purchasing large portions of the global range would be relatively inexpensive, since only several thousand acres may require purchase to ensure long-term protection and survival of the species. Formal conservation agreements and conservation easements may also be effective at protecting Silene catesbaei habitat (USFWS, 2015).
- Perform new searches for the species in the Ocmulgee River basin and Chattahoochee River drainage. Habitat modeling using one-meter Lidar data may be useful for this exercise (USFWS, 2015).
- Continue to fund long-term invasive species control at sites in the Apalachicola and Ocmulgee sites (USFWS, 2015).
- Monitoring needs to be standardized for the species to ensure that data collected from different parties is comparable. Silene catesbaei is clonal and patch-forming, posing difficulties for estimating the number of plants at occupied sites (USFWS, 2015).
- Identify sites within the species range for establishment of new sites and/or population augmentation. (USFWS, 2015)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Activities: 1. Update and finalize the Technical/Agency Draft Recovery Plan (Service 1996, 2006), incorporating population resiliency and species' representation and redundancy into recovery criteria. 2. Revisit and assess all known sites for viability and other population variables at least every two years. 3. Promote and fund long-term population and/or demographic monitoring projects through partnerships. 4. Develop and implement conservation plans for populations on protected lands to improve long-term viability at these sites. 5. Protect additional sites to increase redundancy of protected sites across all four watersheds (Apalachicola, Chattahoochee, Flint, and Ocmulgee). Formal conservation agreements and conservation easements with private landowners may also be effective conservation tools. 6. Standardize long-term monitoring protocols to be used range-wide to track progress toward recovery. 7. Fund and implement long-term management at priority (recovery) sites to abate threats from nonnative, invasive plants, feral hogs, and white-tailed deer. 8. Work with private landowners and the forestry industry to encourage best management practices (e.g., appropriately sized habitat buffers) for forestry and agricultural land uses to protect fringed campion habitat. 9. Identify sites within the species range for establishment of new sites and/or population augmentation. 10. Preserve genetic stock using various approaches such as seed banking and in situ and ex situ safeguarding. 11. Develop and distribute public educational materials supporting fringed campion recovery. 12. Formally adopt the change in nomenclature of fringed campion to Silene catesbaei by

publishing a notice in the Federal register to change the listed entity name in 50 CFR 17.12. Research: 1. Expand knowledge of basic ecology and demography of fringed campion such as pollination ecology and seed viability studies. 2. Expand genetic studies to further evaluate genetic diversity of the species across the range. 3. Monitor and study the long-term effects of habitat alteration from hurricanes (storms) at sites affected by Hurricane Michael. 4. Develop habitat and species distribution models to guide habitat protection efforts and guide searches for new sites in the field. 5. Implement studies to evaluate the effectiveness of deer and hog exclosures. 6. Refine population and representation (recovery) units, as appropriate, using results from ecological, demographic, and genetic research. (USFWS, 2021)

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SPECIES ACCOUNT: *Silene spaldingii* (Spalding's Catchfly)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb with stout stems, 2-8 dm tall. White flowers, forming a tight, leafy flower head, bloom from late June to August. (NatureServe, 2015)

Taxonomy

Spalding's catchfly produce one to several vegetative or flowering stems that arise from a simple or branched persistent underground stem (caudex), which surmounts a long, narrow taproot. Plants range from 20 to 40 cm in height. Each stem typically bears 4 to 7 pairs of simple, opposite leaves that are 5 to 8 cm in length and 2 to 4 cm in width. Similar to the majority of plants in this family, Spalding's catchfly has distinctly swollen nodes located where the leaves are attached to the stem. Reproductive individuals produce 3 to 20 cream to pink or light green flowers that are borne in a branched, terminal inflorescence. All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name 'catchfly' (USFWS, 2016).

Current Range

Regional endemic restricted to remnants of the Poulouse Prairie grasslands of eastern Washington, northeastern Oregon, northern Idaho, and western Montana (barely extending into British Columbia, Canada) (NatureServe, 2015). The species is endemic to the Palouse region of south-east Washington and adjacent Oregon and Idaho, and is disjunct in northwestern Montana and British Columbia, Canada (USFWS, 2016).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Food/Nutrient Narrative

Adult: All green portions of the plant (foliage, stem, and flower bracts) are covered in dense sticky hairs that frequently trap dust and insects, giving this species the common name 'catchfly' (USFWS, 2016).

Breeding Season

Adult: Flowering typically occurs from mid-July through August, but may occasionally continue into October (USFWS, 2016).

Reproduction Narrative

Adult: Plants (both vegetative and reproductive) emerge in mid- to late May. Flowering typically occurs from mid-July through August, but may occasionally continue into October. Rosettes are formed the first and possibly the second year, followed by the formation of vegetative stems.

Above-ground vegetation dies back at the end of the growing season and plants either emerge in the spring or remain dormant below ground for one to several consecutive years. Spalding's catchfly reproduces solely by seed. It lacks rhizomes or other means of reproducing vegetatively (USFWS, 2016). Silene spaldingii is a partially self-compatible, hermaphroditic perennial. Reproduction is apparently via seed only, as rhizomes or other means of vegetative propagation are lacking. Seeds appear to require cold stratification, so germination occurs mainly in the spring. Rosettes are formed the first year and flowering may occur during or after the second season. Flowers are protandrous (Lesica and Heidel 1996). Anthers mature and dehise pollen first. During this time, the styles are unexpanded, and the unexposed stigmatic surfaces are held well below the level of the anthers. After the anthers shrivel and fall from the filaments, the three styles expand and the stigmas become receptive. Each flower persists for two to several days, and two or more flowers may be in bloom on the same plant, so geitonogamous pollination is possible. This system promotes outcrossing while allowing the possibility of self-pollination (Lesica 1991; 1993). The bumblebee, Bombus fervidus, appears to be the only significant pollination vector for S. spaldingii throughout its range (Lesica and Heidel 1996). At least at some populations, S. spaldingii appears to be subject to pollinator limitations, inbreeding depression, and a large genetic load (Lesica 1991; 1993).; Silene spaldingii most frequently occurs in relatively intact climax or successionally advanced mesic grassland communities (Lorain 1991). It does not occur at sites where the native vegetation has been displaced by aggressive weeds. It is apparently tolerant of light to moderate grazing (Schassberger 1988). In areas where grazing occurs, it does not appear to be preferred by cattle, but these populations also are much smaller than those in mature grassland habitats. Lesica (1994) found that prescribed burning at a site in Montana increased growth, recruitment and flowering of Silene spaldingii.; Perfect; Predominantly outcrossing; SEXUAL; ABIOTIC; Self-dispersing; Hymenoptera; (NatureServe, 2015)

Habitat Type

Adult: Palouse Prairie (NatureServe, 2015)

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: The 2007 Recovery Plan describes occupied habitat within five physiographic regions; 1) the Palouse Grasslands in west-central Idaho and southeastern Washington; 2) the Channeled Scablands in eastern Washington; 3) the Blue Mountain Basins in northeastern Oregon; 4) the Canyon Grasslands of the Snake River and its tributaries in Idaho, Oregon, and Washington; and 5) the Intermontane Valleys of northwestern Montana. These regions are distinctive from one another in climate, plant composition, historical fire frequencies, and soil characteristics. These differences are significant in that they may translate into differences in life histories, habitat trends, consequences of fire suppression, and types of weed control as they apply to conservation of catchfly (USFWS, 2016). Restricted to Palouse Prairies, sometimes extending into areas where the grasslands are intermingled with ponderosa pine (Pinus ponderosa) woodlands. Soils are almost always a productive, deep loess. Elevation range is 580-1,220 m. Silene spaldingii is restricted to Festuca idahoensis habitat types and phases throughout its range. These areas are often referred to as Palouse prairie. Sites are often near lower treeline, or near scattered ponderosa pine trees. Populations have been found on all aspects, but there seems to be a preference for northerly-facing aspects. It occurs at elevations ranging from about

1,900 to 3,600 feet, and on flat to steep slopes. Soils are almost always productive silt/loams (loess) that are moderately deep and sometimes gravelly (Gamon 1991; Lorain 1991). The soils are depositional materials from catastrophic floods of glacial Lake Missoula that extend from Montana across Idaho into eastern Oregon and Washington. (NatureServe, 2015)

Dispersal/Migration

Population Information and Trends

Number of Populations:

~109 (USFWS, 2020)

Population Size:

~110,313 (USFWS, 2020)

Population Narrative:

At the time the Recovery Plan was developed in 2007, 99 populations of Spalding's catchfly were reported (22 populations in Idaho, 11 in Montana, 17 in Oregon, 49 in Washington). The last 5-year review (2009) reported 10 new populations, adding 3 in Idaho, 2 in Oregon, and 5 in Washington, bringing the total number of populations to 109, with an estimated rangewide number of individual plants being just under 30,000. As noted above, Spalding's catchfly also barely extends in to British Columbia, Canada. Photo credit: Jannis Jocius, Population Census at Wallowa Lake KCA. However, as this Recovery Plan applies only to populations within Idaho, Montana, Oregon and Washington, occurrences in British Columbia are not reported in this review. The number of known occurrences of Spalding's catchfly has increased since 2009. We have evaluated new occurrences provided to us by the Idaho Fish and Wildlife Information System (IFWIS) database and additional reports from Idaho (Pekas et al. 2019 and Gray et al. 2010); the Montana Natural Heritage Program database; the Oregon Fish and Wildlife Office (OFWO) as adapted from the Oregon Biodiversity Information Center (ORBIC) database, and the Washington Natural Heritage Program database. Currently there are 139 occurrences in the United States: 49 in Idaho, 76 in Montana, 49 in Oregon, and 50 in Washington. The number of individual plants in each population ranged from one to thousands with the estimated total number of plants rangewide being approximately 110,313 individuals (8,142 in Idaho, 20,874 in Montana, 56,379 in Oregon, 24,918 in Washington). However, total plant counts are only rough estimates (unless noted otherwise). Exact plant counts are difficult because observed populations fluctuate drastically from one growing season to another, Spalding's catchfly individuals can remain dormant or appear aboveground only briefly for one or more consecutive years, some plant counts at EOs only represent a portion of the occurrence, not all occurrence data includes a population census count, and at some occurrences plant counts are fairly dated. (USFWS, 2020)

Threats and Stressors

Stressor: Development (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Human development (habitat loss) is listed as a threat to this species (USFWS, 2016).

Stressor: Grazing (USFWS, 2016)
Exposure:
Response:
Consequence: Habitat degradation
Narrative: Habitat degradation associated with adverse grazing and trampling by domestic livestock and wildlife is listed as a threat to this species (USFWS, 2016).

Stressor: Nonnative plants (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Invasions of aggressive nonnative plants are listed as threats to this species (USFWS, 2016).

Stressor: Loss of genetic variability (USFWS, 2016)
Exposure:
Response:
Consequence: Extinction/loss of genetic variability
Narrative: Loss of genetic fitness (the loss of genetic variability and effects of inbreeding) is a problem for many small, fragmented populations where genetic exchange is limited (USFWS, 2016).

Stressor: Fire frequency and seasonality (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire frequency and seasonality is listed as a threat to this species (USFWS, 2016).

Stressor: Off-road vehicle use (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of individuals/habitat degradation
Narrative: Off-road vehicle use is listed as a threat to this species (USFWS, 2016).

Stressor: Herbicides (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Herbicide spraying and drift is listed as a threat to this species (USFWS, 2016).

Recovery

Recovery Actions:

- Ongoing conservation efforts include research, Palouse Grassland conservation actions, invasive nonnative plant control, and land acquisition. Monitoring efforts continue, the technical team has worked towards developing a standardized monitoring protocol, and new monitoring has been initiated (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: The many conservation activities on-going for Spalding's catchfly should continue: • Continue working as a Technical Team to collaborate on recovery actions for this species, particularly at the KCAs. • Continue to pursue additional partnerships at areas identified as having potential to be KCAs. • Continue outplanting efforts in order to increase population numbers at KCAs with less than 500 plants (which includes investing in seed increase and grow-out of Spalding's catchfly plants and studying techniques such as direct seeding and site preparation techniques). • Continue the range-wide monitoring program at each of the KCAs and periodically analyze data sets. • Continue survey efforts to locate potential new populations or document population expansions at known locations. In addition to continuing those efforts, the following recovery actions should be made a priority (for funding and implementation) over the next 5 years: • Initiate development of Spalding's catchfly Habitat Management Plans at KCAs that currently are not covered. • Monitor, manage, and evaluate the response of Spalding's catchfly to site-specific stressors at KCAs, such as livestock, rodent activity, and insect herbivory; fire; potential loss of pollinators, and invasive nonnative plant species. • Prioritize the collection of quantitative invasive nonnative plant cover within KCAs. • Complete long-term seed banking at KCAs as well as smaller populations in order to preserve the breadth of genetic material across the species' range. (USFWS, 2020)

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SPECIES ACCOUNT: *Solanum conocarpum* (Marron bacora)

Species Taxonomic and Listing Information

Listing Status: Endangered

Physical Description

Solanum conocarpum is a dry-forest shrub of the Solanaceae or tomato family, which may attain 3 m (9.8 ft) height. Its leaves are oblong-elliptic or oblanceolate (broader at the distal third than the middle), ranging from 3.5-7 cm (0.62-1.5 in) wide. The leaves are coriaceous (leathery texture) and glabrous (no hairs), and have a conspicuous yellowish mid-vein. The flowers are usually paired in nearly sessile (not stalked) lateral or terminal cymes (flat-topped flower cluster). The corolla consists of five separate petals that are light violet, greenish at the base, and about 2 cm (0.78 in) wide. The fruit, a berry, is ovoid-conical (teardrop shaped), 2-3 cm (0.78-1.2 in) long, and turns from green with white striations to golden yellow when ripe (Acevedo-Rodríguez 1996).

Taxonomy

Solanum conocarpum belongs to the Solanaceae family. The genus Solanum includes about 1,200 species mostly of herbs and shrubs with a worldwide distribution (Liogier and Martorell 1995). Liogier and Martorell (1982) recognized about 24 species of Solanum from the Puerto Rican platform, and 10 species occurring within the island of St. John (Acevedo-Rodríguez 1996).

Historical Range

U.S. Virgin Islands, Island of St. John. Solanum conocarpum was originally known from a type specimen collected by L.C. Richard at Coral Bay, St. John, USVI, in 1787 (Acevedo-Rodríguez 1996). No population estimates are available from Richards discovery, nor are there any known population estimates prior to 1992. However, the species was presumed to be near extinction, as two mature plants were believed to be the only specimens left in the wild, one in NPS land, and the other on private land (B. Kojis and R. Boulon, pers comm., 1996, Vilella and Palumbo 2010). The species was rediscovered in 1992 by P. Acevedo-Rodríguez on the island of St. John (Ray and Stanford 2003). After 1992, six additional populations of Solanum conocarpum were identified and reported to occur on dry, poor soils (Ray and Stanford 2005). Acevedo-Rodríguez (1996) referenced the possibility of the species being present on St. Thomas, and mentioned a collection of one sterile specimen from Virgin Gorda (British Virgin Islands; BVI). Pedro Acevedo-Rodríguez (pers comm., 2002) believes that the specimen from Virgin Gorda belongs to a different species, Cestrum laurifolium. Omar Monsegur, USFWS, conducted a site visit to the John Folly population in 2010 and identified several C. laurifolium adjacent to individuals of S. conocarpum. Both plants (C. laurifolium and S. conocarpum) look very similar and are easy to misidentify (O. Monsegur, pers comm., 2010).

Current Range

Solanum conocarpum is currently known from eight localities in the Island of St. John, USVI. Two locations are found in the north side of the Island (Base Hill and Brown Bay Trail), and six towards the southeast side Nanny Point, Friis Bay, Reef Bay, John Folly, Sabbat Point, and Europa Ridge). All of the eight known localities of S. conocarpum are wild populations each ranging from 1 to 144 individuals. The majority of individuals are found within the NPS boundaries, leaving only two populations on private lands (Friis Bay and Sabbat Point). The

largest population of S. conocarpum is located at Nanny Point. Due to potential urban and tourism development at Nanny Point, most of the natural population has been transferred to NPS lands. The owners of the private properties that harbor the Nanny Point natural population agreed to protect an additional area corresponding to Parcel 30-3 by donating it to the NPS (Carper and Selengut 2003, Ray and Carper 2009). Thus, the entire Nanny Point population now lies within a protected area. Populations located on Base Hill, Brown Bay Trail, Europa Ridge, and Reef Bay, lie within NPS lands.

Critical Habitat Designated

Yes; 7/18/2022.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), are listing marron bacora (Solanum conocarpum), a plant species from the U.S. and British Virgin Islands, as an endangered species and are designating critical habitat for the species under the Endangered Species Act of 1973, as amended (Act). In total, approximately 2,548 acres (1,031 hectares) on St. John, U.S. Virgin Islands, fall within the boundaries of the critical habitat designation.

Critical Habitat Designation

Critical habitat units are depicted for St. John, U.S. Virgin Islands.

Primary Constituent Elements/Physical or Biological Features

Within these areas, the physical or biological features essential to the conservation of marron bacora consist of the following components:

(i) Native forest within the subtropical dry forest life zone in St. John.

(ii) Dry scrubland, deciduous forest, and semi-deciduous forest vegetation at elevations lower than 150 meters (492 feet).

(iii) Continuous native forest cover with low abundance of exotic plant species (e.g., Leucaena leucocephala and Megathyrsus maximus) and that provides the availability of pollinators to secure cross-pollination between populations.

(iv) Habitat quality evidenced by the presence of regional endemic plant species, including Zanthoxylum thomasianum, Peperomia wheeleri, Eugenia earhartii, Eugenia sessiliflora, Cordia rickseckeri, Croton fishlockii, Malpighia woodburyana, Bastardiopsis eggersii, Machaonia woodburyana, and Agave missionum.

(v) Open understory with appropriate microhabitat conditions, including shaded conditions and moisture availability, to support seed germination and seedling recruitment.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. All the designated units are occupied by the species at the time of listing (i.e., are currently occupied) and have mixed ownership of predominantly Federal lands (97 percent) and

private lands (3 percent) (see Table 4, below). The features essential to the conservation of marron bacora may require special management considerations or protection to ameliorate the following stressors: habitat modification and fragmentation (development); erosion (from storm water runoff); feral ungulates (predation); and invasive, exotic plants (habitat intrusion). Special management considerations or protection may be required within critical habitat areas to ameliorate these stressors, and include, but are not limited to: (1) Protect and restore native forests to provide connectivity between known populations and secure availability of pollinators and dispersers; (2) reduce density of feral ungulates; (3) remove and control invasive plants; and (4) avoid physical alterations of habitat to secure microhabitat conditions. Criteria Used To Identify Critical

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate outcrosser

Dependency on Other Individuals or Species

Adult: Species requires other individuals of the same species to outcross (obligate outcrosser).

Reproduction Narrative

Adult: Little is known about the natural history, reproductive biology, and effects of herbivory on S. conocarpum (Ray and Stanford 2003). It has been suggested that this species might be functionally dioecious (requiring male and female flowers from different plants to outcross). However, P. Acevedo-Rodríguez (pers comm., 2002) documented flowers and fruits in a solitary wild plant he discovered in the White Cliff area (Reef Bay general area). He further suggested that S. conocarpum may have less reproductive fitness due to selfing (self-pollination). Later, Ray and Stanford (2005) conducted some pollination studies in a controlled environment, which indicated that the species might be an obligate outcrosser with complete self-incompatibility (plant has both male and female parts, but it needs to outcross with other individuals to produce fruits due to self-incompatibility). These studies were conducted because prior to 2003 a lack of natural recruitment was observed in the wild (Ray and Stanford 2003, J. Saliva, USFWS, pers obs., 2004, O. Monsegur, USFWS, pers obs., 2010, Vilella and Palumbo 2010). DNA sampling of the majority of S. conocarpum populations suggests that most populations have been long isolated (Ray and Stanford 2005). Additionally, genetic work performed at the University of the Virgin Islands by A. Stanford has shown low heterozygosity (a measure of the allele frequency or genetic diversity) (G. Ray, pers comm., 2010). Further, when compared with its close relative S. polyganum, it appears to show a significant reduction in genetic diversity (G. Ray, pers comm., 2010).

Habitat Type

Adult: Dry Forest

Habitat Narrative

Adult: Acevedo-Rodríguez (1996) described the habitat of S. conocarpum as a dry, deciduous forest. The species also has been reported to occur on dry, poor soils (Ray and Stanford 2005). It can be locally abundant in exposed topography on sites disturbed by erosion (depositional zones

at the toe of the slopes), areas that have received moderate grazing, and around ridgelines as an understory component in diverse woodland communities (Carper and Ray 2008). A habitat suitability model suggests that the vast majority of S. conocarpum habitat is found in the lower elevation coastal scrub forest (Vilella and Palumbo 2010).

Dispersal/Migration

Motility/Mobility

Adult: Sessile

Dispersal

Adult: Low due to a lack of seed dispersers and pollinators

Dependency on Other Individuals or Species for Dispersal

Adult: As an obligate outcrosser, the species requires seed dispersers and pollinators.

Dispersal/Migration Narrative

Adult: The nature of the relationships between S. conocarpum and different pollinators and seed dispersers that have interacted with the species over its evolutionary history, is an important factor to consider. Controlled pollination studies concluded that this species is an obligate outcrosser (reproduction requires pollen from another plant) with complete self-incompatibility (Ray and Stanford 2005). As plant populations become reduced and spatially segregated, important life-history needs provided by pollinators and seed dispersers may be compromised (Kearns and Inouye 1997). It is possible that natural fruit dispersers of S. conocarpum had targeted other food sources as the populations of this shrub became increasingly patchy, as a result of deforestation and introduction of exotic plant species. The absence of a fruit disperser may also indicate that the disperser of the species is extinct or that the populations are too small to attract the disperser (Roman 2006).

Population Information and Trends

Number of Populations:

7 locations ranging from 1-201 individuals (USFWS, 2020)

Population Size:

324 individuals (USFWS, 2019)

Population Narrative:

Currently, population sizes range from one to 201 individuals reported at the seven known locations on St. John, however, the ratio of male to female that make up the natural populations is unknown (USFWS, 2020).

Threats and Stressors

Stressor: Human development
Exposure:
Response:
Consequence:

Narrative: Habitat modification may result in irreversible damage to the species natural habitat, decreasing the number of individuals of already small populations. In addition, the current sale of private housing lots adjacent to currently known populations suggests future urban developments that could lead to the extirpation of unknown populations.

Stressor: Non-native mammal species
Exposure:
Response:
Consequence:
Narrative: Exotic mammal browsers are found throughout the range of S. conocarpum in St. John Island. These include feral goats (Capra aegagrus hircus), pigs (Sus scrofa), Key deer (Odocoileus virginianus clavium), and donkeys (Equus asinus) (Vilella and Palumbo 2010; O. Monsegur, USFWS, pers obs., 2010). Feral donkeys, pigs, deer, and goats could directly and indirectly affect S. conocarpum populations by uprooting and eating seedlings, destabilizing slopes, and dispersing exotic plant species, thus preventing or reducing the sustainability of its populations. It is expected that these exotic mammals are modifying the structure of the vegetation, and therefore, the environmental conditions in these areas. This may imply changes on microhabitat conditions that are necessary for seed germination and seedling recruitment of S. conocarpum.

Stressor: Lack of natural recruitment
Exposure:
Response:
Consequence:
Narrative: Lack of natural recruitment represents one of the major threats to S. conocarpum. An example is the structure of the populations of Nanny Point and John Folly, which are predominantly comprised by old individuals. This is also true for the Brown Bay Trail individual. Seedling and sapling stages are missing in these populations, and old individuals are dying due to competition with other species such as vines. Without natural recruitment or successful augmentation from captive propagated individuals, these populations are likely to become extirpated as older individuals die.

Stressor: Absence of dispersers
Exposure:
Response:
Consequence:
Narrative: The nature of the relationships between S. conocarpum and different pollinators and seed dispersers that have interacted with the species over its evolutionary history, is an important factor to consider. Controlled pollination studies concluded that this species is an obligate outcrosser (reproduction requires pollen from another plant) with complete self-incompatibility (Ray and Stanford 2005). As plant populations become reduced and spatially segregated, important life-history needs provided by pollinators and seed dispersers may be compromised (Kearns and Inouye 1997). It is possible that natural fruit dispersers of S. conocarpum had targeted other food sources as the populations of this shrub became increasingly patchy, as a result of deforestation and introduction of exotic plant species. The absence of a fruit disperser may also indicate that the disperser of the species is extinct or that the populations are too small to attract the disperser (Roman 2006).

Stressor: Population fragmentation

Exposure:
Response:
Consequence:
Narrative: The loss of potential breeding partners, reduction or loss of pollinators, and the loss of seed dispersers are examples of negative impacts due to habitat fragmentation (Kearns and Inouye 1997, Murren 2002). As an obligate outcrosser, S. conocarpum encounters another challenge in that isolated and relic individuals may no longer reproduce unless enhancement and artificial propagation projects are conducted. Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007). Habitat fragmentation may also limit the ability of a species to respond to a changing environment (Booy et al. 2000).

Stressor: Lack of genetic variation
Exposure:
Response:
Consequence:
Narrative: Research conducted on S. conocarpum shows a reduction in its genetic diversity (Ray and Stanford 2005). The population with the greatest genetic diversity is the one located at Nanny Point, which also has the largest number of individuals. In addition to attempts to safeguard the genetic diversity of the species, the survival of reintroduced individuals needs to be monitored as well as their development into mature individuals capable of contributing to the natural recruitment of the species. Consequently, the protection and monitoring of known adult individuals should be considered as a high priority for the conservation of the species.

Recovery

Recovery Actions:

- Surveys should continue to update status and distribution of the species, including in St. Thomas and the British Virgin Islands. Surveys should consider the habitat suitability model prepared by Vilella and Palumbo (2010).
- Threats to S. conocarpum as well as the magnitude or the imminence of such threats should be monitored on an annual basis.
- Attempts to safeguard the genetic diversity of the species, the survival of reintroduced individuals, as well as their development into mature individuals need to continue.
- Due to lack of natural recruitment, protection and monitoring of known adult individuals should be considered a high priority for the conservation of the species.
- Efforts to protect S. conocarpum populations on privately-owned lands should be initiated.
- Public education and outreach programs regarding the status of S. conocarpum should be reinforced.
- Due to lack of natural recruitment, protection (e.g., fencing) and monitoring of known adult individuals should be considered a high priority for the conservation of the species.

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SPECIES ACCOUNT: *Solanum drymophilum* (Erubia)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/26/1988; Southeast Region (R4) (USFWS, 2015)

Physical Description

A spiny shrub that may reach 18 feet (5.5 meters) in height. The leaves and petioles have minute, white, star—shaped hairs whereas young twigs, inflorescences and flowers have long, whitish star-shaped hairs. Spines, sharp and stiff, yellowish, 5/16 to 7/16 of an inch (.8 to 1.1 centimeters) long, are found primarily along the mid—vein of the leaves and occasionally along the twigs. The leaves, alternate, lanceolate to lanceolate—oblong and entire, are 5 1/2 to 7 1/2 inches (14 to 19 centimeters) long and 5/8 to 1 1/4 inches (1.5 to 3.2 centimeters) wide (Vivaldi and Woodbury 1981). Inflorescences are lateral, subterminal, many—flowered racemes which may reach 3 to 3 1/2 inches (8 to 9 centimeters) in length. The pedicels are slender and short when in flower but become longer and curved when in fruit. Flowers are perfect with a 5-lobed, bell-shaped calyx. The corolla is 5-lobed, white, folded like a fan, with the lobes united one-third to one-half of their length. The superior ovary is 2-celled and the ovules numerous. The fruit is a glabrous, round, shiny— black berry approximately 3/16 to 5/16 of an inch (5 to 8 centimeters) in diameter. Seeds are numerous, circular, creamy—yellow in color, and about 1/16 of an inch (1.5 millimeters) in diameter (USFWS, 1992).

Taxonomy

Solanum ensifolium has long been known as S. drymophilum, based on a misinterpretation of the original provenance of the type of S. ensifolium. Both names refer to the same species, but S. ensifolium is an older name (1852) than S. drymophilum (1909). However, Solanum ensifolium is the name that is accepted in the recent checklists for Puerto Rico (Axelrod 2011) and the West Indies (Acevedo-Rodríguez and Strong 2012) (USFWS, 2015).

Historical Range

Known from an area known as Piedras del Collado in the Sierra de Cayey, in Salinas in east-central Puerto Rico (USFWS, 1992). Believed to be extirpated from historic sites in Naguabo in eastern Puerto Rico, and Lares in the west-central mountain region of Puerto Rico (USFWS, 2015).

Current Range

Known from the Salinas site in east-central Puerto Rico, and at sites in the municipalities of Florida and Arecibo in northern Puerto Rico (USFWS, 2015). 2019 refinements: Currently, erubia is known from three (3) populations: Las Piedras def Collado (previously known as Las Tetas de Cayey) in the municipality of Salinas (this was the only known population at the time oflisting); Rio Abaja Commonwealth Forest in the municipality of Arecibo; and two localities near road PR-140 in the municipality of Florida. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Biotic (EPA, 2016)

Breeding Season

Adult: In flower and fruiting year-round (USFWS, 1992)

Other Reproductive Information

Adult: Seed production is abundant (USFWS, 1992)

Reproduction Narrative

Adult: Little is known about the pollination mechanism. Species is in flower and fruiting throughout the year; seed production is abundant (USFWS, 1992).

Habitat Type

Adult: Terrestrial (USFWS, 1992)

Habitat Vegetation or Surface Water Classification

Adult: Subtropical wet forest life zone (USFWS, 1992)

Geographic or Habitat Restraints or Barriers

Adult: Elevation 1,000 - 3,000 ft (USFWS, 1992)

Habitat Narrative

Adult: Erubia is endemic to evergreen forests of the subtropical wet forest life zone, on volcanic soils at elevations from 1,000 to 3,000 feet. The habitat has been described as subtropical wet forest in an area of volcanic outcrops (USFWS, 1992). The most recent information indicates that erubia occurs in disturbed sites with poor soils and exposed topography (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Little is known about the dispersal mechanisms for this species (USFWS, 1992).

Population Information and Trends

Population Trends:

Not available.

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

1 (USFWS 2015)

Population Size:

150 - 200 (USFWS, 2015)

Population Narrative:

No new comprehensive surveys of this plant have been completed since the 1992 recovery plan, which reported that 150 plants were known from one locality at Las Piedras del Collado (also known as Las Tetas de Cayey) in the municipality of Salinas. It was thought at that time that this plant occurred in the Lares area as well, but it could not be confirmed. Although other individuals have been documented in other municipalities, all populations have been poorly monitored and their current status is unknown (USFWS, 2015).

Threats and Stressors

Stressor: Habitat modification or destruction (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Although some erubia populations occur on protected areas, most of the known populations occur on privately-owned lands that could be affected directly or indirectly by urban development or lack of appropriate habitat management. Potential urban development or expansion of existing constructions, habitat modification caused by road maintenance, landslides, overgrowth of vegetation and the lack of site management are threats to erubia. However, these threats are non-imminent and of low magnitude (USFWS, 2015).

Stressor: Natural or manmade factors (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Due to its limited distribution and number of natural populations, the cumulative effects of human induced fire, exotic invasive plant species, and climate change are considered detrimental to erubia as a whole (USFWS, 2015)

Recovery

Reclassification Criteria:
1. The privately-owned population site is given protected status (USFWS, 1992)

2. At least two new self-sustaining populations in Commonwealth forest units or otherwise protected lands have been established (USFWS, 1992)

Delisting Criteria:
1. The two (2) existing populations on privately owned lands (i.e., Salinas and Florida) are protected through conservation mechanisms (addresses Factors A and E). (USFWS, 2019).

2. Existing three (3) populations on Las Piedras de/ Collado, Rio Abajo Commonwealth Forest, and the municipality of Florida show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish three (3) new populations on lands protected by conservation mechanisms within the known geographical range of the species that demonstrate a stable or increasing trend,

evidenced by natural recruitment and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor E). (USFWS, 2019).

Recovery Actions:

- Protect the privately-owned "Tetas de Cayey" site (USFWS, 1992)
- Monitor all known individuals (USFWS, 1992)
- Enforce existing Commonwealth and Federal regulations (USFWS, 1992)
- Continue to search for new populations
- Assess habitat requirements (USFWS, 1992)
- Assess phenology and pollination mechanisms (USFWS, 1992)
- New in 2019: Develop and implement a monitoring protocol to adaptively manage the species and its habitat. Additional monitoring should occur after major disturbances (e.g., fires, hurricanes, and landslides) as recommended in the 2015 5-year review status. This recovery action should be coordinated with PRDNER and be included within Task 112: Monitor all known individuals of the approved recovery plan. (USFWS, 2019).
- The recovery of the species should focus primarily on the protection of the known populations and their habitat. The area where erubia exists in Las Piedras del Collado should be incorporated into the already designated natural reserve.
- Comprehensive field surveys on erubia should be conducted within historical sites and in non-traditional sites with suitable habitat to determine the existence and distribution of the species and its current status.
- Enhance existing populations with propagated individuals.
- Studies should be conducted of the species' phenology and reproductive biology to figure out another way to effectively propagate the species.
- Studies should be conducted on the patterns of genetic variation, in order to develop a plan to preserve the species' germplasm.
- All the populations should be monitored on a regular basis, and additional visits should be made after fires, hurricanes, landslides, or other major disturbances.

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SPECIES ACCOUNT: *Solanum sandwicense* (`Aiakeakua, popolo)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/25/1999; Pacific Region (R1) (USFWS, 2016)

Physical Description

A sprawling shrub up to 5 m tall. All parts are covered with yellowish brown hairs. Flowers are white and faint purple (NatureServe, 2015).

Taxonomy

A member of the nightshade family (Solanaceae) (USFWS, 2003). The genus is cosmopolitan, this species is endemic to Kauai & Oahu. Original taxonomy maintained by Wagner et al. (NatureServe, 2015).

Historical Range

Historically, Solanum sandwicense was known from both Kauai and Oahu. On Kauai, it was historically reported from locations in the Kokee region bounded by Kalalau Valley, Milolii Ridge, and Kawaikoi, and extending to the Hanapepe River. On Oahu, S. sandwicense occurred in both the Waianae and Koolau Ranges (USFWS 1994; 2009).

Current Range

This species was last seen on Oahu in 2000 (USFWS, 2003). It currently occurs in Kokee State Park, Kuia Natural Area Reserve, and Na Pali-Kona Forest Reserve at Kahuamaa Flats, Honopu, Awaawapuhi, Nualolo, Kumuwela Ridge, Kawaiiki, Waialae Valley, and Mokuone Stream (Kauai) (USFWS, 2009). Island Distribution: Kauai. Extirpated in Oahu (USFWS, 2021c)

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Solanum sandwicense (`Aiakeakua, popolo) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Solanum sandwicense (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Solanum sandwicense includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Solanum sandwicense on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat desisgnation for Solanum sandwicense includes 7 critical habitat units, covering one ecosystem type, which encompasses approximately 7,823 acres on the Island of

Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch. Oahu—Lowland Mesic—Unit 4 [20 ac (8 ha)]. This area consists of 20 ac (8 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, between the Waipilopilo and Hanaimoa gulches, on State-owned land within the Hauula Forest Reserve. Oahu—Lowland Mesic—Unit 5 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland mesic ecosystem on the windward side of the Koolau Mountains, in Maakua Gulch and ridge; is State-owned; and within the Hauula FR. Oahu—Lowland Mesic—Unit 6 [247 ac (100 ha)]. This area consists of 12 ac (5 ha) State land and 235 ac (95 ha) of privately owned land in the lowland mesic ecosystem on the windward side of the Koolau Mountains, inland of Kaaawa Point, and is partially within Ahupuaa O Kahana State Park. Oahu—Lowland Mesic—Unit 7 [1,669 ac (676 ha)]. This area consists of 681 ac (276 ha) of State land, 129 ac (52 ha) of City and County of Honolulu land, and 852 ac (345 ha) of privately-owned land in the lowland mesic ecosystem on the leeward side of the Koolau Mountains, on Waialae Nui ridge.

The critical habitat designation for Solanum sandwicense includes two units totaling 6,651 acres in Kauai County, Hawaii. The units are Kauai 11—Solanum sandwicense—a, b.

Kauai 11—Solanum sandwicense—a: This unit is critical habitat for Solanum sandwicense and is 2,442 ha (6,039 ac) on State land (Kuia NAR, Kokee and Na Pali Coast State Parks). This unit contains portions of the Awaawapuhi, Berry Flat, Nualolo and Honopu Trails, Kahuamaa Flat, Kainamanu and Kalahu Summits, and Kaunuohua and Kumuwela Ridges. This unit provides habitat for five populations of 300 mature, reproducing individuals of the short-lived perennial Solanum sandwicense and is currently occupied with eight to nine plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered nonviable. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, forest canopies in diverse lowland or montane Acacia koa or Acacia koa-Metrosideros polymorpha mesic or wet forests. This unit provides for five populations within this multiisland species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Kauai 11—Solanum sandwicense—b: This unit is critical habitat for Solanum sandwicense and is 249 ha (614 ac) on State land, containing portions of Kawaiiki Ridge. This unit provides habitat for one population of 300 mature, reproducing individuals of the short-lived perennial Solanum sandwicense and is currently unoccupied. This unit is essential to the conservation of the taxon

because it supports habitat that is importnat to the establishment of additional populations on Kauai in order to reach recovery goals. It provides habitat for the westernmost range of the species that is unique to Kauai. The habitat features contained in this unit that are essential for this species include, but are not limited to, forest canopies in diverse lowland or montane Acacia koa or Acacia koa-Metrosideros polymorpha mesic or wet forests. This unit provides for one population within this multiisland species' historical range on Kauai that is some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Solanum sandwicense critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Solanum sandwicense occurs was known historically (last observed > 20 yrs ago) from the Lowland mesic ecosystem in the Koolau Mountain caldera complex and the Waianae caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3, 4, 5, 6, 7. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Within these units, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Under forest canopies in diverse lowland or montane Acacia koa or Acacia koa-Metrosideros polymorpha mesic or wet forests and containing one or more of the following associated plant species: Alphitonia ponderosa, Athyrium sandwicensis, Bidens spp., Carex meyenii, Coprosma spp., Cryptocarya mannii, Dianella sandwicensis, Dicranopteris linearis, Dubautia spp., Hedyotis spp., Ilex anomala, Melicope spp., Poa spp., Pouteria sandwicensis, Psychotria spp., Syzygium sandwicensis, or Xylosma hawaiiense; and

(ii) Elevations between 540 and 1,290 m (1,770 and 4,232 ft).

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Solanum sandwicense to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their

immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination (USFWS, 2009)

Lifespan

Adult: 4 - 8 years (USFWS, 2009)

Breeding Season

Adult: February - March, May - September (USFWS, 2009)

Reproduction Narrative

Adult: Herbarium vouchers at Bernice P. Bishop Museum (C. Imada, pers. comm. 2008), the herbarium database at the National Tropical Botanical Garden (2008a), and data from Hawaii Biodiversity and Mapping Program (2007) reveal that the species was observed in flower on Kauai from February to March and from May to September; fruiting was observed in all months except for April and November. TNC (2006) reports that plants appear quite capable of self-fertilization, and that plants are relatively short-lived, with outplants and nursery stock surviving for only three years in less-than-ideal habitat. However, the last wild plant on Oahu was at least six years old, and wild plants probably live for four to eight years. Outplantings start producing large amounts of fruit in about two years, but under nursery conditions with heavy fertilization can mature and produce fruit in five months (USFWS, 2009).

Habitat Type

Adult: Terrestrial (NatureServe, 2015); riparian (USFWS, 2003)

Habitat Vegetation or Surface Water Classification

Adult: Diverse lowland to montane mesic and wet forest (USFWS, 1995)

Dependencies on Specific Environmental Elements

Adult: Oahu: open sunny areas (USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: Oahu: 430 - 3,300 ft. elevation (USFWS, 2003); 2,500 - 4,000 ft. elevation (USFWS, 1995)

Habitat Narrative

Adult: Inhabits moist forest in gulches and on flats (NatureServe, 2015). Solanum sandwicense was found on Oahu on talus slopes and in streambeds in open, sunny areas at elevations between 131 and 1,006 m (430 and 3,300 ft.) (USFWS, 2003). This species is typically found in open, sunny areas at elevations between 760 and 1,220 meters (2,500 and 4,000 feet) in diverse lowland to montane mesic forests and occasionally in wet forests (USFWS, 1995).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The genus is bird dispersed (NatureServe, 2015).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Number of individuals stable, number of populations declining (USFWS, 2009)

Number of Populations:

12 (USFWS, 2017)

Population Size:

24-36 wild (USFWS, 2017)

Population Narrative:

Currently, there are five wild populations on Kauai. There are 18 - 20 wild individuals and 446 outplanted individuals. When S. sandwicense was federally listed as endangered, only four of 12 known populations were still extant on both islands (one on Oahu and three on Kauai), totaling about 20 individuals (USFWS 1994) (USFWS, 2009). At the time of the last 5-year review in 2009 there were five populations totaling 18 to 20 individuals from Kahuamaa Flats, Honopu, Awaawapuhi, Nualolo, Kumuwela ridge, Kawaiiki, Waialae Valley, Mokuone stream on the island of Kauai. The last known individual at Palawai Gulch on Oahu died in the 1990s. Currently, there are seven to 12 wild populations totaling 24 and 36 individuals on Kauai (NTBG 2010a-b, 2012a-d, 2014a-c, 2015a; PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017) (USFWS, 2017).

Threats and Stressors

Stressor: Ungulates (USFWS, 2009)

Exposure:
Response:
Consequence:
Narrative: Habitat degradation by feral pigs (Sus scrofa), goats (Capra hircus), mule deer (Odocoileus hemionus) (USFWS, 2009).

Stressor: Predation (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: On Kauai: predation from rats (Rattus spp.). On Oahu: predation on seedlings by various species of introduced invasive slugs (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: On Kauai: competition with introduced invasive plant species such as Hedychium gardnerianum (kalihi ginger), Lonicera japonica (Japanese honeysuckle), Passiflora tarminiana (banana poka), Psidium cattleianum (strawberry guava), Kalanchoe pinnata (air plant), Erigeron karvinskianus (daisy fleabane), Grevillea robusta (silk oak), Myrica faya (fire tree), Mariscus meyenianus (Meyen's flatsedge), Lantana camara (lantana), Setaria parviflora (perennial foxtail), and Rubus argutus (Florida prickly blackberry). On Oahu: competition with the introduced invasive plant species Passiflora suberosa (corky passionflower), Clidemia hirta (Koster’s curse), Toona ciliata (Australian red cedar), Lantana camara, Psidium spp. (guavas), and Schinus terebinthifolius (Christmasberry) (USFWS, 2009).

Stressor: Fire (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Because Hawaiian plants were subjected to fire during their evolution only in areas of volcanic activity and from occasional lightning strikes, they are not adapted to recurring fire regimes and are unable to recover well following a fire. The most prominent threat is fires caused by people pursuing recreational activities, and prevailing winds spreading fires to inland areas. Fire could destroy seeds as well as plants, even on steep cliffs (Clarke and Cuddihy 1980, Corn et al. 1979, Cuddihy and Stone 1990) (USFWS, 1995).

Stressor: Human activity (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: Collection, disturbance, development (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence:

Narrative: The species continues to be vulnerable to extinction caused by randomly occurring natural events (e.g., landslides or hurricanes) or reduced reproductive vigor due to small population size and a limited number of populations (USFWS, 2009).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Solanum sandwicense is vulnerable to the impacts of climate change, with a vulnerability score of 0.563 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future (USFWS, 2017).

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Delisting Criteria:
1. A total of eight to ten populations should be documented on Kauai and at least one other island where they now occur or occurred historically (USFWS, 1995).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 300 mature individuals per population for short-lived perennials (USFWS, 1995).

3. Each population should persist at this level for a minimum of five consecutive years before downlisting is considered (USFWS, 1995).

Recovery Actions:
- Protect current populations, control threats and monitor (USFWS, 1995).
- Expand current populations (USFWS, 1995).
- Conduct research essential to conservation of the species (USFWS, 1995).
- Establish new populations as needed to reach recovery objectives (USFWS, 1995).
- Validate and revise recovery objectives (USFWS, 1995).

- Devise and implement a public education program (USFWS, 1995).
- In order to prevent this taxon from going extinct, propagation efforts and the maintenance of adequate genetic stock ex situ should be undertaken immediately, as well as the protection of remaining wild individuals from feral pigs and alien weed threats (USFWS, 1995).
- Management actions necessary to protect the remaining wild individual on Oahu include selective weeding of Christmas berry and Passiflora suberosa, as well as regular monitoring (J. Crummer, personal communication 1995) (USFWS, 1995).
- Continue collection of fruit and plant material from wild individuals on Kauai and reintroduced individuals on Oahu for future reintroductions (USFWS, 2009).
- Construct exclosure fences to protect individuals from the negative impacts of feral ungulates on Kauai, and eradicate invasive introduced plant species within the exclosures on Kauai and Oahu (USFWS, 2009).
- Establish reintroduced populations within protected habitats (USFWS, 2009).
- Augment current natural populations (USFWS, 2009).
- Initiate planning and contribute to implementation of ecosystem-level management and restoration to benefit this species (USFWS, 2009).
- Survey geographical and historical range for a thorough current assessment of the species (USFWS, 2009).
- Assess genetic variability within extant populations (USFWS, 2009).
- Study Solanum sandwicense populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, specific environmental requirements, limiting factors, and threats (USFWS, 2009).
- New Management Actions: • PEPP botanists collected seeds and cuttings for propagation at Lyon Arboretum, DOFAW, and NTBG (PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016). NTBG has seeds from 15 collections from Makaha (at least three founders), Puu o Kila (at least one founder), and Berry Flats (at least two founders). NTBG also has over a hundred plants in their nursery and dozens of plants throughout their gardens (NTBG 2017). Kokee Rare Plant Facility has 60 plants representing two founders from Kaunuohua and one founder from Berry Flats. Seven founders from Waialae are currently being established at the Lyon Arboretum Micropropagation Lab. There is one founder in the Lyon Arboretum seed bank from Mohihi, two founders from Berry Flats, one founder from Puu o Kila, three founders from Waialae, and one founder from Nualolo Trail (Lyon Arboretum 2017). • Waimea Arboretum has six plants from the Oahu S. sandwicense (2017). Pahole Rare Plant Facility on Oahu has four potted plants (PEPP 2016). There are thousands of seeds representing the Oahu founder via fruit collected from outplants (Lyon Arboretum 2017). • PEPP, NTBG, and The Nature Conservancy outplanted Solanum sandwicense into monitored exclosures at Limahuli (65 individuals), Lapa (35 individuals), Nualolo (30 individuals) and Kalalau (16 individuals) on Kauai (PEPP 2015, 2017). • PEPP on Oahu have been outplanting in three locations. Currently there are 29 outplants in Makaha, 97 outplants in Palikea, and 20 outplants in Pualii, all representing the last wild plant on Oahu (PEPP 2017). • PEPP on Kauai monitors wild populations of Solanum sandwicense at Kumuwela, Berry Flats, Puu o Kila, Mohihi-Waialae Trail, Kawaiiki, Kaunuohua, and Makaha ridge (PEPP 2010, 2011, 2012, 2013, 2014, 2015). • In 2015, this species was not recorded from the Kaluaa and Waieli Management Units on Oahu where it had been previously recorded in 2010 (US Army Garrison 2016) (USFWS, 2017).

- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2009. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey geographical and historical range for a thorough assessment of the species. • Ungulate monitoring and control—Continue to construct exclosure fences to protect individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control nonnative plant species in the immediate vicinity of Solanum sandwicense populations that compete with this species. • Captive propagation for genetic storage and reintroduction—Continue collection of seeds and cuttings, and propagation for reintroduction. • Reintroduction and translocation— o Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. o Augment current natural populations. • Population biology research— o Study Solanum sandwicense populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. o Assess genetic variability within extant populations (USFWS, 2017).

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SPECIES ACCOUNT: *Solidago houghtonii* (Houghton's goldenrod)

Species Taxonomic and Listing Information

Commonly-used Acronym: HOGO

Listing Status: Threatened; 07/18/1988; Great Lakes-Big Rivers Region (R3) (USFWS, 2016)

Physical Description

A perennial herb. Stems are frequently tufted or clumped, up to 7.5 dm high. Leaves become linear upwards on the stems. The inflorescence is a terminal, more-or-less flat-topped cluster of relatively few, large flower heads, each consisting of about 6-9 pale to bright yellow ray flowers and several yellow disk flowers. The branches of the inflorescence are smooth, but the stalks of the flower heads are finely but distinctly hairy. Blooms in August. (NatureServe, 2015)

Taxonomy

FNA (vol. 20, 2006) transfers Oligoneuron houghtonii to Solidago houghtonii. The disagreements concerning the origin of S. houghtonii and, more importantly, the true identities of populations within the currently circumscribed range, argue strongly for considering the species in the broad sense now (USFWS, 1997; NatureServe, 2015)

Current Range

Solidago houghtonii is primarily an endemic of the Upper Great Lakes region, occurring principally on the northern shores of Lakes Michigan and Huron in Michigan and Ontario; peripheral range extends north to Canadian shores of Georgian Bay, also 1 disjunct site in New York. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dependency on Other Individuals or Species

Adult: Jolls' preliminary findings from the 1993 research indicate that S. houghtonii is self-incompatible and thus dependent on insect vectors for successful pollination. Potential pollen vectors include bees (Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). (USFWS, 1997)

Breeding Season

Adult: August to October (USFWS, 1997)

Reproduction Narrative

Adult: Flowering occurs primarily in August and early September but may occur as early as late July and not uncommonly well into October. Fruiting and seed dispersal appears to occur mostly from August through November and undoubtedly later (MNH 1993). Jolls' preliminary findings from the 1993 research indicate that S. houghtonii is self-incompatible and thus

dependent on insect vectors for successful pollination. Potential pollen vectors include bees (Hymenoptera), butterflies (Lepidoptera), flies (Diptera), moths (Lepidoptera), and wasps (Hymenoptera). (USFWS, 1997)

Habitat Type

Adult: Terrestrial and palustrine (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Bog/fen, herbaceous wetland, riparian, barrens, sand/dune (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Prefers cool, moist areas (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found in sparsely vegetated areas at elevations between 100 and 400 m (NatureServe, 2015)

Environmental Specificity

Adult: Narrow. Specialist or community with key requirements common. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Medium (USFWS, 1997)

Habitat Narrative

Adult: Solidago houghtonii occurs primarily along the northern shores of Lakes Huron and Michigan and is restricted to calcareous beach sands, rocky and cobbly shores, beach flats, edges of marl ponds, and especially the shallow, trough-like interdunal wetlands that parallel shoreline areas (MNEI 1993). Much less commonly, S. houghtonii occurs in wet prairie-like habitats in Lower Michigan and locally in a New York marl fen. It also occurs on seasonally wet limestone pavement, which is the species' more typical habitat in the eastern portion of its range. S. houghtonii was collected from open limestone pavements in moist rock crevices (D.F. Brunton 3352, CAN). In sand dune areas, it tends to occur on the lee side of low foredunes and on low stabilized dunes adjacent to interdunal wetlands, especially in moist to saturated sands within and around interdunal depressions. The restriction of S. houghtonii to calcareous sands and dolomitic limestone areas of the Niagaran Escarpment suggests that the species requires a relatively high amount of calcium and magnesium (and possibly sodium and potassium) in its substrate. Dune sands in the region of the Niagaran Escarpment generally have a calcareous component of about 1 to 5 percent that is composed primarily of ground mollusk shells (Collins 1989). The sands in which it grows are circumneutral (pH 7.0) to alkaline (pH 8.0) and may occasionally have a thin covering of organic material (Collins 1989). Solidago houghtonii usually occurs where there is a relatively low density of competing vegetation at elevations between 100 and 400 meters. The species' apparent establishment in the better drained portions of dunes, such as along the backside of foredunes, may indicate it has some resistance to desiccation. Often associated with Solidago ohioensis, Lobelia kalmii, and other calciphiles; occasionally associated with two other rare species: Pitcher's thistle (Cirsium pitcherii) and dwarf lake iris (Iris lacustris). (USFWS, 1997; NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Fruiting and seed dispersal appears to occur mostly from August through November and undoubtedly later (MNH 1993). In researching the ecology of S. shortii, Buchel6 et al. (1991) found their data suggested no persistent seed bank for the species. In examining numerous other studies concerning the phenology of Solidago seed dispersal and germination, they concluded there is a good possibility that members of this genus produce seeds that remain viable for no more than one year, resulting in transient seed banks. (USFWS, 1997)

Population Information and Trends

Population Trends:

Unknown. Inferred from information (USFWS, 2020)

Species Trends:

Unknown. Inferred from information (USFWS, 2020)

Population Growth Rate:

Slowly declining (NatureServe, 2015)

Number of Populations:

~90 (NatureServe, 2015)

Population Narrative:

Long-term population trends suggest declines of 30-70%, whereas short-term trends indicate a decline of <30% to relatively stable. There are approximately 90 occurrences known (Penskar et al. 1996). (NatureServe, 2015). Recent status assessment efforts for a portion of the U.S. populations (45 out of 76 EOs) show many (28 out of 45) stable or increasing HOGO populations, with several locations having well over 10,000 flowering individuals (Leopold and Weber 2019). However, high lake levels, shoreline development, invasive plant species, recreation, and deer browse represent stressors to HOGO that need further evaluation (Leopold and Weber 2019) (USFWS, 2020).

Threats and Stressors

Stressor: Narrow habitat range (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Solidago houghtonii, like several of its associated endemics, is particularly vulnerable to extirpation because of its restriction to narrow shoreline habitats ofthe Great Lakes. In a 1981 status survey, D.C. Nepstad considered habitat destruction to be the greatest threat to populations of S. houghtonii and cited the desirability of shoreline areas for residential housing and the escalating pressure for this type of development as a principal cause of this habitat destruction. The rate of residential development continues to accelerate, and it is highly unlikely that there will be any abatement of this trend in the near future. Nepstad (1981) also noted that some major occurrences of S. houghtonii have been considerably altered and fragmented by private development such that their long-term viability has been severely diminished. This has

been a view supported by subsequent field surveys (MNFI 1993).There are many causes of habitat alterations that have adversely affected S. houghtonii populations. Construction of beach retaining walls and other emergency erosion control measures (e.g. rip-rap and bulkhead installation) prevents or inhibits dune formation. Excessive foot and off-road vehicle (ORV) traffic destabilizes dune and beach flats. Marina construction, road construction, sand mining, and home and cottage construction where improved lake views are desired, have resulted in leveling of dune ridges (Collins 1989). Driveway installation or permitted work performed by utilities and railroads near interdunal wetlands have fragmented colonies and altered the hydrology. Residential development further potentially threatens habitat by altering hydrology with the placement and construction of septic systems whose nutrient loading degrade adjacent interdunal wetlands. Finally, both foot and ORV traffic have caused the direct destruction of plants. (USFWS, 1997)

Stressor: Modification of groundwater (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Disjunct populations, located in calcareous fens and dependent upon calcium rich groundwater flowing through them, face additional threats. Modifications or contamination of the groundwater could cause these sites to become unsuitable for Houghton's goldenrod and could lead to extirpation of this species. As such, this species could be also be threatened by off-site activities. (USFWS, 2011)

Stressor: Invasive species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Invasive species control efforts are underway in three of the four Michigan State Parks with Houghton's goldenrod. New York has had limited success with control efforts at Bergen Swamp. Common reed grass (Phragmites australis) is the non-native invasive species most likely to affect Houghton's goldenrod at Bergen Swamp (Drake, pers. comm. 2010), although encroachment by false brome (Brachypodium sylvaticum) may pose a threat to Houghton's goldenrod also (Steve Young, NYNHP, pers. comm., 2010). Almost all occurrences are threatened by the increase in invasive plant species, such as baby's breath (Gypsophila paniculata), Phragmites australis, purple loosestrife (Lythrum salicaria) and false brome (Brachypodium sylvaticum). If not removed or controlled, these invasive species may threaten the Houghton's goldenrod habitat by outcompeting native species, shading the habitat or altering the hydrology. (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Climate change models predict the climate of the Great Lakes region will grow warmer and drier over the next century, with precipitation increasing in winter and decreasing in summer (AMEC 2006; Anton Reznicek, University of Michigan, pers. comm. 2004; Kling et al. 2003). Average temperatures in the Great Lakes region could increase by 3 to 7°C in winter and 3 to 11°C in summer by the year 2100. While average annual precipitation could increase by 10–20

percent, significant changes in the seasonal precipitation cycle are likely, with winter and spring rain increasing and summer rain decreasing by up to 50 percent (Kling et al. 2003). A warmer, drier summer will affect surface and groundwater levels, as well as soil moisture, which is projected to decrease by 30 percent in summer (Kling et al. 2003). Increased water temperatures will also result in decreased ice cover that when combined with an expected intensity of winter storms, will leave coastal areas more vulnerable to the effects of winter storms and flooding (Fang and Stefan 2000; AMEC 2006), altering Houghton's goldenrod habitat. A warmer climate could also bring about a northward shift and an even greater increase in invasive species that may be more problematic in the dunes and lakeshore systems, thus increasing competition with native plant species (Malcolm et al. 2002; AMEC 2006; Penskar, pers. comm. 2009). (USFWS, 2011)

Stressor: Roads and highways (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Several S. houghtonii occurrences in Michigan are within or along rights-of-way administered by MDOT. Records in the MNFI show that there are at least 11 occurrences partially within or along MDOT rights-of-way, representing nearly 20 percent of the known occurrences in Michigan. Kim D. Herman (1988) notes that S. houghtonii is more vulnerable to disturbance than two other endemics of Great Lakes shorelines, dwarf lake iris and Pitcher's thistle, because of its restriction to narrow bands of interdunal wetland habitats, many of which occur between coastal roads and lakeshores. In some of these sites, highways may be severely fragmenting S. houghtonii populations or preventing them from expanding and colonizing suitable habitat available further inland. Herman (1988) further states that the MDOT activities which resulted in the most adverse effects to this species and other Great Lakes endemics are projects along two major State roadways, US-2 and US-23, located in the Upper Peninsula and Lower Peninsula, respectively. These activities included culvert extensions, pavement recycling, shoulder widening, and other types of safety work. (USFWS, 1997)

Stressor: Road maintenance (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: A number of common road maintenance activities, including emergency repairs on eroding shoreline areas, herbicide application, mowing, road salting, shoulder grading, snow removal, and tree removal, have affected populations of S. houghtonii (Herman 1988). A number of illegal activities which have occurred on or near MDOT rights-of-way have also affected this species and its habitat. Illegal use of sites by commercial fishermen and encroachments by ORV operators and other recreationists have had adverse effects (MNFI 1993). (USFWS, 1997)

Stressor: Off-road vehicles (ORVs) (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Habitat damage resulting from ORV traffic is one of the major threats to S. houghtonii. The restriction of this species to a very limited, narrow expanse of shoreline habitat renders it particularly vulnerable to destruction and habitat fragmentation. Off-road-vehicles are in

widespread use and are very difficult to exclude from most kinds of natural areas, particularly beaches and coastal dunes. Their use and resulting effects on these sites are well documented throughout Michigan (MNFI 1993). Off-road-vehicle traffic or evidence of it has been observed in areas of exemplary S. houghtonii occurrences, such as Crow River Mouth (Mackinac County), Grass Bay (Cheboygan County), and Wilderness State Park (Emmet County) (MNFI 1993), and probably occurs in many and perhaps most other sites throughout the range of the species. (USFWS, 1997)

Stressor: Natural disturbances (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: The restriction of S. houghtonii to low-lying, linear coastal zone habitats also causes it to be highly susceptible to natural disturbance. Rises in lake levels, such as the record highs attained in 1986, may severely reduce population numbers throughout the entire range of the species (Voss 1987). It is thus very important that destructive human activities are minimized or eliminated so as not to exacerbate the effects of natural disturbance (Voss 1987). (USFWS, 1997)

Stressor: Artificial stabilization of lake levels (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: It is unlikely that the range of S. houghronii will expand because of the accelerating habitat loss and fragmentation due to development, increasing human-caused habitat disturbance, and the restriction of nearly all individuals of the species to shores of the Great Lakes. Therefore, essential habitat must be protected. Any artificial stabilization of Great Lakes levels could markedly change the natural dynamics of shoreline habitats and be highly detrimental to S. houghtonii, as well as to many other sensitive species and significant natural communities. Stabilization of the Great Lakes at low water levels might initially benefit S. houghtonii by temporarily exposing maximum suitable habitat. However, unless lake levels are continually lowered, stabilized S. houghtonii habitat is likely to be altered and will become unsuitable through plant succession. As a relatively poor competitor restricted to dynamic shoreline areas, this species depends on the cyclical fluctuations of the Great Lakes. It suffers local extirpations during high water years, but later exploits and colonizes newly exposed habitat as it becomes available again. (USFWS, 1997)

Stressor: Over-collection (USFWS, 1997)
Exposure:
Response:
Consequence:
Narrative: Like many rare species, S. houghtonii can potentially be over-collected by individuals with legal collecting permits, such as those who desire specimens for herbaria in which this taxon is poorly represented. Despite the good intentions of removing live plants for propagation and exhibition in rare plant collections, such activities, if done excessively or without proper permits, also represent a threat to populations. Permits granted for the taking of this species should be issued only after careful consideration and consultation with appropriate, knowledgeable individuals. Permits should stipulate that collections may be made only when an occurrence (i.e., a “population’.’) would not be significantly diminished or adversely affected by removal of

individuals. (USFWS, 1997)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. Protect a minimum of 30 of the most viable occurrences of Houghton's goldenrod and preserve the species' essential habitat and the natural environmental processes that maintain it. (USFWS, 1997)

Recovery Actions:
- Protect all known occurrences, with priority given to the most viable occurrences and the species' essential habitat. (USFWS, 1997)
- Survey suitable habitat for additional occurrences and verify the status of historic occurrences. (USFWS, 1997)
- Educate and notify land managers and the public. (USFWS, 1997)
- Monitor occurrences for population demographics, viability, and threats. (USFWS, 1997)
- Conduct biosystematic research throughout the species' range. (USFWS, 1997)
- Report survey results and habitat and population conditions to the Michigan Natural Features Inventory and the East Lansing Field Office and update element occurrence records. (USFWS, 2011)
- Plan and implement regular surveys and monitoring of occurrences, including better documentation of habitat conditions and populations trends. (USFWS, 2011)
- Reassess ranks of known occurrences. (USFWS, 2011)
- Provide education and outreach to stakeholders and the public. (USFWS, 2011)
- Monitor approach of non-native species and control as appropriate. (USFWS, 2011)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS: • Conduct a Species Status Assessment to inform the next 5-year review • Develop written agreements and management plans for protection on public lands (Recovery plan task: 1.12) • Plan and implement regular surveys and monitoring of occurrences, including better documentation of habitat conditions and populations trends. (Recovery plan tasks: 2.22, 4) o In particular, surveys are needed for sites not visited in 2015-2016 in Michigan. Information on the Ontario populations would also be helpful in evaluating the species' status. • Reassess ranks of known occurrences. (Recovery plan task: 2.24) • Promote landowner involvement in a registry program. (Recovery plan task: 14.143) • Develop strategies to protect occurrences and sites from ORV damage. (Recovery plan task: 13.131) (USFWS, 2020)

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SPECIES ACCOUNT: *Solidago shortii* (Short's goldenrod)

Species Taxonomic and Listing Information

Listing Status: Endangered; 9/5/1985; Southeast Region (Region 4) (USFWS, 2016)

Physical Description

A perennial herb with one to several erect or ascending stems 0.5 to 1.3 m tall, arising from a creeping rhizome. Stems are terete in cross section, slightly ribbed, and minutely scabrid-puberulent at least above the middle. Leaves are alternate, crowded, 5-10 cm long and 0.6 to 1.5 cm wide. Individual leaves are firm, oblong-lanceolate to narrowly elliptic, remotely serrulate and glabrous on both sides. The leaves are largest near the middle of the stem and become progressively smaller towards the inflorescence. Lower leaves are reduced and usually absent during flowering time. The inflorescence is terminal and ranges from racemose to paniculate with divergent, secund branches. Heads are 10-14 flowered on puberulent stalks usually 5 mm or less in length. The involucre is 4-6 mm long and 3 mm wide with imbricate, coriacious and glabrous phyllaries. Ray florets number from 4 to 8 and are 2.5-3.0 mm long. The corollas are elliptic-linear with bright yellow ligules about 2 mm long. The disc florets are also bright yellow with a short tube, funnel form throat and five linear spreading lobes about equaling the throat in length. The white papus is capillary and about 2 mm long. Achenes are cuneate-cylindric, about 2 mm long, and pale brown with appressed, silky pubescence (USFWS, 1988).

Taxonomy

In the Aster family (Asteraceae)(USFWS, 1988).

Historical Range

Historically known from Jefferson, Robertson, Nicholas, and Fleming Counties in Kentucky (USFWS, 1988).

Current Range

Known from Robertson, Nicholas, and Fleming Counties in Kentucky (the vicinity of Blue Licks, Kentucky) and along the Blue River in Harrison County, Indiana (USFWS, 2007).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect (USFWS, 1988)

Breeding Season

Adult: Flowers from mid-August to early November (USFWS, 1988).

Key Resources Needed for Breeding

Adult: Insects for pollination, probably bees (USFWS, 1988)

Reproduction Narrative

Adult: Flowers from mid-August to early November, and fruits mature several weeks after the flowers whither. Specific pollinators have not been documented; sweat bees have been observed visiting the flowers. Germination rates in the field are unknown (USFWS, 1988).

Habitat Type

Adult: Terrestrial (USFWS, 1988)

Habitat Vegetation or Surface Water Classification

Adult: A variety of dry, mostly open habitats, in full sun or partial shade (USFWS, 1988).

Dependencies on Specific Environmental Elements

Adult: Natural disturbance (USFWS, 1988)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Habitat is full sun or partial shade in a variety of dry, mostly open habitats. These include limestone cedar glades, open eroded areas, edges of dry, open oak-hickory woods, cedar thickets, pastures, old fields, power rights-of-way, and rock ledges along highway rights-of -way. This species does not appear to compete well and does best in areas with a low density of other plants. It will not grow in full shade (as in closed canopy woods). Soils are described as flaggy, silty clay texture with 20-30% rock fragments, and slightly acid to moderately alkaline, with slow permeability and rapid runoff (USFWS, 1988). In the long term, it appears that the species can survive only in early successional, short-term habitats (resulting from some disturbance), natural openings associated with animal movements or rock outcrops, or dynamic rocky shorelines along rivers (Indiana occurrence) (USFWS, 2007).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Although goldenrod fruits are normally wind dispersed, there is no evidence that this species is expanding its range by this method. It has been suggested that bison may be a dispersal vector (USFWS, 1988).

Population Information and Trends

Population Trends:

Stable to declining (USFWS, 2007)

Species Trends:

Decline of 10-30% (NatureServe, 2015)

Number of Populations:

20 (USFWS, 2023)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Adaptability:

The plant is clonal and is capable of persisting after some disturbance. Survivorship curves are typical of other herbaceous perennials (Walck et al. 1999b). Does not produce a long-lived seed bank (Walck et al. 1999a) (NatureServe, 2015).

Population Narrative:

Based on the results of numerous surveys and investigations over the past 25 years, the current distribution of S. shortii is restricted to 13 occurrences within a 2-mile radius of Blue Licks Battlefield State Resort Park in Fleming, Nicholas, and Robertson counties, Kentucky and one occurrence along the Blue River in Harrison County, Indiana (Harrison-Crawford State Forest). Despite numerous, intensive searches of similar habitats, only two occurrences (one within Sho1i's Goldenrod SNP in Fleming County, Kentucky and the Indiana occurrence) have been discovered since completion of the recovery plan in 1988. At present, eight Kentucky occurrences (numbers 1, 2, 5, 7a, Sa, 11, 12a, and Short's Goldenrod SNP) and the Indiana occurrence appear to be stable, and some level of protection has been achieved for all but one of these occurrences (number 11). The remaining Kentucky occurrences have shown declines in the number of stems and surface area since 1989 (Smith et al. 2004; Buchele et al. 1989). The reason for these declines is unknown, but competition from exotics and land-clearing activities on private property appear to be the primary causes (USFWS, 2007). Currently, the species is known from 20 extant occurrences, including 12 Blue Licks occurrences (two occurrences are now considered extirpated); 3 introduced occurrences near Claysville in Harrison County, Kentucky; 1 introduced occurrence along the Licking River in Robertson County, Kentucky; 3 introduced occurrences at Clay Wildlife Management Area in Fleming and Nicholas counties, Kentucky; and 1 occurrence along the Blue River, Greenbrier Knob Nature Preserve, in Harrison County, Indiana (Homoya and Abrell 2005) (USFWS, 2023).

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The Kentucky occurrences are most threatened by competition from exotics such as crown vetch, tall fescue, and other species described above, habitat disturbance on private property, and highway and powerline maintenance activities. The Indiana occurrence is most threatened by competition from exotics. The potential raising of the Ohio River's pool level is a possible threat but is unlikely to occur (USFWS, 2007).

Stressor: Overutilization for commercial, recreational, scientific, or educational purposes (USFWS, 2007)
Exposure:
Response:
Consequence:

Narrative: Recent park improvements in Blue Licks Battlefield State Resort Park are expected to increase the recreational use of the park and could lead to adverse impacts to S. shortii individuals if recreational activities (e.g., hiking) are not directed away from S. shortii occurrences. The species' small range and low number of individual plants makes it vulnerable to overcollecting for scientific purposes. Plants within Blue Licks Battlefield State Resort Park cannot be collected without a permit from the Kentucky Department of Parks and KSNPC; these permits are only issued for valid scientific purposes. Plants occurring on private property are not afforded this protection. The Indiana occurrence is also potentially threatened by recreational use (trampling by fishermen, canoeists, hikers). At present, though, recreational use does not appear to be a significant threat in Indiana. In addition, these plants occur on state property and cannot be collected without a permit (USFWS, 2007).

Stressor: Predation (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Over-grazing by cattle on private property has the potential to adversely affect the species by eliminating flower production, but this effect has not been observed directly (USFWS, 2007).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: Occurrences at Blue Licks Battlefield State Resort Park are protected from unauthorized taking; permits administered by the Kentucky Department of Parks and KSNPC are only issued for valid scientific purposes. Portions of occurrences 7a and 12a are protected through an MOU between KSNPC and KYTC (KSNPC 1989) that restricts habitat disturbance within these road rights-of-way. The Indiana occurrence occurs on state property (Harrison-Crawford State Forest) and is also protected from unauthorized taking. No such protection is available for occurrences located on private property in Kentucky or Indiana (USFWS, 2007).

Stressor: Other natural and manmade factors affecting its continued existence (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The species has been reduced to a small number of occurrences with a limited number of individuals. Consequently, the species is vulnerable to natural or human-induced factors (fire suppression) that might directly destroy individuals and further reduce population size (Federal Register 1985). Natural (secondary) succession can eliminate potential habitat for S. shortii through changes in vegetational composition. As old-field habitats and closed canopy woodlands develop, potential S. shortii habitat is lost (USFWS, 2007).

Recovery

Reclassification Criteria:
1. Adequate protection is obtained for the nine high priority occurrences and the habitat they occur in (USFWS, 1988).

2. Protected occurrences are determined to be self-sustaining and maintaining current population levels or above (USFWS, 1988).

3. Species biology and ecological requirements are sufficiently understood to determine and implement long-term management strategies (USFWS, 1988).

Recovery Priority Number: 8

Delisting Criteria:
1. Adequate protection is obtained for the nine high priority occurrences and the habitat they occur in (USFWS, 1988).

2. Protected occurrences are determined to be self-sustaining and maintaining current population levels or above (USFWS, 1988).

3. Species biology and ecological requirements are sufficiently u understood to determine and implement long-term management strategies (USFWS, 1988).

4. At least nine additional protected occurrences, equal in size and significance to the high priority occurrences mentioned above, are discovered in the vicinity of the Blue Licks population or at a currently unknown location (USFWS, 1988).

Recovery Actions:
- Protect existing occurrences and essential habitat. Prioritize occurrences for protection. Contact landowners and negotiate highest or most appropriate level of protection possible (USFWS, 1988).
- Conduct systematic searches for additional occurrences and populations. Identify potential habitat. Conduct ground searches (USFWS, 1988).
- Conduct studies of life history and ecological requirements. Delineate existing occurrences and establish permanent study plots. Analyze physical habitat and characterize habitat factors. Study phenology, pollination, and seed dispersal. Perform ex situ germination study and long-term demographic study. Determine management practices and develop recommendations to maintain health, vigor, and survivability of species (USFWS, 1988).
- Develop management plan and implement recommended management practices if determined beneficial. Conduct controlled burns, if determined beneficial. Remove overstory and/or aggressive competing vegetation if determined beneficial. Implement controlled rotational grazing system, if determined beneficial. Monitor results of management practices and re-evaluate needs as data on management results are obtained (USFWS, 1988).
- Maintain viable seeds. Collect and deposit seeds into seed banks. Make seeds available to organizations or institutions for propagation (USFWS, 1988).
- Continue management and monitoring of naturally occurring and reintroduced occurrences in Kentucky and Indiana, with consideration of intensified management at selected sites (USFWS 2017).
- Consider expansion of reintroduction efforts, with careful consideration of seed origin and genetics (USFWS 2017).

- Investigate and compare the genetic diversity/structure of Kentucky and Indiana populations, including the reintroduced occurrences in Harrison County, Kentucky (USFWS 2017).
- Investigate potential impacts of the bacterial leaf spot observed on occurrences in the Blue Licks area of Kentucky (USFWS 2017).
- Explore the potential threat posed by the horticultural cultivar S. shortii 'Solar Cascade' (USFWS 2017).
- Continue searches for new occurrences in the Blue Licks area, especially near known buffalo traces (USFWS, 2007).
- Conduct searches for new occurrences in riparian outcrop habitats of central Kentucky and southern Indiana or in upland areas of the region with suitable habitat (USFWS, 2007).
- Continue to investigate the life history and ecological requirements of the species (e.g., seedling establishment, seed and pollen dispersal distances) (USFWS, 2007).
- Continue to pursue permanent protection (through registry agreements, easements, or land purchases) of occurrences located on private property (USFWS, 2007).
- Expand the size of extant occurrences through habitat management and augmentation (USFWS, 2007).
- Establish viable occurrences in areas within the historical range that have suitable habitat, especially the Blue Licks Area of Fleming, Nicholas, and Robertson counties; develop criteria for establishing experimental populations in Kentucky (USFWS, 2007).
- Acquire potentially suitable but currently unoccupied habitat for the species where the species can be introduced and managed (USFWS, 2007).
- Continue implementation of management actions for permanently protected occurrences; develop a management strategy for the Indiana occurrence (USFWS, 2007).
- Revise the recovery plan (USFWS, 2007).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery Activities • Continue to pursue permanent protection (through registry agreements, easements, or land purchases) of occurrences under private ownership • Expand the size of extant occurrences through habitat management and augmentation • Establish viable occurrences in areas within the historical range that have suitable habitat, especially the Blue Licks area of Fleming, Nicholas, and Robertson counties, Kentucky, and the Falls of the Ohio area in Clark and Floyd counties, Indiana, and Jefferson County, Kentucky. • Develop criteria for establishing experimental populations in Kentucky • Acquire potentially suitable but currently unoccupied habitat for the species where the species can be introduced and managed • Continue implementation of management actions for permanently protected occurrences; work with Indiana DNR and the Indiana ES Field Office to develop a management strategy for the Indiana occurrence • Revise the recovery plan Monitoring and Research Activities • Continue searches for new occurrences in the Blue Licks area, especially near known buffalo traces • Conduct searches for new occurrences in riparian outcrop habitats of central Kentucky and southern Indiana or in upland areas of the region with suitable habitat • Continue to investigate the life history and ecological requirements of the species (e.g., seedling establishment, seed, and pollen dispersal distances) • Study the species' population genetics (USFWS, 2023)

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SPECIES ACCOUNT: *Solidago spithamaea* (Blue Ridge goldenrod)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) 03/28/1985

Physical Description

A perennial herb with solitary or tufted, erect, unbranched stems, usually 1-3 dm tall. A flat- or round-topped terminal cluster of yellow flower heads, each containing 20-30 flowers, blooms from July to September. This is 1 of only a few southern goldenrods with close affinities to plants now abundant in more northern areas. Populations are thought to be relict in nature, persisting on mountain-tops as the regional climate became warmer and drier. (NatureServe, 2015)

Taxonomy

Blue Ridge goldenrod is a member of a large and taxonomically complex genus which contains over 100 species native chiefly to North America, reaching its greatest complexity in the Eastern United States. The name of the genus comes from the Latin solidus and ago meaning solid and firm, referring to the healing qualities of the members of this genus (Britton and Brown 1970). The genus is within the large and complex family (Asteraceae) (USFWS, 1987).

Historical Range

Only three populations of Blue Ridge goldenrod are known to exist; two are in Avery County, North Carolina, on Grandfather Mountain and Hanging Rock, and one is on the border between Mitchell County, North Carolina, and Carter County, Tennessee, on Roan Mountain USFWS, 1987).

Current Range

Endemic to three mountains, Grandfather Mountain and Hanging Rock Mountain in North Carolina, and Roan Mountain on the North Carolina-Tennessee border (Weakley 2008) (NatureServe, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: rhizomes and seeds? Pollinators unknown (USFWS, 1987)

Breeding Season

Adult: Flowering occurs from July to September (USFWS, 1987).

Reproduction Narrative

Adult: Flowering occurs from July to September. The fruit, which is present from July to October, is a cypsela (referred to by some as an achene or nutlet) 2.5 to 3 millimeters ling (Kral 1979, Massey et al, 1980, Cronquist 1980). Various hymenopterns have been seen visiting the flowers,

but pollinators have not been identified. The plants appear to spread vegetatively by extending ryzomes and presumably reproduce by seed; however, the importance of each mode of reproduction to the species is unknown. Information on seed set, germination and survival of seedlings, flowering frequency, and response of populations to climatic extremes and various forms of disturbance are not available for this species (USFWS, 1987).

Habitat Type

Adult: Rocky outcrops, ledges, cliffs and balds (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Rocky places such as outcrops, ledges, cliffs, and balds at elevations above 1400 m (NatureServe, 2015).

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Rocky places such as outcrops, ledges, cliffs, and balds at elevations above 1400 m. Sites occupied by the species are generally exposed to full sun. Common associates include grasses and sedges, as well as other rare, high-elevation species such as Heller's blazing star (Liatris helleri), Roan Mountain bluet (Houstonia montana) and spreading avens (Geum radiatum) (NCHP 2001) (NatureServe, 2015).

Dispersal/Migration

Motility/Mobility

Adult: Low (inferred from USFWS, 1987)

Dispersal

Adult: Low/Slow (inferred from USFWS, 1987)

Population Information and Trends

Population Trends:

Three historical populations were extirpated by extensive recreational and residential development (NatureServe, 2015).

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

over 1,800 total 'clumps' (NatureServe, 2015)

Additional Population-level Information:

Stable. The known range of Solidago spithamaea (Hanging Rock, Roan Mountain, and Grandfather Mountain) has remained the same since the species was listed in 1985 (Service 1985). As stated in the 2012 5-year review, the Hanging Rock population may consist of fewer than 10 clumps, the Roan Mountain population consists of several hundred clumps, and the Grandfather Mountain population consists of several hundred to 1,000 clumps (Service 2012). It should be noted, at the time of the 2012 population estimate, the species had not been monitored since 2001 and determining consistency of monitoring methods among observers was not possible (Service 2012). A recent range-wide survey, conducted in 2016 and 2017, noted 24 clumps at Hanging Rock, 420 clumps at Roan Mountain, and 1,814 clumps at Grandfather Mountain (Thompson 2018b). Incqnsistent and infrequent monitoring prior to 2016 increases uncertainties associated with the species' status and trends; however, current population estimates are consistent with estimates derived from 2001 monitoring which indicates stability from 2001 to 2016. (USFWS 2019)

Population Narrative:

Three historical populations were extirpated by extensive recreational and residential development. As of 2009 (USFWS), two populations contained no more than 300 and 1500 patches respectively, and no estimates were available for two populations (USFWS 2009). Estimating population size is difficult due to clonal growth (USFWS 2009). Five populations know in North Carolina. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on specific habitat requirements and low population numbers for this species.

Threats and Stressors

Stressor: Recreational Use (USFWS, 2012)
Exposure:
Response:
Consequence: Degradation of habitat
Narrative: The principal source of habitat destruction affecting S. spithamaea is recreational use by people who venture out into the species' habitat in search of high-elevation views or adventurous rock climbing, boulder hopping, or other activities. Trampling compacts the plant's rhizome and can shear plants from the rocks in which they are anchored. In the process, fragile soils that have developed over geologic time frames can also be destroyed, making recolonization of these sites by S. spithamaea exceedingly difficult. Trampling has contributed to declines in at least one subpopulation of the species2 and continues to threaten the long-term viability of several others (USFWS, 2012).

Stressor: Development (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: A related concern stems from the construction of facilities intended to control or direct visitor use. These facilities must be sited and constructed appropriately in order to avoid impacts to S. spithamaea (USFWS, 2012).

Stressor: Woody succession (USFWS, 2012)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: The listing rule identified woody succession as a threat to this species. As soils accumulate and other types of vegetation are able to populate areas where S. spithamaea had been growing, the taller successional species may outcompete S. spithamaea, which would negatively impact its ability to thrive (USFWS, 2012).

Stressor: Rock slides (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Natural rock slides were also described as an additional threat to the species, but natural rock slides may also serve to open up additional areas of newly available habitat for an early-successional species like S. spithamaea. Thus, as with many factors, the frequency and severity of these disturbance events needs to be better understood for a meaningful evaluation of their effects on the continued existence of this species (USFWS, 2012).

Stressor: Climate Change (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Accelerated global climate change is likely to disrupt patterns of climate variability to which S. spithamaea has become adapted; thus, it is likely to exacerbate the threats already mentioned. However, the current scale of most global models of climate change offers little insight into the changes that will likely occur on the high peaks of the Southern Appalachians (USFWS, 2012).

Recovery

Delisting Criteria:
Criterion 1: The three populations at Roan Mountain, Grandfather Mountain, and Hanging Rock are protected (USFWS, 2012).

Criterion 2: Any necessary management actions have been undertaken for these populations by landowners or cooperating agencies and it has been documented that this management is successfully ensuring the continued survival of these populations (USFWS, 2012).

Criterion 3: Through introduction and/or discovery of new populations, two additional self-sustaining populations exist within the species' historical range (it is believed that at least two additional populations are required to ensure that the species will not become extinct in the foreseeable future) (USFWS, 2012).

Criterion 4: All five populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the population (USFWS, 2012).

Recovery Actions:

- The population at Grandfather Mountain occurs on property that, until 2009, was owned by Grandfather Mountain, Inc., a private corporation with a long history of working with the USFWS and other conservation partners toward the conservation of the rare species and habitats found there. The first measures of formal protection occurred in 1979, when this landowner placed portions of its land on a voluntary Registry of Natural Heritage Areas maintained by the North Carolina Natural Heritage Program (NCNHP) (The Nature Conservancy 1996). The landowner signed a Cooperative Agreement with the USFWS and the North Carolina Department of Agriculture in 1983; in 1991, this owner granted the North Carolina Chapter of The Nature Conservancy a perpetual conservation easement on more than 1,000 acres of the property. In 2009, the State of North Carolina announced the purchase of 2,456 acres formerly owned by Grandfather Mountain, Inc., for inclusion in the North Carolina State Park system. Some portions of the S. spithamaea population were retained by Grandfather Mountain, Inc., which has converted to a nonprofit organization--the Grandfather Mountain Stewardship Foundation--and is devoted to education, outreach and environmental stewardship (Jesse Pope, Grandfather Mountain Stewardship Foundation, 2009, personal communication). The population at Roan Mountain occurs on land managed by the U.S. Forest Service (USFS), Pisgah and Cherokee National Forests. This population receives protection under provisions of the Endangered Species Act that require federal agencies to assist in recovery efforts for federally listed species and to consult with the USFWS before undertaking actions which may affect the continued existence of such species. The USFWS has a long history of working with the USFS toward the conservation of Roan Mountain and the rare species that occur there (including six federally listed plants and animals). The Grandfather Mountain and Roan Mountain populations are protected from overt forms of habitat destruction, such as land-use conversion and large-scale commercial or residential development. However, both areas are open to the public and managed (at least in part) for recreational uses, which is an acknowledged threat to S. spithamaea. Additional comments on this threat and efforts to manage it are provided below. The population at Hanging Rock is in private ownership and remains unprotected. (USFWS, 2012).
- Grandfather Mountain, Inc., has a long history of implementing appropriate management actions on behalf of the rare species that occur on its properties. The numerous rock cliffs and outcrops which support S. spithamaea and numerous other rare and endemic plant species have long been closed to climbing and rappelling. Another site was formally closed to the public (and specifically to hang gliding activities) in the early 1990s, due in large part to concerns over impacts to rare species (including S. spithamaea). However, portions of the Grandfather Mountain S. spithamaea population occur in areas that receive considerable visitation by the public for recreational purposes. Documentation that management actions are effectively controlling impacts to S. spithamaea is currently lacking. The USFS closed two Roan Mountain sites containing this species (protecting five of the six S, spithamaea subpopulations supported there) to the public in the early 1990s, primarily in response to concerns that public access was or could result in impacts to the rare species found there. The one Roan Mountain subpopulation that is not closed to the public is in Tennessee, is not visible from a trail, and does not appear to be impacted by recreational visitors (Gary Kauffman, USFS, 2012, personal communication). The population at Hanging Rock is not protected and is not receiving any form of management (USFWS, 2012).
- One additional population has been tentatively identified at The Peak in Ashe County, North Carolina. No other new populations have been discovered or introduced (USFWS, 2012).

- To date, there are three extant populations of the species and a fourth population awaits further confirmation. Threats related to trampling are being managed at the two largest populations of the species (Grandfather Mountain and Roan Mountain); however, some impacts continue to occur at both populations as a result of recreational visitors who disregard signs and established barricades. Vegetation succession and habitat desiccation (both of which may be exacerbated by accelerated global climate change) remain as threats to all populations (USFWS, 2012).
- Solidago spithamaea co-occurs with other federally listed species. Impacts from monitoring could inadvertently occur if field staff conducting monitoring are unaware of other species present or how to identify them. Pre-monitoring, tailgate meetings should occur prior to each monitoring event when species co-occur. Field staff should be briefed on species present, how to identify them, and strategies for avoidance. (USFWS 2019)
- Work with Thompson to document the monitoring protocol and threats assessment used during the 2016 and 2017 field seasons. Share this information with land managers and property owners to ensure consistency during future monitoring events. (USFWS 2019)
- Work with Thompson, or find an appropriate partner, to continue range-wide monitoring and threats assessment according to the protocol used in 2016 and 201 7 so that consistent data can be meaningfully compared. (USFWS 2019)
- Confirm the taxonomic identity of the putative population of S. spithamaea reported at The Peak, in Ashe County, North Carolina (Recovery Task 1.2) (USFWS, 2012).
- Develop a taxonomic key distinguishing co-occurring immature S. glomerata from S. spithamaea (Recovery Task 1.2) (USFWS, 2012).
- Work with appropriate partners to evaluate protection alternatives at Hanging Rock, including the use of voluntary landowner agreements (Recovery Task 1.4) (USFWS, 2012)
- Develop interim research and management plans in conjunction with the USFS; North Carolina Division of Parks and Recreation; and Grandfather Mountain, Inc. (Recovery Task 1.1) (USFWS, 2012).
- Implement monitoring at a representative number of subpopulations across Grandfather Mountain and Roan Mountain (and The Peak, if confirmed) (Recovery Tasks 2, 2.1, 2.3, and 2.6) (USFWS, 2012).
- Compile quantitative data summarizing transplant survivorship across all previously attempted introduction or augmentation efforts involving this species, and evaluate causes for success/failure (Recovery Task 2.8) (USFWS, 2012).
- Evaluate long-term storage requirements for this species, and work with appropriate partners to place representative genetic material in long-term storage (Recovery Task 3) (USFWS, 2012).
- Collaborate with appropriate partners to begin stepping down global climate change models to a meaningful scale for purposes of projecting impacts to high-elevation Southern Appalachian rocky summit and cliff habitats, then devise and evaluate potential adaptation scenarios for S. spithamaea (Recovery Tasks 1.3 and 1.4) (USFWS, 2012).

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SPECIES ACCOUNT: *Sphaeralcea gierischii* (Gierisch mallow)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/12/2013; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A perennial herb with few to many stems from a woody caudex (short, thickened, woody stem, subterranean or at ground-level). Stems are 43-103 cm tall, sparingly leafy, often dark red-purple, and in tall, open clumps. The foliage is bright green and essentially hairless. The leaf blades are 1.2-4 cm long, 1-5 cm wide; usually longer than wide. The leaves are egg-shaped or somewhat heart-shaped, the base heart-shaped to even-ended, with 3-5 lobes. The flowering stem is open, usually with more than one flower per node. The calyx is 5-10 mm long, green, essentially hairless, and the orange petals are 15-25 mm long (Atwood and Welsh 2002 cited in Falk 2008). Blooms April - early June. (NatureServe, 2015)

Taxonomy

Sphaeralcea gierischii is a species described in 2002 from Utah and Arizona (Atwood and Welsh 2002. Novon 12: 159-166). This species is similar to S. rusbyi but has glabrous or glabrescent herbage with few or no stellate hairs. (NatureServe, 2015)

Current Range

Endemic to a small area straddling the Utah-Arizona state line, in northwestern Mohave County, Arizona (vicinity of Black Rock Gulch, Black Knolls, and Pigeon Canyon) and closely adjacent Washington County, Utah (Little Round Valley). (USFWS 2010).

Critical Habitat Designated

Yes; 8/13/2013.

Legal Description

On August 13, 2013, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Sphaeralcea gierischii (Gierisch mallow) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes two critical habitat units (CHUs), in Arizona and Utah (78 FR 49165-49183).

Critical Habitat Designation

The critical habitat designation for Sphaeralcea gierischii includes two CHUs in Mohave County, Arizona, and Washington County, Utah. This species critical habitat encompasses approximately 12,822 acres (ac) (5,189 hectares (ha)) (78 FR 49165-49183).

Unit 1: Starvation Point: This unit consists of 1,339 ha (3,308.7492 ac) in Arizona and Utah, and occurs on land managed by Arizona BLM (220.31 ha; 544.40 ac) and Utah BLM (802.11 ha; 1,982.07 ac), SITLA in Utah (67.73 ha; 167.38 ac), and ASLD in Arizona (248.83 ha; 614.87 ac). This unit was occupied at the time of listing and contains the features essential to the conservation of the species. Unit 1 contains two Gierisch mallow populations, including the second largest population. Unit 1 is located west of I–15 as this highway crosses the State line of Arizona and Utah, and is bounded by the Virgin River to the west and I–15 to the south and east. The features essential to the conservation of the species may require special management considerations or

protection to control invasive plant species, to control habitat degradation due to the recreation and mining activities that disrupt the soil composition, and to maintain the identified associated vegetation and pollinators essential to the conservation of the species. The portion of habitat that occurs on ASLD occurs within the footprint of the Georgia-Pacific Mine, which could resume gypsum mining operations in the near future. Grazing, which can modify the primary constituent elements and may require special management, typically occurs outside of the growing season for Gierisch mallow in the one pasture on Utah BLM and SITLA lands within this unit; however, recent wildfires in adjacent pastures in this allotment have resulted in livestock grazing occurring into the spring growing season for Gierisch mallow. These recently burned pastures have since been rehabilitated, and livestock grazing is anticipated to return to its normal grazing rotation of November 1 to February 28 in the future (Douglas 2012, p. 1).

Unit 2: Black Knolls This unit consists of approximately 3,850 ha (9,513 ac) in Arizona, and occurs on land managed by both Arizona BLM (3,586.28 ha; 8,861.90 ac) and ASLD (263.62 ha; 651.41 acres). This unit is occupied at the time of listing and contains the features essential to the conservation of the species. Unit 2 contains the remaining 16 Gierisch mallow populations, including the largest population. Unit 2 is located south of I–15 as this highway crosses the State line of Arizona and Utah, and is bounded by Black Rock Gulch to the west and Mokaac Mountain to the south and east. The features essential to the conservation of the species may require special management considerations or protection to control invasive plant species, to control habitat degradation due to mining activities that disrupt the soil composition, and to maintain the identified associated vegetation and pollinators essential to the conservation of the species. The largest population of Gierisch mallow occurs in the area of the proposed expansion of the Black Rock Gypsum Mine. As described in the final listing rule published elsewhere in today's Federal Register, grazing on BLM lands in Arizona typically occurs during the growing season for Gierisch mallow on all three BLM allotments within this critical habitat designation and is expected to modify the primary constituent elements, although some of the pastures are in a rest/rotation system in which a pasture may see an entire year of rest before being grazed again.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Sphaeralcea gierischii critical habitat consists of five components (78 FR 49165-49183):

(i) Appropriate geological layers or gypsiferous soils, in the Harrisburg Member of the Kaibab Formation, that support individual Gierisch mallow plants or their habitat, within the elevation range of 775 to 1,148 meters (2,477 to 3,766 feet). Appropriate soils are defined as: (A) Badland, (B) Fluvaquents and Torrifluvents, (C) Riverwash, (D) Cave-Harrisburg-Grapevine complex, (E) Grapevine-Hobcan complex, (F) Nikey-Ruesh complex, (G) Gypill-Hobog complex, (H) Hobog-Tidwell complex, (I) Hobog-Grapevine complex, (J) Grapevine-Shelly complex, and (K) Hindu-Rock outcrop-Gypill complex.

(ii) Appropriate Mojave desert scrub plant community and associated native species for the soil types at the sites listed in paragraph (2)(i) of this entry.

(iii) Biological soil crusts within the soil types listed in paragraph (2)(i) of this entry.

(iv) The presence of insect visitors or pollinators, such as the globemallow bee and other solitary bees. To ensure the proper suite of pollinators are present, this includes habitat that provides nesting substrate for pollinators in the areas described in paragraph (2)(ii) of this entry.

(v) Areas free of disturbance and areas with low densities or absence of nonnative, invasive plants, such as red brome and cheatgrass.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographic area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protection to reduce the direct and indirect effects associated with the following threats: Habitat loss and degradation from mining operations; livestock grazing; recreation activities; and invasive plant species. Please refer to the final listing rule published elsewhere in today's Federal Register for a complete description of these threats. Special management to protect the features essential to the conservation of the species from the effects of gypsum mining include creating managed plant preserves and open spaces, limiting disturbances to and within suitable habitats, and evaluating the need for (and conducting restoration or revegetation of) native plants in open spaces or plant preserves containing similar gypsum soils. Management activities that could ameliorate these threats include (but are not limited to) seed collection from the Gierisch mallow throughout its range, including those plants within the footprint of each mine. These seeds could be used to begin propagation studies to determine the long-term viability of plants growing in reclaimed soils. Additionally, these seeds could be used to begin propagating plants to be planted in other gypsum deposits and to augment existing populations. In addition to collecting seeds directly from plants, the seed bank could be collected from the top 1 inch of soil before the surface disturbance occurs as long as soils are properly handled during seed bank collection (Scoles-Sciulla and DeFalco 2009, entire). Special management may be necessary to protect features essential to the conservation of the Gierisch mallow from livestock grazing, including fencing populations; avoiding activities, such as water trough placement, that might concentrate livestock near or in occupied habitat; and removing livestock from critical habitat during the species' growing and reproductive seasons, especially during periods of flowering and fruiting. Special management that may be necessary to protect the features essential to the conservation of the Gierisch mallow from recreational activities includes directing recreational use away from and outside of critical habitat, fencing small populations, removing or limiting access routes, ensuring land use practices do not disturb the hydrologic regime, and avoiding activities that might concentrate water flows or sediments into critical habitat. Additionally, threats related to both control of nonnative, invasive species and fire suppression and fire-related activities resulting from the spread of nonnative, invasive species include: • Crushing and trampling of plants from fire suppression and treatment activities; • Damage to seedbank as a result of fire severity; • Soil erosion; and • An increase of invasive plant species that may compete with native plant species as a result of wildfires removing non-fire-adapted native plant species or as a result of fire suppression equipment introducing invasive plant species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: April to early June (NatureServe, 2015)

Reproduction Narrative

Adult: Flowers bloom between April and early June. The Service does not know how the flowers are pollinated, the pollination system (self-pollinated or obligate out crosser), seed dispersal mechanisms, or the conditions under which seeds germinate. (NatureServe, 2015)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Desert (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Occurs at elevations between 700 to 1,300 m (NatureServe, 2015)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Habitat Narrative

Adult: Found mainly on gypsiferous outcrops of the Harrisburg Member of the Kaibab Formation (considered to be essentially an obligate gypsophile); also collected on the Moenkopi Formation and on limestone rock/soil. Tends to occur on low terraces with clay to gravelly soil, on north-facing slopes of 5-30% at elevations between 700 and 1,300 m. Plant community is warm desert shrub (Mohave desertscrub), with dominants including creosote bush (Larrea tridentata), blackbrush (Coleogyne ramosissima), saltbush (Atriplex sp.), Yucca sp., Ambrosia sp., and Ephedra sp. Other associated genera and species include: Chrysothamnus, Dalea (prairie-clover), Hilaria jamesii (James' galleta), Hymenoclea salsola (burrow-brush), Lycium andersonii (desert-thorn), Opuntia, Petalonyx (sandpaper-plant), Psorothamnus (indigo bush), Purshia (cliffrose), and gypsiferous biological soil crust species. (NatureServe, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Long-term trends are unknown but short-term trends indicate a decline of 10-30% (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

3 (24 subpopulations) (USFWS, 2024)

Population Size:

16,000 to 26,000 (NatureServe, 2015)

Population Narrative:

Long-term population trends are unknown but short-term trends indicate a decline of 10-30%. A plant of limited range and distribution, including being found in a specific soil composition (gypsum outcrops), it is highly susceptible to habitat destruction and modification. Surveys by Hughes (2012a in USFWS 2013) estimate total population size to be between 11,000 and 18,000 individuals in Arizona. Hughes (2008a, p. 12; Highes 2009, p. 15; in USFWS 2013) conducted more extensive surveys of gypsiferous soils in Utah and estimated the population to be between 5,000 and 8,000 individuals. There are 4 occurrences in a small area of northwest Mohave County, Arizona, while 1 occurrence occurs across the border in Utah. All occurrences are restricted to less than approximately 186 ha (460 ac). Since surveys began, no new populations have been found outside of known areas. (USFWS, 2013). (NatureServe, 2015). We delineated concentrations of Gierisch mallow into 24 subpopulations in three populations. We have little to no data on the abundance of plants in 16 of the subpopulations. Gierisch mallow also occurs outside of our delineated subpopulations; we do not have a good understanding of that distribution. The threats to Gierisch mallow have not been reduced. Four subpopulations are within a proposed mine expansion area. In addition, livestock grazing occurs in Gierisch mallow subpopulations more frequently than we initially thought. Multiple potential threats may be affecting Gierisch mallow plants, but we lack data and analysis to understand the effects they are having on species viability. Additional research is needed to understand species viability; we include this in recommendations for future actions below (USFWS, 2024).

Threats and Stressors

Stressor: Climate change and drought (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Because of the threats of mining, grazing during drought years, recreation, and nonnative species, the cumulative effects of climate change and drought may be of concern for this species in the future. At this time, the state of knowledge concerning the localized effects of climate change and drought is too speculative to determine whether climate change and drought are a threat to these species in the future (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation (herbivory, along with some related trampling) by livestock is a threat that has moderate impacts only during drought years or during the reproductive period. Livestock herbivory during the reproductive period can lead to the flowering stalks being eaten, thus preventing adult Gierisch mallow plants from reproducing (USFWS, 2013).

Stressor: Habitat destruction and modification (USFWS, 2013)

Exposure:
Response:
Consequence:
Narrative: Factors adversely affecting habitat of Gierisch mallow, which are anticipated to result in a significant decrease in both the range of the species and the size of the population of the species, include mining activities, livestock grazing, nonnative plant species, and fire. All of the populations and most of the habitat are located on BLM and ASLD lands, which have an extensive history of, and recent successful exploration activities for, gypsum mining. Although livestock do not typically eat Gierisch mallow, livestock grazing can affect Gierisch mallow habitat more significantly during drought years, as livestock move into the Gierisch mallow habitat searching for forage. Additionally, livestock have been implicated in spreading nonnative, invasive species, such as red brome and cheatgrass, although the extent to which livestock contribute to the spread of these two nonnative grasses is not known. Red brome and cheatgrass are documented to occur in all 18 populations of the Gierisch mallow, although mostly after wet years. The threat of fire caused by annual invasions of nonnative species is exacerbated by mining activities, livestock grazing, and recreation activities (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Small population size and restricted range intrinsic vulnerabilities to the Gierisch mallow that may not rise to the level of a threat on their own. However, the small population sizes and restricted range of this species increase the risk of extinction to the Gierisch mallow populations in conjunction with the effects of global climate change and the potential for stochastic extinction events such as mining and invasive species. Therefore, the small, localized population size are considered to exacerbate the threats of mining, invasive species, and climate change to the species (USFWS, 2013).

Stressor: Mineral Extraction (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: At the time of listing, we identified destruction and modification of habitat (Factor A), specifically from mineral extraction, as the primary threat to Gierisch mallow, and we continue to identify it as the primary threat to the species. In 2009, prior to the Final Rule listing Gierisch mallow as endangered, the BLM approved Western Mining and Minerals, Inc. to expand the Black Rock Mine. The expansion area includes four Gierisch mallow subpopulations (Hill 4, 16, 17, and 18), one of which is the subpopulation with the largest known abundance (Hill 4). Western Mining and Minerals, Inc. has not begun mining in the expansion area. Though regulatory mechanisms allow the BLM, the land manager of most of Gierisch mallow's range, to require reclamation of mined areas, gypsum mining is subject to the Mining Law of 1872 (30 U.S.C. 21 et seq.) which limits the agency's discretion in permitting the mines (Factor D). In the late 1990s, Western Mining and Materials, Inc. restored small gypsum outcrops that were surface mined in the late 1980s to early 1990s (BLM and Red Butte Garden and Arboretum 2018). The company recontoured the mined pits, supplemented the topsoil with gypsum red-fines, a by-product of gypsum extraction, and sowed native seeds. Giersch mallow established naturally in the restored areas, and the BLM monitors these two subpopulations. Since the listing rule, we have 10 more

years of monitoring data for these subpopulations. The numbers of plants peaked around 2015 to 2017 in the monitoring transects and then decreased, which is expected in species that thrive in disturbed habitats as those habitats transition to later seral stages. Abundances at the sites have fluctuated annually, as is typical of other Gierisch mallow subpopulations, and the subpopulations have supported over 200 plants every year from 2016 through 2024 (Table 1) (USFWS, 2024).

Stressor: Recreation (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Recreation may cause destruction and modification of habitat (Factor A). Recreational use, especially off-highway vehicle use, continues to be a potential threat to the North Population, and, because of the growing population in the St. George, Utah area, we anticipate this threat will increase and may expand to other populations (USFWS, 2024).

Stressor: Livestock Grazing (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: In addition to destruction and modification of habitat (Factor A), livestock grazing damages the plants themselves and could affect survival and reproduction (Factor C). At the time of listing, we did not consider livestock grazing a major threat, because we assumed that livestock did not commonly access Gierisch mallow habitat due to its steep terrain. However, recent observations indicate that livestock graze Gierisch mallow (Reisor 2012, n.p.; McBride 2022 p. 20; Miller 2024, entire). Because of this and the active grazing allotments across the species' range, we now consider grazing a potential threat to Giersch mallow, but we do not know the extent to which grazing is affecting the viability of subpopulations (USFWS, 2024)

Stressor: Collection (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Gierisch mallow is not typically a plant of horticultural interest; however, we do have information about commercial vendors offering Gierisch mallow seeds for sale (Factor B) (Roth 2011, n.p.; Frates 2012, n.p.; Taylor 2023, n.p.). We think this is likely occurring intermittently and on a small-scale. (USFWS, 2024)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Recovery Priority Number: 14C

Delisting Criteria:
Delisting criteria are not available.

Recovery Actions:

- Recovery actions are not available.
- Conservation measures are not available.

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS We have identified recovery actions in the draft recovery plan (USFWS 2024b, p. 13) and will specify recovery activities in a recovery implementation strategy. We emphasize the following that, once completed, would inform other recovery actions: • Survey the 16 subpopulations that lack abundance data to estimate the abundance of plants rangewide. Collecting this data will improve our understanding of the species' current condition and the proportion of plants potentially affected by threats. • Map the extent of Gierisch mallow plants outside of subpopulations in the North population to either expand the area of the current subpopulations or add new subpopulations. • Further investigate Gierisch mallow and other Sphaeralcea species in the Pigeon Canyon area and in between Pigeon Canyon and the South population to understand the extent of the species occurrence and the range of morphological characteristics of Gierisch mallow and related species. • Develop and implement a standardized monitoring plan and protocol to collect data sufficient to understand trends of plant abundance. The monitoring plan and protocol should incorporate methodology and data analysis that account for annual abundance fluctuations and are sufficient to estimate if annual fluctuations will allow for subpopulation persistence. Additional data will also help us understand the extent that potential threats such as livestock grazing and nonnative, invasive species are having on the species (USFWS, 2024).

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SPECIES ACCOUNT: *Spigelia gentianoides* (Gentian pinkroot)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/26/1990; Southeast Region (R4)

Physical Description

This small perennial herbaceous species possesses a single, erect, sharply ridged stem 10-30 centimeters (cm) (3.9-11.8 inches (in.)) long. The leaves are opposite, sessile, and in pairs at right angles to the next set of leaves. The leaves are largest at the top of the stem, 3-5 cm long, with lower leaves smaller. Flowers are borne in a short, few-flowered, terminal, determinate cyme. The flower consists of a narrow corolla tube of about 2.5-5 cm long, with five triangular lobes, each 5-6 mm long. The corolla is pale to dark pink; slightly darker at the margins of the lobes for the var. gentianoides. The stamens are within the flower, and the pollen grains are deposited along the bristles of the style (secondary pollen presentation). At anthesis , the corolla lobes of var. gentianoides are partially open, occasionally fully reflexed; whereas the corolla lobes of var. alabamensis are always fully reflexed. The green sepals are 4-6 cm long. The fruit is a capsule with two conspicuous round lobes. Peak flowering season occurs between May and June, however, plants have been seen flowering as early as April and as late as October. In a greenhouse, individual flowers last 2 to 5 days before wilting. Most seeds can be collected in June or July. (USFWS, 2012)

Taxonomy

At the time the Recovery Plan was issued, the species was comprised of two varieties located in Jackson and Calhoun counties (Florida), and Geneva and Bibb counties (Alabama). Morphological and molecular studies reassessed the appropriate ranks of these varieties and elevated variety alabamensis to species (USFWS 2018, Weakley et al. 2011). Consequently, Spigelia gentianoides alabamensis is now a different species. (USFWS, 2019) Spigelia gentianoides var. gentianoides was first collected in north Florida by Alvan Wentworth Chapman in 1837, probably from the west side of the Apalachicola River, in either Jackson or Calhoun counties. He identified the plant as S. floridana, later Alphonse de Candolle (1845) established the current epithet, S. gentianoides. S. gentianoides alabamensis was first found in 1992 by James R. Allison (Georgia Natural Heritage Program, Georgia Department of Natural Resources) with Timothy Stevens, Jim Rodgers, and Debbie Rodgers while exploring the Little Cahaba River in Bibb County, Alabama. (USFWS, 2012)

Historical Range

Var. gentianoides: Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama. Var. alabamensis: Bibb County, Alabama. (USFWS, 2012)

Current Range

Spigelia gentianoides var. gentianoides is present in Washington, Calhoun, and Jackson counties in Florida, and Geneva County in Alabama. Spigelia gentianoides var. alabamensis is present in Bibb County, Alabama. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Abiotic, Biotic, Self-pollination

Breeding Season

Adult: Peak flowering season occurs between May and June; However, plants have been seen flowering as early as April and as late as October. (USFWS, 2018)

Other Reproductive Information

Adult: Spigelia gentianoides can be propagated vegetatively and from seeds. Affolter (2005) successfully propagated S. alabamensis: by transplanting entire plants from the field to well drained potting mix; from stem cuttings, and by germinating seeds using cold stratification (2°C) or gibberellic acid (500-1000 ppm) treatments. Eight weeks of cold stratification provided excellent germination rates. (USFWS, 2018)

Reproduction Narrative

Adult: Secondary pollen presentation, a mechanism presenting the pollen on a structure other than the anther, appears to be present in S. gentianoides (Negrón-Ortiz, 2007, pers. observ.) and S. alabamensis; pollen was observed in the short bristles of the style. At the Geneva SF population, small Halictidae bees (sweat bees) were observed entering and exiting the flower of the S. gentianoides. (USFWS, 2018)

Habitat Type

Adult: Terrestrial (USFWS, 2012)

Habitat Vegetation or Surface Water Classification

Adult: well drained upland pinelands (var. gentianoides); glades (var. alabamensis) (USFWS, 2012)

Dependencies on Specific Environmental Elements

Adult: Fire-dependent ecosystems (USFWS, 2012)

Spatial Arrangements of the Population

Adult: Solitary individual or in small clumps (USFWS, 2012)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2012)

Habitat Narrative

Adult: Spigelia alabamensis is found in glades (open, almost treeless areas within woodland) that have developed over an ancient rock formation known as Ketona Dolomite. The Ketona formation contains a pure form of dolomite, crystalline in texture with only about 2% of siliceous impurities (Garland 2008). The glades vary in size from about 0.1 to 5 hectares with soil high in magnesium and calcium, low in phosphorus and potassium, and a pH ranging from 7.4 to 7.6 (Grossman et al. 1994). The topography varies from flat to sometimes very strongly sloping.

There are patches of exposed rock and thin-soiled areas dominated by grasses and other herbaceous vegetation. The plants in these glades are exposed to extreme heat and drought. At these sites, plants are quite abundant, and mainly found in small clumps adjacent to rocks. (USFWS, 2018)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The mechanism of seed dispersal is unknown, but the fruit does not appear to be adapted for long-distance dispersal (USFWS, 2009).

Population Information and Trends

Population Trends:

Unknown (USFWS, 2018)

Number of Populations:

7 (USFWS, 2023)

Population Size:

Var. gentianoides: ~3,900 individuals; var. alabamensis: unknown ("seems to be abundant") (USFWS, 2023)

Additional Population-level Information:

Very narrow distribution, low population density. (USFWS, 2018)

Population Narrative:

Spigelia gentianoides var. gentianoides is currently restricted to seven extant sites within four counties west of the Apalachicola River: Calhoun, Jackson, and Washington counties in Florida, and Geneva County in Alabama. These sites support about 3,900 plants. The species was originally recorded from nine sites but two sites are considered extirpated. Of the seven extant sites, two new were noted in 2013. Spigelia alabamensis (S. gentianoides var. alabamensis, sensu Gould 1996) is restricted to the Ketona Dolomite formation and glades of Bibb County, AL. This species seems to be abundant but the current number of individuals at these glades is unknown; therefore, population trends are also unknown for S. alabamensis. Some of the 17 glades where this species is found are owned and protected by TNC. (USFWS, 2018). Currently, it is restricted to seven extant locations within four counties west of the Apalachicola River: Calhoun, Jackson, and Washington counties in Florida, and Geneva County in Alabama (Fig. 1, Table 1). As of 2018, these sites supported about 3,900 plants. The species was originally recorded from nine locations, but two are considered extirpated (Fig. 1, Service 2012). Of the seven extant locations, two new were noted in 2013 (FNAI 2017). The extant locations are located on both public and private lands in fire-dependent longleaf pine-wiregrass and pine-oak-hickory ecosystems (USFWS, 2023).

Threats and Stressors

Stressor: Habitat loss or modification (USFWS, 2018)
Exposure:

Response:
Consequence:
Narrative: Conversion of much of the upland forest land in the four counties to pulpwood plantations (clearcutting, mechanical site preparation, and pine plantations) has possibly extirpated other populations. Clearcutting and/or selective thinning are of concern since typical silviculture operations often result in soil disturbance and compaction. In particular, site preparation practices resulting in soil disturbance, change in canopy cover from tree harvest, and change in fire frequency and seasonality are of concern. Land conversion coupled with disruption of pre-historical and historical fire regimes of the longleaf pine-wiregrass ecosystem is responsible for the rapid decline of the ecosystem where S. gentianoides is found. Several studies have shown that frequent prescribed fire regimes are important for maintenance of longleaf pine-wiregrass ecosystem (Hiers et al. 2007). Prescribed burnings at 3 – 5 year intervals seem to maintain optimal S. gentianoides populations. However, areas at Apalachee WMA are on a 2-year fire rotation where the largest population of S. gentianoides appears to be stable (A. Jenkins, FNAI, 8/15/2018, pers. comm.). However, it is unknown 1) if frequent fires is detrimental to recruitment, and 2) the implications of fire seasonality to S. gentianoides survival. Habitats converted to pine plantation, and managed without fire have created a shaded canopy. In addition, pine plantation management induces severe soil disturbance. According to Kral (1983), S. gentianoides would not survive the mechanical site preparation used in pine monoculture. This observation seems accurate due to the fragile nature of these plants, but the population located at the Spigelia Preserve seems to have survived, at least over the short term, after cutting and planting. Nevertheless, the population exhibited a decline immediately after the last timber harvest. Similarly, the population in Jackson Co. on land owned by Guy Anglin emerged in a former pine plantation. Urban development also threaten S. gentianoides. Conversion of much of forest land to residential development has possibly extirpated many populations. More than a third of Florida's land is projected to be developed by 2070 along with a growth of about 33.7 million residents–almost 15 million more people than in 2010 (University of Florida GeoPlan Center 2017). Spigelia alabamensis is restricted to one county in northern Alabama. It is found in 17 glades, and TNC owns and protects about a dozen larger glades and some smaller glades. Populations on private property are threatened by future development for home-sites, agriculture, logging of associated hardwoods, recreational facilities, or other purposes. (USFWS, 2018)

Stressor: Disease or Predation (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Neither diseases nor predation are currently known to be major threats to S. gentianoides or S. alabamensis. However, minor herbivore damage was noted at Three Rivers SRA and Geneva SF (B. Chowdhury, AU, 6/11/2018, pers. comm.) populations. (USFWS, 2018)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: The Endangered Species Act (Act) of 1973, as amended prohibits the removal of federally listed threatened and endangered plants or the malicious damage of such plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas in

violation of state law or regulations or in the course of any violation of a state criminal trespass law. However, the Act does not provide protection for plants on non-federal lands unless it is in violation of state law. In Florida. S. gentianoides is listed as endangered under the Preservation of Native Plant Flora of Florida Act (PNPFF Act) (Rule: 5B-40.0055, Section 581.185-187, Florida Statutes; https://www.flrules.org/gateway/RuleNo.asp?ID=5B-40.0055). The PNPFF Act addresses the protection of endangered, threatened, or "commercially exploited" plants (http://www.sfrc.ufl.edu/Extension/florida_forestry_information/planning_and_assistance/threatened_and_endangered_species.html). The removal of protected plants from a property, whether for transplant, sale, or any other purpose, requires both the written permission of the landowner and a permit from the Florida Department of Agriculture and Consumer Services. In Alabama, the Alabama State Constitution provided the necessary authority to add plants to Alabama's section 6 cooperative agreement. Department of Conservation and Natural Resources has a policy to protect, conserve and increase the wildlife of the state [Ala. Code 9-2-2 (1)], but provides little direction as to how this is to be accomplished. While the state's Natural Heritage Program maintains lists of non-game species considered endangered, threatened, of special concern or poorly known, it does not apply penalties for taking listed species or for altering their habitats. The Nongame Wildlife Program, which was started in 1984, helps administer endangered and threatened species projects on federally and state-listed species, and also issues scientific collecting permits to enable a wide range of projects and collect the data for fishes, amphibians, reptiles, birds, and mammals (USFWS, 2018)

Stressor: Non-native plant interactions (USFWS, 2018)
Exposure:
Response:
Consequence:
Narrative: Currently, non-indigenous plants within or near extant populations of S. gentianoides do not pose a threat. However, Lygodium japonicum (Thunb. ex Murr.) Sw. (Japanese climbing fern) and Lonicera japonica Thunb. (Japanese honeysuckle) have been found in the vicinity of S. gentianoides, and both are becoming problematic in areas of the Southeast. (USFWS, 2018)

Recovery

Reclassification Criteria:
Downlisting of S. gentianoides from endangered to threatened status will be considered when (Criterion 5 was removed per USFWS 2019): (USFWS, 2012; USFWS, 2019)

1. Extant populations and newly discovered sites are identified and mapped (USFWS, 2012; USFWS, 2019).

2. Inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations; (USFWS, 2012)

3. Monitoring programs and management protocols on selected populations (e.g., largest populations) are established for 15 years to track threats to the species and its habitat (e.g., control exotic species, minimize site disturbance, urban development); (USFWS, 2012)

4. For var. alabamensis: the extant populations (including subpopulations at the Ketona Glades, Bibb Co., Alabama) located on public land are stable. (USFWS, 2012)

6. Research on key aspects related to demography (e.g., density, effect of fire on seedling establishment), reproductive biology, and seed ecology is accomplished (USFWS, 2012)

7. Viable germplasm representing > 50% of the populations for each variety is maintained in ex-situ. (USFWS, 2012)

Var. gentianoides: (1) sizes of populations in the Apalachee WMA, Three Rivers State Park, Calhoun Spigelia Preserve in Florida and the Geneva State Forest in Alabama are increased via prescribed burns until plant numbers are stabilized over a period of 15 years; (2) at least one new population is found, and; (3) at least one population is re-established within the historic range, specifically at sites where the plants are currently known to be extirpated. (USFWS, 2012)

Var. alabamensis: (1) 50 % the Bibb Co. glades known to support the variety on private land are protected through conservation agreements, easements, and/or land acquisition. (USFWS, 2012)

Recovery Priority Number: 2

Delisting Criteria:
The following Delisting Criteria are applicable to var. gentianoides: (USFWS, 2019)

1. Existing core populations [Apalachee WMA, TNC Spigelia Preserve, Three Rivers SRA, Rock Hill TNC Preserve, and Geneva SF] are restored and properly managed, and monitoring demonstrates that the populations are stable or increasing over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A, D, and E). (USFWS, 2019)

2. At least five (5) new populations are discovered or established within the historic range of the species on lands protected by a conservation mechanism. These populations should exhibit stable or increasing trends over multiple prescribed burn cycles, evidenced by a type of natural recruitment and/or multiple size-classes (addresses Factors A and E). (USFWS, 2019)

3. Threats to S. gentianoides and its habitat (e.g., exotic species, site disturbance, urban development, hurricanes) have been managed and reduced to ensure the persistence of S. gentianoides into the foreseeable future (addresses Factors A, D, and E). (USFWS, 2019)

Delisting criteria for var. alabamensis have not been developed. (USFWS, 2012)

Recovery Actions:
- 1. Protect, manage, and secure existing populations and habitat. The distribution of Spigelia gentianoides is limited to a few areas in Northwest Florida extending into central Alabama (Fig. 2), thus it is important to secure and stabilize current and any newly discovered populations to prevent further decline of this plant. (USFWS, 2012).
- 2. Conduct surveys/inventories. Inventotory of current and new populations; field surveys and species distribution modeling to determine survey sites. (USFWS, 2012).

- 3. Establish new occurrences within the historic range of var. gentianoides, specifically in the sites where the plants are known to be extirpated (USFWS, 2012).
- 4. Maintain the species ex-situ in a protected facility. Ex-situ populations will serve as an important component for storage of germplasm and reintroducing S. gentianoides populations within the species range. (USFWS, 2012).
- 5. Conduct long-term monitoring and research; establish and implement a long-term monitoring program on selected sites, to include population biology/demographic studies and phenological studies. Conduct research into reproduction, pollination ecology, and breeding systems. Conduct reserach on seed bank, germination, and seedling survival. Conduct taxonomic and genetic studies. (USFWS, 2012)
- 6. Outreach: Develop and distribute information to the general public about S. gentianoides, how to protect and manage it for its recovery, and how lands can be managed to benefit the plant along with meeting landowner needs. Promote the implementation of the recovery actions via private landowners, academia, and public agencies. (USFWS, 2012)
- 7. Review and track recovery progress. (USFWS, 2012)
- Recommended Action from 2018 5-Year Review: Establish protection and management agreements with landowners. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct surveys/inventories on each known population. For each extant population, the following data should be collected once a year: the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring. (USFWS, 2018)
- Conduct a long-term study using populations distributed throughout the species' historical range Recommended Action from 2018 5-Year Review: for 10 years to document both distribution and abundance changes. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since gentian pinkroot occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Investigate if there is a soil seed bank persistence of S. gentianoides seeds throughout the species' geographic range. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct germination studies and investigate whether seedling recruitment is occurring. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Monitoring and managing for invasive species: Frequent inventories or surveys of the Florida populations for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the Three Rivers SRA population conducted by the Park staff. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct surveys/inventories on potentially new sites in Northern Florida and Alabama. This action can include the use of aerial photographs and species distribution n models to determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. (USFWS,

2018)

- Recommended Action from 2018 5-Year Review: Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated. (USFWS, 2018)
- Recommended Action from 2018 5-Year Review: Conduct reproductive studies Since site disturbance occurs within the populations of S. gentianoides, it may pose problems to pollinator diversity (Kevan and Phillips 2001). Therefore, it is important to determine which insects are pollinators, and understand the value and pollinators' requirements so that actions can be taken to incorporate specific management or protection plans. Knowledge of the type of mating systems is essential for conservation of rare plant taxa because mating systems affect genetic diversity within and among populations (Navarro and Guitian 2002). Therefore, floral morphological analysis and experimental hand-pollinations are all recommended. (USFWS, 2018)
- Recommended Action from 2019 Amended Recovery Plan: Conduct research on key aspects related to (1) demography (e.g., density, effect of fire on seedling establishment), (2) reproductive biology, (3) levels and distribution of genetic diversity, (4) seed ecology to facilitate better understanding of this species' biology and potential impacts of threats such as low density, and changes in fire regime and (5) effects of catastrophic events such as hurricanes on populations and habitat of S. gentianoides (addresses Factor E, and resiliency, and inform representation). (USFWS, 2019)
- Recommended Action from 2019 Amended Recovery Plan: The effects of forest management practices (e.g., logging) on long-term persistence of S. gentianoides is assessed and a standardized monitoring technique is in place (addresses Factor D and resiliency). (USFWS, 2019)
- Recommended Action from 2019 Amended Recovery Plan: Inventories (i.e., the total number of individuals, number of flowering vs. non-flowering plants, presence of pollinators, and whether seedling recruitment is occurring) have been conducted across the species' historic sites and/or on new locations where appropriate habitat exists (addresses Factors A and D). (USFWS, 2019)
- Recommended Action from 2019 Amended Recovery Plan: A living collection of viable germplasm, collected from genetically distinct sites, is maintained in protected facilities (ex-situ) for research, recovery, and public outreach (addresses Factors A and E, and representation). (USFWS, 2019)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIVITIES 1. Establish protection and management agreements with landowners. 2. Conduct surveys/inventories on each known population. For each extant population, the following data should be collected once a year: the total number of individuals, number of flowering vs. non-flowering plants, presence of visitors to the flowers, and whether seedling recruitment is occurring. 3. Conduct a long-term study using populations distributed throughout the species' historical range for 10 years to document both distribution and abundance changes. Observations of flowering and fruiting are important and should be integrated with variables such as plant size and seedling data. Since gentian pinkroot occurs in fire prone habitats, the effect of this disturbance (including winter vs. growing season prescribed fire, fire frequency, intensity, duration, and timing) on survival and fecundity should be also monitored. Such studies should be conducted on large populations. Plants should be monitored several times during a 12-month cycle (e.g., flowering and fruiting seasons) the first year, then annually or biannually over an extended number of years. 4. Investigate if there is a soil seed bank persistence of seeds throughout

the species' geographic range. 5. Conduct germination studies and investigate whether seedling recruitment is occurring. 6. Monitoring and managing for invasive species, Frequent inventories or surveys of the Florida populations for invasive plant species should be established, which will help with the early detection and eradication of small patches of exotic invasive plants within the sites. This is an ongoing action for the Three Rivers SRA population conducted by the Park staff. 7. Conduct surveys/inventories on potentially new sites in Northern Florida and other suitable habitats. This action can include the use of aerial photographs and species distribution models to determine potential sites, with subsequent field inventory of the site using a consistent, statistically valid, repeatable inventory method. If new populations are discovered, protection should be sought. 8. Reintroduce plants within the historic range, specifically in the sites where the plants have been extirpated. 9. Determine the long-term impacts of hurricanes and salvage logging on S. gentianoides populations. 10. Assess impacts of a reduced fire interval (2-year compared to longer 3- to 5-year interval) on populations of S. gentianoides including seed bank, seed germination, and recruitment. Specifically, to assess populations at Apalachee WMA and Geneva SF. (USFWS, 2023)

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SPECIES ACCOUNT: *Spiraea virginiana* (Virginia spiraea)

Species Taxonomic and Listing Information

Listing Status: Threatened; 06/15/1990; Northeast Region (Region 5) (USFWS, 2015)

Physical Description

Colonial shrub up to 1.2 m high; largest stems 3-4 cm in diameter, dark gray, often arching or nearly horizontal; young stems upright, greenish-yellow to reddish-brown; branching often profuse in older specimens; leaves alternate, very variable in shape, size and degree of serration, generally mucronate-tipped, glaucous beneath, simply and singly serrate to entire, ranging from ovate to lanceolate; flowers 6 mm wide, bright to creamy white in tightly packed corymbs; corymbs variable in size, ranging from 5-22 cm, wide; follicles small, 2.0 mm long, 1.5 mm wide; seeds rarely produced. Fruit is a follicle. Flowering in June and July. Fruiting in August and September. (NatureServe, 2015)

Taxonomy

The two varieties sometimes recognized (var. serrulata and var. virginiana) are not maintained by Kartesz (1994 and 1999), nor are they recognized by any Heritage Program in the species' range, or by the U.S. Fish and Wildlife Service. Spiraea virginiana is distinguished from most other Spiraea by its creamy white flowers in corymbs, and its leaves which have an acute apex (Weakley 2004). (NatureServe, 2015)

Historical Range

Known historically in Pennsylvania. (NatureServe, 2015)

Current Range

Pennsylvania and Ohio south to Georgia and Tennessee. Records for Pennsylvania are historic. It occurs on streams that drain into the Ohio River and primarily within the Appalachian (Cumberland) Plateau and Blue Ridge physiographic regions, with at least one outlier in the Bluegrass Region of Kentucky. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (vegetative) and sexual (NatureServe, 2015)

Breeding Season

Adult: June to July (NatureServe, 2015)

Key Resources Needed for Breeding

Adult: The species' flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long—horn beetles, a flower beetle,

and a soldier beetle (R.L. Hoffman pers. comm.). (USFWS, 1992)

Reproduction Narrative

Adult: Although this element may flower profusely, it is clonal and almost exclusively reproduces vegetatively. Sexual reproduction will occur when genets are placed in close proximity but is rare in the native habitat (D.W. Ogle, pers. comm., 1996). Flowers bloom in June and July. The species' flowers are visited by a host of insects, most commonly beetles. Identified insects, which are common and widespread, include flower long—horn beetles, a flower beetle, and a soldier beetle (R.L. Hoffman pers. comm.). (USFWS, 1992)

Habitat Type

Adult: Riverine, Palustrine, and terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: High gradient, herbaceous wetland, riparian, scrub-scrub wetland, bare rock/talus/scree (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevations between 850 to 2,400 feet (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Colonies (USFWS, 1992)

Environmental Specificity

Adult: Very narrow. Specialist or community with key requirements scarce. (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: High (USFWS, 1992)

Habitat Narrative

Adult: Spiraea virginiana is found along the banks of high gradient sections of second and third order streams, or on meander scrolls and point bars, natural levees, and other braided features of lower reaches (often near the stream mouth). Leopold et al. (1964) theorized that such areas are slow—changing, dependable aspects of the equilibrium in river systems. If this is true, the S. virginiana populations located there may be relatively stable; otherwise, they may be highly susceptible to extirpation. The habitat of this species is in oft-disturbed early successional areas, and its associates are determined by availability to recolonize after disturbance. A rangewide list of associates would run to several hundred, usually disturbance—adapted, species. A list of these species compiled from a sample of element occurrence records is found in Rawinski (1988) (USFWS, 1992).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds seem to be rarely produced. The seeds are very small (> 2 mm long x ca. 0.5 mm wide) and could be dispersed by wind or water. (USFWS, 1992)

Population Information and Trends

Population Trends:

Short-term trends indicate a decline of 10 to 30% (NatureServe, 2015)

Adaptability:

Moderate (USFWS, 1992)

Population Narrative:

The current range of Virginia spiraea is generally unchanged since the 1992 recovery plan, occurring in 7 states (Georgia, Kentucky, North Carolina, Ohio, Tennessee, Virginia, West Virginia) within the Ohio and Tennessee River basins; the species remains extirpated from Pennsylvania and Alabama. One EO with historic documentation has been rediscovered (Cheoah River, North Carolina) and 38 additional EOs (32 of them extant as of 2019) and 74+ sub-EOs have been discovered due to searches of rivers/streams with suitable habitat in known drainages, surveys of rivers/streams with known occurrences, and incidental finds when surveying for other species. However, 11 EOs became presumed extirpated (F or X rank) since 1992 when the species' recovery plan was completed. (USFWS, 2021)

Threats and Stressors

Stressor: Impoundments (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Impoundments are a double threat to the species: clones are not only destroyed by rising water, but the impoundment may also serve as a "death trap" for propagules washed down-stream. The probability of being washed into a suitable habitat may decrease from slim to none, thus breaking any possible continuity in downstream motility. (USFWS, 1992)

Stressor: Road-building and water release regulation (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: A site on the Cheoah River in Graham County, North Carolina was probably destroyed by road-building and water release regulation (erosion control) below a dam. (USFWS, 1992)

Stressor: Industry development (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Areas along Hominy Creek in Buncombe County, North Carolina have been extensively developed by industries. (USFWS, 1992)

Stressor: Watershed management (USFWS, 1992)
Exposure:
Response:
Consequence:

Narrative: Cumulative and more subtle problems could occur from lack of watershed management and uncontrolled development of rivers. Bowles and Apfelbaum (1989) illustrate the effects of stochastic environmental events on another riverine species and graphically describe necessary conditions for survival. “Extinction possibility is increased by low disturbance, which favors plant succession and competition, or by high disturbance, which exceeds levels of ... population maintenance.” (USFWS, 1992)

Stressor: Reproduction and genetics (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: “Weak points” in the species’ biology may be a threat to its survival. Paucity of sexual reproduction dramatically decreases the intrinsic rate of reproduction and the dispersal potential of the plant’s small seeds. Genetic “fixation” of the clonal material may have adverse effects on the future breeding potential of the species, and the small number of genetically different individuals may constitute a threat. (USFWS, 1992)

Stressor: Insect predation (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Various insect pests have been seen on virginiana plants. Aphids of several types cluster at the rapidly growing shoot tips. Most of these are tended by ants, which move the aphids from place to place on the same plant, or from plant to plant. Aphids are most common on plants growing away from the water’s edge. On the beneficial side, lady bug beetles are regularly seen on these same stem tips. In another case, K. Walton (pers. comm.) identified a copper underwing moth caterpillar, a common and widespread species, that was doing damage in one population. However, for the most part, there is little evidence of anything other than local damage by insect pests. (USFWS, 1992)

Stressor: Introduced plants (USFWS, 1992)
Exposure:
Response:
Consequence:
Narrative: Introduced alien plant species (e.g., Polygonatum cuspidatum, Liqustrum sinense, Spiraea japonica, and Rosa multiflora) are another, almost uncontrollable, detriment. (USFWS, 1992)

Recovery

Reclassification Criteria:
Reclassification criteria are not available.

Delisting Criteria:
1. Three stable populations are permanently protected in each drainage where populations are currently known. (USFWS, 1992)

2. Stable populations are established on protected sites in each drainage where documented vouchers have been collected. (USFWS, 1992)

3. Potential habitat in the states with present or past collections has been searched for additional populations. (USFWS, 1992)

4. Representatives of each genotype are cultivated in a permanent collection. (USFWS, 1992)

Recovery Actions:

- Protect existing populations and essential habitat through landowner cooperation and land acquisition. (USFWS, 1992)
- Search for additional populations. (USFWS, 1992)
- Conduct site-specific habitat manipulation as needed to maintain populations. (USFWS, 1992)
- Distinguish between N and n individuals and identify genetically different populations. (USFWS, 1992)
- Maintain cultivated sources for reproduction studies as well as conservation and reintroduction activities. (USFWS, 1992)
- Study the species' environmental tolerances and habitat characteristics. (USFWS, 1992)
- Re-establish populations within the historic range of the species. (USFWS, 1992)
- Inform land owners and managers about the plant's recovery needs. (USFWS, 1992)
- Monitor populations and evaluate effectiveness of recovery efforts. (USFWS, 1992)
- Protect existing populations and essential habitat. (USFWS, 1992)
- Conduct rangewide searches in areas of suitable habitat for additional populations. (USFWS, 1992)
- Conduct site-specific manipulation to maintain existing populations. (USFWS, 1992)
- Distinguish between N and n individuals. (USFWS, 1992)
- Maintain representative material from each known genotype in permanent cultivation. (USFWS, 1992)
- Investigate the species environmental tolerances and habitat characteristics. (USFWS, 1992)
- As appropriate, reintroduce S. virginiana in additional drainage systems within the species' historical range. (USFWS, 1992)
- Develop an information packet for landowners and land managers. (USFWS, 1992)
- Evaluate the effectiveness of protection and management programs and redirect efforts as necessary. (USFWS, 1992)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Clarify recovery criteria 1 and 2 to support consistent evaluation and to reflect current information. Specifically, both recovery criteria should be clarified in terms of population assessment measures (e.g., what factors determine a "stable" population) and definition of "population." In addition, the definition of "drainage system" should be clarified as it relates to this species' recovery and definition of a population. Recommendations for specific recovery actions and priority number (1-3, based on priority number definitions in the Virginia spiraea recovery plan [Service 1992]): 1. Continue genetic analysis of Virginia spiraea across its range and within collections to determine genotypes and ploidy numbers, which will help guide potential propagation efforts and determine which localities/genotypes should be added to cultivated collections to provide genetic representation [Priority 1]. 2. Develop specific guidance on the

treatment of invasive species that threaten this species and recommendations for habitat management to increase viability of the populations, in particular EOs with C or D ranks. Include invasive species specialists and encourage practical application of invasive species and habitat management in populations across the range [Priority 1]. 3. If deemed necessary based on the genetic analysis, develop a rangewide propagation and reintroduction plan [Priority 2]. 4. Coordinate with natural resource agencies to complete rangewide review and revision, if needed, of the Virginia spiraea species distribution model to help identify potential suitable habitat [Priority 2]. 5. Conduct comprehensive surveys of potential habitat in streams/rivers with known occurrences and no known occurrences, but identified in a species distribution model, to find new populations. Efforts should focus within the Blue Ridge and Appalachian Plateau physiographic provinces, where almost all EOs occur [Priority 2]. 6. Conduct surveys of extant EOs that have not been surveyed for more than 10 years to verify presence and update their EO ranks [Priority 2]. 7. Determine if there is suitable habitat in areas where the species has been historically documented or extirpated and search these areas. Some areas that should receive priority ranking for survey work include, but are not limited to: Cypress Creek, AL; Youghiogheny River, MD and PA; Little River, TN; Hominy Creek, NC; Monongahela River, WV; and New River, WV [Priority 3]. 8. Coordinate with natural resources agencies and Service Field Offices to develop methods and resolve nomenclature for accurately counting/measuring individual plants, population size, and populations to provide consistency and allow objective assessment of populations. Also coordinate to define appropriate ecological units (e.g., HUC units) to assist with organizing populations as it relates to species' recovery [Priority 3]. 9. Coordinate with natural resource agencies and NatureServe to utilize consistent definitions of EO and EO rank for Virginia spiraea across the range to allow analysis of population trends and consistent assessment of status [Priority 3]. 10. Develop educational materials for local government and public use aimed at increasing public awareness of the species, in particular in areas where development and recreational activities may impact Virginia spiraea [Priority 3]. (USFWS, 2021)

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SPECIES ACCOUNT: *Stahlia monosperma* (Cobana negra)

Species Taxonomic and Listing Information

Listing Status: Threatened; Southeast Region (R4) 04/05/1990

Physical Description

Stahlia monosperina (cobana negra) is a medium-sized, evergreen tree that reaches 25 to 50 feet in height, and 1 to 1.5 feet in diameter. It is a member of the Family Fabaceae, easily identified by (1) pinnately compound leaves with 6 to 12 opposite, lance-shaped to ovate leaflets on red stalks and with scattered black raised dots on lower surface; (2) clusters of pale yellow flowers about one-half of an inch across the five petals; (3) odd. elliptic, thick and fleshy, red pods 2 inches or less in length; and (4) yellow-green and slightly pendulous foliage (Little and Wadsworth 1964). Flowers are yellow and are produced between March and May, depending on rainfall. Flower clusters are terminal, 3 to 6 inches long, and unbranched. The slightly hairy flowers have a funnel-shape, broad base, 10 stamens and a one-celled, slender and curved ovary. A thin, red, fleshly fruit is produced during late June and mid-July. Fruit pods are about 1.5 inches broad and three-fourths of an inch thick, with an odor of ripe apples, light brown tasteless flesh, and one large seed (Little and Wadsworth 1964). Fruits mature in summer and fall. The sapwood is light brown, and the heartwood is dark brown. The wood is very hard, heavy, strong, durable, and resistant to attack by dry wood termites (USFWS, 1996).

Taxonomy

Stahlia monosperma belongs to a monotypic Genus endemic to Puerto Rico and Hispaniola (USFWS, 1996).

Historical Range

Stahlia monosperma (cobana negra) is a tree currently known from parts of the southwestern and northeastern coasts of Puerto Rico and the island of Vieques (USFWS, 1996).

Current Range

At present, natural populations of Cóbana negra are found in nine areas: Punta Ventana, Punta Guaniquilla, Laguna Joyuda, Punta Melones, Road PR 307 (Boquerón Country Club), near Villa Taina, Sierra Bermeja, Punta Picúa, and Vieques Island (Table 2). Additionally, based on a propagation effort conducted for more than 13 years, the species has been planted at least 18 municipalities throughout Puerto Rico (Figure 3). This information does not include those individuals that have been planted as part of reforestation efforts and public education, and those that have been planted island-wide around public parks, and along state and rural roads and private parcels (USFWS, 2014).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Dispersal/Migration

Population Information and Trends

Population Trends:
Increasing (USFWS, 2014)

Number of Populations:
Nine (USFWS, 2020)

Population Size:
1,118 (USFWS, 2020)

Population Narrative:
Cóbana negra is a legume found throughout Puerto Rico and Dominican Republic. Although the scientific community accepts Libidbia as the appropriate genus for the species, the Service will continue using the listed taxonomic classification of Stahlia monosperma until a formal revision of the species' genus can take place. Information gathered during this review resulted in a total of 1,118 Cóbana negra individuals (157 (14%) adults, 942 (84%) saplings, and 19 (2%) seedlings) documented in five of the nine currently known natural populations that were monitored between 2014 and 2020. Additional to the natural populations, numerous Cóbana negra individuals have been planted in both public and private lands managed for conservation through different conservation programs and initiatives over the past five years. These efforts aim at establishing self-sustainable populations of Cóbana negra in suitable habitats to ensure the recovery of the species. As of the time of this 5 year status review, approximately 2,500 Cóbana negra individuals had been planted since 2014 in different populations throughout Puerto Rico. (USFWS, 2020)

Threats and Stressors

Stressor: Illegal dumping (USFWS, 2014)
Exposure:
Response:
Consequence: Loss/degradation of habitat
Narrative: Some of the wetland areas are commonly used as illegal dumping sites where used tires, mattresses, refrigerators, and other kind of trash are left in suitable areas for the species (USFWS, 2014).

Stressor: Human development (USFWS, 2014)
Exposure:
Response:
Consequence: Loss/degradation of habitat
Narrative: The development of these areas has resulted in habitat modification and fragmentation, and has limited the natural expansion of currently known populations of Cóbana negra (USFWS, 2014).

Stressor: Predation (USFWS, 2014)
Exposure:
Response:

Consequence: Loss of individuals
Narrative: At the time of listing, browsing of seedlings was considered a threat to the species especially in the first year following establishment. Currently, Sierra Bermeja, Villa Taina and Laguna Joyuda, are areas where livestock may still graze on Cóbana negra. The individuals in grazing areas grow sparse and only reach adulthood where cattle are limited. (USFWS, 2014). Because most of the wild individuals are in protected areas restricted from livestock, and some have conservation measures for the protection of the species, we believe that the threat of predation is low (USFWS, 2014).

Stressor: Lack of individual recruitment (USFWS, 2014)
Exposure:
Response:
Consequence: Limited population growth
Narrative: The Cóbana negra populations have been affected by lack of natural recruitment despite the abundant fruit production and the fact that seeds germinate very well under nursery conditions. The best information available indicates that little recruitment is occurring on natural populations, and when present, seedlings and saplings are located just below the parent tree, suggesting problems of seed dispersal. Due to the lack of long term monitoring efforts, it remains unknown if these individuals will develop as mature plants capable of reproduction. Thus, the Service is unable to determine if the natural populations are actually stable or improving. In the case of reintroduced material, a rapid assessment conducted by the Service on individuals planted since 1998 at Laguna Cartagena NWR, identified several size classes, which suggests some recruitment (USFWS 2014a). However, a thorough assessment of the entire population at Laguna Cartagena is needed to determine if natural recruitment is actually occurring. Also, other reintroduced individuals have been planted in private and public lands, which are not suitable natural habitats for the species (e.g. pasturelands and urban areas). Hence, we do not consider these plantings self-sustaining and the chances for these populations to be expanding are very limited. Therefore, we believe that the factors mentioned above are a threat to the species (USFWS, 2014).

Stressor: Hurricanes and climate change (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Disturbances such as hurricanes may affect small relic populations of Cóbana negra. These populations are very important as they may harbor an important genetic stock of the species. Cóbana negra may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Even if Cóbana negra resists adverse effects of hurricanes, the cumulative effects of severe storms, soil erosion and increased sediment runoff may compromise the establishment of seedlings along drainages, which usually provide suitable habitat for the species. Habitat modification may result in irreversible damage to the species' natural habitat, decreasing the number of individuals in already small populations. However, the current frequency of severe hurricanes is low, therefore, the Service considers severe tropical storms as a low and non-imminent threat to the species (USFWS, 2014).

Stressor: Human induced fires (USFWS, 2014)
Exposure:

Response:
Consequence:
Narrative: Caribbean ecosystems are vulnerable to natural and anthropogenic events. Native plants and endemic species with limited distribution are particularly susceptible to human induced fires. Restoring native plant communities is challenging where invasive plants have altered fire regimes and ecosystem properties (Brooks et al. 2004). In Puerto Rico, the native plant community of subtropical dry forests is not fire-adapted; hence, it has been affected by human induced fires (Wolfe 2008). These fires may lead to destruction of the native vegetation seed bank, and usually favor conditions for the establishment of exotic plant species (e.g., Leucaena leucocephala and Megathyrsus maximus). Moreover, exotic plants increase direct competition for resources and limit native plant species recruitment in highly degraded areas (Wolfe 2008). The possibility of severe droughts triggered by climate change may contribute to an increase in the number and frequency of fires on Puerto Rico. These cumulative factors may reduce the number of individuals and further reduce populations of Cóbana negra. The Service is aware of natural populations of Cóbana negra being directly affected by human induced fires and the associated habitat modification in the area of Sierra Bermeja (USFWS 2014b). Moreover, areas managed for conservation, and where the species have been widely planted, have been recently affected by fires (i.e., Cabo Rojo NWR and Laguna Cartagena NWR). Nonetheless, we consider the threat of human-induce fires to be low and non-imminent because their effect is local and they do not threaten all populations of Cóbana negra at once (USFWS, 2014).

Stressor: Genetic variation (USFWS, 2014)
Exposure:
Response:
Consequence: Limited population viability
Narrative: Cóbana negra occurs in small natural populations with a limited geographic distribution. These factors along with habitat fragmentation, and the fact that planted individuals come from propagated material from the same seed source, may result in the erosion of genetic variation of the species (Honnay and Jacquemyn 2007). Such genetic erosion also may limit the species' ability to respond to environmental changes (Booy et al. 2000). As previously mentioned under the section about new genetic information, Cóbana negra may be facing a population bottleneck due to a severe reduction in population size in the recent past. Based on the above information, we consider the low genetic variation as a high, but non-imminent threat to the species (USFWS, 2014).

Recovery

Delisting Criteria:
1. Self-sustaining new populations (following the appropriate ecological and genetic studies to determine self-sustainability) are established within protected areas (USFWS, 2014).

2. Specimens or populations found on privately-owned lands are placed under protective status (USFWS, 2014).

Recovery Actions:
- Criteria 1 has been initiated with the introduction of individuals in protected areas (USFWS, 2014).

- Criteria 2 has been partially met as most natural individuals (80%) are in areas managed for conservation by governmental and non-governmental organizations (USFWS, 2014).
- The Service, in cooperation with PRDNER and academia, needs to determine how many individuals constitute a self-sustaining population. After this work, the recovery plan should be revised to establish objective, measurable delisting criteria (USFWS, 2014).
- Genetic studies should be conducted to determine the genetic variation of planted individuals (USFWS, 2014).
- Efforts to protect privately-owned populations should be started. Areas like Punta Melones, near Villa Taina, Laguna Joyuda and Sierra Bermeja are susceptible to development. Hence, working with the private landowners to conserve these natural areas is essential. Private-lands initiatives such as Partners for Fish and Wildlife and Coastal Programs are needed to further protect the areas where Cóbana negra is known to occur naturally (USFWS, 2014).
- The Service should continue the efforts to promote the collection of seed material from natural populations and not from plantations. This actions help to increase the genetic variation of Cóbana negra (USFWS, 2014).
- Conduct periodic surveys of introduced populations to assess the success of planting efforts and determine if recovery actions are effective (USFWS, 2014).

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SPECIES ACCOUNT: *Stenogyne kanehoana* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/1992; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial rambling vine with 1 - 2 m long stems. Flowers are whitish or pale yellow, with pinkish-purple lips (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2003).

Historical Range

Stenogyne kanehoana was known from the east ridge of Puu Kanehoa in the Waianae Mountains, near the summit of the ridge connecting Puu Kanehoa with Puu Hapapa to the north and Puu Kaua to the south, a distance totaling approximately 2.8 km (1.7 mi) (USFWS, 2003).

Current Range

Occurs in the southern Waianae Mountains (NatureServe, 2015). The population near the summit of Puu Kanehoa on privately owned land was found dead recently. An additional occurrence in Kaluaa Gulch was discovered in 2000 by Joan Yoshioka of TNCH (USFWS, 2003).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Stenogyne kanehoana under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Stenogyne kanehoana (77 FR 57648-57862). The critical habitat designation includes 3 critical habitat units, which encompass approximately 5,884 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Stenogyne kanehoana includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Stenogyne kanehoana includes 3 critical habitat units, covering one ecosystem type, which encompasses approximately 5,884 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole

NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Stenogyne kanehoana critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Stenogyne kanehoana occurs within the indicated ecosystem in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Stenogyne kanehoana to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual: vegetative (USFWS, 2013)

Lifespan

Adult: 7 - 12 (USFWS, 2003)

Breeding Season

Adult: Primarily February - March, sometimes January - April (USFWS, 2003)

Key Resources Needed for Breeding

Adult: Precipitation (USFWS, 2003)

Reproduction Narrative

Adult: This species is not setting seed or at least is not successfully reproducing (Herbst, 1992) (NatureServe, 2015). It is a short-lived perennial (fewer than 10 years). Three factors were

identified as affecting the rarity of Stenogyne kanehoana: Vegetative reproduction of S. kanehoana by long, rambling stems, which may root when contacting the ground, leading to the formation of additional plants; infrequent or inconsistent flowering; a large percentage of non-flowering or non-fruiting plants (U.S. Army Garrison 2008) (USFWS, 2013). Stenogyne kanehoana generally flowers from February through March, but flowering depends on precipitation, and flowers have been noted from January to as late as April. Fruits mature within six weeks. The lifespan of this species appears to be about seven to 12 years (USFWS, 2003).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Low mesic Metrosideros, Eugenia, Osmanthus and Myrsine forest (NatureServe, 2015; USFWS, 2003)

Geographic or Habitat Restraints or Barriers

Adult: 1,834 - 3,831 ft. elevation (USFWS, 2003)

Habitat Narrative

Adult: Inhabits diverse mesic forest under canopy of Metrosideros, Eugenia, Osmanthus and Myrsine (NatureServe, 2015). It is found in lowland mesic forest between 559 and 1,168 m (1,834 and 3,831 ft.) elevation (USFWS, 2003).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Not available

Number of Populations:

1 (USFWS, 2013)

Population Size:

150 re-introduced (USFWS, 2019)

Population Narrative:

There is one wild individual and 124 outplanted individuals (USFWS, 2013). Currently there are approximately 150 reintroduced individuals of Stenogyne kanehoana in three populations in the Waiʻanae mountains of Oʻahu. Eighty percent of these are in the more recently established Haleʻauʻau reintroduction. Some recruitment via vegetative propagation has been observed at one reintroduction site. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that S. kanehoana is highly vulnerable to the effects of climate change. Collection (from reintroductions and ex situ collections), propagation, and

reintroductions are ongoing. Three areas are fenced and managed for ungulates and nonnative plants, and one area is managed for rodents. Reintroductions appear to decline fairly rapidly. (USFWS, 2019)

Threats and Stressors

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2013).

Stressor: Disease (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: An undetermined species of powdery mildew has been identified as a new threat to Stenogyne kanehoana (U.S. Army Garrison 2008) (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Invasive slugs have negatively impacted the regeneration of Stenogyne kanehoana (U.S. Army Garrison 2010) (USFWS, 2013).

Stressor: Nonnative plants (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: Competition for space, water, light, and nutrients by the nonnative species Clidemia hirta, Paspalum conjugatum, Passiflora suberosa, Psidium cattleianum, and Schinus terebinthifolius (USFWS, 2003).

Stressor: Small population size (USFWS, 2003)
Exposure:
Response:
Consequence:
Narrative: The extremely small number of individual plants and their restricted distribution increases the potential for extinction from naturally occurring events (USFWS, 2003).

Stressor: Habitat degradation (USFWS, 2003)
Exposure:
Response:
Consequence:

Narrative: Habitat degradation by feral pigs, predation by the two spotted leafhopper, and trampling by hikers are also thought to be threats to this species (HINHP Database 2001; Service 1998b; 57 FR 20592) (USFWS, 2003).

Recovery

Reclassification Criteria:
1. A total of five to seven populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1998).

Delisting Criteria:
1. A total of 8 to 10 populations should be documented on Oahu and at least one other island where they now occur or occurred historically (USFWS, 1998).

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 300 mature individuals per population (for short-lived perennials) (USFWS, 1998).

3. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1998).

Recovery Actions:
- Protect habitat and control threats (USFWS, 1998).
- Expand existing wild populations (USFWS, 1998).
- Conduct essential research (USFWS, 1998).
- Develop and maintain monitoring plans (USFWS, 1998).
- Reestablish wild populations within historic range (USFWS, 1998).
- Validate and revise recovery criteria (USFWS, 1998).
- Conduct surveys (USFWS, 1998).
- Maintain adequate genetic stock (USFWs, 1998).
- Enhance wild populations and establish of new populations (USFWS, 1998).
- Captive propagation for genetic storage and reintroduction: Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. Manage nursery collections to promote flowering. Continue research in pollination and continue to hand-pollinate. This includes collecting pollen, testing pollen viability, and pollinating all flowering plants, both in situ and ex situ (USFWS, 2013).
- Reintroduction / translocation: While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions. Continue to reintroduce the species back into its known historical range (USFWS, 2013).

- Ungulate exclosures – Construct, maintain, and monitor ungulate-proof exclosures around each population (USFWS, 2013).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations. Continue to target all canopy weeds along the catchment ridge of Kalauu to maintain native dominated matrix with care to avoid damaging the Dicranopteris linearis (uluhe) understory which is needed for successful growth of Stenogyne kanehoana (U.S. Army Garrison 2011) (USFWS, 2013).
- Threats research: Invasive slugs negatively impacted the regeneration of Stenogyne kanehoana (U.S. Army Garrison 2010). In 2009, slug control research using Sluggo, a slug and snail bait, began in the field at the Kahanahaiki population unit on U.S. Army lands (U.S. Army Garrison 2009, 2010). In October 2010, Sluggo was registered for use by the Hawaii Department of Agriculture (U.S. Army Garrison 2010) for control of slugs and nonnative snails in forested areas for the protection of native, threatened, and endangered plants of Hawaii. However, since native snails also exist in areas where threatened and endangered plants occur, additional research is need to find a control method that can be used in areas where native snail species co-occur with listed plants (USFWS, 2013).
- Surveys / inventories – Survey geographical and historical range for a thorough current assessment of the species status (USFWS, 2013).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of military activities and hikers (USFWS, 2013).
- Fire protection – Develop and implement fire management plans for all wild and reintroduced populations (USFWS, 2013).
- Alliance and partnership development - Enhance coordination and collaboration among other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2013).
- Population biology research – Study Stenogyne kanehoana with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2013).
- Threats research: Assess the modeled effects of climate change on this species, and use the results to determine future landscape needed for the recovery of the species. Investigate appropriate controls for powdery mildew outbreaks. Implement controls for invasive slugs around Stenogyne kanehoana populations (USFWS, 2013).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Surveys and inventories—Continue to survey geographical and historical range for a thorough assessment of the species' status. • Ungulate monitoring and control—Continue to maintain fencing and monitor reintroduced populations to protect plants from impacts of feral ungulates. • Invasive plant monitoring and control— o Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with Stenogyne kanehoana at all reintroduced populations. o Continue to avoid damaging the fern understory (Dicranopteris linearis, uluhe) which is needed for successful growth of S. kanehoana. • Fire management—Implement fire management plans and coordinate fire response efforts. • Climate change adaptation strategy—Assess the effects of

climate change on this species and use to determine future landscape needed for the recovery of the species. • Disease—Investigate appropriate controls for powdery mildew outbreaks. • Slug predation and herbivory—Implement effective control for slugs at all reintroduced populations. • Captive propagation for genetic storage and reintroduction— o Continue seed and cuttings collections from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Manage nursery collections to promote flowering. Continue research of pollination and hand pollination, including viability testing both in situ and ex situ. • Reintroduction— o Continue to establish new populations and determine which sites have the highest likelihood of maintaining new introductions. o Implement measures to reduce the impact of hikers and military activities on populations. • Population biology research—Study Stenogyne kanehoana with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Alliance and partnership development—Continue to work with the ANRP, the Division of Forestry and Wildlife, and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2019)

- New Management Actions: • Ungulate control—All reintroductions are within fenced and managed areas; however, all fences must be monitored for ungulate incursion (ANRP 2018). • Nonnative invasive plant control—All reintroductions are within areas managed for control of nonnative plants (ANRP 2018). • Rodent control—The ANRP controls rats at the Mākaha management unit (ANRP 2018). • Captive propagation for genetic storage and reintroduction— o The Lyon Micropropagation Laboratory reports storage of 82 explants representing one individual each from the now extirpated Haleʻauʻau and Kaluaa populations (Lyon Arboretum 2018.). o The Army Natural Resources Program-Oʻahu (ANRP) reports 29 plants in their nursery representing these same two individuals, , and one seed in storage from the Kaluaa individual) (ANRP 2018). Genetic storage goals have been met representing the last known wild individuals (ANRP 2018). • Reintroductions—Plants are grown from cuttings of nursery plants and clonal material in micropropagation. Since the last 5-year review there have been approximately 570 individuals of Stenogyne kanehoana reintroduced into three populations (Haleʻauʻau, Kaluaa, and Mākaha), about 150 of these currently survive (ANRP 2018). (USFWS, 2019)

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SPECIES ACCOUNT: *Stenogyne kauaulaensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 06/27/2013; Pacific Region (R1) (USFWS, 2016)

Current Range

Distribution: Maui (USFWS, 2021)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Stenogyne kauaulaensis under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes four detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Stenogyne kauaulaensis includes four CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Maui—Montane Mesic—Unit 2 (and) Palmeria dolei—Unit 19—Montane Mesic (and) Pseudonestor xanthophrys—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuehunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Lysimachia lydgatei, Remya mauiensis, and Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants Geranium hillebrandii, Huperzia mannii, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) Palmeria dolei—Unit 20—Montane Mesic (and) Pseudonestor xanthophrys—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant Geranium hillebrandii, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not

known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) Palmeria dolei—Unit 21—Montane Mesic (and) Pseudonestor xanthophrys—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) Palmeria dolei—Unit 22—Montane Mesic (and) Pseudonestor xanthophrys—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Remya mauiensis and Santalum haleakalae var. lanaiense, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) Palmeria dolei—Unit 20—Montane Mesic (and) Pseudonestor xanthophrys—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant Geranium hillebrandii, and contain unoccupied habitat

that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Stenogyne kauaulaensis critical habitat consists of one component. Montane mesic (west Maui) (81 FR 17790-18110):

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and

Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago

princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Vegetatively reproducing (USFWS, 2021)

Lifespan

Adult: Short (USFWS, 2021)

Habitat Type

Adult: Montane mesic ecosystem (USFWS, 2016)

Habitat Narrative

Adult: Stenogyne kauaulaensis (NCN), a short-lived perennial vine in the mint family (Lamiaceae), occurs on Maui. This recently described (2008) plant is found only along the southeastern rim of Kauaula Valley, in the montane mesic ecosystem on west Maui (USFWS, 2016).

Dispersal/Migration

Motility/Mobility

Adult: No information found

Population Information and Trends

Population Trends:

No information found.

Number of Populations:

1 (USFWS, 2023)

Population Size:

3 (USFWS, 2023)

Population Narrative:

There is one mature wild individual of Stenogyne kauaulaensis. What started out as a discovery of 15 individuals in the wild in 2008 has since declined to one individual by 2019. There are seeds and propagules in cultiavation, and reintroduction efforts are ongoing. Attempts at hand-pollination in living collections to produce seeds for storage and propagation are also ongoing (USFWS, 2020)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from nonnative plants, fire, drought, landslides, rockfalls, and hurricanes. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). Fire can destroy dormant seeds and plants, even in steep and inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants. Dought, landslides, and rockfalls destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Potential impacts from climate change have also been identified (USFWS, 2013).

Stressor: Predation and herbivory (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species (slugs) is considered an ongoing threat to Stenogyne kauaulaensis throughout the species range. Non-native animals cause mechanical damage to plants and destruction of plant parts (branches, fruits, and seeds) (USFWS, 2013).

Stressor: Small populations (USFWS, 2013)
Exposure:
Response:
Consequence:
Narrative: Stenogyne kauaulaensis faces the threat of limited numbers (i.e., there are fewer than 50 individuals in the wild). Stenogyne kauaulaensis is only known from three individuals. These plants face imminent threats from landslides and rockfalls because of their location on steep slopes, and from drought and fire in the montane mesic ecosystem on west Maui (USFWS, 2013).

Recovery

Reclassification Criteria:
Number of populations and individuals needed for each plant species to meet Preventing Extinction Stage target based on population and life history characteristics: Number of Populations: 6. Mature Individuals per population: 50. (USFWS, 2021) Number of populations and individuals needed for each plant species to meet the Interim Stage target based on population and life history characteristics: Number of Populations: 6. Mature Individuals per population: 300. (USFWS, 2021) Number of population and individuals needed for downlisting based on population and life history characteristics: Number of Populations: 10. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Priority Number: 5

Delisting Criteria:
Number of populations and individuals needed for delisting based on population and life history characteristics: Number of Populations: 20. Mature Individuals per population: 500. (USFWS, 2023)

Recovery Actions:
- There is no recovery plan for this species.

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to conduct surveys for Stenogyne kauaulaensis in potentially suitable habitat. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species and those that compete with S. kauaulaensis. • Fire protection - Develop and implement fire management plans for all wild and reintroduced populations. • Climate change adaptation strategy—Research suitability of habitat in the future due to the impacts of climate change. • Slug predation and herbivory—Develop and implement effective control methods for slugs. • Captive propagation for genetic storage and reintroduction—Continue to collect seeds and cuttings for storage and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of drought, hurricanes, landslides, climate change and low numbers. • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)
- Current Management Actions: • Surveys and monitoring—PEPP regularly monitors occurrences of Stenogyne kauaulaensis on Maui (PEPP 2019, entire; PEPP 2018, p. 34; PEPP 2017, pp. 217-218; PEPP 2016, p. 43, 225). • Ecosystem-altering invasive nonnative plant control— In 2018, 2017, and 2013, the Plant Extinction Prevention Program controlled invasive plant species around the population in west Maui during routine monitoring trips (PEPP 2018, p. 34; PEPP 2017, p. 217-218; USFWS unpublished data). • Captive propagation for genetic storage and reintroduction— o PEPP supports conservation of plant species that have fewer than 50 plants remaining in the wild by securing seeds or cuttings (with permission from the State, Federal, or private landowners) from the rarest and most critically endangered native species for propagation and planting (http://pepphi.org). Funding for this program is from the State of Hawai‘i, Federal agencies (e.g., Service), and public and private grants. PEPP is collecting seeds and cuttings (PEPP 2019, entire; PEPP 2018, p. 34; PEPP 2017, pp. 217-218; PEPP 2016, p. 43, 225). o Lyon Arboretum Seed Conservation Laboratory reported 2 seeds in storage, but they were later withdrawn for propagation by PEPP (Lyon Arboretum 2018). o The Olinda Rare Plant Facility (ORPF) reports six potted plants growing in their nursery. The Facility propagated 18 individuals for the reintroduction (ORPF 2018). In 2014 and 2018, the wild population of Kaua’ula was monitored and cuttings were collected and delivered to the ORPF for propagation (PEPP 2019, p.168; PEPP 2019, entire). In June 2019, a couple of the plants grown from cuttings collected in the wild have flowered and hand pollination was conducted in an attempt to cross pollinate the individuals (Oppenheimer pers. comm. 2019). It is too early to report on the results of the hand pollination efforts at ORPF. • Reintroduction and translocation—There are two reintroduction sites for Stenogyne kauaulaensis; one at Panaewa Natural Area Reserve and the second at Launiupoko on west Maui (PEPP 2019, p. 1) and one augmentation site at Kau ‘aula (PEPP 2016, p. 225). (USFWS, 2020)

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SPECIES ACCOUNT: *Stenogyne kealiae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/13/2010; Pacific Region (R1)

Physical Description

A trailing vine. Leaves are thinly to moderately coriaceous, broadly lanceolate to elliptic-lanceolate, 8 - 15 cm long. Flowers are 3 - 5 per verticillaster. Corollas are deep pinkish purple (NatureServe, 2015).

Taxonomy

A member of the mint family (Lamiaceae) (USFWS, 2010b). The supplement to the revised Manual of the Flowering Plants of Hawaii (Wagner et al. 1999) resurrects this species from synonymy of S. purpurea. Kartesz lists it in synonymy of S. purpurea in his 1994 checklist, but recognizes it as distinct in the 1999 Synthesis (NatureServe, 2015).

Historical Range

Historically, this species occurred at Pohakupili near Kealia in the Kealia Forest Reserve on the island of Kauai (USFWS, 2010b).

Current Range

Currently, this species occurs at Honopu, Kalalau, Malamalamaiki, Pohakupili, and Wainiha (Kauai) (USFWS, 2010b).

Critical Habitat Designated

Yes; 4/13/2010.

Legal Description

On April 13, 2010, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Stenogyne kealiae under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 11 critical habitat units (CHUs), in Hawaii (75 FR 18960-19165).

Critical Habitat Designation

The critical habitat designation for Stenogyne kealiae includes 11 CHUs in Kauai County, Hawaii (75 FR 18960-19165).

Kauai—Lowland Wet—Section 1: Lowland Wet–Section 1 consists of 1,164 ac (471 ha) in the lowland wet ecosystem (117 ac (47.4 ha) on State land; 1,047 ac (424 ha) on private land), including wet forest extending from Kulanalilia into Limahuli Valley to Honoonapali, in the Halelea Forest Reserve (Figure 2-A). The section includes 1,099 ac (445 ha) of State and privately owned land within previously designated critical habitat and 65 ac (26 ha) of newly designated critical habitat on private land. The area that falls within designated critical habitat lies within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and newly designated Critical Habitat Unit 20, Map 217c. This section is occupied by the plants Chamaesyce remyi var. remyi, Charpentiera densiflora, Labordia helleri, and Phyllostegia renovans. This section also contains unoccupied habitat that is essential to the conservation of these four species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section

includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 1 is not known to be occupied by the species Chamaesyce remyi var. kauaiensis, Cyanea eleeleensis, C. kolekoleensis, C. kuhihewa, Cyrtandra oenobarba, Dubautia imbricata ssp. imbricata, Melicope paniculata, M. puberula, Platydesma rostrata, Stenogyne kealiae, Tetraplasandra bisattenuata, and T. flynnii, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 2: Lowland Wet–Section 2 consists of 172 ac (70 ha) in the lowland wet ecosystem, including wet forest extending from Alealau to Pohakea, within the Hono o Na Pali NAR and the Na Pali Coast State Park (Figure 2-A, above). The entire section is Stateowned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plant Melicope puberula. This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 2 is not known to be occupied by the species Chamaesyce remyi var. kauaiensis, C. remyi var. remyi, Charpentiera densiflora, Cyanea eleeleensis, C. kolekoleensis, C. kuhihewa, Cyrtandra oenobarba, Dubautia imbricata ssp. imbricata, Labordia helleri, Melicope paniculata, Phyllostegia renovans, Platydesma rostrata, Stenogyne kealiae, Tetraplasandra bisattenuata, and T. flynii, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 3: Lowland Wet–Section 3 consists of 756 ac (306 ha) in the lowland wet ecosystem, including wet forest in upper Wainiha Valley, on privately owned land in the Halelea Forest Reserve (Figure 2-B). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants Chamaesyce remyi var. kauaiensis, Cyrtandra oenobarba, Melicope puberula, Phyllostegia renovans, and Stenogyne kealiae. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 3 is not known to be occupied by the species Chamaesyce remyi var. remyi, Charpentiera densiflora, Cyanea eleeleensis, C. kolekoleensis, C. kuhihewa, Dubautia imbricata ssp. imbricata, Labordia helleri, Melicope paniculata, Platydesma rostrata, Tetraplasandra bisattenuata, and T. flynii, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 4: Lowland Wet–Section 4 consists of 591 ac (239 ha) in the lowland wet ecosystem, including wet forest at the head of Lumahai Valley, on State (10 ac, 4.1 ha) and privately owned (581 ac, 235 ha) land in the Halelea Forest Reserve (Figure 2-B, above). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70a, and is occupied by the plants Chamaesyce remyi var. remyi, Cyrtandra oenobarba, Melicope paniculata, Phyllostegia renovans, and Platydesma rostrata. This section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 4 is not known to be occupied by the species Chamaesyce remyi var. kauaiensis, Charpentiera densiflora, Cyanea eleeleensis, C. kolekoleensis, C. kuhihewa, Dubautia imbricata ssp. imbricata, Labordia helleri, Melicope puberula, Stenogyne kealiae, Tetraplasandra bisattenuata, and T. flynii, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population numbers of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 5: Lowland Wet–Section 5 consists of 1,541 ac (624 ha) in the lowland wet ecosystem, including wet forest extending from the headwaters of the Wailua River at ‘‘Blue Hole’’ south to Iole, on State (442 ac, 179 ha) and privately owned (1,099 ac, 445 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-C). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants Cyrtandra oenobarba, Dubautia imbricata ssp. imbricata, Melicope paniculata, Phyllostegia renovans, and Platydesma rostrata. This section also contains unoccupied habitat that is essential to the conservation of these five5 species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 5 is not known to be occupied by the species Chamaesyce remyi var. kauaiensis, C. remyi var. remyi, Charpentiera densiflora, Cyanea eleeleensis, C. kolekoleensis, C. kuhihewa, Labordia helleri, Melicope puberula, Stenogyne kealiae, Tetraplasandra bisattenuata, and T. flynii, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Lowland Wet—Section 6: Lowland Wet–Section 6 consists of 789 ac (319 ha) in the lowland wet ecosystem, including wet forest extending from Kapalaoa to Kanaele Bog and Lauahihaihai in the Wahiawa Mountains, on State (134 ac, 54 ha) and privately owned (655 ac, 265 ha) land in the Lihue-Koloa Forest Reserve (Figure 2-D). The entire section is within previously designated critical habitat, falling within Critical Habitat Unit 10 of 50 CFR 17.99(a)(1), Map 36a, and is occupied by the plants Chamaesyce remyi var. remyi, Cyrtandra oenobarba, Dubautia imbricata ssp. imbricata, Platydesma rostrata, and Tetraplasandra bisattenuata. This

section also contains unoccupied habitat that is essential to the conservation of these five species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the lowland wet forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the lowland wet ecosystem (Table 3). Although Lowland Wet–Section 6 is not known to be occupied by the species Chamaesyce remyi var. kauaiensis, Charpentiera densiflora, Cyanea eleeleensis, C. kolekoleensis, C. kuhihewa, Labordia helleri, Melicope paniculata, M. puberula, Phyllostegia renovans, Stenogyne kealiae, and Tetraplasandra flynii, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 1: Montane Mesic–Section 1 consists of 2,423 ac (980 ha) in the montane mesic ecosystem, including the area above Honopu Valley to Mahanaloa Valley, on State owned land in Kokee State Park, the Na Pali-Kona Forest Reserve, and Kuia NAR (Figure 3-A). The entire section is within previously designated critical habitat for the plant species, falling within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c, and is occupied by the plants Chamaesyce remyi var. remyi, Labordia helleri, Myrsine knudsenii, Platydesma rostrata, Psychotria grandiflora, Stenogyne kealiae, and Tetraplasandra flynii. This section is also occupied by the akekee and the picture-wing fly; maps of critical habitat for these species can be found at 50 CFR 17.95(b) for the akekee and akikiki (Unit 1–Montane Mesic), and at 50 CFR 17.95(i) for the picture-wing fly (Unit 1–Montane Mesic). This section also contains unoccupied habitat that is essential to the conservation of these nine species by providing the physical and biological features necessary for the expansion of the existing wild populations. This section includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as species-specific PCEs for the akekee and akikiki (arthropod prey) and picture-wing fly (the larval-stage host plants, Cheirodendron sp. and Tetraplasandra sp.). Although Montane Mesic–Section 1 is not known to be occupied by the species Diellia mannii, Myrsine mezii, and the akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Kauai—Montane Mesic—Section 2: Montane Mesic–Section 2 consists of 376 ac (152 ha) in the montane mesic ecosystem and includes a portion of the area surrounding a tributary of Nawaimaka Stream east to Kumuwela Ridge (Figure 3-A, above). The entire section is State-owned within Kokee State Park, and includes 8 ac (3 ha) of newly designated critical habitat. This section is occupied by Diellia mannii and the picture-wing fly Drosophila sharpi, and includes the montane mesic forest, the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3), as well as the larval-stage host plants (Cheirodendron sp. and Tetraplasandra sp.) associated with the picture-wing fly. This section also contains unoccupied habitat that is essential to the conservation of these two species by providing the physical and biological features necessary for the expansion of the existing wild populations. Although Montane Mesic–Section 2 is not known to be occupied by the

plants Chamaesyce remyi var. remyi, Labordia helleri, Myrsine knudsenii, Myrsine mezii, Platydesma rostrata, Psychotria grandiflora, Stenogyne kealiae, and Tetraplasandra flynnii, or by the birds the akekee and akikiki, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historical range, as well as species-specific PCEs for the akekee and akikiki (arthropod prey). Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, that portion of the section that overlies previously designated critical habitat falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 70c. The previously undesignated land comprises Critical Habitat Unit 21 of 50 CFR 17.99(a)(1), Map 217d. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 2–Montane Mesic), and for the picture-wing fly at 50 CFR 17.95(i) (Unit 2–Montane Mesic).

Kauai—Montane Mesic—Section 3: Montane Mesic–Section 3 consists of 139 ac (56 ha) in the montane mesic ecosystem, including the upper portion of the Nawaimaka Valley up to Kapukapaia Ridge, on State-owned land in the Na Pali-Kona Forest Reserve (Figure 3-B). This section is not in previously designated critical habitat and includes the only montane mesic forest occupied by the plant Myrsine mezii, and the moisture regime, and canopy, subcanopy, and understory plant species identified as PCEs in the montane mesic ecosystem (Table 3). This section also contains unoccupied habitat that is essential to the conservation of this species by providing the physical and biological features necessary for the expansion of the existing wild population. Although Montane Mesic–Section 3 is not known to be occupied by the plants Chamaesyce remyi var. remyi, Labordia helleri, Myrsine knudsenii, Myrsine mezii, Platydesma rostrata, Psychotria grandiflora, Stenogyne kealiae, and Tetraplasandra flynnii; by the birds the akekee and akikiki; or by the picturewing fly Drosophila sharpi, we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range. It also provides for the species-specific PCEs for the akekee and akikiki (arthropod prey) and the larval-stage host plants (Cheirodendron sp. and Tetraplasandra sp.) associated with D. sharpi. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery. For the plants, this section comprises Critical Habitat Unit 22 of 50 CFR 17.99(a)(1), Map 217e. Maps of critical habitat for the akekee and akikiki can be found at 50 CFR 17.95(b) (Unit 3– Montane Mesic), and for the picturewing fly at 50 CFR 17.95(i) (Unit 3– Montane Mesic).

Kauai—Dry Cliff—Section 1: Dry Cliff–Section 1 consists of 404 ac (163 ha) in the dry cliff ecosystem, along cliffs from Kalanu to Pihea peak, within the Na Pali Coast State Park (Figure 5). The entire section is within previously designated critical habitat and is State-owned; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plants Chamaesyce eleanoriae, Lysimachia scopulensis, Schiedea attenuata, and Stenogyne kealiae. This section includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3).

Kauai—Dry Cliff—Section 2: Dry Cliff–Section 2 consists of 309 ac (125 ha) in the dry cliff ecosystem, including cliffs and ridges extending from Kanakou to Keanapuka and along Manono Ridge, surrounding the hanging valley Pohakuao, in the Na Pali Coast State Park (Figure 5, above).

The entire section is State-owned and within previously designated critical habitat; it falls within Critical Habitat Unit 11 of 50 CFR 17.99(a)(1), Map 67a. This section is occupied by the plant Chamaesyce eleanoriae and includes the dry cliffs, the moisture regime, and subcanopy and understory plant species identified as PCEs in the dry cliff ecosystem (Table 3). Although Dry Cliff - Section 3 is not known to be occupied by the plants Lysimachia scopulensis, Schiedea attenuata, and Stenogyne kealiae, we have determined this area to be essential for the conservation and recovery of these dry cliff species because it provides the physical and biological features necessary for the reestablishment of wild populations within their historic range of the species. Due to the small numbers of individuals or low population sizes of each of these species, each requires suitable habitat and space for expansion or reintroduction to achieve recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Stenogyne kealiae critical habitat consists of three components (Lowland wet, Montane mesic and Dry cliff) (75 FR 18960-19165):

Ecosystem: Lowland Wet. Elevation: <3,000 ft (<914 m). Annual precipitation: >75 in (>190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Mesic. Elevation: 3,300–5,243 ft (914–1,598 m). Annual precipitation: 50–75 in (127–190 cm). Substrate: weathered aa lava, rocky mucks, thin silty loams, deep volcanic ash soils. Canopy: Acacia, Metrosideros, Psychotria, Tetraplasandra, Zanthoxylum. Subcanopy: Cheirodendron, Coprosma, Kadua, Ilex, Myoporum, Myrsine. Understory: Bidens, Dryopteris, Leptecophylla, Poa, Scaevola, Sophora.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: < 75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contains the physical or biological features essential to the conservation of the species that may require special management considerations or protection. It is recognized that activities in and adjacent to areas designated as critical habitat may affect one or more of the PCEs found in these areas. Special management is needed throughout each of the designated critical habitat units. The following discussion of special management needs is applicable to each of the 47 Kauai species for which we are designating critical habitat. These 47 Kauai species include 41 species that are currently found in the wild, and 6 species that are not currently extant in the wild. For each of the 41 Kauai species found in the wild, we have determined that the features essential to their conservation are primarily dependent on maintaining the successful functioning of the ecosystem(s) in which they occur (Tables 3 and 4). In some cases, additional species-specific primary constituent elements have also been identified (Table 4). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical and biological features essential to the conservation of all of these species include

habitat destruction and modification by feral ungulates, predation by nonnative species, competition with nonnative species, hurricanes, landslides, flooding, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by feral ungulates (pigs, goats, and black-tailed deer). Feral ungulates also impact the habitat through predation and trampling. The State of Hawaii provides game mammal (feral pigs and goats, and black-tailed deer) hunting opportunities on one or more State-designated public hunting areas on the islands of Kauai, Oahu, Maui, Molokai, Lanai, and Hawaii (Hawaii Administrative Rules 13-123; DLNR 2009a). Management of game animals by the State ranges from providing maximal sustained public hunting opportunities and benefits (e.g., ''sustained yield'') in some areas to game animal removal by State staff, or their designees, in other areas (DLNR 2009b). Public hunting areas are not fenced, and game mammals have unrestricted access to most areas across the landscape, regardless of the underlying land use designation. While fences are sometimes built to provide protection from game mammals to the natural resources within the fenced area, the current number and locations of fences are not sufficient to prevent habitat destruction and degradation. Without special management, the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat in this rule requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new alien plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species will help to address the threat presented by fire to three critical habitat areas in particular (Kauai—Lowland Mesic— Section 1, Kauai—Montane Mesic— Section 2, and Kauai—Dry Cliff— Section 1; see Table 5 for corresponding CFR unit numbers). This threat is primarily due to the presence of nonnative species, such as the grasses Andropogon sp. and Setaria sp., which increase the fuel load and quickly regenerate after a fire. These species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64– 66; Brooks et al. 2004, p. 680). In addition, five sections (Kauai—Dry Cliff—Section 1, Kauai—Dry Cliff— Section 2, Kauai—Wet Cliff—Section 1, Kauai—Wet Cliff—Section 2, and Kauai—Wet Cliff—Section 3; see Table 5 for corresponding CFR unit numbers) may require special management to reduce the threat of landslides and flooding, which threaten to further degrade the habitat conditions and have the potential to eliminate some species in their entirety (e.g., Schiedea attenuata). In summary, we find that each of the areas we are designating as critical habitat contains features essential to the conservation of the species that may require special management considerations or protection to ensure the conservation of the 47 Kauai species. These special management considerations and protections are required to preserve and maintain the essential features provided to these species by the ecosystems upon which they depend. A more detailed discussion of each of these threats is presented above, under the Summary of Factors Affecting the Species section.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: No specific characteristics known (USFWS, 2021c)

Lifespan

Adult: short (USFWS, 2021c)

Reproduction Narrative

Adult: Not available

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic to wet shrublands and forests (NatureServe, 2015); dry cliff, lowland wet, and montane mesic ecosystems (USFWS, 2010b)

Geographic or Habitat Restraints or Barriers

Adult: 2,231 - 4,100 ft. elevation (USFWS, 2010b)

Habitat Narrative

Adult: Inhabits mesic to wet shrublands and forests (NatureServe, 2015). It occurs in the dry cliff, lowland wet, and montane mesic ecosystems, in Metrosideros polymorpha forest, M. polymorpha-Acacia koa forest, and M. polymorpha-Dicranopteris linearis shrubland, at elevations between 3,550 and 4,100 ft. (1,082 and 1,250 m) (Wagner and Weller 1991, p. 51; TNCH 2007). One population (Wainiha), however, is reported between 2,231 and 2,707 ft. (680 and 825 m) elevation (HBMP 2007) (USFWS, 2010b).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Species Trends:

Declining (NatureServe, 2015)

Number of Populations:

5 (USFWS, 2022).

Population Size:

8 (USFWS, 2022).

Population Narrative:

The long term population trend is unknown. Known declining due to numerous threats, exact percentage is unknown (HBMP 2007) (NatureServe, 2015). There are currently 18 wild individuals of Stenogyne kealiae in four locations. Propagation and outplanting efforts are ongoing (USFWS, 2017). Island Distribution: Kauai Known or estimated number of populations: 4 (USFWS, 2021c). Known or estimated number of individuals: 18 (USFWS, 2021c). Population and Life History Characteristics : No specific characteristics known (USFWS, 2021c) Currently, Stenogyne kealiae is known from five populations at Honopu, Kalalau, Miloli‘i, Huleia, and Awaawapuhi on Kaua‘i, totaling 8 individual plants (Perlman et. al. 2015; Kishida and Perlman 2016; Perlman 2018; Plant Extinction Prevention Program [PEPP] 2021) (USFW, 2022)

Threats and Stressors

Stressor: Habitat destruction or modification (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Adverse impacts on habitat of this species have been identified from non-native plants, pigs, goats, deer, fire, hurricanes, landslides, and climate change. The effects of nonnative plants on native plant species include competition and displacement; competition may be for water, light, or nutrients, or it may involve allelopathy (chemical inhibition of other plants). The effects by nonnative animals includes the destruction of vegetative cover; trampling of plants and seedlings; direct consumption of native vegetation; soil disturbance; dispersal of alien plant seeds, and through the spread of seeds in feces; and creation of open, disturbed areas conducive to further invasion by nonnative pest species. Hurricanes adversely impact native Hawaiian terrestrial habitat by destroying native vegetation, opening the canopy and thus modifying the availability of light, and creating disturbed areas conducive to invasion by nonnative pest species. Landslides destabilize substrates, damage and destroy individual plants, and alter hydrological patterns, which result in changes to native plant and animal communities. Fire can destroy dormant seeds and plants, even in steep in inaccessible areas. Successive fires can remove habitat for native species by altering microclimate conditions favorable to alien plants.

Stressor: Predation and herbivory (USFWS, 2010)
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by nonnative animal species present an immediate and significant threat to Stenogyne kealiae throughout its range due to documented browsing and trampling by pigs, goats, and deer, and documented mechanical damage by rats (USFWS, 2010).

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor:
Exposure:
Response:

Consequence:
Narrative:

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
Number of populations and individuals needed to meet Preventing Extinction Stage based on population and life history characteristics: 3 Populations, 50 Mature Individuals per Population (USFWS, 2021c). Number of populations and individuals needed to meet Interim Stage based on population and life history characteristics: 3 Population, 300 Mature Individuals per Population (USFWS, 2021c). Number of populations and individuals needed for Downlisting based on population and life history characteristics: 10 Populations, 500 Mature Individuals per Population (USFWS, 2021c).

Recovery Priority Number: 2

Delisting Criteria:
Number of populations and individuals needed for delisting based on population and life history characteristics: 10 Populations, 500 Mature Individuals per Population (USFWS, 2021c).

Recovery Actions:
- Assess the distribution, current status, and potential future distribution of existing ecosystems and determine the most important sites for ecosystem management. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand species distributions and priority ecosystem areas for targeting future surveys (USFWS, 2010a).
- Initiate control of ecosystem-modifying threats, such as ungulates and invasive introduced plant species, as soon as possible within the highest priority management units (USFWS, 2010a).
- Stabilize and protect remaining extant populations of the 45 plants and 2 bird species. Conduct systematic, island-wide surveys for additional populations. Make use of landscape modeling, spatial analysis, remote sensing technology, and existing survey data to better understand distributions and priority areas for targeting future surveys (USFWS, 2010a).
- Restore and maintain multiple viable populations of the 45 plants and 2 bird species by protecting, restoring, and maintaining existing habitats or areas with potential for restoration that are within their historical range (USFWS, 2010a).
- Conduct research on control methods for introduced slugs and avian malaria (USFWS, 2010a).
- Develop an augmentation plan to collect and propagate seed from the 45 plant species that can later be utilized for population restoration, augmentation, and reintroduction (USFWS, 2010a).

- Prevent the influx of new pests and invasive species into recovery areas. Increase the efforts of the Kauai Invasive Species Committee and improve border security (USFWS, 2010a).
- Prioritize research studies that will provide information and tools aiding in the mitigation of known threats and limiting factors of the species and ecosystems (USFWS, 2010a).
- Increase outreach effort and coordination with State agencies and private landowners regarding ecosystem conservation. Promote opportunities to assist in the recovery of these species through Habitat Conservation Plans, Safe Harbor Agreements, and through various conservation partnerships funded by State and Federal agencies and private organizations (USFWS, 2010a).
- RECOMMENDATIONS FOR FUTURE ACTIONS: • Surveys and inventories—Continue to survey for populations of Stenogyne kealiae in areas of potentially suitable habitat. • Ungulate monitoring and control—Protect all occurrences against browsing and disturbances from feral ungulates. Construct and maintain fenced exclosures around existing populations to prevent imminent extinction. • Invasive plant monitoring and control o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Predator and herbivore monitoring and control—Implement effective measures to control rodents around all populations. • Invertebrate predation or herbivory control—Study Stenogyne kealiae populations to determine level of threat from invertebrate predation or herbivory, effective control actions, and any additional needed recovery actions. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue reintroduction of individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study Stenogyne kealiae populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and storms. • Based on the recovery criteria above, consider development of a recovery plan (USFWS, 2017).
- This species is monitored by the Plant Extinction Prevention Program, which focuses on those plant species with fewer than 50 individuals remaining in the wild. The goal of the program is to achieve the general interim recovery guidelines set by the Hawaii and Pacific Plants Recovery Coordinating Committee (1994), which are: 3 populations of 25 (long-lived species), 50 (short-lived), or 100 (annual) mature, reproducing individuals; all threats to those populations being managed; and all individuals are represented in genetic storage (USFWS, 2010a).
- This species is currently in controlled propagation for genetic storage and/or reintroduction efforts (USFWS, 2010a).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated or updated for the 5-year review for 2022. • Surveys and inventories—Continue surveys throughout historical range and suitable habitat for populations of Stenogyne kealiae and monitor known populations. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of

browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with S. kealiae. • Site and habitat protection—Develop and implement effective control measures to reduce the impact of collection. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. • Predator and herbivore monitoring and control—Determine and implement effective methods to control rodents and slugs. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy to reduce impacts of climate change, stochastic events, reduced viability due to low numbers, and other threats. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within and between populations and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2022).

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SPECIES ACCOUNT: *Stephanomeria malheurensis* (Malheur wire-lettuce)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/10/1982; Pacific Region (R1) (USFWS, 2016)

Physical Description

Stephanomeria malheurensis is an annual up to 50 cm tall, with a basal rosette of glabrous leaves; stem single, much branched, with scale-like leaves; heads numerous clustered or single on short peduncles; florets 5-11 per head, the ligules pink, white, or rarely orange-yellow. Pappus bristles are connate in groups of 2 to 4 at the base. (USFWS, 1990)

Taxonomy

At the time of listing, the Malheur wire lettuce was considered to be the species S. malheurensis. Malheur wire lettuce was first discovered in 1966 and subsequently described by Gottlieb in 1978 (Gottlieb 1978). Gottlieb used prior publications (Gottlieb 1973, 1973a, 1974, 1977, and 1978) to support the hypothesis that the diploid annual plant referred to as "malheurensis" evolved from the population of S. exigua subsp. coronaria (Greene). Gottlieb examined morphometric and meristic characters in samples and determined that the data supports classification of Malheur wire lettuce as a distinct species (Gottlieb 1978). Additional research and published results support the classification of Malheur wire lettuce as a species (Gottlieb 1977a, 1991, 2003, Gottlieb and Bennett 1983, Brauner and Gottlieb 1987, Brauner and Gottlieb 1989, and Joongku Lee et al. 2002). Malheur wire lettuce is accepted as a species by Integrated Taxonomic Information System (ITIS) and The International Compositae Alliance through the Smithsonian Institution in collaboration with the USDA National Plant Data Center and is listed on the ITIS website (Integrated Taxonomic Information System 2011). (USFWS, 2011) Stephanomeria Malheurensis is classified as Dicot (USDA, NRCS. 2021. The PLANTS Database (http://plants.usda.gov, 08/16/2021). National Plant Data Team, Greensboro, NC USA.)

Historical Range

The maximum historical range is unknown, (USFWS, 2011)

Current Range

Endemic to central Harney Co., Oregon, U.S.A., in an area called the Narrows, near Malheur and Harney lakes. (USFWS, 2011). Specifically, it is found on a broad hill top on BLM lands near Narrows, Oregon (south of Burns in Harney County), and has never been found outside of this one site despite efforts to locate potential additional populations. Critical habitat is designated on a 160-acre (65-hectare) area at this site, within what is now the South Narrows Area of Critical Environmental Concern. (USFWS, 2019).

Critical Habitat Designated

Yes; 12/10/1982.

Legal Description

On November 10, 1982, the U.S. Fish and Wildlife Service (Service) designated critical habitat (effective December 10, 1982), for Stephanomeria malheurensis (Malheur wire-lettuce) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Oregon (47 FR 50881-50886).

Critical Habitat Designation

The critical habitat designation for Stephanomeria malheurensis includes one CHU in Harney County, Oregon. A description is presented below; a map is available in the Final Rule. This species' critical habitat encompasses approximately 160 acres (47 FR 50881-50886).

In Harney County, Oregon: the lands west of Highway 205 within the SE ¼ of the NE ¼ and the NE ¼ of the SE ¼, Section 11; and the W ½ of the SW ¼ of the NW ¼, and the SE ¼ of the NE ¼ of the SW ¼, and the NW ¼ of the SW ¼ Section 12, T27S. R30E. Willamette Meridian.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Stephanomeria malheurensis critical habitat consists were not defined in the Final Rule (47 FR 50881-50886).

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinating (USFWS, 2010)

Lifespan

Adult: Annual plant (USFWS, 2010)

Breeding Season

Adult: Flowering typically occurs in July and August (USFWS, 2010).

Other Reproductive Information

Adult: Since the time of its discovery, Malheur wire-lettuce has been held forth as a rare example of sympatric speciation (e.g., Gottlieb 1973, p. 552; Gottlieb 1991, pp. 11-12). The species Stephanomeria malheurensis is thought to have arisen by way of a mutation event in a single plant from the obligate outcrossing parent species, Stephanomeria exigua subsp. coronaria, resulting in an individual capable of self-pollination. Originally differentiated from its putative progenitor by only a single allele, chromosomal rearrangement in the descendent inbreeding lineage likely resulted in reproductive isolation between the two Stephanomeria despite their lack of geographic isolation (Gottlieb 1973, pp. 550, 552; Gottlieb 1977, p. 879; Gottlieb 1978, entire). Malheur wire-lettuce was accepted as a valid species at the time of listing due to the combination of reproductive isolation and distinctive morphological characters (e.g., Gottlieb 1973, p. 552; Gottlieb 1978, entire; Gottlieb and Bennett 1983, p. 276), but it appears that the species was discovered in its nascency. The genome of Malheur wire-lettuce is a slender subset of the variability observed in the parent species, and its original discoverer, Dr. Leslie Gottlieb, described the species as “still within a bottleneck state having to do with its recent origin” (Gottlieb 1973, p. 553). Furthermore, the recently evolved species displayed

several characteristics that Gottlieb (1973, p. 553) and later Sherman (2009, p. 81) described as "maladaptive." These include, among others, a relaxation of seed germination requirements that can result in Malheur wire-lettuce sprouting in the fall rather than spring, with consequent high levels of seedling mortality over the cold winters (Gottlieb 1973, p. 553). Citing to the perennially low numbers of Malheur wire-lettuce and its potentially maladaptive traits, Sherman (2009, p. 81) states that the species "may be predisposed to extinction, as is the case with many neospecies." Even relatively soon after its initial discovery, Dr. Gottlieb reflected "without additional genetic augmentation stemming from mutation or hybridization, and in its present harsh environment, the probability that "Malheurensis" will persist seems small" (Gottlieb 1973, p. 553). (USFWS, 2019). All of these considerations pose a dilemma in the conservation of Malheur wire-lettuce. The researcher most intimately familiar with the species questioned its ability to survive over the long term, and another considered it predisposed to extinction. Concerted efforts over the years to reintroduce the species to its type locality after it has repeatedly gone extinct in the wild have failed, as have attempts to introduce the species to similar habitat nearby. We are thus left with a species that is of scientific interest as it represents one of the only known examples of sympatric speciation of a diploid species, but that species persists only in the form of stored seed, and it appears incapable of surviving independently in its natural habitat. (USFWS, 2019).

Reproduction Narrative

Adult: Malheur wirelettuce is an annual plant in the composite family (Asteraceae). It can reach 5 dm (20 inches) in height. This species forms a rosette of hairless leaves that arise from its base. The single stems are many-branched with scale-like leaves. Flower heads are either numerous and clustered, or solitary on short stems. The strap-shaped petals are pink, white, or rarely orange-yellow. Flowering typically occurs in July and August. The Malheur wirelettuce is co-located with an ancestral relative, small wirelettuce (Stephanomeria. exiqua ssp. coronaria); however, the two species do not interbreed. While the Malheur wirelettuce is self-pollinating, its ancestral relative is not (USFWS, 2010).

Habitat Type

Adult: Desert hill top (USFWS, 2010)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2010)

Environmental Specificity

Adult: Narrow/specialist (USFWS, 2010)

Tolerance Ranges/Thresholds

Adult: Low (USFWS, 2010)

Site Fidelity

Adult: High (USFWS, 2010)

Habitat Narrative

Adult: Species inhabits a broad hilltop composed of volcanic tuff (in contrast to soils in the surrounding flats, which are primarily derived from basalt). The native vegetation is dominated by big sagebrush (Artemesia tridentata) and rabbit-brush (Chrysothamnus spp.). (NatureServe,

2015). Malheur wirelettuce occurs in the high desert of the northern portion of the Great Basin and is located in an area south of Burns, Oregon. It occurs on top of a dry, broad hill on volcanic soil intermixed with layers of limestone. Dominant plants at the site are big sagebrush (Artemisia tridentata), gray rabbitbrush (Chrysothamnus nauseosus), green rabbitbrush (Chrysothamnus viscidiflorus), and, more recently, cheatgrass. Malheur wirelettuce may be one of the few species able to survive on and around the otherwise barren harvester ant hills at the site (USFWS, 2010). The species narrow environmental specificity, clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity as well as low tolerance ranges are based on the narrow geography this species inhabits and its specific habitat requirements, as well as the few known populations that are known to occur.

Dispersal/Migration

Dispersal

Adult: Harvester ants appear to be a dispersal agent (USFWS, 2011)

Dispersal/Migration Narrative

Adult: Observations made by Brauner (1988, pp. 15, 16, and 20) and BLM (1987, no pagination) indicate harvester ants (Pogonomyrmex owyheei) contribute to loss of seed through granivory, but also may to a lesser extent contribute to seed dispersal. Additional observations of harvester ants collecting seed have been made by ODA staff during the ongoing restoration activity (Currin et al. 2009, pp. 29-30). Granivory could be a hindrance to seed recruitment, but it is possible that harvester ants facilitate seed burial or possibly facilitate seed germination. Further investigation on harvester ant influence on Malheur wire lettuce is recommended (Currin et al. 2009, p. 30) (USFWS, 2011).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Size:

250 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Does not appear to compete well with exotic annual taxa. Presumed extinct in the wild in 1985. Decline of >90% 1028 plants transplanted in 2008, though the trend has been for these reintroduced populations to fail in a matter of years. Recruitment from previous years' seed is low. Two EOs, one presumed extinct in the wild and another a novel reintroduction site. Both populations are maintained by transplants. (NatureServe, 2015). The Malheur wire lettuce population continues to be small and remains vulnerable to natural fluctuations. Cheat grass that invaded Malheur wire lettuce habitat in the early 1970s persists within the habitat and likely affects the site conditions for re-establishing Malheur wire lettuce (BLM 2005 and 2006). Between 1986 and 1990, over 1,300 seedlings were planted within the ACEC and designated critical habitat in an attempt to restore the plant in the wild. As of 1989, there were 939

seedlings established through these efforts. After 1990, the population was left to persist on its own and was extirpated in the wild after 13 years (Currin et al. 2007). The restoration project being implemented by the ODA has made progress toward meeting the recovery criteria for establishment of Malheur wire lettuce at a minimum of four locations within the designated critical habitat area described in the recovery plan (Fish and Wildlife Service 1991). Narrows 1, Narrows 2, and Narrows 3 sites have been installed, and currently support Malheur wire lettuce within the designated critical habitat (see section 2.3.1.1.). Over the past four years, nearly 4,000 seedlings have been planted, and 46,000 seeds have been sown within the Narrows ACEC. ODA estimates the planted seedlings have contributed over 154,000 seeds to the soil seed bank at the Narrows restoration sites (Currin and Meinke 2010, p. 33). Whether the seeds are able to successfully germinate, grow, reproduce and ultimately create a self-sustaining population of Malheur wire lettuce over time (for at least 15 years) without human assistance remains to be seen. The additional site known as the "Dunes" site was planted in 2007 and 2008, but is not within the designated critical habitat. An additional 5,000 seeds have been added to the conservation seed bank at Berry Botanical Garden (USFWS, 2011). Low resiliency, represenation and redundancy are based on the species becoming extinct in the wild and having to be re-introduced. The re-introductions have resulted in three new populations that are being monitored. Between 2007 and 2011, an intensive multi-year restoration program for Malheur wire-lettuce took place in the protected 160-acre critical habitat location. More than 4,500 seedlings were planted and hand-watered for 8 weeks following planting. Approximately 46,000 seeds were directly sown, and more than 150,000 seeds produced by transplants were estimated to have been contributed to the soil seed bank at the restoration site (U.S. Fish and Wildlife Service 2011, p. 17; Oregon Department of Agriculture 2012, entire). Despite these efforts, annual surveys in 2016 found only three individuals in poor condition, leading the ODA to declare the species "functionally extinct" (Oregon Department of Agriculture 2017, p. 2). In a subsequent visit by Service biologists in 2017, again no representatives of the species were observed (Brumbelow and Mauer, pers. obs. 2017). (USFWS, 2019).

Threats and Stressors

Stressor: Surface mining (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The lone population of this species is vulnerable to any substantial habitat alteration and faces the potential threat of surface mining for zeolites on and near the site where it occurs (USFWS, 1991).

Stressor: Cheat grass (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: It is immediately threatened by competition with an exotic grass, Bromus tectorum (USFWS, 1991).

Stressor: Grazing (USFWS, 1991)
Exposure:
Response:

Consequence: Loss of indidivuals
Narrative: It is immediately threatened by grazing of native herbivores (probably black—tailed jackrabbits) (USFWS, 1991).

Stressor: Insect predation (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: The larvae of an unidentified insect may be foraging on the plant (USFWS, 1991).

Stressor: Small population size (USFWS, 1991)
Exposure:
Response:
Consequence: Extinction
Narrative: Natural fluctuations in small population size may lead to extinction (USFWS, 1991).

Stressor: Invasive plants, allopathic affects (USFWS, 1991)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Possible allelopathic (inhibitory) affects by introduced plants, i.e. cheatgrass, (Bromus tectorum) (USFWS, 1991).

Recovery

Reclassification Criteria:
The 160-acre Critical Habitat is secure from the threats of fire (USFWS, 2011).

The 160-acre Critical Habitat is secure from the threats of mining (USFWS, 2011).

The 160-acre Critical Habitat is secure from the threats of grazing (USFWS, 2011).

The 160-acre Critical Habitat is secure from the threats of introduced exotic species for five years (USFWS, 2011).

Flowering plants produce seeds in at least four separate locations within the designated critical habitat (USFWS, 2011).

Delisting Criteria:
In the 5-Year Review (USFWS 201), the Service acknowledged that the development of delisting criteria is impracticable for Malheur wire-lettuce because the repeated failed attempts to restore the species to its only known habitat clearly indicate that we do not adequately understand the life history requirements of the species, nor do we have sufficient information to identify and address the limiting factors acting on the species such that it appears to be incapable of sustaining itself in the wild.

Recovery Actions:

- A buffer zone or fire lane was established and is being maintained around the critical habitat of Malheur wire lettuce to enhance the plant's survival (Fish and Wildlife Service 1991, p. 12). The BLM currently maintains native surface roads which roughly follow the boundary of the South Narrows Area of Critical Environmental Concern (ACEC) on three sides, with State highway 205 on the fourth side. Fire lines are generally successful in holding a fire (Meinick 2011) (USFWS, 2011).
- The ACEC was designated to incorporate the designated critical habitat into BLM management. All present and future mining claims have been withdrawn (Fish and Wildlife Service 1991, p. 12). All mining claim activity within the ACEC remains inactive (Meinick 2011) (USFWS, 2011).
- The area was fenced to keep livestock from the ACEC. The fence is maintained by BLM. Plantings of Malheur wire lettuce conducted within the ACEC in 1987 and 1989 were protected by rodent proof fencing (Fish and Wildlife Service 1991, p. 12). Transplanting seedlings into plots surrounded by rabbit exclosure fencing had little effect on the survival and reproduction of the seedling transplants (Currin et al. 2007, p 47 and Currin and Meinke 2008, p. 15). The livestock fence is still maintained, but current restoration efforts do not rely on rodent fencing to protect seedlings from natural herbivory (Currin and Meinke 2008, p. 15; and Currin et al. 2009, p. 14) (USFWS, 2011).
- Cheatgrass (Bromus tectorum), an exotic species, was identified as a threat to Malheur wire lettuce that competes for water, and is possibly allelopathic (inhibition of growth in one species of plant by chemicals produced by another species of plant). Reducing its influence was considered necessary in the recovery plan. The recovery plan recommended a study of allelopathy to determine the extent of impact cheat grass has on Malheur wire lettuce. A study was initiated in 1987 and preliminary results indicted a slight allelopathic affect from cheat grass on lettuce seeds, used as a proxy rather than using seeds of Malheur wire lettuce, and recommended continued investigation using Malheur wire lettuce seeds to test significance of allelopathy (Davidson and Bargen 1987, pp. 4-5). No additional studies of allelopathy have been conducted for Malheur wire lettuce. The recovery plan also recommended rogueing (weeding out) of cheatgrass throughout the growing season within 1-2 ft. radius of existing Malheur wire lettuce plants. Before the Narrows fire in 1972, Malheur wire lettuce inhabited the open areas between shrubs and bunchgrasses (Currin and Meinke 2007, p. 8). After the fire, cheatgrass invaded the site and at times formed an almost complete groundcover in the open areas. Higher levels of cheatgrass corresponded with a decline in Malheur wire lettuce (Brauner 1988, pp. 4 and 21-23). Several treatments to reduce cheatgrass were conducted with varying results (Gottlieb 1991, p. 12). According to Taylor (1997), the act of weeding may have negative impacts on Malheur wire lettuce plants due to disturbance during weeding activities. No additional cheatgrass removal activities have been conducted (Fish and Wildlife Service 1991, p. 12). The BLM reported a reduction in the amount of cheat grass plants present at the designated critical habitat area in comparison with the amount reported after the Narrows Fire in 1972, but also noted an increase in other exotic annual forbs including burr buttercup (Ranunculus testiculatus), jagged chickweed (Holosteum umbellatum), pale alyssum (Alyssum alyssoides), and tumble mustard (Sisymbrium altissimum) (BLM 2005). During the restoration activities conducted from 2007 to present, selection of transplant site plots were located in areas observed to have reduced amounts of cheatgrass present. The designated critical habitat is not free from exotic species at this time. Additional restoration work, monitoring, and analysis is needed to determine if the exotic plants present at the site constitute a continued threat to Malheur wire lettuce (USFWS, 2011).

- No Malheur wire lettuce plants were observed in surveys conducted in 2004 through 2007. The restoration efforts have focused on planting seedlings in plots scattered in two different areas within the ACEC and the designated critical habitat. The success of the planting has varied from year to year and among the various plots. Currently there are three plots with reproducing plants located within the ACEC and designated critical habitat boundary (See section 2.3.1.1) (USFWS, 2011).
- 2019 recommended action 1: Continue seed bulking to retain current seed supply. (USFWS, 2019).
- 2019 - 2: Halt seedling planting at designated sites until we gain an improved understanding of habitat needs for the species. (USFWS, 2019).
- 2019 - 3: Monitor habitat of Malheur wire-lettuce for signs of survival of the species in the wild. (USFWS, 2019).
- 2019 - 4: Cooperate with The Nature Conservancy to develop an experimental seed planting of Malheur wire-lettuce using novel techniques they are developing for restoration in the harsh desert environments of the Great Basin. For example, they have developed a variety of "seed pods" that are designed to give plants a boost to overcome multiple barriers preventing establishment. (USFWS, 2019).
- 2019 - 5: Monitor planting of "seed pods" or other novel techniques to determine seed to maturation success at the native site. (USFWS, 2019).
- 2019 - 6: Continue "conservation reliant" management and restoration once experimental tactics are validated. (USFWS, 2019).
- 2019 - 7: Adapt techniques and reassess recovery goals as needed. (USFWS, 2019).
- Continue to work with ODA, BLM, and Native Plant Society to accomplish restoration and monitoring activities benefitting Malheur wire lettuce. Plant seedlings and supplement seed on four sites within the designated critical habitat and ACEC site (recovery plan objectives 1 and 5) (USFWS, 2011).
- Continue to bulk seed for use in implementation of future recovery efforts as well as to increase and replace stored seed of Malheur wire lettuce (recovery plan objective 51) (USFWS, 2011).
- Continue annual census of Malheur wire lettuce. Sampling should occur starting in April when rosettes are observable and continue through July to detect flowering plants. Additional monitoring should be conducted during flowering to estimate seed production. Continuation of monitoring is needed to observe the demography of the species and to assess its responses to climate changes, particularly drought conditions, over time (USFWS, 2011).
- Work with the BLM and ODA to develop a long-term management and monitoring plan for the Malheur wire lettuce and its habitat. The plan should address the threats described in the original listing (restricted range, mining, herbivores, limited population, and cheatgrass) and recovery plan. Monitoring should be sufficient to track fluctuations in available habitat, and abundance of nonnative or invasive plant species (USFWS, 2011).
- Evaluate the potential for control of introduced non-native and competing plant species particularly cheat grass. Also consider potential for preventing introduction and spread of other invasive species (USFWS, 2011).
- Evaluate granivore – seed interactions related to harvester ants and dispersal of seed. Determine whether harvester ants are a hindrance to restoration of if they aide in recovery through caching and dispersal of viable seed (USFWS, 2011).

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SPECIES ACCOUNT: *Streptanthus albidus ssp. albidus* (Metcalf Canyon jewelflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An annual herb, up to 1+ m tall. Basal leaves are narrow, coarsly toothed, the upper leaves not toothed and becoming linear. Flowers (April-July) are borne in leafless terminal clusters; they have have white to whitish-green sepals and white petals with purple-brown veins. The erect, flattened seed pods are 3-8 cm long. (NatureServe, 2015)

Taxonomy

Streptanthus albidus ssp. albidus (Metcalf Canyon jewelfiower) was first collected in 1887 by Volney Rattan, a botany teacher and author, from hillsides a few miles south of San Jose (Greene 1887). Edward Greene described Streptanthus albidus ssp. albidus in 1887 (Greene 1887); later he redefined the limits of Euclisia, formerly a subgenus of Streptanthus, treating it as a genus in its own right (Greene 1904). Streptanthus albidus ssp. albidus, as a member of the Euclisia group, was included in this change. Jepson (1925) returned Euclisia to subsection status, and later authors followed his treatment. Jepson (1925) also treated Streptanthus albidus ssp. albidus as a subspecies of Streptanthus glandulosus. Kruckeberg published a revision of the Streptanthus glandulosus complex in which he recognized the close relationships among Streptanthus glandulosus, Streptanthus albidus, and Streptanthus niger (Kruckeberg 1958). In this paper, he notes that the "sharp genetic discontinuity between Streptanthus albidus and all other populations, coupled with the morphological distinctness and regional restriction of Streptanthus albidus warrant the restoration of this Greeneian species." He recognized two subspecies: Streptanthus albidus ssp. albidus and Streptanthus albidus ssp. Perarnoenus (Kruckeberg 1958). Recent research affirms the distinctiveness of Streptanthus albidus ssp. albidus. Streptanthus albidus ssp. peramoenus, and Streptanthus niger (M. Mayer. in litt., 1998) (USFWS, 1998).

Current Range

Santa Clara county, California. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Streptanthus albidus ssp. albidus flowers April to June (Kruckeberg 1977) (USFWS, 1998).

Reproduction Narrative

Adult: Streptanthus albidus ssp. albidus flowers April to June (Kruckeberg 1977). No detailed data on its reproductive biology or demography are available. Nine populations totaling approximately 20,000 to 25,000 plants have been recorded (McCarten I992b) (USFWS, 1998).

Habitat Type

Adult: Outcrops

Spatial Arrangements of the Population

Adult: clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits serpentine outcrops with shallow soils (NatureServe, 2015). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on this species restricted habitat requirements and geography.

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Number of Populations:

9 (USFWS, 2023)

Population Size:

Highly variable (USFWS, 2023)

Population Narrative:

Known from 22 total occurrences, but only nine presumed extant (NatureServe, 2015). When we listed the subspecies in 1995, we estimated there were a total of 20,000 to 25,000 plants, based on estimates by McCarten (1992, pp. 4–6) for 8 of the 9 populations recognized at that time (Service 1995, p. 6676). The majority of those plants (15,000) were in Occurrence 4 (McCarten 1992, p. 6), which has since been determined to consist of most-beautiful jewelflower rather than Metcalf Canyon jewelflower (Vondracek 2021, p. 1). When we published our last status review in 2013, additional population estimates were only available for four unspecified occurrences (Service 2013, p. 14). Three of those estimates were published in 1989 and one in 2006. The four occurrences were highly variable in abundance, with counts of 27, 40, 1,000, and 5,000 plants (due to a typographical error, we reported the last count as

4,000 rather than 5,000 in our last review, but still indicated the total count as 6,067 (Service 2013, p. 14)). Three of the counts (27, 1,000, and 5,000) appear to be for Occurrences 2, 12, and 4, respectively (Diversity Database 2009, pp. 1, 3, 8). It is unclear which occurrence the fourth count (for 40 plants) refers to (Diversity Database 2009, entire). As discussed above, Occurrence 4 (with 5,000 of the 6,067 total plants) actually consists of most-beautiful jewelflower (Vondracek 2021, p. 1), and so would no longer count towards total abundance. Currently, Occurrence 2 is the largest occurrence, both by area and by number of plants. It consists of several subpopulations within 0.25 miles of each other, both within Metcalf Canyon and extending about a mile north and half a mile south of the canyon, encompassing about 200 acres in all (Diversity Database 2022). Total number of plants in the occurrence varied, with upwards of 14,000 in 2013, over 250,000 in 2014, upwards of 10,000 in 2015, and 5,000-plus in 2016 (Diversity Database 2023, p. 1). Occurrence 12 had 710 plants in 2013, about 1,675 the following year, upwards of 1,000 in 2015, and about 300 in 2016 (Diversity Database 2023, p. 4). Occurrence 17 had about 75 plants in 2013, 730 the following year, about 500 in 2015, and about 1,000 in 2016. Occurrences 15 and 18, on the Silver Creek Preserve, have survey counts starting prior to our last status review and continuing for several years after, although the counts for both occurrences were often combined. Table 1 shows the combined counts for Silver Creek Preserve. Although we lack total abundance estimates for Metcalf Canyon jewelflower across its range, there is nothing to indicate it has decreased since our last status review. Counts from year to year in the same locations have been highly variable, making it difficult to discern trends. Seedbanks likely contribute to the high variability from year to year by allowing plants to sprout in good years from seed left over the course of several years (Niederer and Whittall 2017, p. 60). The length of time that seeds remain viable in a seedbank is unknown and would provide an appropriate subject for research (USFWS, 2023).

Threats and Stressors

Stressor: Development (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: t the time of listing, there were 13 documented sites, 9 of which still harbored plants. Two occurrences were known from herbarium records only. One of the historical records was visited in 1990, but no plants were found. Strepanthus albidus ssp. albidus was last observed at the other historical site in 1895. One population consisting of approximately 9,000 plants, approximately 45 percent of all known plants, occurred on the proposed site of the Cerro Plata residential and golf course project (also known as Ranch on Silver Creek Development). Although no direct destruction of any plants were planned at the time of listing, it was thought that construction activities, human disturbance, and habitat fragementation would result in significant impacts to the population. There was a proposed Valley Christian School and South Valley Christian Church that would destroy 61 percent of the 2,700 plants occurring on the site. The remaining 7 populations were also threatened by impending or potential development. The Ranch on Silver Creek Development (Cerro Plata) has been constructed since the time of listing. Although all direct impacts to Strepanthus albidus ssp. albidus were avoided as described in the biological opinion (Service 2000), the populations within the 580 acre parcel are intermixed with residential homes, golf course, and facilities. Ten years of monitoring (2001-2010) of the preserved populations within the on-site Hassler Ranch Preserve show that the Plant Conservation Areas are still occupied by Strepanthus albidus ssp. albidus. The total area occupied

within the Plant Conservation Areas has increased slightly by 3.65 acres. The numbers of plants have drastically reduced from 75,000 plants in 1998 to an average of 11,266 plants over 10 years (2001-2010). This is a reduction of 85% percent of the baseline prior to construction of the Silver Creek Development. One location at Tulare Hill was covered by fill during construction of a housing development (CNDDB 2012). Three sites within the Metcalf Energy Center Ecological Preserve are proposed for reintroduction (Whittall 2011). The reintroduction plan includes monitoring and preparation of a management plan (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Herbivory was observed on approximately 8 individuals of Streptanthus albidus ssp. albidus at the Metcalf Motorcycle County Park. The herbivory was likely due to invertebrate herbivores since aphids and Pierid caterpillars have been observed in the populations there previously (Whittall, 2011) (USFWS, 2013).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, the Endangered Species Act is the primary Federal law that provides protection for these species since their listing as endangered in 1995. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of the Endangered Species Act (USFWS, 2013).

Stressor: Nitrogen deposition (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: A relatively recently identified threat is nitrogen deposition into grasslands from air pollution sources and the resultant increase in productivity of the soils has facilitated increased invasion of nonnative species (ICF 2012). The main effect for Santa Clara Valley dudleya and Metcalf Canyon jewelflower is their vulnerability to annual grass overgrowth. Nonnative annuals are much less dominant in serpentine areas, although increasing nitrogen deposition from air pollution has increased the productivity of serpentine soils and allowed a greater number of nonnatives to invade (Evens and San 2004; Harrison et al. 2003; Weiss 1999). Santa Clara Valley dudleya (Dudleya setchellii) lives on rock outcrops and is relatively immune from grass invasions except when extremely tall grasses smother small rock outcrops. The species persists on medium to large rock outcrops in ungrazed areas. Metcalf Canyon jewelflower can be a poor competitor against dense annual grasses, and some degree of grazing appears necessary to maintain populations (ICF 2012). Livestock grazing is an important management tool to combat increased invasive nonnative plants in serpentine grasslands due to atmospheric nitrogen deposition (Weiss 1999) (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: ICF (2012) summarized the potential effects of climate change to serpentine plant species and its relationship to the proposed permitted activities during the Santa Clara Valley Habitat Plan's proposed 50 year permit span. Serpentine plant distribution is restricted to highly specialized and localized habitat requirements that include species-specific microclimate conditions coincident with serpentine soil occurrence. Restriction to serpentine soils limits species range and distribution to this soil type. Climate change could change microclimate conditions so that species can no longer persist within their current range. Increase in favorable microclimate conditions could lead to an expansion of distribution and increase in abundance, both in terms of number of populations and number of plants within each population. Change in timing or intensity of seasonal events could have an effect on pollinator reproductive and plant flowering periods leading to phonological mismatches. The Santa Clara Habitat Plan (ICF 2012) includes a conservation strategy reserve design to reduce species vulnerability and provides opportunities for species and natural communities to adapt in response to climate changes (USFWS, 2013)

Stressor: Grazing (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Although grazing is extremely useful for addressing threats from competition and nitrogen deposition, an incompatible grazing regime can also constitute a threat in its own right. A study of simulated grazing impacts on the closely related most-beautiful jewelflower found that jewelflowers can be clipped in half in early May with either no effect or a positive effect on growth and seed production, but that clipping close to the ground produces negative impacts (Weiss et al. 2007, pp. 7, 37). A comparison of grazed and ungrazed introductory plots on Tulare Hill (Occurrence 27) showed negative effects from grazing throughout the growing season, with the biggest impacts beginning in late April (Niederer and Whittall 2017, p. 34). This is the time when jewelflower plants start producing flowers and seeds and thereby become more attractive to cattle. As summer progresses jewelflowers are targeted even more by cattle, because they remain green and stand out against the drying grass (Niederer and Whittall 2017, p. 50). The reproductive stage of the Metcalf Canyon jewelflower lasts through November (Niederer and Whittall 2017, p. 34), so the largest threat from grazing is likely to occur from late April through November (USFWS, 2023).

Stressor: Climate change (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: In our last status review we noted that climate change could have either positive or negative effects, depending on how it affects microclimate conditions in occupied serpentine areas (Service 2013, pp. 26–27). Microclimate conditions refer to the set of atmospheric conditions typical for a small area. We note here that climate change could also produce indirect impacts by increasing variation in weather conditions, thereby elevating the likelihood of atypical conditions such as droughts or unusually heavy precipitation (Ault 2014, pp. 7529, 7545; Williams et al. 2015, p. 6819; Berg and Hall 2015, pp. 6324, 6332). Either of these effects could lead to

negative impacts on Metcalf Canyon jewelflower, depending on grazing and topography at a given occurrence. High-precipitation years would tend to encourage growth of annual grasses, which would then compete with Metcalf Canyon jewelflower unless held in check by grazing or other methods (WRA 2019, p. 23). High precipitation could also cause landslides which could bury or undermine Metcalf Canyon jewelflower growing on steep slopes, particularly at roadcut occurrences such as 12, 26, and portions of Occurrence 2. Droughts would tend to restrict growth of competing nonnative grasses but could result in increased grazing damage if adequate forage elsewhere was unavailable during summer months. More serious droughts could also directly impact the ability of Metcalf Canyon jewelflowers to grow and reproduce, and any such droughts that lasted several years might tend to deplete the jewelflower seedbank at a given location (USFWS, 2023).

Stressor: Hybridization with most-beautiful jewelflower (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: The southeastern end of the Metcalf Canyon jewelflower range meets and somewhat overlaps the northwestern end of the most-beautiful jewelflower range in an area southeast of Metcalf Canyon (Whittall et al. 2023, p. 50). Because the two jewelflowers can interbreed (ICF 2012, p. 7-69; Valley Habitat Agency 2020b, p. 34), there is a potential, that we have not previously considered, for one or more southern Metcalf Canyon jewelflower occurrences to be lost due to takeover of the areas by hybrids. It is also likely that the proposed Metcalf Canyon jewelflower occurrences in the CROSP are hybridized to some extent, which must be considered when deciding whether they constitute Metcalf Canyon jewelflower occurrences (see below). Hybridization could be occurring in three ways: (1) due to short flights of pollinating insects between plants of different subspecies that essentially occupy the same occurrence in areas of range overlap; (2) due to long-distance flights of pollinating insects between separate occurrences of each subspecies; and (3) by transport of seeds from occurrences of one subspecies to another via the coats or manure of cattle. This would be followed by cross pollination between the resulting plants growing in the occurrence (USFWS, 2023).

Recovery

Reclassification Criteria:
Secure and protect specified recovery areas. Occupied habitat along with adjacent unoccupied habitat and a 150-meter (500- foot) buffer at nine known sites. Management plan approved and implemented for recovery areas, including survival of the species as an objective. For all populations and any occupied or unoccupied habitat identified as essential to survival.

Recovery Priority Number: 3C

Delisting Criteria:
Secure and protect specified recovery areas. 18 populations representing entire historic range of the species. from incompatible uses:

Recovery Actions:

- Population monitoring in specified recovery areas shows: Downlist: Stable or increasing for a period of 20 years that include the normal precipitation cycle (or longer if suggested by the

results of demographic monitoring). Delist: No decline after downlisting; if declining, determine cause and reverse trend.

- Preserve, protect, manage, and monitor Dudleya setchellii CNDDB occurrence number 43. Occurrence number 43 was found in the year 2005, subsequent to listing of the species and the Recovery Plan. The occurrence represents the most southwesterly extent of its current known range (USFWS, 2013).
- Confirm if the historic and current westernmost and southernmost occurrences for Streptanthus albidus ssp. albidus are valid. Perform additional surveys in suitable habitat around CNDDB number 6 and 21 to confirm if the range of the species is smaller than previously understood (USFWS, 2013).
- Conservation measures should include focus on preserving, monitoring, and managing pollinator fauna as it appears to be essential for any significant fruit set in Streptanthus albidus ssp. Albidus (USFWS, 2013).
- Streptanthus albidus ssp. albidus plant numbers can fluctuate drastically from year to year (Whittall 2011). Reliable methods should be developed to evaluate when a population should be considered as stable and viable. The methods should include ways to measure and evaluate natural and human influenced variables

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of the Metcalf Canyon jewelflower. 1. Research should be conducted into the length of time that Metcalf Canyon jewelflower seeds can remain viable in the soil. This would support estimates regarding the ability of a population to rebound from multiple years of poor conditions, and to maintain genetic diversity. 2. Work with the landowner of the Silver Creek Preserve (Occurrences 15 and 18) to establish and fund an endowment for long-term management of the habitat and ongoing monitoring of the jewelflower population. 3. Grazing should be considered as a management tool at all known occurrences to control invasive grasses. If grazing is not feasible, the extent of competition with non-native grasses in the area should be monitored so that the importance of, and options for, weed abatement can be considered. 5. Monitoring of both direct grazing impacts to jewelflower plants, and of residual dry matter (RDM) should be implemented at Occurrence 27 at Tulare Hill, as described in the 2021 annual monitoring report for the site (Weiss et al. 2021, pp. 26, 93). This will provide better information on how much grazing the site can support, and over what time periods, before it changes from beneficial to detrimental for the jewelflower. 6. Efforts should continue to develop tests (including genetic tests) allowing consistent and accurate differentiation of Metcalf Canyon jewelflowers, most-beautiful jewelflowers, and hybrids of the two. This will allow biologists to investigate the extent to which hybrids may be spreading through Metcalf Canyon jewelflower occurrences, particularly in the southern portion of the range. It will also allow biologists to confirm the Metcalf jewelflower occurrences tentatively identified in the CROSP. 7. Research should be conducted into the ease of transport and subsequent germination of Metcalf Canyon jewelflower and most-beautiful jewelflower seeds on the coats, or in the digestive tracts, of cattle. 8. Now that the reintroduction effort to establish Occurrence 27 at Tulare Hill appears successful, additional new populations should be created using the knowledge gained. For instance, seeding densities for such new populations should be high, and seeding efforts should be conducted over multiple years (Weiss et al 2021, p. 93). Provisions should also be taken to limit grazing impacts to the extent possible, such as by seeding in areas less accessible to cattle, or by establishing a grazing plan that applies adaptive management techniques to monitor post-April grazing impacts and adjust grazing limits accordingly. 9. The discovery of up to eight possible new populations in the CROSP (Niederer

et al. 2017, p. 19) suggests there may be additional undiscovered natural populations within the subspecies' range. Additional surveys should be conducted to either establish or provisionally rule out their presence in currently unsurveyed areas, as well as to monitor the occurrences in the CROSP. Population numbers can occasionally drop to zero and then rebound from seeds, so a single negative survey would only rule out an area provisionally. 10. A final survey of the area in the general vicinity of Occurrence 19 at Communications Hill should be conducted, preferably early in the growing season, over at least two years spanning a wide range of precipitation levels, to rule out the possibility of any jewelflower plants persisting at or near the location. 11. The Recovery Priority Number for this subspecies is currently 3C. The "C" indicates a potential conflict with development or with other forms of economic activity (48 FR 4304). Although the Valley HCP removes development as a likely source of conflict, there may be other forms of economic activity such as grazing that remain in potential conflict at some occurrences. At this point, the potential for such conflicts remains unclear. We recommend reconsidering this issue in our next status review (USFWS, 2023).

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SPECIES ACCOUNT: *Streptanthus bracteatus* (Bracted twistflower)

Species Taxonomic and Listing Information

Listing Status: Threatened

Physical Description

Bracted twistflower (Streptanthus bracteatus) is a herbaceous annual plant of the Mustard Family (Brassicaceae) currently reported from five counties of south-central Texas. The seeds germinate in response to fall and winter rainfall, forming basal rosettes (clusters of leaves that radiate from the root crown); the young plants resemble radish seedlings. The waxy bluish-green basal leaves, up to 15 centimeters (cm) (5.9 inches (in)) long, have broadly lobed margins. Flower stalks emerge the following spring bearing showy lavender-purple flowers; often these stalks are un-branched and 46 to 61 cm (18 to 24 in) tall, but may reach 137 cm (54 in) in height, and have several long branches. The lower stem leaves have an elongated heart shape and the upper leaves are progressively shorter, ultimately reduced to very short, triangular bracts (modified leaves) at the base of each flower stem. Thin seed pods, known as siliques, are up to 12 cm (4.7 in) long and 4 millimeters (mm) (0.15 in) wide; they mature and dry during the summer, finally splitting open to release flattened seeds with narrow wings. The foliage withers as the fruits mature, and the plants die during the blazing heat of summer.

Taxonomy

Family: Brassicaceae (mustards). About 100 species of Streptanthus have been described, although many of these have more recently been placed in Caulanthus, Boechera, Thelypodium, or other genera (Tropicos 2011a, pp. 12). Gray (1848, p. 146) described Streptanthus bracteatus as a new species, based on specimens collected by Ferdinand Lindheimer near New Braunfels, Texas, in 1846. Kuntze (1891, p. 933, cited in Tropicos 2011c, p. 1) classified this taxon as Erysimum bracteatum (A. Gray) Kuntz. Nevertheless, the Flora of North America (Al-Shehbaz 2011, p. 706), Tropicos (2011b, p. 1), the Integrated Taxonomic Information Service (2011, p. 1), the International Plant Names Index (2011, p. 1), and the Plants Database (Natural Resources Conservation Service 2011, p. 1) treat this taxon as a valid species with the name Streptanthus bracteatus. Pepper (2010, p. 14) concluded that S. bracteatus is a morphologically and evolutionarily distinct species; its closest extant relative is the broadpod jewelflower, S. platycarpus, a west Texas endemic. Poole et al. (2007, p. 470) list bracted twistflower and bracted jewelflower as common names for this species. While the latter is also used by the Plants Database, the botanists and conservation organizations who work with this species primarily use the former name. For the purposes of this document, we will refer to Streptanthus bracteatus as bracted twistflower.

Historical Range

U.S., Texas. Historic collection records where the species has not been observed since 1989: Comal, Bandera/Kerr, Real, Bexar counties.

Current Range

U.S., Texas. Bexar, Hays, Medina, Travis, and Uvalde counties. Endemic to a small area of the Edwards Plateau of Texas.

Critical Habitat Designated

Yes; 5/11/2023.

Legal Description

We, the U.S. Fish and Wildlife Service (Service), determine threatened species status under the Endangered Species Act of 1973 (Act), as amended, for the bracted twistflower (Streptanthus bracteatus), a plant species from Texas. In addition, we designate critical habitat for the bracted twistflower. In total, approximately 1,596 acres (646 hectares) in Uvalde, Medina, Bexar, and Travis Counties, Texas, fall within the boundaries of the critical habitat designation. This rule applies the protections of the Act to this species and its designated critical habitat.

Critical Habitat Designation

Critical habitat units are depicted for Bexar, Medina, Travis, and Uvalde Counties, Texas.

Primary Constituent Elements/Physical or Biological Features

The physical or biological features essential to the conservation of bracted twistflower consist of the following components:

(i) Karstic, dolomitic limestones underlain by less permeable limestone strata, where perched aquifers seep to the surface along slopes. These are often found within 2 kilometers of the exposed boundary of the Edwards or Devils River and Glen Rose geological formations

(ii) Native, old-growth juniper-oak woodlands and shrublands along the Balcones Escarpment

(iii) Herbivory from white-tailed deer and introduced ungulates of such low intensity that it does not severely deplete populations prior to seed dispersal

(iv) Tree and shrub canopy gaps that allow direct sunlight to reach the herbaceous plant layer at least 6 hours per day

(v) Viable populations of native bee species and the abundant, diverse forb and shrub understory that support them

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features which are essential to the conservation of the species and which may require special management considerations or protection. The features essential to the conservation of this species may require special management considerations or protections to reduce the following threats: Habitat loss due to urban and residential development, increased woody plant cover, severe herbivory by native and introduced ungulates, and trampling and erosion from recreational use. Management activities that could ameliorate these threats include (but are not limited to) juniper thinning, prescribed fire, fencing to exclude deer and other herbivores, herd management of local ungulate populations, and protection from foot and bicycle traffic. These management activities will protect the physical and biological features essential for the conservation of the species by reducing herbivory, maintaining open canopies, protecting the habitat from trampling and erosion, and conserving diverse shrub and forb understory vegetation that supports the species' native bee pollinators.

Life History

Food/Nutrient Resources

Lifespan

Adult: 1 year (annual) (USFWS, 2021)

Breeding Season

Adult: Bloom April and may continue to May and early June

Reproduction Narrative

Adult: Bracted twistflower has an annual lifespan, meaning that it completes its entire life span within one year. It may also be considered a winter annual or biennial, since the seeds germinate in the fall of one calendar year, and the emerging plants reach maturity, produce seeds, and die during the summer of the following year. Zippin (1997, p. 222) determined that from 79 to 90 percent of seed germination occurs during the months of October and November. The plants form a rosette of radially-arranged basal leaves (Figure 1.1) that develop during the fall and winter; during this time, the plants store nutrients and water in a tap root. Positive identification is somewhat difficult during the rosette stage, since bracted twistflower resembles other members of the Mustard family, including rock cress (Arabis petiolaris) (Damude and Poole 1990, p. 6). (USFWS, 2021)

Habitat Type

Adult: Primarily in oak-juniper woodlands and associated openings on slopes and in canyon bottoms with shallow, well drained, gravelly clays and clay loams over limestone. Often found amid dense shrub growth where some protection from browsing animals is afforded, but is not ideal habitat.

Habitat Vegetation or Surface Water Classification

Adult: Forest/Woodland; Shrubland/Chaparral, Woodland - Mixed

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2014)

Habitat Narrative

Adult: Bracted twistflowers are best adapted to sites with less than 50 percent cover of woody plants, and that severe herbivory by dense populations of white-tailed deer has largely extirpated the plant from its optimal habitats. It may persist for a time in the protection of dense thickets, or it may gradually decline. In addition, the germination of seeds and reproduction of bracted twistflower in the wild appears to respond to as-yet unknown triggers. This compels us to consider how historic vegetation changes may have affected bracted twistflower populations. Bray (1904, pp. 14, 22) described a very apparent, ongoing transition of Edwards Plateau uplands from grassland to woodland at the beginning of the twentieth century. At that time, the well-watered canyons supported dense forests with trees over 500 years old; stunted but continuous forest covered hills and bluffs; sparse trees were found on loose, stony slopes in the eastern Edwards Plateau (precisely where bracted twistflower populations currently occur); and trees were then invading the open prairies on the level plateau divides (uplands), which previously were free of woody vegetation (Bray 1904, pp. 1415). He attributed

this change to overgrazing and the consequent depletion of grasses, erosion, and cessation of wildfires, and stated that open prairies had been converted to dense oak scrub in a span of 25 years (Bray 1904, pp. 1415, 2223). These historic descriptions support a hypothesis that bracted twistflower is a relict of a woodland-grassland ecotone (transition zone) that occurred at or near the confluence of loose, stony slopes and prairie uplands. This savanna, in the broad sense of the term, would have been influenced periodically by wildfires of varying intensity and frequency. Some Streptanthus species, such as S. heterophyllus (San Diego wild cabbage), germinate following wildfires (Moreno and Oechel 1991, pp. 19992000), thus, fire may also be a trigger of bracted twistflower emergence.

Dispersal/Migration

Dispersal

Adult: Seeds disperse by gravity (Fowler et al. 2012, p. 1512), although other mechanisms, such as water flowing over the soil, may also occur. The foliage withers as the fruits mature, and the plants die during the blazing heat of summer (USFWS, 2023).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2023).

Number of Populations:

13 EOs (=populations); 9 with intact habitat, 4 with degraded or partially destroyed habitat (USFWS, 2014). 14 extant populations (USFWS, 2023).

Population Size:

~6,200 individuals (USFWS, 2014)

Population Narrative:

Of the 16 EOs (Element Occurrences=geographic sites) observed since 1989, 9 EOs remain with intact habitat, 2 EOs are partially intact, 2 are on managed rights-of-way, and 3 sites have been developed and the populations are presumed extirpated. Only 7 of the intact EOs and portions of 2 EOs, representing 2,502 individuals (33 percent of the maximum populations observed since 1989), are on protected natural areas. Four EOs with 3,708 individuals (48 percent of the maximum populations) are intact but vulnerable to development and other impacts. Five EOs have been partially or completely developed, resulting in the loss of 1,449 individuals (19 percent of the maximum populations). Two EOs were destroyed in 2012 and 2013 (USFWS, 2014). The maximum populations observed at these EOs range from a few up to about 2,000 individuals; in 2012, a pulse year for many populations, 1,463 individuals were observed at 14 extant EOs. Since 1989, two EOs have been eradicated and four others have been mostly destroyed by residential development. We estimate that 33 percent of the potential population has been lost due to habitat development during this time. Populations on many of the remaining habitats have also declined. We recognized bracted twistflower as a candidate for listing under the Endangered Species Act (ESA) on October 26, 2011 (76 FR 66370). Additionally, on July 31, 2014, we received a petition to list the species (USFWS, 2023).

Threats and Stressors

Stressor: Urban development
Exposure: Degradation and destruction of habitat
Response:
Consequence:
Narrative: The greatest threat to bracted twistflower is habitat loss due to urban and residential land development (McNeal 1989, p. 17; Damude and Poole 1990, p. 51; Zippin 1997, p. 229; Fowler 2010, p. 2; Pepper 2010, p. 5). Our analysis of the 16 EOs reported since 1989 indicates that 3 have been extirpated, portions of 2 have been extirpated, 2 are in disturbed habitat, and 9 are intact. Of the intact EOs, 2 are vulnerable to development, and 7 intact EOs and portions of 2 EOs, representing 33 percent of the maximum populations recorded since 1989, occur in protected natural areas. The Rough Hollow population in Hays County was discovered in 2010; by 2012, the site had been bulldozed. The Cat Mountain population in Travis County, which was a core reservoir of the species genetic diversity (Pepper 2010, p. 12), was located on private land that was sold in 2011 (Bracted Twistflower Working Group 2010, pp. 34; Stewart 2012); this site was completely bulldozed in 2013 (Fowler 2014, p. 16). Habitat loss is an imminent threat throughout the species range to the populations not on protected natural areas and is likely to continue.

Stressor: White-tailed deer, small mammals, exotic ungulates
Exposure: Browsing
Response:
Consequence:
Narrative: Severe herbivory by white-tailed deer is a major, imminent threat to bracted twistflower throughout the species' range, except where populations are protected from deer by fencing or intensive herd management (hunting) (McNeal 1989, p. 17; Damude and Poole 1990, pp. 5253; Dieringer 1991, p. 341; Zippin 1997, pp. 39197, 227; Leonard 2010a, pp. 3643; Fowler 2014, pp. 17, 19) and is exacerbated by the extremely high deer densities in the Edwards Plateau of Texas (Zippin 1997, p. 227). The foliage of bracted twistflower is very palatable to many browsing animals, including squirrels (Fowler 2010, p. 7), and even humans (Kral 1990 cited in Damude and Poole 1990, p. 51). Exotic ungulate species such as aoudad (Ammotragus lervia), which have been widely introduced on game ranches and now exist in self-sustaining feral populations in central Texas, present an additional potential threat (Damude and Poole 1990, pp. 52 - 53). It is also likely that bracted twistflower populations were impacted during historic periods of poor rangeland management in central Texas, particularly by herds of goats and sheep.

Stressor: Woody plant density
Exposure: Decreased habitat
Response:
Consequence:
Narrative: Changes in vegetation structure and composition, specifically the increased density of woody plant cover, appear to be detrimental to bracted twistflower (Pepper 2010, p. 5). The species benefits from higher light intensity and duration than it receives in many of the extant populations; its persistence in dense thickets may be due to increased herbivory of the plants growing in more open vegetation (Leonard 2010a, p. 63; Ramsey 2010, p. 22). The positive reproductive response of bracted twistflower to higher light levels is consistent with the hypothesis that it may also be a fire-adapted species (Fowler 2010, pp. 3, 10). Bray (1904, pp.

1415, 2324) documented the rapid transition of grasslands to woodlands in the Edwards Plateau occurring more than a century ago; he attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. We conclude that bracted twistflower habitats were probably influenced by frequent wildfires and that the frequency of wildfires has decreased greatly since pre-settlement times; therefore, bracted twistflower may be a fire-adapted species, and the lack of wildfire may have contributed to its decline. The increase in density of woody plant cover has occurred incrementally over a span of decades, but affects most bracted twistflower populations, including those on protected natural areas, and may also have caused a gradual decline in population sizes. In addition, optimal vegetation management of bracted twistflower populations may be incompatible with the management of nesting habitat of the endangered golden-cheeked warbler.

Stressor: Powdery mildew fungus
Exposure: Disease infestation
Response:
Consequence:
Narrative: Bracted twistflower is highly susceptible to attack from a powdery mildew fungus (Ascomycota, family Erysiphaceae) which may be more severe when plants grow in dense, shaded thickets (Ramsey 2010, p. 21; Leonard 2010a, p. 53). The species of fungus has not yet been identified; it may be an introduced pathogen to which bracted twistflower has no resistance (Bracted Twistflower Working Group 2010, p. 2). We do not yet know the magnitude of this threat. However, Fowler (2014, p. 17) found that, contrary to expectation, the incidence of powdery mildew was positively associated with reproductive output (plants with greater degrees of powdery mildew infestation produced more viable seed).

Stressor: Recreation
Exposure: Erosion and trampling
Response:
Consequence:
Narrative:

Stressor: Land use changes (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: A major threat to bracted twistflower is habitat loss due to urban and residential land development (McNeal 1989, p. 17; Damude and Poole 1990, p. 51; Zippin 1997, p. 229; Fowler 2010, p. 2; Pepper 2010, p. 5). As described in Section 2.4, 82 percent of bracted twistflower EOs are within 2 km (1.2 mi) of the Edwards/Devils River and Glen Rose geological formations. This narrow crescent along the eastern and southern edges of the Edwards Plateau follows the Balcones Escarpment. Along this escarpment are many springs that provide good quality water from the Edwards Aquifer. Since potable surface water is scarce in many parts of Texas, colonists built towns along the escarpment during the 18th and 19th centuries. These towns have now grown into cities, including Georgetown, Austin, San Marcos, New Braunfels, and San Antonio; collectively known as the Interstate 35 corridor, this is one of the fastest-growing urban complexes in the U.S. Consequently, urban development has consumed all or most of the habitat at six EOs. Figure 10 shows the known populations of bracted twistflower overlaid on projected urban growth along this corridor by 2050 (Hill Country Alliance 2018)—a visual demonstration

that additional populations and habitats are threatened by urban development and other land use changes. (USFWS, 2021)

Stressor: Changes in the structure and composition of vegetation and in wildfire frequency (USFWS, 2021)
Exposure:
Response:
Consequence:
Narrative: Laboratory and field experiments conducted by Fowler (2010, pp. 10–11), Leonard (2010a, p. 63), and Ramsey (2010, p. 20) demonstrated that growth and reproduction of bracted twistflower benefits from higher light intensity and duration than it receives in many of the extant populations; its persistence in dense thickets may be due to increased herbivory of the plants growing in more open vegetation (Leonard 2010a, p. 63; Ramsey 2010, p. 22). Some Streptanthus species, such as S. heterophyllus, germinate in response to wildfire (Moreno and Oechel 1991, pp. 1999 to 2000). One trial showed that bracted twistflower seed germination is enhanced by exposure to karrikins, substances produced by burned vegetation that stimulate germination of many fire-following plants (Flematti et al. 2004; Stewart 2012c, d, e). The positive reproductive response of bracted twistflower to higher light levels and its germination response to karrikins are consistent with the hypothesis that it may also be a fire-adapted species (Fowler 2010, pp. 3, 10; see discussion in Sections 2.3, 2.4, and 3.2). Bray (1904, pp. 14–15, 23–24) and Fonteyn et al. (1988, p. 79) documented the rapid transition of grasslands and savannas in the Edwards Plateau to dense juniper thickets beginning around 1850; they attributed this change to over-grazing, the depletion of grasses, and the cessation of wildfires. An alternate viewpoint concluded that pre-settlement juniper forests were extensive, and that fire frequency has not decreased in the last 150 years, in the Balcones Escarpment region of the Edwards Plateau (O'Donnell 2019, pp. 35–36). Nevertheless, we conclude that the preponderance of evidence supports the hypothesis that bracted twistflower habitats were periodically renewed by frequent wildfires in pre-settlement times and that the frequency of wildfires has subsequently decreased; bracted twistflower is likely to be a fire-adapted species adapted to woodland edges and openings, and the lack of wildfire may have contributed to the deterioration of its habitat and to the decline of its populations. Woody plant cover has increased in density incrementally over a span of decades andaffects most bracted twistflower populations, including those on protected natural areas. (USFWS, 2021)

Recovery

Recovery Actions:

- Search for new populations on public conservation land as well as private lands (with landowner permission).
- Provide technical guidance and material support to private landowners who voluntarily wish to conserve the species on their land.
- Manage the existing populations on protected natural areas more rigorously, including installation of deer exclosures, closing illicit foot and mountain bike trails, enforcing applicable regulations that protect the habitats on public property, and conducting public outreach.
- Maintain less than 50 percent cover of woody plants at occupied habitats to the extent allowed under the existing habitat management plans or applicable regulations.

- Protect multiple populations within each area of the species genetic diversity in Medina and Travis counties.
- Investigate the species ecology and optimal habitat requirements, particularly the fire ecology, geology, and associated vegetation structure.
- Conduct pilot reintroductions to determine effective methods of population reintroduction and augmentation. Reintroduction and augmentation must use seeds from ecotypes adapted to the sites. Avoid translocating propagules of an ecotype into sites that support a genetically distinct ecotype.
- Collect seeds from extant populations for seed bank storage and propagation. Propagate plants from the representative genetic ecotypes (genotypes that are specifically adapted to a specific ecological area) and produce seed for experimental and reintroduction efforts (to prevent excessive collection from wild sources and depletion of the soil seed bank at extant populations).

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SPECIES ACCOUNT: *Streptanthus niger* (Tiburon jewelflower)

Species Taxonomic and Listing Information

Listing Status: Endangered; 3/6/1995; Pacific Southwest (R8)

Physical Description

An annual herb of the mustard family (Brassicaceae) that reaches 30 to 60 centimeters (1 to 2 feet) in height. The lower leaves are toothed, the upper leaves less toothed or not at all. The sepals are a very dark purple; the petals have a purple claw and a white blade with a purple midvein. The pods are erect, almost straight and 4 to 7 centimeters (1.5 to 2.75 inches) long (Kruckeberg and Etienne 1977). The zig-zag inflorescence pattern (Kruckeberg and Etienne 1977) and the lack of hairs (Greene I886b) distinguish Streptanthus niger from its near relative Streptanthus glandulosus (bristly jewelfiower). (USFWS, 1998)

Taxonomy

Streptanthus niger was described by Edward L. Greene, from a type specimen he collected at St. Hilary's Church in the town of Tiburon in Marin County (Greene 1886). Greene later changed the genus to Euclisia (Greene 1904), but Jepson (1925) returned the genus to Streptanthus, and others followed. In 1959, Munz and Keck referred to the plant as a subspecies of Streptanthus glandulosus, but in 1968, Munz returned it to S. niger, following Kruckeberg (1958). Molecular genetic research in the 1990s concluded that S. niger, while genetically distinct, did not form a reciprocally monophyletic unit and was nested within the larger and more widespread S. glanulosus clade (Mayer and Soltis 1999). Based on these results, Al-Shehbaz and Mayer (2008) proposed a reclassification of S. niger to Streptanthus glandulosus niger. We originally listed the species as endangered under the name S. niger (U.S. Fish and Wildlife Service 1995). However, to remain up-to-date with current nomenclature, we will recommend that an amendment be submitted to change the listing to Streptanthus glandulosus niger. (USFWS, 2010)

Historical Range

Marin County, California. (USFWS, 2010)

Current Range

In California, on southwest facing slopes on the Tiburon Peninsula of Marin County. (USFWS, 2010)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinated (USFWS, 1998)

Breeding Season

Adult: Seedlings of Streptanthus niger appear in March and April (Hunter 1 989b), and the plants flower from May to June (Kruckeberg and Etienne 1977) (USFWS, 1998).

Reproduction Narrative

Adult: Seedlings of Streptanthus niger appear in March and April (Hunter 1 989b), and the plants flower from May to June (Kruckeberg and Etienne 1977). The species is self-pollinated (Kruckeberg 1957). The seed capsules open in late June (Hunter 1989b). Populations have fluctuated from 50 to 2,000 plants (Hunter 1989b, A. Allen, in litt., 1991). A 1990 survey found a total of approximately 800 plants in the two occurrences together (E. Buxton, pers. comm. as cited in Morey and Hunter 1990). The known occurrences combined comprise approximately 5 hectares (12 acres) of habitat (Morey and Hunter 1990). No detailed data are available on the reproductive biology or demography of the species (USFWS, 1998).

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine slopes (NatureServe, 2015)

Environmental Specificity

Adult: Very Narrow (inferred from USFWS, 1998)

Habitat Narrative

Adult: Streptanthus niger occurs at elevations of approximately 100 meters (350 feets) on the slopes of the southern Tiburon Peninsula on shallow rocky serpentine soils, which are formed from weathered volcanic (ultramafic) rocks such as serpentinite, dunite, and peridotite (Service 1998). These soils provide a harsh environment for plant growth, however, this species has adapted to this harsh environment and requires it for survival . Associated federally listed species are Hesperolinon congestum (Marin dwarf-flax) and Castilleja affinis ssp. neglecta (Tiburon paintbrush). Other associated plants include Nassella lepida (foothill needlegrass), Eriophyllum confertiflorum (golden yarrow), Hemizonia congesta ssp. congesta (hayfield tarweed), Nassella pulchra (purple needlegrass), Calamagrostis ophitidis (serpentine reedgrass), Calycadenia multiglandulosa (sticky calycadenia), and Eriogonum luteolum var. caninum (Tiburon buckwheat) (Service 1998). (USFWS, 2010)

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2022)

Population Size:

>4,000 (USFWS, 2022)

Population Narrative:

Two populations are known from the southern end of the peninsula where they occur within 3 kilometers (2 miles) of one another (CNDDB, 2009). One is at the tip of the peninsula at Old St. Hilary's Church Preserve (Preserve), and the other is along the Middle Ridge of the peninsula. No historical occurrences are known outside of the Tiburon Peninsula, and it is likely S. niger never occurred elsewhere (Morey and Hunter 1989). Both of the reported localities were known at the time of listing, and both populations are currently extant. However, population numbers fluctuate yearly and have been reported to include lows of 50 individuals and highs of 2,000 plants per population (Hunter 1989, Service 1998). During favorable growing conditions in 2009 the Middle Ridge site had a population of approximately 2,000 individuals (R. Brittman, California Department of Fish and Game, in litt. 2010). Current abundance information is not available for the Preserve site (E. Buxton, California Native Plant Society, in litt. 2010). (USFWS, 2010). Distribution: Historically, the Tiburon jewelflower was thought to encompass the entire Tiburon Peninsula of Marin County as one large population that was likely composed of thousands of individuals (Swope 2019, p. 2). However, by the time the final listing rule published the species was restricted to just two populations within the southern portion of the peninsula (Service 1995, p. 6673). The current distribution of Tiburon jewelflower is similar to what was described in the final listing rule, the previous 5-year review, and the recovery plan amendment (Service 1995, p. 6673; Service 2010, p. 3; Service 2019, pp. 15–16). It is only known to occur at two locations found within 3 kilometers (2 miles) of one another; one at the tip of the peninsula at Old St. Hilary's Preserve and the other along the Middle Ridge of the peninsula (Service 1995, pp. 6673, 6678). No other occurrences outside of Old St. Hilary's Preserve and Middle Ridge have been documented (Morey and Hunter 1990, pp. 2–3); however, as described above an experimental population of Tiburon jewelflower was introduced to the Ring Mountain Preserve on the Tiburon Peninsula in 2016. This small population has had only limited success and is unlikely to be selfsustaining without continued augmentation into the future (Marin County 2021, p. 3). Abundance: The final listing rule indicated the two populations can have anywhere from 50 to 2,000 individuals (Service 1995, p. 6673), but does not give a further description of what time period these estimates came from or whether one population is larger than the other. As described in the previous 5-year review, the Middle Ridge site had a population of approximately 2,000 individuals in 2009 and abundance information for Old St. Hilary's Preserve was not available (Service 2010, p. 3). The recovery plan amendment described the Middle Ridge population as approximately 400-500 individuals and the Old St. Hilary's Preserve population as approximately 3,000 individuals (Swope pers. comm. 2018; Service 2019, p. 15). A 2018 survey of the Old St. Hilary's Preserve population documented 4,086 individuals spread out across three areas of the preserve (Marin County Parks 2021, p. 3). We do not have an updated population estimate for the Middle Ridge population since the recovery plan amendment (USFWS, 2022).

Threats and Stressors

Stressor: Residential development (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Of the two Streptanthus niger records present in the CNDDB (2009), one is protected by Town of Tiburon Open Space (Middle Ridge) and the other is partially protected by Marin County Open Space (Old St. Hilary's Church Preserve) but a portion at the top of the hill is

proposed for development (E. Buxton, California Native Plant Society, in litt. 2010) (Table 1). LSA Associates, Inc. (LSA) is currently writing a vegetation and fire management plan for the Town of Tiburon which includes conservation measures for this species in the area (USFWS, 2010).

Stressor: Foot traffic (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The threat of trampling has intensified since the time of listing. Currently, Streptanthus niger is threatened by trampling from hikers, joggers, dog walkers, and off-trail bicyclists. The Middle Ridge and Preserve occurrences are adjacent to the Ring Mountain open space managed by the Marin Open Space District. Ring Mountain is a very popular site and heavily visited by the public whose activities extend into S. niger habitat. Dog walkers and off-leash dogs currently create the greatest impact, followed by hikers, joggers, and mountain bicyclists (G. Ngarangad, Marin County Open Space District, pers. comm. 2010). The Middle Ridge site is used extensively by professional dog walkers and dogs are frequently off-leash resulting in additional trampling of S. niger habitat (R. Brittman, California Department of Fish and Game, in litt. 2010; E. Buxton, California Native Plant Society, in litt. 2010). Trampling has also increased due to off trail hikers and illegal bicycle trails. Rangers from the Marin County Open Space District and a contracted Sherriff's deputy patrol the area and both educate individuals about the environment and issue citations (G. Ngarangad, Marin County Open Space District, pers. comm. 2010) (USFWS, 2010).

Stressor: Road construction (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Road construction is listed as a threat to this species (USFWS, 2010)

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, regulatory mechanisms thought to have some potential to protect Streptanthus niger included: (1) listing under the California Endangered Species Act (CESA); (2) the California Environmental Quality Act (CEQA) and the National Environmental Protection Act (NEPA); and (3) the Federal Endangered Species Act in those cases where S. niger occurs and is incidentally protected in habitat occupied by a listed wildlife species. The listing rule (60 FR 6671) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid.(USFWS, 2010)

Stressor: Non-native plant species (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition with introduced species continues to be a serious threat to serpentine native plants (Service 1995, Service 1998). Competition and displacement from invasive plant species poses a potential threat to Streptanthus niger. Exotic and/or invasive, weedy plant

species reduce native plant diversity and diminish the habitat suitability for native species; this is particularly the case in sensitive habitats (G. Cooley, California Department of Fish and Game, pers. comm. 2008). The consistent pattern of heavy growth of nonnative grasses when not controlled by grazing or other management can 'smother' native plants, resulting in the subsequent crowding out, outcompeting, or overshadowing of native annuals. A common consequence of such heavy annual grass growth is development of thatch, which adds to the strong smothering effect by inhibiting annuals' germination and growth (Weiss et al. 2007). S. niger is particularly threatened by nonnative invasive species such as Genista monspessulana (French broom), Cytisus scoparius (Scotch broom), Avena fatua (wild oats), and Cortaderia selloana (pampas grass) (USFWS, 2010).

Stressor: Restricted range (USFWS, 2010)
Exposure:
Response:
Consequence: Extinction/lack of genetic variability
Narrative: Streptanthus niger is extremely restricted in its range, and known from only two occurrences on the Tiburon Peninsula in Northern California, each of which fluctuates between 50 and 2,000 individuals between years. The small population sizes and the restricted range of the species places S. niger at risk from catastrophic or stochastic events and loss of genetic variability. Potential future development of the areas surrounding the Preserve, and on the top of the hill at Old St. Hilary's Church would have direct negative effects on this species and exacerbate the threat from low numbers of individuals. Since the total number of individuals per year fluctuates drastically (from 50 to 2000 individuals per locality), these populations are at risk of extirpation by a random event such as a disease outbreak, drought, fire, or other natural or human-caused factors. Additionally, few populations, low population numbers and, large population fluctuations among years increase the likelihood of loss of genetic variability which may lead to a decrease in average fitness and reduced resilience to environmental stressors such as disease and alterations in habitat (USFWS, 2010).

Stressor: Climate change (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat/extinction
Narrative: A modeling study completed by Loarie et al. (2008) provides an evaluation of potential trends to California's floristic communities under climate change scenarios. In general, plant diversity will shift in two divergent directions: along the coast and northwards at higher elevations; and southwards at higher elevations of the Sierra Nevada. The models suggest that climate change has the potential to break up local floras, resulting in new species combinations, with new patterns of competition and biotic interactions (Loarie et al. 2008). Based on these modeling results, Streptanthus niger may be unable to shift its range because of isolated, small populations, whose growth depend upon particular hydrological regimes and soil characteristics, and the limited available, suitable habitat surrounding extant occurrences (USFWS, 2010).

Recovery

Reclassification Criteria:
A/1: Occupied habitat at the Old St. Hilary's Preserve and Middle Ridge site is fully protected and managed with the primary intention of preserving the populations in perpetuity. In

addition, secure and protect adjacent unoccupied habitat and a 150-meter (500- foot) buffer around protected occupied habitat, where possible. If additional individuals or populations are discovered on private lands that are not part of the Old St. Hilary's Preserve or protected land at Middle Ridge, they are secured through voluntary land acquisitions, conservation easements, or other means. (USFWS, 2019)

A/2: Management plan(s), approved by the Service, are developed and implemented for populations at Old St. Hilary's Preserve and Middle Ridge, and any other location(s) where the species may be discovered (see A/1). Management plans will include survival of the species as an objective and will include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for annual standardized monitoring of each population to determine demographic trends and actions to control invasive plant species. Adequate funding must be dedicated in order to implement the management plan in perpetuity. (USFWS, 2019)

E/1: As described in A/2, standardized population monitoring at Old St. Hilary's Preserve, Middle Ridge and any other location(s) where the species may be discovered (see A/1) shows stable or increasing populations over a period of 20 years that include two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). If monitoring shows any population is declining, determine the cause of decline and reverse the trend. (USFWS, 2019)

E/2: Unless research shows otherwise, the St. Hilary's Preserve and any other population that may be discovered (see A/1) contain an average of at least 3,000 flowering individuals, and the Middle Ridge population contain an average of at least 2,000 flowering individuals. This will allow each population to maintain its breadth of genetic diversity and adaptive potential over the long-term, attract sufficient pollinators, and maintain a stable or increasing population. (USFWS, 2019)

E/3: Seeds stored in at least two Center for Plant Conservation certified facilities48 and reliable seed germination and propagation techniques are understood. (USFWS, 2019)

Recovery Priority Number: 5C

Delisting Criteria:
A/1: A minimum of one new population is established in an area on the Tiburon peninsula that contains suitable protected habitat and appropriate plant associates. Each introduced population is maintained over a 20-year period that includes two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). (USFWS, 2019)

A/2: Service-approved management plan(s) are developed and implemented for the introduced population(s) from A/1. Management plan(s) include survival of the species as an objective and include any adjacent occupied or unoccupied habitat identified as essential to survival. The plans include provisions for annual standardized monitoring to determine demographic trends and control invasive species. Adequate funding is dedicated to implement the management plan in perpetuity. (USFWS, 2019)

A/3: The population(s) described in A/1 is secured and protected, along with adjacent unoccupied habitat and a 150-meter (500- foot) buffer, where possible. The introduced

population(s) is secured through voluntary land acquisitions, conservation easements, or other means. (USFWS, 2019)

E/1: Unless research shows otherwise, the introduced population described in A/1 contains an average of at least 3,000 plants. This will allow the introduced population to maintain its breadth of genetic diversity and adaptive potential over the long-term, attract sufficient pollinators, and to maintain a stable or increasing population. (USFWS, 2019)

E/2: Population monitoring of introduced populations under A/1 shows evidence of natural recruitment and contain a stable or increasing population over a 20-year monitoring period that include two normal precipitation cycles (or longer if suggested by the results of demographic monitoring). The other populations are stable or increasing after downlisting. (USFWS, 2019)

Recovery Actions:

- 1. Introduce and maintain one new Tiburon jewelflower population in an area on the Tiburon peninsula that contains suitable protected habitat and the appropriate plant associates. (Priority 1) (USFWS, 2019)
- 2. Work with Marin County Parks and Open Space to update their current management plan to include the Tiburon jewelflower. Institute a species-specific management plan to ensure a self-sustaining population over the long-term. (Priority 1) (USFWS, 2019)
- 3. Conduct research to better understand the relationship between genetic diversity and the species capacity for adaptive evolution (Priority 1). (USFWS, 2019)
- 4. Store seeds in at least two Center for Plant Conservation certified facilities. Unless storage techniques and/or research show otherwise, replenish seed stock every 10 years to ensure seed viability. (Priority 2) (USFWS, 2019)
- 5. Establish a Service-approved monitoring plan to cover a minimum of 5 years post-delisting of Tiburon jewelflower. The plan will be ready for implementation at the time of delisting to ensure the ongoing conservation of the species and the continued effectiveness of management actions. Adequate funding must be dedicated in order to implement the delisting management plan. (Priority 3) (USFWS, 2019)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and research recommendations which will aid in the recovery and conservation of the Tiburon jewelflower. Some of these recommendations have already been discussed in previous recovery documents (Service 2011, p. 13; Service 2019, pp. 52–53) and remain valid. 1. Preserve and protect all Tiburon jewelflower habitat in perpetuity. Only a portion of the Tiburon jewelflower population located at the Old St. Hilary's Preserve is currently protected and areas near Middle Ridge could be threatened by future development. Protecting all potential and occupied habitat in perpetuity would eliminate this threat. 2. Continue to conduct research on the species, specifically on its demography, reproduction, and genetics. Additional information on these topics would be helpful in trying to manage and preserve the existing populations. It is also important to better understand the potential effects of global climate change on the habitat and microclimate of the Tiburon Peninsula; potential changes in phenology and demography of Tiburon jewelflower; ecosystem associates such as pollinators; and pest and disease outbreaks associated with Tiburon jewelflower. 3. Manage a seed bank of this species for potential reseeding in newly created or discovered habitat, and to ensure that a seed bank exists for replanting in case of total loss of wild populations. 4. To increase

species redundancy and meet delisting criterion A/1 (Service 2019, p. 44), introduce and maintain one new Tiburon jewelflower population in an area on the Tiburon peninsula that contains suitable protected habitat and the appropriate plant associates. 5. Work with Marin County Parks and Open Space to update their current management plan to include the Tiburon jewelflower. Implementation of species-specific management actions will ensure a self-sustaining population over the long-term. 6. Conduct research to better understand the relationship between genetic diversity and the species capacity for adaptive evolution. 7. In order to reflect the most current understanding of the species taxonomy, formally change the species name in the Code of Federal Regulations from Streptanthus niger to Streptanthus glandulosus niger. 8. Conduct annual surveys at all known locations to track population sizes each year. Given the low number of individuals in some years, it is extremely important to be aware of when these lows are occurring, and to ensure that the populations do not disappear altogether (USFWS, 2022).

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SPECIES ACCOUNT: *Styrax portoricensis* (Palo de jazmin)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/22/1992; Southeast Region (R4) (USFWS, 2016)

Physical Description

Styrax portoricensis is an evergreen tree of 10-12 m in height. The leaves are simple, alternate, exstipulate, and glabrous, measuring 6-12 cm long, and 3-5 cm wide. The leaf blades are elliptic, with a cuneate base, and an acute or acuminate apex; the petiole is 6- 12 long and lepidote. Both surfaces are finely reticulate-veined; the upper side is shiny dark green, the lower surface is pale green with scattered stellate scales. The axillary or terminal flower racemes are 2-5 cm long, bearing three to six perfect flowers with ferrugineolepidote, curved pedicles of 10-15 mm long. The calyx is cup-shaped, ferrugineo-lepidote, with five 4-5 mm long sepals. The white corolla is valvate, with five 12-25 mm long petals which are silvery lepidote inside. The 10 stamens present are free, with filaments as long as anthers, and with long stellate hairs at the base. The superior ovary contains numerous ovules. The pistil is as long as the corolla lobes, with a three-lobed stigma. The fruit is one-seeded, oblong-elliptic, lepidote, drupe of 2.5-3.5 cm long and 1.3-1.5 cm in diameter. The fruit apex is acuminate, and the fruit base maintains the calyx (persistent). The fruit bear only one seed, 19 mm long and 8-10 mm wide, which is pale reddish brown (USFWS, 1993).

Taxonomy

Styrax portoricensis (palo de jazmin) was described in 1892 by Krug and Urban from specimens collected by Sintenis in 1885 in the Sierra de Naguabo and Sierra de Yabucoa of eastern Puerto Rico. In October of 1935, the species was collected somewhere in the Luquillo Mountains by C. Horn and L. Holdridge (Vivaldi et al. 1981c). Fruits of the species were collected in 1954 in the El Verde area of the Luquillo Mountains (Little et al. 1974). Besides the collections mentioned, no record of the species was made until the early 1980's, when it was rediscovered in the Luquillo Mountains, being known at present from a single individual (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

All the currently known localities of Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis, and Ternstroemia subsessilis occur within the Caribbean National Forest, which is administered by the USDA Forest Service. The following are known sites for the species: Barrio Guzman Arriba. Rio Grande municipality. Only a single tree is known, growing west of El Cacique (USFWS, 1993). Currently, palo de jazmin is only known to naturally occur within the palo colorado forest type at EYNF where 19 individuals have been documented at five locations (USFWS 2015). Palo de jazmin has been planted on other sites within EYNF, and in a land managed for conservation by Para La Naturaleza in the municipality of Barranquitas (USFWS 2015). (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. Fruits are present in Sintenis herbarium specimen number 1169 of Styrax portoricensis, collected on April 26, 1885 (Vivaldi and Woodbury 1981c) (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander at al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of Callicarpa ampla and Styrax portoricensis, and some localities of Ternstroemia luquillensis and Ternstroemia subsessilis occur within the palo colorado vegetation type. Some localities of Ternstroemia luquillensis and Ternstroemia subsessilis, and all the localities of Ilex sintenisii occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (Inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends

Population Trends:
Unknown (USFWS, 2015)

Species Trends:
Unknown (USFWS, 2015)

Number of Populations:
One (USFWS, 2015)

Population Size:
~19 individuals (USFWS, 2015)

Population Narrative:
Styrax portoricensis: Palo de jazmín is a tree only known from the Luquillo Mountains in eastern Puerto Rico (Liogier and Martorell 2000). At the time of listing (1992) palo de jazmín was known from a single individual growing in the Palo colorado forest west of El Cacique in the Luquillo Mountains. The current number of individuals in the wild (natural populations) is estimated at about 19 trees (Table 2) within the following areas of El Yunque National Forest: Monte Cacique area (1-3 ind.), Río Espiritu Santo (2 ind.), Palo Hueco (8 ind.), Arboretum (2 ind.), and Cristal Trail (4 ind.) (Luis Rivera, USFS, 2011, pers. comm.). The USFS also reported a single planted individual in the Catalina area (USFS office at El Yunque National Forest). There are also unconfirmed records of the species in the area surrounding the Puerto Rican Parrot Aviary (Anastacio Gómez,USFS, 2012, pers. comm.). In addition, the PRCT planted about 5 individuals of this species within a property they manage in the municipality of Barranquitas. These trees have developed as reproductive individuals and are managed for conservation purposes. Despite the historical information, during the 2011 surveys no individuals of natural populations mentioned above were located at El Yunque National Forest. Since there is no long term monitoring of the natural populations and some of the historical populations seem to be lost or probably extinct, it is not possible to establish any trend about the population's status or demography (USFWS, 2015). In addition, Low resiliency, representation and redundancy are inferred based on low number of populations and individuals. Out of the three species, Styrax portoricensis and Callicarpa ampla appears to be persisting, although, their population numbers and individuals per populations are very low, and no recruitment was observed during the assessments conducted by PRDNER. As for Ilex sintenisii, a new population was found and the number of individuals are higher than the other two species, but the assessment showed a decline in individuals compared to the numbers from the 2015 5-year status review, in addition no recruitment was observed in these populations. Although we do not have new data for Ternstroemia luquillensis and T. subsessilis, their population levels were low at the time of listing, and individuals were not found during the 2011 surveys. (USFWS, 2021)

Threats and Stressors

Stressor: Forest management (USFWS, 2015)
Exposure:

Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of I. sintenisii, S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to I. sintenisii, S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, I. sintenisii seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for I. sintenisii is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of I. sintenisii, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental

conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of I. sintenisii as well as S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of viability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of I. sintenisii, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:
An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis , and Ternstroemia subsessilis within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:
1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).

2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:

- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved "Revised Land and Resource Management Plan" (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).
- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).
- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating Styrax portoricensis. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting Styrax portoricensis (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated Callicarpa ampla by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (Ilex sintenisii, Ternstroemia luquillensis and Ternstroemia subsessilis) (USFWS, 2015).

- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2019 - 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 2019 - 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).
- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of I. sintenisii. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus Ilex in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).
- 6. Enhancement of natural populations should be considered a priority, particularly for S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations are additional to the recommendations provided in the 2015 5- year status review for these species. 1. Search for the species outside the trails where the historic populations are located, and within suitable habitat in private lands adjacent to EYNF. 2. Conduct genetic studies to determine the viability of these species into the future. 3. Conduct a seed viability study particularly for Callicarpa ampla and Styrax

portoricensis to determine if that is a factor that could be affecting their recruitment. 4. Develop a propagation and reintroduction protocol for all five species in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza, and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species. 5. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside the boundary of EYNF to safeguard these lands since they share similar vegetation and habitat characteristics. (USFWS, 2021)

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SPECIES ACCOUNT: *Styrax texanus* (Texas snowbells)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/12/1984; Southwest Region (Region 2) (USFWS, 2016)

Physical Description

A shrub, usually with several stems from the base, up to 4 m tall. The leaves are alternative, suborbicular, 4-8 cm long, and about as broad. The leaf margins are entire and the leave bases are cuneate to truncate or rounded. The upper leaf surface is glabrous, bright green and smooth and the lower leaf surface is conspicuously white with a very fine and dense silky tomentum. Flowers are axillary, solitary or in 2-5 flowered racemes with puberulent pedicles 10-12 mm long. The calyx is 4-6 mm long, pale, densely puberulent, apex grandular, and 5-7 toothed. There are 10 stamens with bright orange-yellow anthers. Fruits are dry, globose to subglobose, 7-8 mm in diameter (Gonsoulin, 1974). Produces showy white flowers borne in clusters among the rounded, bright green leaves with white undersurfaces. Blooms primarily in April. (USFWS, 1987; NatureServe, 2015)

Taxonomy

Fritsch (1996, 1997) completed isozyme analysis and DNA sequencing on Texas snowbells. These two studies in addition to others completed on Styrax morphology by Fritsch led to the designation of S. texana as a subspecies of S. platanifolius, along with four other subspecies: platanifolius, stellatus, youngiae, and mollis (Fritsch 1997). Fritsch (1997) considered the morphological variation recognized by Cory (1943) and Gonsoulin (1974) to be taxonomically unreliable or inconsequential. Fritsch (1997) confirmed the ranges of three of the subspecies (platanifolia, stellata, and texana) did overlap, but genetically they are different enough to be subspecies. USFWS currently recognizes this plant as S. platanifolius ssp. texanus (USFWS, 2008; 2018).

Historical Range

At the time of listing, 25 Texas snowbell plants were known from Edwards, Real, and Kimble Counties, Texas however, a report of four individuals from Kimble County was later determined to be incorrect. Other plants thought to be Texas snowbells were reported in 1942 from Val Verde County, Texas, but have not been reconfirmed (49 FR 40036-40037, TPWD circa 1995). (USFWS, 2008)

Current Range

Endemic shrub of the Edwards Plateau of Texas. Since 1986, field surveyors have documented 400 mature and 452 immature Texas snowbells plants in 22 naturally occurring sites in Real, Edwards, and Val Verde counties (USFWS, 2018)

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Obligate out-crosser; fertilization requires transfer of pollen between individuals that are not too closely related (USFWS, 2018).

Dependency on Other Individuals or Species

Adult: The known pollinators include native species of bumblebee and carpenter bee and the introduced honey bee (USFWS, 2018).

Breeding Season

Adult: Texas snowbells usually flowers in April, and if fertilized, flowers produce a typically single-seeded dry fruit that matures in August (USFWS, 2018).

Other Reproductive Information

Adult: Fruits usually have one seed, but may have up to four under the most favorable conditions (Poole et al. 2007, p. 476 in USFWS, 2017).

Reproduction Narrative

Adult: Texas snowbells usually flowers in April, and if fertilized, flowers produce a typically single-seeded dry fruit that matures in August. However, investigations of the breeding system of Texas snowbells and another closely related species of Styrax indicate that it is an obligate out-crosser; fertilization requires transfer of pollen between individuals that are not too closely related. The known pollinators include native species of bumblebee and carpenter bee and the introduced honey bee. High rates of fertilization probably require that Texas snowbells plants are separated by no more than 0.5 to 1.0 km (0.3 to 0.6 mi). Almost all documented reproduction of Texas snowbells in the wild, as indicated by the presence of immature plants, occurs among populations that have at least 56 mature individuals dispersed over a distance of 1.6 km (1.0 mi) or less. Little or no reproduction occurs among isolated individuals and small populations. Reproductive success depends on the size and distribution of populations for two reasons: , Texas snowbells is very likely to be obligately xenogamous and pollen must be transferred between genetically compatible individuals that are within the foraging range of suitable bee or butterfly pollinators (USFWS, 2017; 2018a).

Habitat Type

Adult: Populations occur in limestone bluffs, boulder slopes, cliff faces, and gravelly stream-beds, usually along perennial streams or intermittent drainages in canyon bottoms, in full sun or in partial shade of cliffs and/or sycamore-little walnut woodlands, oak-juniper woodlands, or mixed oak-shrublands (Poole et al., 2007 in USFWS, 2017).

Habitat Vegetation or Surface Water Classification

Adult: Sycamore-little walnut, oak, oak-juniper woodland; near river drainages, canyons, and draws (USFWS, 2008; NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Annual precipitation ranges from 51.3 centimeters (cm) (20.2 inches [in]) to 69.5 cm (27.4 in); average temperatures range from a minimum of 0.9° Celsius (C) (33.6° Fahrenheit [F]) in January to a maximum of 36.3° C (97.3° F) in July (USFWS, 2018b).

Geographic or Habitat Restraints or Barriers

Adult: Elevations range from 372 to 579 m (1,220 to 1,900 ft) (USFWS, 2018b).

Environmental Specificity

Adult: Narrow (USFWS, 2018b)

Habitat Narrative

Adult: Pockets of rocky clay soils or crevices in limestone cliffs, bluffs, and ledges above permanent streams or rivers or above rocky stream beds with high water tables. (The steep areas are probably not the plant's primary habitat, but are refuges from extreme livestock grazing pressure.) Texas snowbells occur in moist habitats such as river drainages, canyons, and draws, which are abundant in the Edwards Plateau (Correll and Johnston 1970, Vines 1984, Poole and Birnbaum 2005, Riskind and Diamond 1988). Most plants occur in areas where they receive at least partial shade from surrounding vegetation during the day (Poole and Cook 1996). This species is found at elevation ranges from 372 to 579 m (1,220 to 1,900 ft). The surrounding vegetation is sycamore-little walnut (Platanus occidentalis-Juglans microcarpa), oak, or oak-juniper woodland. Average precipitation ranges from 51.3 centimeters (cm) (20.2 inches [in]) to 69.5 cm (27.4 in); average temperatures range from a minimum of 0.9° Celsius (C) (33.6° Fahrenheit [F]) in January to a maximum of 36.3° C (97.3° F) in Jul. (NatureServe, 2015; USFWS, 2018b)

Dispersal/Migration

Dispersal

Adult: Low (USFWS, 2008)

Dispersal/Migration Narrative

Adult: Most Texas snowbell seeds fall directly beneath the parent plant (Poole 1993). Those seeds may stay where they fall on the ground, be moved by water if growing over a stream or creek, or be carried off by small mammals such as rock squirrels (Spermophilus variegates) or wood rats (Neotoma sp.) (TPWD 1990, Poole 1993). (USFWS, 2008)

Population Information and Trends

Population Trends:

Stable to increasing (USFWS, 2017)

Species Trends:

Stable to increasing (USFWS, 2017)

Resiliency:

Resilience is low because all known populations are far below the estimated minimum viable population level (USFWS, 2017).

Representation:

Texas snowbells is endemic to a small area and has a low level of genetic diversity, and therefore has low representation (USFWS, 2017).

Redundancy:

'There are few populations, hence redundancy is low' Our assessment of species viability, defined as the likelihood of persistence over the long term, is based on the concepts of representation, redundancy, and resilience. Texas snowbells is endemic to a small area and has a low level of genetic diversity, and therefore has low representation. There are few populations, hence redundancy is low. Resilience is low because all known populations are far below the estimated minimum viable population level. In synthesis, the viability of Texas snowbells is low (USFWS, 2017).

Number of Populations:

22 (USFWS, 2018a)

Population Size:

852 (USFWS, 2019)

Minimum Viable Population Size:

900-1,200 individuals (USFWS, 2018a)

Population Narrative:

Since 1986, field surveyors have documented 400 mature and 452 immature Texas snowbells plants in 22 naturally occurring sites in Real, Edwards, and Val Verde counties. Fifteen of the documented sites had fewer than 10 individuals and 2 had at least 100. Fifteen naturally occurring populations are on private land, 5 are on private conservation land (Dolan Falls Preserve and conservation easements managed by The Nature Conservancy), and 2 are on public conservation land (Devil's River State Natural Area). The subspecies has also been reintroduced in 22 sites on private land and 2 sites at Dolan Falls Preserve. By comparing with other plant species that have similar, well-studied life histories, we estimate that the minimum viable size of metapopulations is from 900 to 1,200 individuals. The global population spans a range of 121 km (75 mi) east to west and 35 km (22 mi) north to south. The known populations occur along watercourses, on or near steep slopes, in exposed limestone and gravel of the upper reaches of the Nueces, West Nueces, and Devils River watersheds. We estimate that about 15,043 ha (37,172 ac) of potential habitat exist in these watersheds. An unconfirmed population has also been reported from the lower West Frio River. The number of mature, naturally occurring Texas snowbells plants documented in 2013 was 8 times greater than in 1984 when it was federally listed as an endangered species. However, this increase primarily reflects new discoveries of individuals and populations rather than actual population growth. Texas snowbells has a low level of resilience because all known populations are far below the estimated minimum viable population level. There are few populations, hence redundancy is low. The subspecies is endemic to a small area with little ecological differentiation, and has little genetic diversity and therefore has low representation. In synthesis, the viability of Texas snowbells is low (USFWS, 2017; 2018a; 2018b). By 2013, 400 mature and 452 immature Texas snowbells plants had been documented in 22 naturally-occurring sites. Fifteen of the documented sites had fewer than 10 individuals and 2 had at least 100. Fifteen naturally occurring populations are on private land, 5 are on private conservation land (Dolan Falls Preserve and conservation easements managed by The Nature Conservancy), and 2 are on public conservation land (Devil's River State Natural Area). The subspecies has also been reintroduced in 22 sites on private land and 2 sites at Dolan Falls Preserve. (USFWS, 2019)

Threats and Stressors

Stressor: Browsing by white-tailed deer, goats, and introduced ungulates (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: White-tailed deer population density is very high in much of the Edwards Plateau. In addition, ranchers introduced large numbers of goats in Real County (and elsewhere) beginning in the early 20th century; by 1930 there were 137,000 goats in the county (Minton 2010, pp. 3-4). More recently, the introduction of exotic ungulates has been promoted as an economic opportunity for Texas landowners (Mungall and Sheffield 1994, pp. 188-194). Some introduced ungulates, including aoudads, blackbuck antelope (Antilope cervicapra), axis deer, and fallow deer (Dama dama), have escaped and established large breeding populations in the wild. All of these ungulates browse to some degree on woody plants (Huerta-P. et al. 2005, pp. 239-242). In many parts of the Edwards Plateau an abrupt browse line in trees and shrubs provides stark evidence of the intensity of ungulate browsing. Poole (1993) demonstrated that browsing is a major cause of mortality to Texas snowbells seedlings. Fulton (2010, attachment) provided photographic documentation of feral aoudads eating Texas snowbells plants. Successful recruitment and reintroduction of Texas snowbells occurs where plants are protected from browsers with fencing or other barriers, or where population densities of ungulate browsers are lower. Barriers are useful, short-term solutions to the browsing problem; full recovery of Texas snowbells will require better management of deer and feral ungulate populations (USFWS, 2017).

Stressor: Severe floods (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The steep, rocky terrain of the Edwards Plateau and frequent occurrence of heavy rainfall contribute to the severity of the region's flash floods (Eckhardt 2015, pp. 1-2). Texas snowbells seeds often fall on dry stream beds and may germinate and establish there, only to be swept away during flash floods. The vulnerability of young Texas snowbells plants was demonstrated when a flood washed away the seedlings that were initially planted at EO2. The incidence of flash flooding is a natural and unavoidable feature of the narrow riparian habitats of Texas snowbells. However, flash flooding could become more frequent or more severe as a result of climate change (USFWS, 2017).

Stressor: Drought (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Tree ring data indicate that severe, extended droughts have occurred repeatedly in the Edwards Plateau since the year 1500 (Cleaveland et al. 2011, all). At EO17, average annual mortality of Texas snowbells was 6%, but increased to about 22% during the exceptional drought of 2011 (Reemts et al. 2016, p. 1). Therefore, the intensity and duration of drought are factors that affect the survival of Texas snowbells. Since it is likely that the intensity and/or duration of droughts will increase on a regional to global scale due to climate changes (IPCC 2013, p. 23), the viability of Texas snowbells may decline as a result (USFWS, 2017).

Stressor: Land ownership (USFWS, 2017)

Exposure:
Response:
Consequence:
Narrative: A large portion of the known individuals and populations of Texas snowbells occurs on privately owned land. This does not constitute a threat to the subspecies, and in fact many landowners have demonstrated interest and enthusiasm for conservation of Texas snowbells. However, private ownership makes conservation more challenging for several reasons. Access to populations and habitats is subject to the interests of hundreds of individual landowners. Consequently, our knowledge of the subspecies' actual status is far from complete. Establishing and maintaining cooperative relationships with large numbers of private landowners is time-consuming, and these important relationships may lapse when personnel of conservation organizations retire or pursue other career choices. The ownership of private lands changes hands over time, and future owners may choose not to continue conservation efforts that were supported by previous owners. Hence, it is difficult to assure permanent conservation on private lands. These challenges underscore the importance of effective landowner outreach in the conservation of Texas snowbells (USFWS, 2017).

Stressor: Small population size (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Texas snowbells has been documented in 22 sites; 15 of these sites had less than 10 individuals. The entire global population of about 400 mature, reproductive individuals is less than an estimated MVP of 900 to 1,200 individuals. In addition to the lack of reproduction, small populations are more vulnerable to extirpation from stochastic (random) events. For example, it is more likely that a single landslide or flood could wipe out every individual of a small colony of Texas snowbells than a larger population with colonies spread out over a wider area (USFWS, 2017).

Stressor: Lack of genetic diversity (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Fritsch (1996, p. 350) found low levels of genetic diversity among the Texas subspecies of Styrax platanifolius, suggesting that the group had undergone a genetic bottleneck. Adams and Poole (2011, pp. 200-202) also found very little evidence of variation between individuals or among populations of Texas snowbells. This lack of genetic diversity may reduce the potential to adapt to new or existing diseases and parasites, extreme weather, and climate changes. Low genetic diversity may also reduce fertilization and seed production if remaining individuals are too closely related for out-crossing (USFWS, 2017).

Stressor: Population fragmentation and isolation (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Successful fertilization probably requires the transfer of pollen between individuals that are not closely related. In addition to low population size, the fragmentation and isolation of individuals and small colonies decreases the likelihood of successful reproduction. The progeny

of small colonies may be too closely related to fertilize each other, so small colonies are more likely to die out than larger ones. An important factor for long-term management of the subspecies is the effective pollination range of its insect pollinators. We estimate that genetically diverse individuals should be not more than about 0.5 to 1.0 km (0.3 to 0.6 mi) apart for high fertilization rates to occur (USFWS, 2017).

Stressor: Pollinator deficiency (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: We currently do not have information on the population statuses of the known pollinators of Texas snowbells. However, many pollinator species, including bumblebees (Williams and Osborne 2009, pp. 368-374), have declined in many parts of the world. Since fertilization of Texas snowbells probably requires outcrossing, and depends on bumblebees and other insect pollinators, declines in populations of these pollinators within the subspecies' habitats represents a potential threat to its viability (USFWS, 2017).

Stressor: Climate change (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: The Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013, p. 23) projects the following changes by the end of the 21st century, relative to the 1986 to 2005 averages: It is virtually certain that most land areas will experience warmer and/or fewer cold days and nights; it is virtually certain that most land areas will experience warmer and/or more frequent hot days and nights; it is very likely that the frequency and/or duration of warm spells and heat waves will increase in most land areas; it is very likely that the frequency, intensity, and/or amount of heavy precipitation will increase in mid-latitude land masses; it is likely that the intensity and/or duration of droughts will increase on a regional to global scale. The magnitude of projected changes varies widely, depending on which scenario of future greenhouse gas emissions is used. These scenarios are called Representative Concentration Pathways (RCPs). Under the best-case scenario of RCP2.6, the combined emissions of carbon dioxide, methane, and nitrous oxide, expressed as the carbon dioxide equivalent, will stabilize at 475 parts per million (ppm) by the year 2100. This figure rises to 630, 800, and 1,313 ppm under the RCP4.5, RCP6.0, and RCP8.5 scenarios, respectively (IPCC 2013, p.22).The report also states, "In many mid-latitude and subtropical dry regions, mean precipitation will likely decrease..." (p. 16). However, the Fifth Assessment does not simulate regional precipitation patterns well (p. 11). Furthermore, we do not know how Texas snowbells would respond to changes in temperatures and rainfall amounts and patterns. Since these changes could be detrimental to the subspecies, climate change represents a potential threat to its continued survival (USFWS, 2017).

Stressor: Endemism (USFWS, 2017)
Exposure:
Response:
Consequence:
Narrative: Texas snowbells is endemic to a very limited area. We estimate that only about 15,043 ha (37,172 ac) of potential habitat exist in the upper portions of three watersheds; the subspecies' global range spans 121 km (75 mi) east to west and 35 km (22 mi) north to south.

While endemism is not a threat, per se, it increases the subspecies' vulnerability to other threats. For example, climate change could further reduce the amount of potential habitat, or a single prolonged drought or catastrophic rainfall and flooding could increase mortality throughout the subspecies' range (USFWS, 2017).

Recovery

Reclassification Criteria:
Texas snowbells may be reclassified as a threatened species when the following conditions have been met: Self-sustaining metapopulations have reached the MVP level of at least 500 individuals of reproductive age in each recovery unit (occupied watershed): The upper Nueces, West Nueces, and Devils River. If wild populations are discovered in other watersheds, this criterion must also be met in those watersheds. MVP is based only on mature, reproductive individuals since mortality of young Texas snowbells plants is very high, and apparent population sizes can fluctuate wildly if immature plants are included. Metapopulations may be considered self-sustaining when: a) Unaided recruitment equals or exceeds mortality over a 10-year span, which is the expected minimum time to complete an entire generation (as defined in III.7); b) facilitated population augmentation and reintroduction are no longer necessary for successful recruitment; and c) fenced exclosures or other types of barriers are no longer necessary to reduce mortality from ungulate browsing. However, we anticipate that population management of white-tailed deer and introduced ungulates, pollinator conservation, and other habitat management practices will continue to be necessary in this region. The continuation of these practices will not preclude the attainment of this criterion (USFWS, 2018b).

Downlisting Criterion. Texas snowbells may be reclassified as a threatened species when the following conditions have been met: Self-sustaining metapopulations have reached the MVP level of at least 500 individuals of reproductive age in each of the three currently known recovery units (occupied watersheds, shown in Figure 1): The upper Nueces, West Nueces, and Devils River. If wild populations are discovered in other watersheds, they may contribute to the criterion of three self-sustaining metapopulations, but would not be required to meet the criterion. MVP is based only on mature, reproductive individuals since mortality of young Texas snowbells plants is very high, and apparent population sizes can fluctuate wildly if immature plants are included. Metapopulations may be considered self-sustaining when: a) Unaided recruitment equals or exceeds mortality over a 10-year span, which is the expected minimum time to complete an entire generation (as defined in III.7); b) facilitated population augmentation and reintroduction are no longer necessary for successful recruitment; and c) fenced exclosures or other types of barriers are no longer necessary to reduce mortality from ungulate browsing. However, we anticipate that population management of white-tailed deer and introduced ungulates, pollinator conservation, and other habitat management practices will continue to be necessary in this region. The continuation of these practices will not preclude the attainment of this criterion. (USFWS, 2019)

Delisting Criteria:
Recovery will be signified by: Resilient, redundant, viable metapopulations in the Nueces, West Nueces, and Devils River watersheds (and possibly other watersheds, if other naturally-occurring populations are discovered), where spontaneous recruitment over time equals or exceeds mortality; and the conservation of its ecological and genetic representation through the restoration of gene flow throughout each extant metapopulation (USFWS, 2018b).

Texas snowbells may be removed from the endangered species list when: All downlisting criteria (IV.1.a. b, and c) have been met and sustained, and self-sustaining metapopulations have been established in each recovery unit (occupied watershed) and have remained stable or increasing for 20 additional years (2 additional generations, as described in III.7); this is a total of at least 30 years (3 generations). The completion of 3 generations would likely span multiple periods of high and low precipitation. This represents the minimum number of generations required to detect demographic trends; however, a longer time frame may be necessary if a clear trend has not yet been observed (USFWS, 2018b).

Delisting Criterion. Texas snowbells may be removed from the endangered species list when: All downlisting criteria (IV.1.a. b, and c) have been met and sustained, and self-sustaining metapopulations have been established in each recovery unit (occupied watershed) and have remained stable or increasing for 20 additional years (2 additional generations, as described in III.7); this is a total of at least 30 years (3 generations). The completion of 3 generations would likely span multiple periods of high and low precipitation. This represents the minimum number of generations required to detect demographic trends; however, a longer time frame may be necessary if a clear trend has not yet been observed. (USFWS, 2019)

Recovery Actions:

- Priority 1(1): Promote awareness and conservation of Texas snowbells on private lands in the upper Nueces, West Nueces, and Devils River watersheds, as well as other watersheds if natural populations are discovered there (USFWS, 2018b).
- Priority 1(2). Protect remnant populations and individuals of Texas snowbells from ungulate browsers, and reduce browse intensity through population management of native white-tailed deer and introduced ungulates in the upper Nueces, West Nueces, and Devils River watersheds (USFWS, 2018b).
- Priority 1(3). Conduct scientific investigations to guide conservation efforts (USFWS, 2018b).
- Priority 2(4).Augment small populations and isolated individuals to increase reproductive rates, and reintroduce populations to restore gene flow between and among remnant populations in the upper watersheds of the Nueces, West Nueces, and Devils Rivers. Augmentation and reintroduction may also be appropriate in the Frio, West Frio, Dry Frio, and Sycamore Creek watersheds if natural populations are confirmed there, but is contra-indicated if other subspecies of Styrax platanifolius occur there, since this could lead to hybridization between subspecies (USFWS, 2018b).
- Priority 3(5). Search for new populations in potential habitats throughout the subspecies' range. In particular, the discovery or confirmation of populations in the Frio, West Frio, Dry Frio, or Sycamore Creek watersheds would increase our knowledge of the subspecies' geographic range and adaptability, and might confer greater ecological and genetic diversity (representation) to the subspecies as a whole (USFWS, 2018b).
- Priority 3(6). Promote conservation and management of native bees, butterflies, and other pollinators in the upper Nueces, West Nueces, and Devils River watersheds (USFWS, 2018b)
- Priority 3(7). Verify that viable, self-sustaining populations occur within each recovery unit and have maintained stable or increasing population sizes for three or more generations (a minimum of 30 years). One generation has passed when individuals are successfully recruited through seed germination within habitats, survive to maturity, produce viable seed, and the second-generation seed germinates in the same habitats. Based on observed

growth rates in the wild, a single generation takes at least 10 years to complete (USFWS, 2018b).

- Update the Recovery Plan to include objective and measurable recovery criteria that address all of the five listing factors that are relevant to the species. (USFWS, 2008)
- Obtain information on all natural and reintroduced populations to adequately assess the status of the species. (USFWS, 2008)
- Map the amount and distribution of potential Texas snowbell habitat across the range. (USFWS, 2008)
- Conduct a population viability analysis. (USFWS, 2008)
- Draft a reintroduction plan to maximize efficiency and success for meeting recovery criteria. (USFWS, 2008)

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SPECIES ACCOUNT: *Suaeda californica* (California seablite)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

An evergreen shrub that forms low mounds, leafy with fleshy, narrow leaves, each 5-35 mm long. The tiny flowers (2-3 mm across) are borne July-October. (NatureServe, 2015)

Taxonomy

Suaeda californica was first described by Sereno Watson in 1874, based on type material collected by Bolander and Kellogg in San Francisco Bay tidal marshes. Amos Heller published the name Dondia californica in 1898, recognizing the genus name used by Michel Adanson in 1763. However, the name Suaeda has been conserved (Abrams 1944). Munz (1959) recognized several previously recognized taxa as subspecies of S. californica, and described the range as extending from San Francisco Bay south to Lower (Baja) California. Ferren and Whitmore (1983) noted that much of what had been identified as S. californica in southern California was a distinct taxon, which they named S. esteroa. Further study revealed that the only extant populations of Suaeda that resemble the type specimen of S. californica are those that occur in the vicinity of Morro Bay. In his revision of the genus, Ferren (1993) recognized S. californica as a full species (USFWS, 2013).

Historical Range

See Current

Current Range

Extirpated from the San Francisco Bay area; now known only from Morro Bay, San Luis Obispo County. May have once occured in Sonoma County as well (Skinner and Pavlik 1994). Does NOT occur in southern California or Baja California - plants of these areas are referable to S. esteroa &/or S. taxifolia (Skinner and Pavlik 1994, USFES 1994). (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Wind pollinated? (USFWS, 2013)

Breeding Season

Adult: Flowers typically appear from May to October, but mostly in late summer. Occasional flowers may be found at other times of the year, sometimes emerging as early as late spring (McMinn 1939, Baye pers. observ.) (USFWS, 2013).

Reproduction Narrative

Adult: Suaeda californica produces seeds throughout its lifespan. Reproduction appears to be entirely by seed (sexual); there are no known reports of natural regeneration from vegetative fragments. The spread of individual plants can be extensive, and sometimes resembles clonal populations. However, they have not been observed to spread clonally. Vegetative stem cuttings of S. californica treated with synthetic auxins (hormones) are easily rooted for artificial propagation (P. Baye pers. observ. 1991-1999). Reproductive maturity may in some cases be reached in as little as one year (P. Baye unpubl. data 1998). Flowering occurs on portions of the current year's shoot growth, usually on lateral branches of older wood. Flowers typically appear from May to October, but mostly in late summer. Occasional flowers may be found at other times of the year, sometimes emerging as early as late spring (McMinn 1939, Baye pers. observ.). Differences in flowering phenology may be an indication of genetic variation. One entire colony of Suaeda californica on Pickleweed Island, Morro Bay, was observed to flower precociously in April, while adjacent plants and all other colonies were entirely vegetative (P. Baye unpubl. data 2000). The longevity of individual plants is unknown, but large woody plants in stable substrate appear to live for over a decade. Very little information is available on the breeding system of Suaeda californica; however, a predominantly outcrossing breeding system would be expected for this wind-pollinated, often colonial, shrub. Abundant seed (many hundreds per plant) is produced on fruiting plants at Morro Bay. The ability of isolated plants in cultivation to produce seed (P. Baye pers. observ. 1998) suggests that at least some individuals possess a degree of self-compatibility. Abundant seed set occurred spontaneously in outdoor container-grown nursery plants at the Golden Gate National Recreation Area nursery in San Francisco in 1998. These seeds were viable and produced vigorous seedlings (E. Heimbinder pers. comm. 1999). Based on observations by marsh ecologist Peter Baye, abundant seedling establishment at Morro Bay appears to be episodic, corresponding to storm events that cause both vegetation gaps and deposits of driftline debris with seeds. Seedlings were widespread and abundant along the backbarrier shoreline following the erosive winter storms of 1998. Many thousands of seedlings and multiple-branched juvenile plants had established in the erosion zone in driftlines and litter rafts by late April 1998. Seedlings rooted in debris rafts without roots in the marsh substrate were subject to high mortality. No evidence of long distance dispersal and colonization was observed. Re-survey of the extensive 1998 seedling colonies in April of 1999 and 2000 revealed only regeneration of remnant mature shrubs that survived erosion. No juvenile or young mature plants were detected, indicating extremely high mortality of the post-storm cohort of seedlings. In contrast, the colonies of mature Suaeda californica at the north end of Morro Bay were mostly unaffected by the 1998 storm. These narrow, dense colonies acted as a significant refugia for survival and seed production during the catastrophic mortality that affected most of the population along the bayshore of the central sand spit (USFWS, 2013).

Habitat Type

Adult: Salt marsh (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species is restricted to the upper intertidal zone of a coastal salt marsh along the perimeter of a bay (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the relatively low number of known populations.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seeds of Suaeda californica are somewhat hard-coated, and are enclosed in fleshy calyces that become spongy and buoyant upon drying, and which remain attached to the fruits after dehiscence and dispersal (USFWS, 2010).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

Nine (USFWS, 2013)

Population Size:

1 - 1000 individuals (NatureServe, 2015); ~500 (NatureServe, 2015)

Population Narrative:

< 500 genetic individuals estimated by McLeod (1991) as cited in USFWS 1994. (NatureServe, 2015). USFWS (2013) notes that there are nine known occurrences of this species 5 naturally occurring in Morro Bay and 4 re-introduced locations in San Francisco Bay. Low Resiliency, representation and redundancy are inferred based on the low number of occurrences and individuals as well as the small geographic range this species inhabits.

Threats and Stressors

Stressor: Alteration and Loss of Habitat (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The historical rarity of Suaeda californica in San Francisco Bay may have been due in part to the natural rarity of its sandy high marsh and beach habitat, but its extirpation seems related to the early spread of urban and port development over the East Bay shoreline from Richmond to Alameda, centered around Oakland (P. Baye pers. comm. 2004). This heavily urbanized area was the center of both the bay's sandy shorelines and S. californica distribution. Oakland and Alameda Marshes were filled and urbanized before the 20th century, eliminating populations there, but it was the destruction of Bay Farm Island for the construction of the

Oakland International Airport in the 1950s and 1960s that probably destroyed the only remaining viable population in San Francisco Bay. Other species with affinity for sandy tidal marsh edges, such as Atriplex californica, were also described as occurring either along sandy beaches or sandy marsh edges within San Francisco Bay (Brewer et al. 1880, Jepson 1911, Greene 1894). These, too, have become extirpated. The Morro Bay population has suffered little habitat loss compared with San Francisco Bay, and has relatively abundant habitat there, despite declines following El Niño winter storm erosion. However, it is subject to strong fluctuations in abundance due to natural disturbances, particularly dune migration and shoreline erosion, and its regeneration following disturbance is vulnerable to numerous threats. Though the population has in the past been threatened by strong residential and commercial real estate development pressures on the east shore of Morro Bay, centered at Baywood Park and Los Osos, these pressures have been reduced drastically (J. Vanderweir pers. comm. 2009). Loss of habitat and individuals, and failed regeneration after natural catastrophes could cause extirpation of this population. Other threats include interference by non-native vegetation, trampling, oil spills, sea level rise associated with climate change, excessive dune mobilization, and alteration of shoreline dynamics due to stabilization and shoreline repair projects (USFWS, 2013).

Stressor: Recruitment failure (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals/Weakening population
Narrative: Trampling of seedlings in Morro Bay may contribute to the failure of Suaeda californica regeneration following catastrophic shoreline erosion caused by major storms. Trampling results from both recreational activities (hiking) and by black-tail deer (Odocoileus hemionus) populations on the sand spit, and represents a relatively infrequent threat. However since seedling recruitment is episodic and local, impacts to seedlings (which are difficult to detect) could be severely detrimental at times. This is indicated by tracks and footprints along the Morro Bay shoreline in a devegetated zone nearly 0.5 meter (0.55 yd) wide (P. Baye pers. observ. 1997-1999). As recreational pressure on the Morro Bay shoreline increases with local residential population and increased visitor use at Montaño de Oro and Morro Bay State Parks, this impact is likely to become more severe (USFWS, 2013).

Stressor: Competition with non-native species (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Exotic invasive vegetation, primarily Carpobrotus edulis X chilensis hybrids (iceplant), Eucalyptus globulus (blue gum), and Cupressus macrocarpa (Monterey cypress; a native to the Monterey peninsula only), cause significant damage to Suaeda californica by direct interference and indirect adverse habitat modification. Carpobrotus edulis establishes clonal colonies in adjacent uplands above saline influence, and can encroach by transporting nonsaline soil moisture from portions of the clone above the high tide line (P. Baye unpubl. data 1997). Most stands of S. californica along the perimeter road to Morro Beach State Park have been partially smothered by C. edulis, which grows through and over the S. californica colonies there. Carpobrotus edulis impacts are particularly significant for seedling regeneration along the backbarrier shore of Morro Bay spit. As the sandy backbarrier shoreline retreats into dense continuous stands of C. edulis on the dunes, C. edulis overhangs the erosional scarp and forms a canopy that drapes over the base of the scarp and upper shoreline. This sharply reduces or

eliminates open seedling habitat for S. californica—its regeneration niche. It may also inhibit regeneration of storm-eroded remnants of S. californica. Therefore, spread of C. edulis along the dunes of the backbarrier shoreline is likely to reduce population resilience of S. californica. In fact, removal of C. edulis near S. californica populations has had a striking effect of recovery of the later (Baye in litt. 2009). Heavy leaf litter and canopy shade from non-native trees, Cupressus macrocarpa and Eucalyptus globulus, are detrimental to seedling habitats for Suaeda californica, and apparently cause decline in vigor of remnant stands of mature plants (e.g., near the entrance of Morro Bay State Park and in Baywood Park). Degradation of the ecological niche for seedling regeneration is probably a more severe long-term threat to the viability of the S. californica population than local disturbance of existing mature colonies. Stands of S. californica have been damaged directly by broken and fallen limbs of E. globulus adjacent to Morro Beach State Park (P. Baye unpubl. data 1997-2000). The persistence of suitable and restorable habitat for reintroduction of Suaeda californica to San Francisco Bay is also threatened by non-native vegetation. In San Francisco Bay, the spread of invasive Spartina (Daehler and Strong 1996) caused the conversion of open mudflat into stabilized tidal marsh that traps sediment and moderates estuarine wave energy. This invasive vegetation intercepted alongshore transport of sand in the middle and lower intertidal zone, and inhibited the wave deposition of the sandy higher elevation marsh-beach ecotone that is important for establishment of S. californica. Invasive Spartina eradication efforts have likely eliminated the further spread of the species which could have precluded the long-term viability of S. californica reintroduction (USFWS, 2013).

Stressor: Dredging (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Navigational dredging may threaten stands of Suaeda californica that have colonized the marina shoreline at Morro Bay State Park. Dredging of the inlet channel steepens the subtidal shore profile, probably resulting in shoreline erosion along the unarmored eroding south shore of the interior shoreline of the marina, which could threaten the S. californica colony there. The marina subpopulation of S. californica is particularly significant to the species' conservation because it is highly sheltered from storm wave erosion that threatens the main population along the spit's backbarrier shoreline (USFWS, 2013).

Stressor: Predation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: In the absence of natural predators, hunting, or management in Morro Bay, deer populations are likely to forage intensively along the backbarrier shoreline where seeps provide fresh water, soft herbaceous vegetation, and flat travel corridors (USFWS, 2013).

Stressor: Small number of populations (USFWS, 2013)
Exposure:
Response:
Consequence: Extirpation
Narrative: Suaeda californica is vulnerable to extinction in the wild largely because it has been reduced to a very small number of populations distributed in a very narrow zone of the Morro

Bay and San Francisco Bay shorelines. In Morro Bay, most of the colonies occur along the erodible backbarrier shore of the Morro Bay sand spit, which is susceptible to erosion by occasional extreme storm tides and high wind-generated waves, and rapid burial by migrating dunes. Severe storm erosion occurred along this shoreline in the winter of 1997-1998, creating an extensive erosional scarp in the narrow S. californica zone. The population has not yet rebounded from this event. Although this was a natural catastrophe and rebound may occur in time, erosion events may become a recurrent threat if climate change increases storm intensity, frequency, and sea level rise rates (USFWS, 2013).

Stressor: Climate change (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/extirpation
Narrative: Extreme local fluctuations of climate (winter storms, high winds, summer drought) may be associated with global climate change. A series of severe winter storms followed by years of drought could cause catastrophic reproductive failure of the species. Global climate change and associated sea level rise may also cause long-term changes in the stability of sand beach and dune shorelines (SCOR Working Group 1991), such as those of Morro Bay spit. Suaeda californica occurs in abundance only where the backbarrier shoreline is adjacent to dune scrub vegetation that stabilizes dunes. It is sparse or absent where bare mobile dunes retreat over the backbarrier shoreline. Many of the remaining colonies are being encroached on by mobile dunes, and are not expected to survive more than a few years. The formation of new “marsh coves” (potential S. californica habitat) in the lee of stabilizing dunes may occur in the future, but none are foreseeable now. A combination of shoreline retreat and increased dune movement could significantly reduce the largest subpopulation of S. californica. Accelerated sea level rise and shoreline retreat could also force conflicts between natural movement of the Suaeda californica zone on the east shore of Morro Bay and landowner needs. Where costly residential developments are threatened by shoreline retreat, response typically involves armoring (structural stabilization) of the shoreline (e.g., revetments, seawalls, rip-rap, etc.). Currently, S. californica appears to be able to migrate with the slowly retreating shorelines of eastern Morro Bay (Baywood Park, heron rookery) (USFWS, 2013).

Stressor: Oil spills (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/extirptation
Narrative: Oil spills and clean-up operations may have significant adverse effects on Suaeda californica populations at Morro Bay, particularly on seedlings. Spilled oil tends to accumulate near the high tide line, the narrow marsh zone in which S. californica is largely restricted. Oil would probably cause high mortality of seedlings and juvenile plants during years of seedling regeneration by coating and smothering small plants with oil, and possibly by direct toxicity. Oil clean-up operations involving mechanical removal (raking, excavation) of oiled sand would also cause significant disturbance of S. californica habitat. Direct toxic effects of oil on older woody S. californica are uncertain, but are probably less damaging than effects of clean-up operations (USFWS, 2013).

Stressor: Rust Disease (USFWS, 2023)
Exposure:

Response:
Consequence:
Narrative: Researchers collected and identified a new species of rust fungus (Uromyces rebeccae) on California seablite plants from Morro Bay (Bruckart et al. 2020, pg. 546). In general, rust disease on plants may cause leaf chlorosis (yellowing), withering, and premature abscission (falling off). Heavy rust infestation reduces overall vigor and extreme cases may kill plants (Royal Horticultural Society 2023, website). Rust disease on California seablite is a new threat to the species (USFWS, 2023).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

1. Within the Morro Bay Recovery Unit, dunes are revegetated with native species to achieve natural shoreline stability consistent with that which existed in historic dune systems. (USFWS, 2023)

2. Eradication of iceplant (Carpobrotus edulis) is conducted throughout habitat for California seablite at the Morro Bay Recovery Unit. (USFWS, 2023)

3. Habitat supporting at least three populations in the Central/South San Francisco Bay Recovery Unit must exist on land in conservation ownership or under conservation management. (USFWS, 2023)

4. To provide sufficient resilience to stochastic events, all conditions under downlisting criteria 1 through 3 (above), have been met and have resulted in at least the following: a. Number of populations: a minimum of three populations must occur in the Morro Bay Recovery Unit and a minimum of three populations must occur in the Central/South San Francisco Bay Recovery Unit. A population shall be any concentration of plants separated by greater than 1.9 km (1.2 miles) from other such concentrations of plants, with no intervening locations observed over a period of five years. b. Number of plants: minimum – for five consecutive years of monitoring, the three populations in the Morro Bay Recovery Unit must total a minimum of 3,000 individuals. c. For five consecutive years of monitoring, the three populations around the San Francisco Bay must total a minimum of 1,500 individuals. (USFWS, 2023).

Delisting Criteria:
1) protection of the population at Morro Bay to ensure its long-term survival (USFWS, 2013).

2) re-establishment of suitable habitat with new populations in San Francisco Bay, the historical range of the species

Recovery Actions:

- 1. Any person collecting information on Suaeda californica as part of field surveys or research should be encouraged to submit occurrence information to the CNDDB to provide a more comprehensive picture of this species distribution and status throughout its range (USFWS, 2010).

- 2. Potential re-introduction sites for Suaeda californica within the San Francisco Bay area and other sites within its historic range should continue to be evaluated by the Service (USFWS, 2010).
- 3. Land managers and the Service should work cooperatively to begin population surveys in all potentially suitable and legally-accessible habitat along the central coast to determine if there are yet undiscovered occurrences of Suaeda californica and to update the status of known occurrences (USFWS, 2010).
- 4. The CDPR and the Service should continue monitoring of existing outplanting efforts and seek to identify additional sites for outplanting of Suaeda californica on Federal, State, or otherwise conserved lands along the coastline in San Luis Obispo County (USFWS, 2010).
- 5. Establish site-specific and species monitoring protocols to identify potential impacts of sea-level rise and storm surge associated with climate change. This will assist in determining the effects of projected sea level rise and increased storm surge events on Suaeda californica and its habitat (USFWS, 2010).
- 6. The CDPR and Morro Coast Audubon Society should develop and implement active nonnative invasive species eradication programs for those occurrences of Suaeda californica under their management authority. Post-eradication, sites should be evaluated for their potential to re-establish occurrences of S. californica (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Obtain access (if possible) to all known/mapped California seablite occurrences to conduct monitoring surveys of the status, abundance, approximate size and age of plants observed, and evaluate threats at these locations. Include estimates of numbers of individuals present, global positioning system (GPS) mapping of occupied spatial area, ecological setting, co-occurring and co-dominant vegetation, presence of natives versus nonnative plant species, timing of phenology, soils and hydrological data, and observations of potential insect pollinators. Update information in resource agency databases (CNDDB) to ensure that these data remain accurate and current. 2. Develop site-specific, comprehensive management plans for California seablite occurrences designed to ameliorate the species threats, and ensure that progress towards achieving the recovery criteria outlined in the recovery plan is made, so that the criteria are ultimately met. 3. Ensure that partners at all occurrences conduct invasive weed reduction and elimination activities, with special attention toward eradication of ice plant. If necessary, dune restoration efforts should also occur, focusing on outplanting of native species to achieve natural shoreline levels of stability and curtail erosion. 4. Conduct experimental research on the species population genetic structure. Assess the genetic constitution of colonies within Morro Bay and levels of connectivity between them. Then compare these data with outplanted colonies in the San Francisco Bay Area to determine if genetic diversity in the species is maintained, if new variations occurred, and other potential effects from outplanting. Genetics work to assess the overall ability of California seablite to withstand stochastic events also needs to occur. 5. Continue experimental research on the reproductive biology of the species. In particular, we need to better understand California seablite's capacity to both outcross and self, the degree that it is utilizing these different pathways in the wild, identify insect pollinators (if they are being used), and the possible implications of these factors on the species recovery. 6. Make accessions for conservation seed banking throughout the species range, so all occurrences are represented in the collections. Conduct seed bulking of accessions that may serve as a source for recovery efforts, and a backup in the event of stochastic loss and local extirpation. (USFWS, 2023)

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SPECIES ACCOUNT: *Tabernaemontana rotensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small to medium-sized tree (USFWS, 2015). It grows to heights of perhaps 6 m (20 ft.) and is rather weak and spindly in appearance, with large, yellow-green to dark-green leaves and thin, milky sap. The inflorescence consists of a few to over 30 flowers with 5 spirally arranged, united white petals that appear slightly folded until they flare at the tips. The fruits occur singly or twinned and have one to three ridges. Each fruit is relatively small, 3 to 7 cm (1.2 to 2.8 in) long, dehiscent (they open at maturity) (USFWS, 2000).

Taxonomy

A member of the dogbane family (Apocynaceae). The genus is widespread throughout tropical and subtropical regions (USFWS, 2015). Kanehira (1936) first described the species as Ervatamia rotensis from his type collection from Rota (Kanehira 3666). Stone (1965, 1970) recognized the species from the Rota and Guam collections (Stone 5256, Kanehira 3666, Hosokawa 9832) as Tabernaemontana rotensis (USFWS, 2000).

Historical Range

It is historically known from Guam and Rota (USFWS, 2015). Historically, Tabernaemontana rotensis was known from lowland dry forest on Rota; on Guam, T. rotensis was known from individual specimens in the limestone forests along clifflines at Asanite, on the University of Guam campus, and at the ‘‘Japanese Overlook’’ of the Naval Magazine (Raulerson and Rinehart 1997) (USFWS, 2000).

Current Range

It currently occurs on Guam and Rota (Mariana Islands) (USFWS, 2015). Distribution: Guam, Rota (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (inferred from USFWS, 2000)

Breeding Season

Adult: Guam: January, May, July (herbarium specimens); Rota: October - November (herbarium specimens) (USFWS, 2000)

Reproduction Narrative

Adult: Each fruit contains 4 to 10 seeds in a red pulp. Herbarium specimens show flowering in Guam plants has occurred in January, May, and July; specimens collected on Rota were in flower in October and November (USFWS, 2000).

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest (USFWS, 2015)

Habitat Narrative

Adult: It occurs in the forest ecosystem (USFWS, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: On Guam, seeds have been observed to mold in the seed case without separating from the fruit, indicating that birds may be useful in distributing the seeds (G. Wiles, in litt. 1998) (USFWS, 2000).

Population Information and Trends

Population Trends:

Not available

Species Trends:

Increasing (USFWS, 2015)

Number of Populations:

Guam: 6; Rota: 1 (USFWS, 2015). 7 (USFWS, 2020b)

Population Size:

Guam: 21,000; Rota: 9 wild, 30 outplanted (USFWS, 2015). 22,413 (USFWS, 2020b).

Population Narrative:

In 2004, T. rotensis was known from 8 individuals on Rota, and at least 250 individuals on Guam (69 FR 1560; January 9, 2004). The best scientific data currently available indicate that on Guam, T. rotensis is known from 6 occurrences totaling approximately 21,000 individuals (M and E Pacific, Inc. 1998, p. 61; UOG 2007, pp. 32–42), and on Rota, T. rotensis is known from 9 individuals (CNMI DLNR 2014, in litt.). Additionally, there are 30 surviving outplanted individuals on Rota (USFWS, 2015). There are approximately 15,341 naturally occurring individuals (including seedlings) of Tabernaemontana rotensis in 8 populations on Guam and 6 locations Rota, but the vast majority (14,993 individuals, including seedlings) are in a single population, and there are only 9 individuals total known on Rota. This number includes seedlings, immature, and mature plants. This is An approximate decline of 5,000 individuals from what was reported at the time of listing. However, it is unknown whether some of the historic populations were lost or simply not surveyed. (USFWS, 2020)

Threats and Stressors

Stressor: Development, military training, urbanization (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: In their 2015 Final SEIS (http:// guambuildupeis.us/) (see ‘‘Historical and Ongoing Human Impacts,’’ above), the U.S. Department of Navy states that approximately 5,000 Marines will be relocated from Okinawa to Guam, accompanied by approximately 1,300 dependents, with a concurrent introduction of support staff and development of infrastructure, and increased use of resources such as water (Berger et al. 2005, p. 347; JGPO– NavFac, Pacific 2015, p. ES–3). The current preferred alternative sites on Guam for cantonment and live-fire training include the Naval Computer and Telecommunications Station Finegayan and Northwest Field on Andersen AFB, where this species occurs. In November 2007, the people of Rota voted to legalize casino gambling to increase tourism, and two development projects have been proposed. Development around and within forested areas on Rota will also directly impact the forest habitat and individuals of this species (USFWS, 2015).

Stressor: Ungulates (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Several herds of Asiatic water buffalo or carabao roam southern Guam and the Naval Magazine area, and cause damage to the ecosystem that supports this species. Philippine deer have caused extensive damage resulting in changes in the forest structure, including erosion, grazing to the point of clearing the entire herbaceous understory, consumption of seeds and seedlings preventing regeneration of native plants and the spread of invasive plant species, and other physical damage (e.g., trunk rubbing) (Schreiner 1997, pp. 179–180; Wiles et al.1999, pp. 193–215; Berger et al. 2005, pp. 36, 45–46, 100; CNMI– SWARS 2010, p. 24; JGPO–NavFac, Pacific 2010b, p. 3–33; SWCA 2011, pp. 35, 42; Harrington et al. 2012, in litt.). Feral pigs are extremely destructive and have both direct and indirect impacts on native plant communities. While rooting in the earth in search of invertebrates and plant material, pigs directly impact native plants by disturbing and destroying vegetative cover, and trampling plants and seedlings. Pigs may also reduce or eliminate plant regeneration by damaging or eating seeds and seedlings (USFWS, 2015).

Stressor: Fire (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Fire is a human-exacerbated threat to native species and native ecosystems throughout the Mariana Islands, particularly on the island of Guam. Fire can destroy dormant seeds of native species as well as plants themselves, even in steep or inaccessible areas. Successive fires that burn farther and farther into native habitat destroy native plants and remove habitat for native species by altering microclimate conditions to those favorable to alien plants (USFWS, 2015).

Stressor: Small population size/lack of reproduction (USFWS, 2000)

Exposure:
Response:
Consequence:
Narrative: The primary threat to Tabernaemontana rotensis is the lack of reproductive vigor and seed distribution due to reduced numbers of individuals. This situation includes a lack of observed seed production on Rota, which may be due to either the lack of a pollinator or predation by insects, mice, or rats (G. Hughes, pers. comm. 1998) (USFWS, 2000).

Stressor: Nonnative plants (USFWS, 2000)
Exposure:
Response:
Consequence:
Narrative: Competition with the nonnative vines Momordica charantia (balsam pear), Mikania scandens (mile-a-minute vine), and Passiflora suberosa (wild passionfruit) may threaten seedlings and saplings (G. Wiles, in litt. 1998) (USFWS, 2000).

Recovery

Reclassification Criteria:
Not available - this species does not have a recovery plan.

Delisting Criteria:
Not available - this species does not have a recovery plan.

Recovery Actions:

- Not available - this species does not have a recovery plan.
- Area 50, a 59-ac (24-ha) exclosure on Andersen AFB on Guam containing a relictual patch of limestone forest, was created to exclude ungulates and the brown treesnake (Hess and Pratt 2006, p. 2). This enclosure was maintained for ecosystem and species experimental research. Several individuals of the tree Tabernaemontana rotensis occur within the enclosure, and would benefit from protection from predators and habitat disturbance (Hess and Pratt 2006, p. 7). However, researchers found the enclosure in a state of neglect, and invaded by nonnative plant species and pigs, with only 20 ac (8 ha) of undisturbed primary forest remaining by 2006 (Hess and Pratt 2006, p. 24) (USFWS, 2015).
- In 2014, the Navy funded a project to examine the distribution and abundance of Tabernaemontana rotensis on Joint Regional Marianas (JRM) lands (DON 2014, in litt.) (USFWS, 2015).
- Rota's Department of Fish and Wildlife constructed exclosures for two occurrences of Tabernaemontana rotensis in the Sabana Conservation Area, but only one exclosure remains, as the other burned in a fire (Hess and Pratt 2006, p. 33; 65 FR 35029, June 1, 2000) (USFWS, 2015).
- Threat and Recovery Potential: Full species with a moderate degree of threat and a high recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Surveys and inventories—Continue to conduct surveys for Tabernaemontana rotensis in historical locations and any potentially suitable habitat. •

Fire control—Identify T. rotensis populations at risk from wildfires and develop appropriate mitigation strategies. • Ungulate monitoring and control—Construct and maintain fenced exclosures to protect suitable habitat from the negative impacts of feral ungulates. • Invasive species monitoring and control—Control established ecosystem-altering nonnative invasive plant species and those that compete with T. rotensis in suitable and historical habitat. This includes brown tree snake control. • Return pollinators —Facilitate the return and translocation of suitable pollinators to populations of T. rotensis in an effort to create and maintain self-sustaining populations. • Plant propagation and translocation—Collect seeds in an effort to maintain the full genetic diversity of T. rotensis. Continue efforts to propagate, translocate, and monitor outplanted T. rotensis. Efforts should focus on bolstering the smaller sized populations. Seed banks may also serve as a safeguard in the event of extirpation from a catastrophic event like a typhoon. • Ordnance and Live Fire Control—Work with DoD to identify vulnerable areas to protect T. rotensis from damage. • Climate change planning—Develop a plan for species recovery that accounts for climate change. • Regulatory mechanisms—Recognize T. rotensis in the ESA of Guam and the CNMI. Implement more protective measures and policies regarding T. rotensis. • Alliance and partnership development—Contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- Current Management Actions: • Life History and Reproductive Biology Research—Marler et al. (2015, p. 1051) studied short-term seed storage, germination, and early seeding growth of T. rotensis which are critical for prescribing optimal nursery protocols to produce plants for use in species recovery efforts. • Reintroduction and translocation—In 2012, the Guam Plant Extinction Prevention Program (GPEPP) was formed to address conservation concerns for a select group of native Mariana Islands plant species; Tabernaemontana rotensis is listed as one of the species that GPEPP is working on. GPEPP's main objectives are monitoring, collecting, surveying, managing, and preserving genetic material. They work with conservation partners to protect wild populations and reintroduce plants to their natural habitat (GPEPP 2014, in litt.). As of May of 2019, GPEPP has propagated 160 individuals of T. rotensis in the GPEPP's nursery and translocated 114 of these individuals in various locations: 14 at Inarajan; 20 near the University of Guam Marine Lab; 16 in Yigo OP1; 35 in Yigo OP2; 31 in Yigo OP4; and 12 at the Guam National Wildlife Refuge (GPEPP 2015, in litt.; L. Gutierrez Service, 2016, pers. comm.; GPEPP 2019a, in litt.). Between August 2014 and July 2015, seed storage laboratory activities focused on viability (or germination) of T. rotensis (GPEPP 2015, in litt.). • Ungulate control— o Rota's Department of Fish and Wildlife constructed exclosures for two occurrences of T. rotensis in the Sabana Conservation Area; only one exclosure remains as the other burned in a fire (Hess and Pratt 2006, p. 33). T. rotensis was translocated across the island of Rota; the 30 surviving individuals range 4.3 to 23 ft (1.3 to 7 m) (USFWS 2015, p.59438). o There are also a number of ungulate proof fencing areas around Guam notably in and around AAFB. These include 161 acres (ac) (65 hectares (ha)) of the Habitat Management Unit (HMU) (BTS TWG 2015, entire), approximately 4,400 ft (1,341 m) of coated chain link fence along Route 2A on the perimeter of NBG as an ungulate exclosure for the 3114 ac (1,260 ha) of the main base, a 81.5 ac (33 ha) ungulate exclusion area at Naval Magazine (DoN 2018, in litt) and in Area 50, a 59 ac (24 ha) exclosure was created to exclude ungulates and the BTS (Hess and Pratt 2006, pp. 5, 32- 33).While the current state of these particular fences are unknown, several fencing projects were outlined in the Ungulate Management Plan of Andersen Air Force Base in 2012 where the majority of T. rotensis individuals are located (DoD 2012, p. 33- 42). Ungulate proof fencing have also been installed within the Guam National Wildlife Refuge on the Northeast side of Guam near Ritidian Point (USFWS 2013, p. 2). • Brown Tree Snake Control—The Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs (U.S. Geological

Survey, USFWS), are using variety of control methods for BTS around Guam including fencing, detector dogs, bait and trap, and other chemical methods including the aerial applications of acetaminophen to suppress brown tree snakes over forested areas in AAFB (Phillips 2014, in litt; BTS TWG 2015, entire; Dorr et al. 2016, entire; Clark et al. 2018). In addition, repeated and sustained applications could drastically reduce brown tree snake abundance on a landscape scale (Siers, et al. 2018, p. 1). This significant development makes reintroduction of the extirpated avian species a real possibility on Guam. Several fences to exclude ungulates and brown tree snakes were installed by the DoD. These include approximately 161 acres (ac) (65 hectares (ha)) of the Habitat Management Unit (HMU) (BTS TWG 2015, entire), approximately 4,400 ft (1,341 m) of coated chain link fence along Route 2A on the perimeter of Naval Base Guam as an ungulate exclosure for the 3114 ac (1,260 ha) of the main base, a 81.5 ac (33 ha) ungulate exclusion area at Naval Magazine (DoN 2018, in litt) and in Area 50, a 59 ac (24 ha) exclosure was created to exclude ungulates and the brown tree snake (Hess and Pratt 2006, pp. 5, 32-33). Several individuals of the T. rotensis individuals occur within this enclosure. A check of fences in 2006found the enclosure in a state of neglect, and invaded by nonnative plant species and pigs (Hess and Pratt 2006, p. 27). The current state of these exact fences are unknown. There are also BTS control efforts including baiting, trapping, and fencing within the Guam National Wildlife Refuge (USFWS 2013, p. 2). In June 2020, the Department of the Interior announced the release of $3,442,389 in fiscal year 2020 grant funding to suppress and control the BTS (DOI 2020, entire). • Biosecurity prevention— o A major biosecurity focus within the Mariana Islands is preventing the spread of brown tree snake to the CNMI from Guam. Federal agencies support local capacity both in Guam and the CNMI. Efforts include inspection of all arriving cargo from Guam to the CNMI by brown tree snake detection dogs as well as specialized trapping around all major ports of entry (DoD 2010, p. 10-7; Dorr et al. 2016, p. 20). o Tabernaemontana rotensis has been recognized as a species of greatest need by the Guam Division of Aquatics and Wildlife Resources (GDAWR) but has not been recognized as an endangered species in the Endangered Species Act (ESA) of Guam or the CNMI. (USFWS, 2020)

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SPECIES ACCOUNT: *Taraxacum californicum* (California taraxacum)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb from a taproot. Leaves are all basal. Flower heads (May-August) are pale yellow, borne on leafless, hollow stalks, about 5-20 cm tall. (This species differs from the ubiquitous dandelion, T. officinale, in several ways including paler foliage and flower color and less deeply lobed leaves.) (NatureServe, 2015)

Taxonomy

Generally accepted as a distinct species endemic to California (San Bernadino Mountains only); accepted by all pertinent references: Munz (Flora of California, 1959), Stebbins in Jepson manual (Hickman, 1993), California Native Plant Society list (Skinner and Pavlik, 1994), California Natural Diversity Database (1999), and Kartesz (1994 checklist and 1999 Floristic Synthesis). Formally listed in 1998 as an endangered species by U.S. Fish and Wildlife Service. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Endemic to the San Bernardino Mountains, ranging from the Holcomb and Bear Valleys to South Fork Meadows in the Santa Ana River watershed (USFWS, 2013)

Critical Habitat Designated

Yes; 8/14/2008.

Legal Description

On August 14, 2008, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Taraxacum californicum (California taraxacum) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes eleven critical habitat units (CHUs), in California (73 FR 47706-47767).

Critical Habitat Designation

The critical habitat designation for Taraxacum californicum includes eleven CHUs in San Bernardino County, California. This species critical habitat encompasses approximately 1,914 acres (775 ha) (73 FR 47706-47767).

Unit 2: North Baldwin Meadow We are designating Unit 2 as critical habitat for both Poa atropurpurea and Taraxacum californicum. Unit 2 consists of approximately 177 ac (72 ha) of non-degraded meadow occupied by both species at the time of listing; both species continue to occur within this unit. Unit 2 contains all of the features essential to the conservation of both species. It is located within the SBNF, on the north shore of Baldwin Lake, and northeast of Big Bear Lake. Approximately half of Unit 2 is federally owned and half is owned by CDFG. Habitat in Unit 2 was historically impacted by authorized and unauthorized vehicle use, mining activity, residential development, and grazing by burros (CNDDB 2006a, p. 1; SBNF 2002a, p. 33; SBNF

2002b, p. 57). The meadow is protected, but it is adjacent to State Route 18 and accessible to the public (SBNF 2000, p. 57). Disruption of the hydrologic regime by upstream development, trampling during illegal woodcutting, and quartzite theft activities were identified as past threats in this unit (CNDDB 2006b, p. 16). Additionally, Poa atropurpurea and Taraxacum californicum and their essential features are threatened in this unit by competition from invasion of nonnative, herbaceous annuals, and T. officinale has been reported to occur in this meadow (Krantz 2007, p. 2). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 2 due to the threats from upstream development, nonnative species invasion, hybridization, and human disturbance.

Unit 3: Belleville Meadow We are designating Unit 3 as critical habitat for both Poa atropurpurea and Taraxacum californicum. Unit 3 consists of an approximately 414-ac (168-ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Unit 3 (also referred to as Upper Holcomb Valley) contains all of the features essential to the conservation of both species. Although most individuals of P. atropurpurea observed were reported to be male, both sexes are present (SBNF 2000, p. 47). In 1999, the T. californicum population in Unit 3 was reported to be ''large'' and ''healthy'' with no apparent T. officinale hybrids (SBNF 2000, p. 56). Although no hybrid individuals are reported from this meadow, recent reports indicate that T. officinale is present at this location and the two species could hybridize (Krantz 2007, p. 2). Unit 3 is located within the SBNF, north of Big Bear Lake, and east of Hitchcock Meadow (Unit 4). The majority of lands within this unit are federally owned (409 ac (166 ha)), with only 5 ac (2 ha) of meadow habitat privately owned by the Lithuanian Scouts Association. Meadow habitat in this Unit 3 may be impacted by recreational activities and nearby diffuse mining operations (CNDDB 2006a, p. 6; Eliason 2007b); and placement of USFS roads has resulted in habitat loss and effects to meadow hydrology. Several areas of Belleville Meadow are currently heavily utilized for dispersed recreation, including vehicle use along the classified roads through the site, hiking and mountain biking along the Gold Fever Trail, and use of Holcomb Valley Campground near the western portion of the meadow. Additionally, several mining claims also exist in the meadow. Unauthorized vehicle activity and mountain biking off of classified roads and trails have caused devegetation and alteration of surface hydrology in some areas (SBNF 2002a, p. 36). Finally, Poa atropurpurea and Taraxacum californicum and their physical and biological features are threatened in this unit by invasion of nonnative, herbaceous annuals, and T. officinale has been reported to occur in this meadow (Krantz 2007, p. 2). The USFS erected signs and fencing and conducted outreach to protect occurrences in Unit 3 (SBNF 2002a, p. 37). For example, to reduce impacts to Poa atropurpurea, trails within Holcomb Valley Campground were disguised and rehabilitated, and the area was protected through barricading and signing (SBNF 2002a, p. 5). Nearby trails that did not pass through listed plant habitat were delineated and signed to encourage visitors to use those trails (SBNF 2002a, p. 5). However, special management considerations or protection may still be required to restore, protect, and maintain the essential features in Unit 3 due to the threats from human disturbance; current nearby mining activities; hybridization; and invasive, nonnative plant species.

Unit 4: Hitchcock Meadow We are designating Unit 4 as critical habitat for both Poa atropurpurea and Taraxacum californicum. Unit 4 consists of an approximately 497-ac (201-ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Although T. officinale is present, no apparent hybrids have been reported (SBNF 2000, p. 56). We do not have any information about the ratio of male to female P. atropurpurea plants in this meadow. Unit 4 contains all of the features essential to the conservation of both species

and is located within the SBNF, north of Big Bear Lake, and west of Belleville Meadow (Unit 3). The majority of Unit 4 (also referred to as Holcomb Valley) is privately owned by the Boy Scouts of America (BSA) and used as a recreational and educational activity camp (BSA 2007, p. 1). Unit 4 has been historically impacted by OHV use, horse grazing, and other human disturbance (CNDDB 2006b, p. 18). It is currently impacted by recreational and educational activities and horse grazing (SBNF 2000, p. 56; SBNF 2002a, p. 51). Additionally, Poa atropurpurea and Taraxacum californicum and their physical and biological features are threatened in this unit by invasion of nonnative, herbaceous annuals. Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 4 due to the threats from past human disturbance; current camp activities; and invasive, nonnative plant species.

Unit 5: Bluff Meadow We are designating Unit 5 as critical habitat for both Poa atropurpurea and Taraxacum californicum. Unit 5 consists of an approximately 205-ac (83- ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Although T. officinale is present, no hybrids are reported (SBNF 2000, p. 56). We do not have any information about the ratio of male to female P. atropurpurea plants in this meadow. Unit 5 contains all of the features essential to the conservation of both species. It is located within the SBNF, south of the west end of Big Bear Lake. The majority of Unit 5 is privately owned by the Wildlands Conservancy, and currently leased to the San Bernardino County Regional Parks Division as an outdoor science education camp (Wildlands Conservancy 2005). Unit 5 has been historically impacted by recreational activities, cattle grazing, and other human disturbance (CNDDB 2006b, p. 12), although impacts are limited to recreational and educational activities (Eliason 2007b; SBNF 2000, p. 57; SBNF 2002a, p. 42). Poa atropurpurea and Taraxacum californicum and their physical and biological features are also threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization of T. californicum with T. officinale (SBNF 2000, p. 57; SBNF 2002a, p. 42). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 5 due to the potential impacts of past human disturbance; current camp activities; hybridization; and invasive, nonnative plant species.

Unit 6: North Shay Meadow We are designating Unit 6 as critical habitat for Taraxacum californicum only. Unit 6 consists of an approximately 21-ac (8-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although occupancy of Unit 6 was documented one year after listing, we consider Unit 6 to be occupied at the time of listing because it contains approximately 12 percent of the total number of individuals reported since 1999 and has the second highest number of total individuals reported from any one unit, and therefore, we believe this area has been occupied for several years despite having been discovered in 1999 (see ‘‘Criteria Used to Identify Critical Habitat’’ section). Although T. officinale is present, no hybrids are reported (SBNF 2000, p. 56). This unit contains all of the features essential to the conservation of the species. It is located within the SBNF, east of Big Bear Lake, on the southern shore of Baldwin Lake, and north of Shay Road. The land in this unit is federally owned. This northern portion of Shay Meadow has been isolated by development from the southern meadow adjacent to East Big Bear Boulevard. Lakeshore habitat within Unit 6 is currently impacted by recreational activities due to the use of trails connecting private land to the lakeshore for OHV use, hiking, mountain biking, and horseback riding (SBNF 2000, p. 57; SBNF 2002a, p. 23). Additionally, Taraxacum californicum and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential

hybridization with T. officinale (CNDDB 2006b, p. 36; SBNF 2000, p. 57). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 6 due to the impacts of human disturbance; hybridization; and invasive, nonnative plant species.

Unit 7: Horse Meadow We are designating Unit 7 as critical habitat for Taraxacum californicum only. Unit 7 consists of an approximately 74-ac (30-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Occupancy throughout the meadow was confirmed as recently as 2002 (Denslow et al. 2002, pp. 12 and 13). Although T. officinale is present, no hybrids have been reported (SBNF 2000, p. 56). Unit 7 contains all of the features essential to the conservation of the species. It is located within the SBNF, southwest of Big Bear Lake, and northwest of San Gorgonio Mountain. Unit 7 is federally owned and located in the San Gorgonio Wilderness Area of the SBNF. Recreational impacts from foot-traffic are reported in Unit 7 (Denslow et al. 2002, pp. 12 and 13; CNDDB 2006b, p. 5; SBNF 2000, p. 57; SBNF 2002a, p. 54). Additionally, Taraxacum californicum and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with T. officinale (SBNF 2000, p. 57). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 7 due to threats from human disturbance; hybridization; and invasive, nonnative plant species.

Unit 8: Fish Creek Meadow We are designating Unit 8 as critical habitat for Taraxacum californicum only. Unit 8 consists of an approximately 89-ac (36-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although T. officinale is present, no hybrids are reported (SBNF 2000, p. 56). Unit 8 contains all of the features essential to the conservation of the species. It is located within the SBNF, southwest of Big Bear Lake, and northeast of San Gorgonio Mountain. Unit 8 is federally owned and occurs within the San Gorgonio Wilderness Area of the SBNF. Habitat conditions in Unit 8 are reported to be undisturbed, although diffuse recreational use impacts are likely due to trails around meadow in forested area (CNDDB 2006b, p. 6; SBNF 2002a, p. 52). Additionally, Taraxacum californicum and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with T. officinale (SBNF 2000, p. 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 8 due to the threats from human disturbance; hybridization and invasive; nonnative plant species.

Unit 9: Broom Flat Meadow We are designating Unit 9 as critical habitat for Taraxacum californicum only. Unit 9 consists of an approximately 188-ac (76-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although T. officinale is present, no hybrids are reported (SBNF 2000, p. 56). Although occupancy of Unit 9 was documented 2 years after listing, we consider it to have been occupied at the time of listing because Unit 9 supports approximately 9 percent of the total number of T. californicum individuals reported since 1999, which is the fifth largest recorded population out of 35 and more than double the average recorded population size. This unit contains all of the features essential to the conservation of the species. Unit 9 is federally owned and located within the SBNF southeast of Big Bear Lake. Unit 9 is historically impacted by OHV activity, cattle and burro grazing, and other human disturbance (CNDDB 2006b, p. 28; SBNF 2002b, p. 64). This unit and essential features therein are currently impacted by diffuse recreational activities and cattle

grazing (SBNF 2000, p. 58; SBNF 2002a, p. 46) and by invading, nonnative, herbaceous annuals, including potential hybridization with T. officinale (CNDDB 2006b, p. 28; SBNF 2002a, p. 45). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 9 due to the potential impacts of human disturbance; hybridization; and invasive, nonnative plant species.

Unit 10: Wildhorse Meadow We are designating Unit 10 as critical habitat for Taraxacum californicum only. Unit 10 consists of an approximately 52-ac (21-ha) meadow occupied by the species at the time of listing; the species continues to occur within this unit. Although T. officinale is present, no hybrids are reported (SBNF 2000, p. 56). Although occupancy of Unit 10 was documented 1 year after listing, we consider Unit 10 to have been occupied at the time of listing because Unit 10 has the highest number of total documented individuals since the time of listing among all the units (SBNF 2000, p. 56; CNDDB 2006b, pp. 30 and 31) and hosts approximately 20 percent of the total number of individuals reported since 1999, and therefore, we believe that this area was occupied for several years despite having been discovered in 1999 (see ''Criteria Used to Identify Critical Habitat'' section). Unit 10 was also reported to be occupied by Poa atropurpurea in 1981, although surveys in 1999 and 2000 did not locate any individuals (SBNF 2000, p. 47). Therefore, this unit is designated as critical habitat for T. californicum only. This unit contains all of the features essential to the conservation of the species. The land in this unit is federally owned and is located within the SBNF southeast of Big Bear Lake. Habitat in Unit 10 is reported to be of ''excellent'' quality and well protected, although some diffuse recreation impacts have been reported (SBNF 2000, pp. 56 and 58; SBNF 2002a, p. 69). Taraxacum californicum and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with T. officinale (CNDDB 2006b, p. 31; SBNF 2000, p. 56 and 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 10 due to the potential impacts of invasive, nonnative plant species; hybridization; and diffuse recreation impacts.

Unit 11: Cienega Seca Meadow We are designating Unit 11 as critical habitat for both Poa atropurpurea and Taraxacum californicum. Unit 11 consists of an approximately 81-ac (33- ha) meadow occupied by both species at the time of listing; both species continue to occur within this unit. Although T. officinale is present, no hybrids are reported (SBNF 2000, p. 56). We do not have any information about the ratio of male to female P. atropurpurea plants in this meadow. Unit 11 contains all of the features essential to the conservation of both species. It is located within the SBNF adjacent to State Route 38, southeast of Big Bear Lake, and northeast of San Gorgonio Mountain. The majority of Unit 11 (also referred to Blue Sky Meadow) is privately owned by the Los Angeles County Education Foundation (LACEF), and currently used as an outdoor science education camp (Wildlands Conservancy 2007; LACEF 2007). Unit 11 has been historically impacted by changes in the hydrologic regime due to recreational activities, cattle grazing, and other human disturbance (CNDDB 2006a, p. 2, 2006b, p. 2). Water usage from a well and vehicle use on some access roads are current threats to meadow habitat (SBNF 2002a, p. 77). Poa atropurpurea and Taraxacum californicum and their essential features are also threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization of T. californicum with T. officinale (CNDDB 2006b, p. 2; SBNF 2000, p. 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 11 due to the threats from past human disturbance; current camp activities; hybridization; and invasive, nonnative plant species.

Unit 12: South Fork Meadow We are designating Unit 12 as critical habitat for Taraxacum californicum only. Unit 12 consists of approximately 116-ac (47-ha) of meadows occupied by the species at the time of listing; the species continues to occur within this unit. Although T. officinale is present, no hybrids have been reported (SBNF 2000, p. 56). Unit 12 contains all of the features essential to the conservation of the species. It is located on Federal lands within the San Gorgonio Wilderness Area of SBNF, southwest of Big Bear Lake on the northern slope of San Gorgonio Mountain. Habitat in Unit 12 is reported to be virtually undisturbed, but possibly impacted by irregular and recreational use (CNDDB 2006b, p. 1; Krantz 2007, p. 2; SBNF 2000, pp. 56 and 58). Threats include impacts of hikers, horseback riding, and camping; however, the meadows are minimally disturbed (SBNF 2002a, p. 66). Additionally, Taraxacum californicum and features essential to its conservation are threatened in this unit by invasion of nonnative, herbaceous annuals, including potential hybridization with T. officinale (SBNF 2000, pp. 56 and 58). Therefore, special management considerations or protection may be required to restore, protect, and maintain the essential features in Unit 12 due to the threats from human disturbance; hybridization; and invasive, nonnative plant species.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Taraxacum californicum critical habitat consists of two components (73 FR 47706-47767):

(i) Wet meadows subject to flooding during wet years and forest openings with seeps, springs, or creeks in the San Bernardino Mountains in San Bernardino County located at elevations of 6,700 to 9,000 feet (2,000 to 2,800 meters), that provide space for individual and population growth, reproduction, and dispersal; and

(ii) Well-drained, loamy alluvial to sandy loam soils occurring in the wet meadow system or forest openings with seeps, springs, or creeks, with a 0 to 46 percent slope, to provide water, air, minerals, and other nutritional or physiological requirements to the species.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the areas occupied at the time of listing contain the features essential to the conservation of the species that may require special management considerations or protection. Major threats to Poa atropurpurea and Taraxacum californicum, and, therefore, to the features essential to their conservation, include development on private lands, grazing, off-highway vehicle (OHV) use, road maintenance activities, ground disturbance that affects surface hydrology, mining activities, recreational activities, habitat fragmentation, and the invasion of nonnative herbaceous plants. Please refer to the unit descriptions in the ‘‘Final Critical Habitat Designations’’ section for further discussion of special management considerations or protection of the physical and biological features related to geographically specific threats to P. atropurpurea and T. californicum. Special management considerations or protection of the wet meadows may be needed to address concerns such as reducing nonnative plant invasions and maintaining populations. Control and monitoring of nonnative, invasive plant species may be required to maintain wet meadows and or forest openings such that they can continue to support populations of Poa atropurpurea and or Taraxacum californicum. Nonnative species alter the meadow habitat by creating mats of thatch which cover bare ground needed for P. atropurpurea and T. californicum to become established,

and also use water resources that could be used by P. atropurpurea and T. californicum. The growth of nonnative species may adversely impact and change the physical and biological features of the meadow habitat. Implementing management actions that support fertilization and seed set of P. atropurpurea (Curto 1992, p. 11; Soreng 2000, pp. 1–4), and provide monitoring and protection of male P. atropurpurea clones may be required to maintain populations of P. atropurpurea. Special management considerations or protections for wet meadow habitat may need to be implemented to control the impacts associated with direct competition and hybridization caused by the nonnative Taraxacum officinale. This nonnative species occupies open niches, which can reduce the bare ground needed for T. californicum to become established, and may alter the physical and biological features of the meadow habitat. Management may include the removal of T. officinale from montane meadows where this species co-occurs with T. californicum. Additionally, it may be appropriate to remove hybridized individuals; however, we believe this course of action warrants further investigation. There are two USFS management guides that address conservation of Poa atropurpurea and Taraxacum californicum: (1) The CNF Habitat Management Guide for the Sensitive Plant Species: Delphinium hesperium ssp. cuyamacae, Lilium parryi, Limnanthes gracilis var. parishii, and P. atropurpurea, in Riparian Montane Meadows (CNF 1991, pp. 1–36) addresses conservation of P. atropurpurea; and (2) the SBNF Meadow Habitat Management Guide (SBNF 2002a pp. 1–155) addresses conservation of both species. In some cases, significant management actions have been implemented by the USFS (for example, cattle exclosures in Laguna Meadow (CNF 1991, p. 17), recreational trail closures in Belleville Meadow near Big Bear Lake (SBNF 2002a, p. 5)).

Life History

Food/Nutrient Resources

Habitat Type

Adult: Alpine meadows (NatureServe, 2014)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits edges of moist meadows at 1620-2800 m elevation (NatureServe, 2015). Taraxacum californicum occurs in moist meadow habitats in the San Bernardino Mountains at elevations from 2,000 to 2,800 m (6,700 to 9,000 ft) and is often associated with Poa atropurpurea. These taxa are restricted to the relatively open edges apart from more mesic plants such as P. pratensis, Carex spp. or Juncus spp. (Krantz 1981b). The perimeter of such meadows often intergrades with sagebrush scrub dominated by sagebrush or pine forest (Krantz

1981b) (USFWS, 1998). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and it's the relatively narrow geographic range it inhabits.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: We have no information on age class structure, pollen and seed dispersal, seedling establishment, persistence of seed in the soil, or adult mortality of any of the occurrences (USFWS, 2013).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

17 extant and 19 presumed extant occurrences (USFWS, 2021)

Population Size:

2 to 300 indivduals/occurrence (USFWS, 2013)

Population Narrative:

Based on those updates, there are 42 non-erroneous occurrences of Taraxacum californicum (Table 1), of which 17 are extant, 19 are presumed extant, 4 are possibly extirpated, and 2 are extirpated. The occurrence status updates show a decrease in the number of extant occurrences between 2013 and 2021 (Table 1). Rangewide maximum abundance estimates from across occurrences (Table 2) indicate that fewer plants were found between 2001 and 2012 than between 2013 and 2021. In summary, there are 42 occurrences of Taraxacum californicum. Monitoring for the species has occurred at 24 occurrences since 2013 (Table 1), providing new information about the species' presence and abundance. We also reassessed our 2013 occurrence status determinations and updated the status of 26 occurrences (Table 1, Table 3), based on new monitoring data, the date since last survey, and information from State and Federal partners. (USFWS, 2021)

Threats and Stressors

Stressor: Alteration of hydrological conditions (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The listing rule identified alteration of hydrological conditions as a significant threat to Taraxacum californicum habitat, noting potential impacts from roads and OHV activity (USFWS 1998, pp. 49012–49013). As discussed in the 2008 review, the SBNF identified alteration of hydrological conditions as a threat in their Meadow Habitat Management Guide (SBNF 2002). According to the management guide, meadows exist as a function of hydrology. Alteration of the local hydrology is, therefore, perhaps the greatest threat to this type of habitat. Any activities that affect site hydrology (e.g., lowering of water table, water diversion, overgrazing, off-road

driving, roads, trails, mining, and historical or recent grazing) pose threats to meadow habitat and meadow plants (SBNF 2002, pp. 22, 24) (USFWS, 2013).

Stressor: Urbanization (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The listing rule identified the relatively unrestricted development of privately-owned parcels in the Big Bear area outside the boundaries of the SBNF as a continuing threat. Half of the Taraxacum californicum occurrences at the time of listing—10 out of 20—were reported to be located within, or adjacent to, urbanized areas such as Big Bear City, Big Bear Lake Village, and Sugarloaf (USFWS 1998, p. 49009). Of these, four occurrences located at Metcalf Meadows (north occurrence), China Gardens/Eagle Point Meadows, Pan Hot Springs Meadow, and Rathbun (also known as Moonridge) Meadow fell within areas depicted as residential, commercial, or flood plain on a zoning map for the City of Big Bear Lake (USFWS 1998, p. 49013). The listing rule noted the apparent extirpation of the occurrence at Rathbun Meadow (T. Krantz, Environmental Consultant, 1993, pers. comm.). Development currently remains a threat to meadow habitat of five Taraxacum californicum occurrences on private land in the Big Bear area. Another six T. californicum occurrences are located in meadow habitat adjacent to developed areas and are threatened by indirect effects related to urbanization. In addition to directly removing meadow habitat, development degrades meadow habitat by altering site hydrology, increasing access to foot and vehicular traffic, and introducing nonnative plant species (USFWS, 2013).

Stressor: Roads and unauthorized Off Highway Vehicular (OHV) Use (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/Habitat degradation
Narrative: Roads and unauthorized OHV use has been ameliorated at two occurrences through management actions of the SBNF (fencing, etc.), but continues to be a moderate threat to meadow habitat at 13 of 23 Taraxacum californicum occurrences. Nine of these occurrences are within or partially within CDFW and SBNF lands, though they continue to pose management challenges. Four occurrences entirely within private land in the Big Bear area are threatened by roads and unauthorized OHV use due to lack of protection and close proximity to roads (USFWS, 2013).

Stressor: Developed and dispersed recreation (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/Habitat degradation
Narrative: Developed and dispersed recreation remains a moderate threat to meadow habitat at 17 of 23 Taraxacum californicum occurrences (Appendix 1). Since listing, developed and dispersed recreation due to close proximity to campgrounds has been identified as a threat at five additional meadows (in addition to North Shore Meadows identified at listing): Bluff Meadow, Hitchcock Meadow and Belleville Meadow in Holcomb Valley, Red Ant Meadow, and Merriman Meadow. Additionally, a popular dispersed campsite on the SBNF (referred to as Yellow Post Site 25) threatens adjacent T. californicum habitat in Metcalf Meadow. Dispersed recreation has the potential to affect all occurrences of T. californicum, including occurrences entirely within private land in the Big Bear area. Seven, or nearly one-third of T. californicum

occurrences, are recognized by the SBNF as particularly vulnerable to these threats due to their close proximity to campgrounds and concentrated use areas (USFWS, 2013).

Stressor: Mining activities (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/Habitat degradation
Narrative: We have not received any new information to change our conclusion from the 2008 5-year review that mining is a current threat to Taraxacum californicum habitat at one occurrence (USFWS 2008a, p. 14) (USFWS, 2013).

Stressor: Grazing (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat/Habitat degradation/Loss of individuals
Narrative: Grazing is a moderate threat to 26 percent (6 of 23) of Taraxacum californicum occurrences. Horse grazing continues to threaten T. californicum and its habitat at three occurrences on private land. Significant steps were taken by the BLM and SBNF to reduce cattle and wild burro grazing within habitat occupied by T. californicum such that cattle grazing is not a substantial threat at this time. Although burro grazing has been reduced, it still threatens T. californicum and its habitat at four occurrences (USFWS, 2013).

Stressor: Competition with other plant species (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Alteration of habitat, through competition with other plant species continues to be a rangewide and moderate threat to meadow habitat at all 23 Taraxacum californicum occurrences (USFWS, 2013).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In summary, the Act provides the greatest regulatory protection to Taraxacum californicum. Many occurrences (13 in whole and 4 in part) are on USFS lands, and 1 occurrence is on both USFS and State land, where protection is afforded through land management plans. The NFMA in conjunction with the requirements of NEPA provides important guidance and policy for maintaining ecosystem and species-specific biodiversity on USFS lands via the development and implementation of land management plans (and environmental impact statements). This includes amendments or revisions to the land management plans, as well as conservation recommendations provided in the Meadow Habitat Management Guide (SBNF 2002). CDFW manages one occurrence within the Baldwin Lake Ecological Reserve. Finally, one occurrence on private land is owned and managed by TWC in their Bluff Lake Reserve. Thus, 15 occurrences in whole and 4 in part currently have some protections provided by Federal and State agencies, and private organizations. However, these protections are discretionary and subject to funding availability (USFS 2012a, p. 93). Therefore, current conservation measures are not sufficient to reduce all threats and are largely dependent on the federally listed status of T. californicum. As a

result, regulatory mechanisms provided by other Federal, State, and local laws and ordinances do not independently or collectively provide adequate regulatory protection to T. californicum (USFWS< 2013)

Stressor: Hybridization (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of genetic viability
Narrative: Since our 2008 review, we received information indicating that hybridization with another nonnative dandelion, Taraxacum erythrospermum (red-seeded dandelion), may be a threat. Similar to T. officinale, it has a range of chromosome counts, including a count of 16 (2n=16, 32) (Brouillet 2006, pp. 245–246). This species has been identified at three occurrences in Big Meadow, Horse Meadow, and Holcomb Valley (CCH 2011, pp. 1–3; Eliason 2011a, pers. comm.) (USFWS, 2013).

Stressor: Limited numbers of Taraxacum californicum individuals (USFWS, 2013)
Exposure:
Response:
Consequence: Lack of genetic diversity
Narrative: In the listing rule, we identified the limited number of Taraxacum californicum individuals as a threat to T. californicum; however, no specific meadow areas or population densities were identified (USFWS 1998, pp. 49016–49017). Barrett and Kohn (1991) have discussed the consequences of small population size in plants. They stress the need for maintaining genetic diversity, especially for rare alleles (different forms of a gene). Maintaining diversity of alleles in self-incompatible (outcrossing) plants is important to ensure production of fertile seeds, and thus is important for the survival of plant populations. The likelihood of maintaining diversity decreases in smaller populations (Barrett and Kohn 1991, pp. 9, 10, 13). Thus, factors that negatively affect Taraxacum californicum individuals are more likely to threaten the survival of the species as a whole. The limited number of Taraxacum californicum individuals is a substantial threat of particular concern at 18 of 23 occurrences (78 percent), and possibly rangewide (USFWS, 2013).

Stressor: Fire suppression measures (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Since 2008, implementation of fire suppression measures has been identified as a new threat at 9 of 23 extant Taraxacum californicum occurrences. The San Bernardino County Land Use/Fire Hazard Abatement Division (see FACTOR D discussion) requires that owners must remove weeds and grasses in areas where this vegetation acts as a fuel that may pose a fire threat. Weeds and grasses are described by the County of San Bernardino generally as annuals that grow and dry out each year, and they did not discriminate for rare plants (County of San Bernardino 2011a, pp. 3–4; County of San Bernardino 2011b, p. 1). Weed and grass removal generally involves mowing, which damages or destroys individual T. californicum plants. If removal activities are conducted before or during T. californicum flowering and fruit development, the plants reproductive output and germination may be significantly impacted (USFWS, 2013).

Stressor: Climate change and drought (USFWS, 2013)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although there is uncertainty in climate change projections and the effects of climate change on this particular species, it seems likely that Taraxacum californicum, a species restricted to montane meadows in a single small portion of a mountain range found on particular soils with particular hydrological needs, would be threatened rangewide by differences in climatic regimes brought on by changes to the climate in the future. Therefore, based on the best available scientific data at this time, we believe climate change and drought is likely a significant threat to this species (USFWS, 2013).

Recovery

Recovery Actions:

- No recovery plan (USFWS, 2013)
- 1. Continue to work with the State to purchase Taraxacum californicum habitat from willing sellers (e.g., Shay Meadow, Metcalf Meadow) (USFWS, 2013).
- 2) Continue to work with the Big Bear City Community Services District to adopt and implement the draft Pan Hot Springs Habitat Management Plan and record the Restrictive Covenant per the plan (USFWS, 2013).
- 3) Continue to work with local partners to identify an appropriate entity or entities to hold and manage conservation easements that protect Taraxacum californicum habitat (USFWS, 2013).
- 4) Expand the existing seed bank at Rancho Santa Ana Botanic Garden to include samples from populations determined to be key by the SBNF and the Service to buffer the species from genetic loss, should small populations become extirpated (USFWS, 2013).
- 5) Recommendation specific to threats from limited numbers of Taraxacum californicum individuals and hybridization: 1) Determine the breeding system of T. californicum and confirm the nature and extent of introgression with T. officinale and T. erythrospermum. Determine accurate rangewide chromosome counts of T. californicum, local T. officinale and T. erythrospermum. 2) Support SBNF efforts to conduct a prescribed burn of Juniper Meadow and study whether this burn will facilitate germination of any existing T. californicum seed in the soil (USFWS, 2013).
- 6) Recommendation specific to threats from competition with other plant species: Promote research and work with partners to determine the extent to which buildup of thatch contributes to the decline of Taraxacum californicum and to conduct comparative work on thatch removal methods (i.e., study the benefits and risks of fire, mowing, and any other thatch removal methods). Support SBNF efforts to conduct a prescribed burn of Juniper Meadow (USFWS, 2013).
- 7) Recommendation specific to threats from roads and unauthorized OHV use, and developed and dispersed recreation: Support SBNF efforts to identify additional key areas to close to human access (e.g., Yellow Post Site YP25 at Metcalf Meadows) (USFWS, 2013).
- 8) Recommendation specific to threats from inadequacy of existing regulatory mechanisms: Work with the State and San Bernardino County to help facilitate implementation of the weed abatement plan while minimizing impacts to rare plants including Taraxacum californicum. (USFWS, 2013).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS 1. Continue to collect additional seed from Taraxacum californicum occurrences to expand the ex-situ conservation seed bank at the California Botanic Garden (formerly Rancho Santa Ana Botanic Garden). 2. Study Taraxacum californicum population genetics, including levels of genetic diversity and differentiation within and among occurrences, and levels of inbreeding, relatedness, and ploidy. This information will allow us to assess levels of current genetic diversity and gene flow, assess whether genetic management is needed, and assess appropriate seed sources for potential future reintroduction or augmentation activities. 3. Develop a propagation protocol for Taraxacum californicum to support potential future augmentation or reintroduction activities. 4. Coordinate with landowners to identify opportunities for conservation on private lands. Work with private landowners, local governments, and conservation organizations to conserve, manage, and enhance habitat for Taraxacum californicum. 5. Continue to monitor Taraxacum californicum occurrences to update occurrence status, size, and threats. That information can be used to identify high-priority occurrences for management or areas for restoration. 6. Monitor meadow hydrological conditions and identify opportunities for meadow restoration. 7. Identify opportunities for Taraxacum californicum augmentation to meadows where occurrence size is small. (USFWS, 2021)

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SPECIES ACCOUNT: *Ternstroemia luquillensis* (Palo colorado)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) 04/22/1992

Physical Description

Ternstroemia luquillensis is an evergreen tree of up to 20 meters in height, with dark gray smooth bark. The elliptic to oblong-elliptic entire, extipulate, and coriaceous leaves are about 6-12 cm long and 2.5-4 cm wide. The leaves are acute at both ends, with the midvein sunken; they are black punctate below, with stout petioles of 6-12 mm long. The perfect, actinimorphic flowers are fragrant and solitary, congregating at the end of the branches. The flowers measure about 2.5 cm in diameter, with a slender pedicel of 2.5-9 cm long. The flowers contain five 9 mm long imbricated sepals, and five 12 mm long creamy white petals. Flowers bear numerous stamens, adnate to the base of the corolla, and a two-celled superior ovary with 16-20 ovules in each cell. The fruit is an ovoid capsule with a persistent style, which contain several small bright red seeds of 3 mm long (USFWS, 1993).

Historical Range

See current range/distribution.

Current Range

Ternstroemia luquillensis (palo colorado) is an evergreen tree only known from six individuals within the palo colorado and dwarf forests of the Luquillo Mountains (USFWS, 1993). As of 2019, there is a botanical voucher that reports the presence of palo colorado in the municipality of Maricao on the opposite side of the Island (interior west of Puerto Rico; USFWS 2015). However, no further information is known from this site. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology. Ternstroemia luquillensis has been collected with flowers in June and July (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest; dwarf/elfin forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander at al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of Callicarpa ampla and Styrax portoricensis, and some localities of Ternstroemia luquillensis and Ternstroemia subsessilis occur within the palo colorado vegetation type. Some localities of Ternstroemia luquillensis and Ternstroemia subsessilis, and all the localities of Ilex sintenisii occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

Four (USFWS, 2015)

Population Size:

Six total individuals (USFWS, 2015)

Population Narrative:

When the recovery plan was approved in 1995, the number of individuals of T. luquillensis was known to be 6 individuals in 4 populations, and 37 individuals in 4 populations for T. subsessilis, all within the Luquillo Mountains (USFWS 1995) In addition to the populations of El Yunque National Forest, there are two specimen collections of T. luquillensis at the herbarium of the University of Puerto Rico at Mayaguez (MAPR) that were collected within the Maricao Commonwealth Forest. However, the herbarium specimens do not contain any information about the abundance of the species in the area. Based on the above, the USFWS does not have enough data to accurately determine the status of these two species at this time. Because of the absence of sightings, it is possible that the species' status may be declining or that some of their populations are extinct, but further monitoring is needed to support this conclusion (USFWS, 2015). In addition, Low resiliency, representation and redundancy are inferred based on low number of populations and individuals. (USFWS, 2015). Out of the three species, Styrax portoricensis and Callicarpa ampla appears to be persisting, although, their population numbers and individuals per populations are very low, and no recruitment was observed during the assessments conducted by PRDNER. As for Ilex sintenisii, a new population was found and the number of individuals are higher than the other two species, but the assessment showed a decline in individuals compared to the numbers from the 2015 5-year status review, in addition no recruitment was observed in these populations. Although we do not have new data for Ternstroemia luquillensis and T. subsessilis, their population levels were low at the time of listing, and individuals were not found during the 2011 surveys. (USFWS, 2021)

Threats and Stressors

Stressor: Forest management (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of I. sintenisii, S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to I. sintenisii, S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive

landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, I. sintenisii seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for I. sintenisii is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of I. sintenisii, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of I. sintenisii as well as S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of viability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of I. sintenisii, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-

imminent (USFWS, 2015).

Recovery

Reclassification Criteria:
An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis , and Ternstroemia subsessilis within the Caribbean. National Forest property has been prepared and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:
1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).

2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:
- 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline

information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations are additional to the recommendations provided in the 2015 5- year status review for these species. A11 1. Search for the species outside the trails where the historic populations are located, and within suitable habitat in private lands adjacent to EYNF. 2. Conduct genetic studies to determine the viability of these species into the future. 3. Conduct a seed viability study particularly for Callicarpa ampla and Styrax portoricensis to determine if that is a factor that could be affecting their recruitment. 4. Develop a propagation and reintroduction protocol for all five species in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza, and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species. 5. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside the boundary of EYNF to safeguard these lands since they share similar vegetation and habitat characteristics. (USFWS, 2021)

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SPECIES ACCOUNT: *Ternstroemia subsessilis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) 04/22/1992

Physical Description

Ternstroemia subsessilis is an evergreen shrub or small tree of up to 5 m height. The leaves are alternate, exstipulate, and thick, measuring 3-7 cm long and 1.5-2.8 wide. The leaf blade is obovate to oblanceolate, with an obtuse and sometimes apiculate apix, and a cuneate base. The leaves are revolute, with a punctate lower leaf surface. Petioles are stout, measuring 6.6 mm long. The flower is perfect, actinomorphic and solitary, growing axillary from the end of the branches. The short pedicel, of 1-2 mm long, makes the flower appear sessile or subsessile, as the specific epithet of this plant suggests. The calyx consists of five glandular, imbricate sepals, 2-5 mm long. The corolla contains five white, connate, orbicular or concave petals, 10 mm long. The stamens are numerous, being adnate at the base of the corolla. The ovary is superior and probably two-celled. The fruit is an ovoid-conical capsule of 10 mm long, with a sharp point (USFWS, 1993).

Historical Range

Ternstroemia subsessilis (no common name) is an evergreen shrub or small tree which has been reported from the Luquillo Mountains and the Maricao Forest. It is currently known only from a population that consists of 37 individuals from nine sites at the Luquillo Mountains (USFWS, 1993).

Current Range

USFWS (2015) notes that there are 4 populations, all within the Luquillo Mountains.

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 2015)

Reproduction Narrative

Adult: Little is known about the reproductive biology of this species. Ripe fruits were observed on various individuals of Ternstroemia subsessilis in May 1991 (Garcia and Laboy 1991) (USFWS, 1993).

Habitat Type

Adult: Palo colorado forest (USFWS, 1993)

Habitat Vegetation or Surface Water Classification

Adult: Palo colorado forest; dwarf/elfin forest (USFWS, 1993)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1993)

Site Fidelity

Adult: High (inferred from USFWS, 1993)

Habitat Narrative

Adult: The Luquillo Mountains region is of volcanic origin and of a rough topography, with cliffs and rock exposures at high elevations. Six major rivers are born in the mountains and waterfalls are numerous. Nineteen soils belonging to four soil associations have been identified within the Caribbean National Forest (Silander at al. 1986), of which the Los Guineos-Guayabota-Rock land association constitutes the most extensive one (USDA 1977). This association contains acidic, shallow to deep, well drained to poorly drained steep soils. The Caribbean National Forest holds four vegetation types: tabonuco forest, palo colorado forest, palma de sierra forest, and dwarf or elfin forest. All the known localities of Callicarpa ampla and Styrax portoricensis, and some localities of Ternstroemia luquillensis and Ternstroemia subsessilis occur within the palo colorado vegetation type. Some localities of Ternstroemia luquillensis and Ternstroemia subsessilis, and all the localities of Ilex sintenisii occur in the dwarf forest vegetation type (USFWS, 1993). High ecological integrity and site fidelity as well as low tolerance ranges are inferred based on species specific habitat needs and low number of populations.

Dispersal/Migration

Motility/Mobility

Adult: Low (Inferred from USFWS, 1993)

Dispersal

Adult: Low (inferred from USFWS, 1993)

Dependency on Other Individuals or Species for Dispersal

Adult: Low/Slow (inferred from USFWS, 1993)

Population Information and Trends

Population Trends:

Unknown (USFWS, 2015)

Species Trends:

Unknown (USFWS, 2015)

Number of Populations:

Four (USFWS, 2015)

Population Size:

37 total individuals (USFWS, 2015)

Population Narrative:

There are four known populations with a total of 37 individuals. Species level and population level trends are unknown based on lack of data (USFWS, 2015). In addition, Low resiliency, representation and redundancy are inferred based on low number of populations and individuals. (USFWS, 2015). Out of the three species, Styrax portoricensis and Callicarpa ampla appears to be persisting, although, their population numbers and individuals per populations are very low, and no recruitment was observed during the assessments conducted by PRDNER. As for Ilex sintenisii, a new population was found and the number of individuals are higher than the other two species, but the assessment showed a decline in individuals compared to the numbers from the 2015 5-year status review, in addition no recruitment was observed in these populations. Although we do not have new data for Ternstroemia luquillensis and T. subsessilis, their population levels were low at the time of listing, and individuals were not found during the 2011 surveys. (USFWS, 2021)

Threats and Stressors

Stressor: Forest management (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: At the time of listing, forest management practices such as the establishment and maintenance of plantations, selective cutting, trails and roads construction and maintenance, and shelter construction may have affected these trees. Furthermore, the proposed reconstruction and reopening of Road PR 191 was considered as a direct threat to some populations of these species. The destruction of the dwarf or elfin forests for the construction and/or expansion of communication facilities by the U.S. Navy and private entities were also considered a threat. Based on the available information, the core of the known populations of I. sintenisii, S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis occur within the boundaries of El Yunque National Forest. Since the time of listing the USFWS has not documented any case of an individual of an endangered species being affected by forest management practices (management of plantations, trail maintenance or road construction). Moreover, the plans to reopen Road PR 191 have been abandoned due to the potential for further landslides that may compromise the project. Nonetheless, the USFS consults with the Service under Section 7 of the ESA when proposing actions within the forest to ensure that possible adverse effects to listed species are avoided or minimized before any such project is implemented. In addition, the USFS conduct environmental reviews documents under NEPA for all actions in the forest. These consultation mechanisms are effective tools to minimize possible effects of management activities on species and their habitats. Based on the above, we consider the present or threatened destruction, modification, or curtailment of the species habitat or range as low in magnitude and not imminent threat to these species (USFWS, 2015).

Stressor: Overutilization (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Despite the fact that plant collection in El Yunque National Forest is prohibited, when the five species were listed, collection was considered a threat due to the ornamental potential of these species. However, there is no evidence indicating that the species has been affected by these factors. Based on the above, we believe that overutilization for commercial, scientific or

educational purposes is no longer a threat to these species (USFWS, 2015).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Since the currently known populations of these species are mostly restricted to El Yunque National Forest, and there are appropriate Commonwealth and Federal laws and regulations protecting these five species, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to them. However, historical collections indicate that suitable habitat may extend to private properties adjacent to El Yunque. In fact, some of the known populations that occur within El Yunque National Forest are located just along the boundaries of the forest. Thus, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred with other federally listed species due to lack of knowledge of the species by private land owners and law enforcement officers (USFWS, 2015).

Stressor: Hurricanes (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Due to the low number of populations and individuals, hurricanes were identified as a threat to I. sintenisii, S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in the final rule. As endemic to the Caribbean, these tree species should be well adapted to tropical storms disturbance. However, the low number of populations and individuals pose a threat to the species by making them more susceptible to stochastic events such as hurricanes. In fact, it is not clear to what extent populations of these species may have been affected by Hurricane Hugo (which devastated El Yunque National Forest in 1989) or Hurricane Georges (in 1998). The heavy rains associated with tropical storms and hurricanes in the mountains of Puerto Rico often lead to landslides. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Natural landslides are common as part of the forest dynamics of El Yunque and it is expected that the frequency of this disturbance increases as a result of severe extreme rain events or droughts. Given the steep slopes on which most of these species grow, massive landslides may extirpate entire populations. The USFWS is aware that an area of road PR 191 that formerly connected the municipalities of Río Grande and Naguabo, and that run across the forest has historically been affected by landslides. This area was the site of some populations that were not located by the interagency group in 2011. Due to the severity of landslides, it was determined that it was not logistically and economically feasible to repair this road. Based on the 2011 surveys, I. sintenisii seems to be the only species that is not imminently threatened by hurricanes and landslides. The prime habitat for I. sintenisii is associated with dwarf forest vegetation. Due to the low agricultural value and inaccessibility of this habitat, this vegetation

was not cleared during the peak of the deforestation of the island, and thus some of the highest parts of El Yunque remain as pristine forest. This explains the relative abundance of the species along the summits of Pico El Yunque and Pico del Este. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: This species may be further threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008). Vulnerability to climate change impacts is a function of sensitivity to those changes (e.g., changes rain regime and moisture availability), exposure to those changes, and adaptive capacity (Glick et al. 2011). Despite the relative abundance and apparently stability of the populations of I. sintenisii, its habitat is considered rare in Puerto Rico. These areas (dwarf forest vegetation) are ecological islands that harbor unique vegetation and environmental conditions. Shifts of vegetation communities are expected as temperatures and moisture regimes are altered by climate change. Under this scenario populations of I. sintenisii as well as S. portoricensis, C. ampla, T. subsessilis, and T. luquillensis may be displaced or outcompeted by native or exotic species with wider environmental plasticity. Despite the low number of populations and individuals, the USFWS considers hurricanes, landslides and climate change as a moderate and non-imminent threat to these species (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of viability
Narrative: Along with a decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007) and may also limit the ability of a species to respond to a changing environment (Booy et al. 2000). Given the extremely small population size and lack of connectivity between populations of S. portoricensis, C. ampla, T. subsessilis and T. luquillensis in Puerto Rico, it is highly likely that their genetic variability is extremely low. Based on the above, we consider the lack of genetic variation a high and imminent threat to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Overall, we consider hurricanes, landslides, climate change and genetic variation as threats to S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. Due to the small number of populations, the USFWS considers the above mentioned threats as high in magnitude and imminent for those species. In the case of I. sintenisii, the species is at least stable and probably improving, thus we consider the above mentioned threats as low and non-imminent (USFWS, 2015).

Recovery

Reclassification Criteria:
An agreement between the Fish and Wildlife Service and the USDA Forest Service concerning the protection of Callicarpa ampla, Ilex sintenisii, Styrax portoricensis, Ternstroemia luquillensis , and Ternstroemia subsessilis within the Caribbean. National Forest property has been prepared

and implemented (USFWS, 1993).

An agreement between the Fish and Wildlife Service and the Department of Natural and Environmental Resources (DNER) concerning the protection of the three species in Commonwealth forests has been prepared and implemented, if the species is found within DNER properties (USFWS, 1993).

New populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas (USFWS, 1993).

Delisting Criteria:
1. Existing natural populations exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors E). (USFWS, 2019).

2. Establish or discover four (4) additional populations within the current range at EYNF that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

3. Establish or discover two (2) new populations outside the current range but within the historical range (e.g., Carite, Guilarte or Toro Negro Commonwealth Forests) that exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E). (USFWS, 2019).

4. Threats have been addressed and/or managed to the extent that the species will remain viable into the foreseeable future (addresses Factor A and E). (USFWS, 2019).

Recovery Actions:
- Criterion 1 has been partially met. There is no formal agreement between the USFS and the USFWS for the implementation of a management plan to protect these five species. However, the El Yunque National Forest is managed by the USFS for conservation, and has an approved “Revised Land and Resource Management Plan” (1997), which is currently under revision. Moreover, Federal agencies are mandated to carry out programs for the conservation of endangered species under Section 7 of the Endangered Species Act (ESA) to ensure that any action authorized, funded or carried out by a Federal agency is not likely to jeopardize the continued existence of a federally listed species. Thus, the USFS continually consults with the USFWS to avoid and minimize impacts to listed species and their habitat at El Yunque National Forest. In addition, on July 26, 2005, the U.S. Congress enacted the Caribbean National Forest Act to designate approximately 10,000 acres of land in the El Yunque National Forest as wilderness and as a component of the National Wilderness Preservation System in accordance with the Wilderness Act (16 U.S.C. 1131 et seq.). This Act prohibits certain activities (e.g., timber harvest) within wilderness designated areas, although it does not preclude the installation and maintenance of facilities (e.g., data collection and remote transmission facilities) essential to the scientific and conservation purposes of the Forest Service. Therefore, the majority of the habitat upon which these species depend upon is essentially protected (USFWS, 2015).
- Criterion 2 has been partially met. Although there is no specific agreement between USFWS and the PRDNER concerning the protection of these three species in Commonwealth forests, there is an agreement between the two agencies under Section 6 of the Endangered Species

Act, in which the PRDNER carries out conservation activities for the benefit of threatened and endangered species. Furthermore, these five species are listed by the PRDNER as endangered, and thus are protected by regulations of the Commonwealth of Puerto Rico (See factor D.). Therefore, special consideration is taken when considering actions within areas that harbor suitable habitat for these species (USFWS, 2015).

- Criterion 3 has been initiated. The Puerto Rico Conservation Trust (PRCT) is successfully propagating Styrax portoricensis. The USFWS has utilized some of this material and begun planting this species (approximately 50 individuals) at El Yunque National Forest. In addition, the PRDNER began planting Styrax portoricensis (approximately 5 individuals) in the Carite Commonwealth Forest. Furthermore, the USFS has propagated Callicarpa ampla by air layering (cloning by promoting rooting of branches using hormones), and has planted about three individuals at El Portal in El Yunque National Forest. However, little information is available about the reproductive biology and the ecology of these species. Further research and monitoring of reintroduced individuals is required to determine the success of these actions. There is no information about the propagation of any of the remaining three species (Ilex sintenisii, Ternstroemia luquillensis and Ternstroemia subsessilis) (USFWS, 2015).
- New in 2019: 1. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside/bordering EYNF since these lands share similar vegetation and habitat characteristics. This new action should be included within Recovery Task 11. (USFWS, 2019).
- 2019 - 2. A protocol for the propagation and reintroduction of all five species should be developed in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation in Ft. Collins. This new action should be included within Recovery Task 33. (USFWS, 2019).
- 2019 - 3. Studies in the species' population genetics should be conducted to determined patterns of genetic diversity across the species natural distribution, and to provide baseline information for sound management of these species. This new action should be included within Recovery Task 3. (USFWS, 2019).
- 1. The USFS should establish a long term monitoring program for the populations of listed plants at El Yunque National Forest to determine population trends for these species. The guidelines for these monitoring should be included as part of the El Yunque National Forest Management Plan (USFWS, 2015).
- 2. Develop a comprehensive survey and assessment of the population of I. sintenisii. This survey must be standardized to ensure that the habitat (dwarf forest) is efficiently surveyed (USFWS, 2015).
- 3. Molecular studies should be conducted to determine the relationships within the genus Ilex in Puerto Rico (USFWS, 2015).
- 4. The USFS, PRDNER and the USFWS should develop an intensive survey program to inventory areas within and outside El Yunque National Forest with potential habitat for these species. This program should include training to field biologists to allow personnel to recognize listed species in the field (USFWS, 2015).
- 5. The populations that are actively producing seeds need to be identified and monitored to collect seed material for recovery purposes. A protocol to collect seed should be developed

and implemented to avoid altering the natural recruitment of the species (USFWS, 2015).

- 6. Enhancement of natural populations should be considered a priority, particularly for S. portoricensis, C. ampla, T. subsessilis and T. luquillensis. The development of adequate propagation techniques is essential for the recovery of these species (USFWS, 2015).
- 7. Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species genetic variability (USFWS, 2015).
- 8. The recovery plan should be revised to establish measurable delisting criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2015).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The following recommendations are additional to the recommendations provided in the 2015 5- year status review for these species. 1. Search for the species outside the trails where the historic populations are located, and within suitable habitat in private lands adjacent to EYNF. 2. Conduct genetic studies to determine the viability of these species into the future. 3. Conduct a seed viability study particularly for Callicarpa ampla and Styrax portoricensis to determine if that is a factor that could be affecting their recruitment. 4. Develop a propagation and reintroduction protocol for all five species in collaboration with partners (e.g., University of Puerto Rico, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza, and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking these species. 5. Establish long-term conservation mechanisms (e.g., land conservation easements and conservation agreements) for private lands outside the boundary of EYNF to safeguard these lands since they share similar vegetation and habitat characteristics. (USFWS, 2021)

References

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SPECIES ACCOUNT: *Tetramolopium arenarium* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tetramolopium arenarium ssp. arenarium is an erect tufted shrub 0.8 to 1.3 meters (2.6 to 4.3 feet) tall. Plants are covered with tiny glands and straight hairs. Leaves are alternate, shallowly toothed (or toothless), and lance-shaped. They range in length from 15 to 35 millimeters (0.6 to 1.5 inches) and in width from 3 to 9 millimeters (0.1 to 0.4 inch). Inflorescences are terminal with 5 to 10 heads. Each head has 20 to 34 bracts beneath a single series of white florets (male ray florets) on the outside and fewer than 15 inner bisexual maroon-petalled disk florets. The fruits are compressed achenes (U.S. Army 2003a).

Taxonomy

Tetramolopium arenarium is a member of the Asteraceae, or sunflower family. Current classification recognizes three intraspecific taxa: T. arenarium ssp. arenarium var. arenarium, T. arenarium spp. arenarium var. confertum, and T. arenarium ssp. laxum. These are distinguished from other members of the genus by its erect habit; presence and types of glands and hairs on the plant; few-flowered head clusters; large male ray florets; few, bisexual, maroon-petalled disk florets; and wide achenes (U.S. Army 2003a).

Historical Range

Historically, Tetramolopium arenarium ssp. arenarium was known from the islands of Maui and Hawaii.

Current Range

Currently, between 292 and 296 individuals occur only on the island of Hawaii (see Figure 49 in the Transformation Biological Assessment) (U.S. Army 2003a).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Shrublands

Habitat Narrative

Adult: Tetramolopium arenarium ssp. arenarium occurs in Dodonaea viscosa dominated lowland and montane dry shrublands at elevations from 800 and 1,500 meters (2,625 and 4,921 feet). At the Pohakuloa Training Area (PTA) on the island of Hawaii the species is found in the Dodonaea Mixed Shrubland at elevations between 1,300 and 1,700 meters (4,265 and 5,577 feet). Tetramolopium arenarium ssp. arenarium is extremely rare on very old Mauna Kea flows (greater than 10,000 years old) (U.S. Army 2003a).

Dispersal/Migration

Population Information and Trends

Number of Populations:
1 (USFWS, 2020)

Population Size:
398 (USFWS, 2020)

Adaptability:
Fragility unknown. (NatureServe, 2015)

Population Narrative:
Fragility unknown. Currently fewer than 500 plants known. Three current (between 1982 and 1997) and three historical occurrences. (NatureServe, 2015). Currently, 398 wild individuals of Tetramolopium arenarium occur within PTA on the island of Hawai‘i in one population with recruitment observed. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that T. arenarium is vulnerable to the effects of climate change. The population is provided protection from feral ungulates by fencing and ungulate control, with some nonnative plant management. There have been no recent reintroductions on State or federal lands. Natural recruitment has been reported. Germination trials are ongoing. (USFWS, 2020)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The primary threats to Tetramolopium arenarium ssp. arenarium are feral ungulates that browse on the plant; rooting by feral pigs; competition from non-native plant species such as Pennisetum setaceum; and conversion of habitat to a fire-based vegetation community. Army training such as mounted and dismounted off-road maneuvers, bivouac, and live-fire training, increase the risk of fire, habitat fragmentation and alien plant seed spread. Off-road and on-road driving and training increases the level of dust (which can compromise plant health and vigor) due to the fine soils in northern PTA. In addition, due to the very limited distribution of this species, a single natural or human-caused environmental disturbance could be catastrophic (U.S. Army 2003a).

Stressor:
Exposure:
Response:
Consequence:
Narrative: If the species is still extant in the general area in which it was originally collected, it is threatened by alien plants, introduced ungulates, and fire. (NatureServe, 2015)

Stressor:
Exposure:
Response:
Consequence:
Narrative: Threats include fire, military activities, sheep, goats, and pigs. (NatureServe, 2015)

Recovery

Recovery Actions:

- The following important conservation actions are needed for Tetramolopium arenarium ssp. arenarium: control of non-native plant species and feral ungulates; reduction of fire risk; and research on habitat requirements, population structure, reproductive biology, and seed biology. Augmentation of small populations and re-establishment of new populations within the historical range of the species are also expected to benefit the species (U.S. Army 2003a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of T. arenarium ssp. arenarium is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from specific actions occurring at PTA (and discussed below), the Service is unaware of species-specific conservation actions being conducted for Tetramolopium arenarium ssp. arenarium.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Site, area, and habitat protection—Continue to develop and implement effective measures to reduce the impact of military activities. • Population viability monitoring—Continue to monitor wild and reintroduced populations at PTA. Determine viability and success of reintroductions at Pu‘uwa‘awa‘a. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of habitat destruction and degradation, and browsing and trampling by ungulates. • Established ecosystem-altering invasive plant monitoring and control— Control established ecosystem-altering nonnative invasive plant species, and those that compete with Tetramolopium arenarium at all populations. • Fire management—Continue to develop and implement fire management plans for PTA and Pu‘uwa‘awa‘a. • Drought management—Continue emergency hand-watering of the PTA population as necessary. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Invertebrate monitoring and control—Monitor T. arenarium for evidence of plant disease and infestations by nonnative invertebrates, and develop and implement effective control methods if necessary. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—Determine optimal sites for reintroduction including sites outside of PTA and continue to reintroduce individuals into these areas that are managed for known threats to achieve recovery goals. • Population biology research— o Study the reproductive biology of T. arenarium in the field to determine pollinators. o Research possible causes of low survivability of immature plants. • Alliance and partnership

development—Continue to work with the U.S. Army Garrison, Department of Land and Natural Resources-Division of Forestry and Wildlife, and other partners and land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—Field surveys to monitor and confirm the status of wild and reintroduced populations of Tetramolopium arenarium are conducted within PTA (U.S. Army Garrison 2020, pp. 6, 13). Threats and their impacts are monitored (U.S. Army Garrison 2020, pp. 13, 28–29). • Drought degradation and destruction—Between 2016 and 2019, water stress was the most significant stressor to T. arenarium (U.S. Army Garrison 2020, pp. 28– 29). • Nonnative invertebrate predation and herbivory— Between 2016 and 2019, aphids, spittlebugs, scale, and ants caused stress and damage to individuals of T. arenarium (U.S. Army Garrison 2020, pp. 28–29). • Captive propagation for genetic storage and reintroduction— o In 2013, PTA reported collection of more than 26,000 seeds from the only wild population, representing 222 founders, for genetic storage (U.S. Army Garrison 2013, p. 14). At least 25 percent of seeds germinated readily and seeds can be stored and retain viability for eight years (U.S. Army Garrison 2013, p. 16). o In 2019, PTA reported a total of approximately 3,700 seeds collected for storage representing 25 founders (U.S. Army Garrison 2020, pp. 35, 67– 68). The total numbers of seeds in storage are: more than 71,000 from wild individuals, almost 4,000 from greenhouse plants, and more than 8,000 from reintroduced individuals (U.S. Army Garrison 2020, p. 37). In addition, there are 258 plants in inventory (U.S. Army Garrison 2020, p. 42). o Only two plants were propagated at Pu‘uwa‘awa‘a in 2018 (Pu‘uwa‘awa‘a 2018). • Reintroduction—In 2013 and 2019, there were no reintroduction efforts (U.S. Army Garrison 2013, pp. 17; U.S. Army Garrison 2020, pp. 43–44). • Population biology—PTA conducted 10 seed germination trials using 1,465 seeds that produced 179 seedlings (approximately 12 percent germination rate) (U.S. Army Garrison 2020, p. 40). (USFWS, 2020)

References

USFWS 2016. Status of the Species and Critical Habitat: Tetramolopium arenarium (no common name). U.S. Fish and Wildlife Service 2600 SE 98TH Ave., Suite 100. Portland, OR 97266. Provided to FESTF from Chris Mullens 9/30/2016.

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SPECIES ACCOUNT: *Tetramolopium rockii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/08/1992; Pacific Region (R1) (USFWS, 2017)

Physical Description

Tetramolopium rockii, a member of the aster family, is a glandular, hairy, prostrate shrub, which forms complexly branching mats 5 to 10 cm (2 to 4 in) tall and 8 to 40 cm (3 to 16 in) in diameter. Leaves of variety calcisabulorum are 2 to 3 cm (0.8 to 1.2 in) long and 5 to 7 mm (0.2 to 0.3 in) wide, have slightly inrolled edges, and are whitish due to the long silky hairs on their surfaces. Variety rockii has smaller, less hairy, flat, yellowish-green leaves, 1.5 to 2.1 cm (0.6 to 0.8 in) long and about 0.4 to 0.6 cm (0.2 in) wide. The leaves of both varieties are spatula shaped with glands and smooth margins. Flowerheads, arranged singly at the ends of flowering stalks 4 to 12 cm (1.6 to 4.7 in) long, have a hemispherical involucre 4 to 8 mm (02 to 0.3 in) high and 10 to 18 mm (0.4 to 0.7 in) in diameter. Approximately 60 to 100 white ray florets, 3 to 4.5 mm (0.1 to 0.2 in) long and 0.5 to 1 mm (0.02 to 0.04 in) wide, surround 30 to 55 functionally male, yellow, funnel-shaped disk florets. Fruits are achenes, 2 to 2.5 mm (0.08 to 0.1 in) long and about 0.7 to 0.9 mm (0.03 in) wide when fertile, and are topped with white bristles 2.5 to 4 mm (0.1 to 0.2 in) long. This species differs from others of the genus by its growth habit, its hairy and glandular surfaces, its spatulate leaf shape, and its yellow disk florets (USFWS 1992). (USFWS, 1996)

Taxonomy

A member of the sunflower family (Asteraceae) (USFWS, 2016). St. John (1974) described a new genus, Luteidiscus, for the species of Tetramolopium with yellow disk flowers. He transferred T. rockii to the new genus and also described a new species, L. calcisabulorum. The current treatment reduces St. John's two species to varieties of Tetramolopium rockii: the nominative variety and var. calcisabulorum (USFWS 1992). (USFWS, 1996)

Historical Range

Tetramolopium rockii var. rockii was first discovered on West Molokai at Moomomi about 80 years ago. (USFWS, 2011)

Current Range

Tetramolopium rockiivar. rockii remains in two areas: from Kapalauoa to Kahinaakalani on West Molokai, and north of Kalawao on Kalaupapa Peninsula on East Molokai. (USFWS, 1996)

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Tetramolopium rockii under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes seven detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Tetramolopium rockii includes seven CHUs in Maui County, Hawaii with detailed unit information (81 FR 17790-18110).

Molokai—Coastal—Unit 1 consists of 70 ac (28 ha) of privately owned land, and 54 ac (22 ha) of federally owned land (U.S. Coast Guard) at Laau Point, from Kahaiawa to Keawakalani, along the western coast of Molokai. This unit is occupied by the plant Marsilea villosa, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 1 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 2 consists of 263 ac (106 ha) of State land, and 710 ac (287 ha) of privately owned land, from Ilio Point to Kaa Gulch, along the northwestern coast of Molokai. This unit is occupied by the plant Marsilea villosa and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai—Coastal—Unit 2 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 3 consists of 794 ac (321 ha) of State land, and 3 ac (1 ha) of federally owned land (Kalaupapa National Historical Park), from Kahiu Point to Wainene, along the north-central coast of Molokai. This unit is occupied by the plants Pittosporum halophilum, Schenkia sebaeoides, and Tetramolopium rockii, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 3 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Peucedanum sandwicense, or Sesbania tomentosa, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small

numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 4 consists of 10 ac (4 ha) on Mokapu Island on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants Peucedanum sandwicense and Pittosporum halophilum, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 4 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 5 consists of 1 ac (0.5 ha) on Huelo islet on the northern coast of Molokai. This area is State-owned, and is classified as a State Seabird Sanctuary. This unit is occupied by the plants Brighamia rockii, Peucedanum sandwicense, and Pittosporum halophilum, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 5 is not known to be occupied by Bidens wiebkei, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 6 consists of 190 ac (77 ha) of State land, and 1,685 ac (682 ha) of privately owned land, from Kaholaiki Bay to Halawa Bay, on the northeastern coast of Molokai. This unit is occupied by the plants Bidens wiebkei, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, and Ischaemum byrone, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Coastal—Unit 6 is not known to be occupied by Brighamia rockii, Hibiscus brackenridgei, Marsilea villosa, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low

population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Coastal—Unit 7 consists of 49 ac (20 ha) of privately owned land from Alanuipuhipaka Ridge to Kalanikaula, on the northeastern coast of Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Molokai—Coastal—Unit 7 is not known to be occupied by Bidens wiebkei, Brighamia rockii, Canavalia molokaiensis, Hibiscus arnottianus ssp. immaculatus, H. brackenridgei, Ischaemum byrone, Marsilea villosa, Peucedanum sandwicense, Pittosporum halophilum, Schenkia sebaeoides, Sesbania tomentosa, or Tetramolopium rockii, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Tetramolopium rockii critical habitat consists of one component. Coastal (Molokai) (81 FR 17790-18110):

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be

currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C.

munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Not available.

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrubland/chaparral (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Coastal ecosystem (USFWS, 2016)

Geographic or Habitat Restraints or Barriers

Adult: Found between 10 to 200 meters (30 and 650 feet) in elevation (USFWS, 1996)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1996)

Habitat Narrative

Adult: Inhabits dry coastal shrubland on solidified calcareous sand dunes (NatureServe, 2015). Tetramolopium rockii is restricted to hardened calcareous sand dunes or ash-covered basalt in the coastal spray zone or Coastal Dry Shrublands and Grasslands between 10 to 200 meters (30 and 650 feet) in elevation. Associated native species such as Boerhavia repens (alena), Cassytha filiformis (kaunaoa pehu), Chenopodium oahuense (aheahea), Cuscuta sandwichiana (kaunaoa), Euphorbia degeneri (akoko), Euphorbia skottsbergii var. skottsbergii (akoko), Heliotropium anomalum var. argenteum (hinahina-ku-kahakai), Ipomoea indica (koali awa), Ipomoea pes-caprae subsp. brasiliensis (pohuehue), Jacquemontia ovalifolia subsp. sandwicensis (pau-o-Hiiaka), Melanthera integrifolia (nehe), Scaevola taccada (naupaka), Sesbania tomentosa (ohai), Sesuvium portulacastrum (akulikuli), and Waltheria indica (uhaloa) with various lichens including Buellia sp. and Caloplaca sp. and grasses and sedges including Fimbristylis cymosa (mauu aki aki), Panicum torridum (kakonakona), and Sporobolus virginicus (aki aki) (Canfield 1990; Perlman 2010; Tangalin 2009). (USFWS, 1996; USFWS, 2011) Occurrences are in the coastal ecosystem (USFWS, 2016).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:
Decreasing (USFWS, 2023).

Number of Populations:
4 (USFWS, 2016)

Population Size:
Currently, there are approximately 7,000-10,000 individuals of Tetramolopium rockii var. rockii, and 1,000-2,000 of Tetramolopium rockii var. calcisabulorum on Molokaʻi (USFWS, 2023)

Population Narrative:
In 2003, T. rockii was known from four occurrences totaling thousands of individuals (68 FR 12982, March 18, 2003). Tetramolopium rockii var. calcisabulorum was reported from Kaiehu Point to Kapalauoa, intergrading with var. rockii. Tetramolopium rockii var. rockii occurred from Kalawao to Kahinaakalani, Kaiehu point to Kapalauoa, and Moomomi to Kahinaakalani. Currently, numbers fluctuate considerably from year to year but remain in the thousands (USFWS, 2016). Approximately 94,000 plants known. There are 3 current (between 1982 and 1997) and no historical occurrences. (NatureServe, 2015). At the time of the previous review in 2018, there were at least 10,000 individuals of Tetramolopium rockii var. rockii, and 2,000 individuals of Tetramolopium rockii var. calcisabulorum (USFWS 2018). Currently, there are approximately 7,000-10,000 individuals of Tetramolopium rockii var. rockii, and 1,000-2,000 of Tetramolopium rockii var. calcisabulorum along the northwest coast of Molokaʻi from Kaʻa Gulch to Kahinaʻakalani, and from ʻĀlau to Makaliʻi in the Kalaupapa National Historical Park (Bakutis, pers. comm. 2023). • Currently, there are approximately two known founder lines represented in ex situ storage and propagation collections, as well as additional founders of unknown origins from Molokaʻi. These collections include seeds in seed banks (Lyon Arboretum 2022; National Tropical Botanical Garden (NTBG) 2022). New Status Information: • There are at least 10,000 individuals of Tetramolopium rockii var. rockii, and 2,000 of variety calcisabulorum along the northwest coast of Molokaʻi from Kaʻa Gulch to Kahinaʻakalani, and from ʻĀlau to Makaliʻi in the Kalaupapa National Historical Park. Numbers vary widely depending on rainfall (Bakutis 2018a, in litt.; Bakutis 2018b, in litt.; Haase 2018, in litt.; National Park Service (NPS) 2015). • In 2016, the IUCN reported extreme fluctuations in population size for both varieties (Chau 2016). • In 2016, seven critical habitat units in the coastal ecosystem designated on Molokaʻi for T. rockii (4,222 ac; 1,549 ha) (81 FR 17790, March 30, 2016) (USFWS, 2018). Currently, there are approximately 7,000-10,000 individuals of Tetramolopium rockii var. rockii, and 1,000-2,000 of Tetramolopium rockii var. calcisabulorum on Molokaʻi, a slight decline from previous estimates in 2018. Seed collections are ongoing. (USFWS, 2023)

Threats and Stressors

Stressor: Trampling by deer (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Feral deer (Axis axis) trample native plants including Tetramolopium rockii var. calcisabulorum at Moomomi Preserve (Ed Misaki, The Nature Conservancy Hawaii, pers. comm. 2010). Deer are also a threat to Tetramolopium rockii var. rockii wherever the species is not protected by fenced exclosures at Kalaupapa (G. Hughes, pers. comm. 2010). (USFWS, 2011)

Stressor: Invasive introduced plants (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Invasive introduced plant species modify the habitat and compete for resources with both varieties of the species. These invasive plants include Atriplex semibaccata (Australian saltbush), Cenchrus ciliaris (buffelgrass), Chenopodium murale (lamb's quarters), Cynodon dactylon (Bermuda grass), Dactyloctenium aegyptium (beach wiregrass), Digitaria ciliaris (Henry's crabgrass), Lantana camara (lantana), Leucaena leucocephala (haole koa), Urochloa maximum (Guinea grass), Melinis repens (Natal redtop), Prosopis pallida (kiawe), Setaria parviflora (perennial foxtail), and Sporobolus indicus (smutgrass). Lantana camara grows in dense patches. Prosopis pallida forms dense thickets in this coastal zone. Weedy grasses can also out-compete Tetramolopium rockii (Canfield 1990; Perlman 2010; Tangalin 2009). The introduced invasive plant species are a threat to Tetramolopium rockii because they compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Browsing by deer, rats, goats, and cattle (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Deer, rats (Rattus spp.), and feral goats (Capra hircus) are considered threats at Moomomi, and deer are considered a threat at Kalaupapa (Perlman 2010; E. Misaki, pers. comm. 2010). Although deer have not been observed to directly browse on this species, however deer do browse on other native plants at Moomomi, including the endangered Sesbania tomentosa, and trample all native plants (E. Misaki, pers. comm. 2010). Cattle (Bos taurus) browsing was reported to be a threat to Tetramolopium rockii in 1991 (Wood 2010) but cattle have since been removed from Moomomi Preserve (E. Misaki, pers. comm. 2010). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:

Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that Tetramolopium rockii is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.893 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts (USFWS, 2018).

Stressor: Hybridization
Exposure:
Response:
Consequence:
Narrative: This species may hybridize in a narrow zone of contact along the dunes (Lowrey in Wagner et al. 1999).

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Molokai and at least one other island where they now occur or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1996)

Recovery Priority Number: 14

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Molokai and at least 1 other island where they now occur or occurred historically. (USFWS, 1996)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1996)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1996)

Recovery Actions:

- The highest priority for the recovery of the Molokai plant cluster taxa is the implementation of immediate recovery actions needed to keep “on-the-brink” species (those that number fewer than 100 individuals in the wild) from going extinct. These actions include propagation and maintenance of genetic stock ex situ, and protection of remaining wild individuals from threats. (USFWS, 1996)
- Secondly, the plan proposes the delineation of management units to conserve not only these taxa, but their habitats as well. These units should be managed to preserve as many native species (flora and fauna) as possible, through threat-control and forest-restoration programs. (USFWS, 1996)
- The next step in the recovery of these species is augmentation of small populations and re-establishment of new populations within the historical range of the species. This includes selection of areas for augmentation and reestablishment, determination of the best methods for ex situ propagation and transplanting, selection of the best genetic stock for each area, propagation of suitable stock, preparation of sites for seeding and/or transplanting, and monitoring and maintenance of new individuals and populations as they are established. (USFWS, 1996)
- A research program is also recommended to study the growth and reproductive viability of each taxon, determine the parameters of viable populations of each taxon, study the reproductive strategy and pollinators of each taxon, and study possible pests and diseases. (USFWS, 1996)
- Finally, the recovery criteria should be refined and revised as new information becomes available. (USFWS, 1996)
- Recommendations for Future Actions: Hybridization is reported as a possible threat to these varieties; however, we are not aware of any significant new information regarding the species’ biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to monitor populations using the baseline survey to track how the populations change over time. • Ungulate monitoring and control—Remove feral ungulates from within existing large-scale fences surrounding naturally occurring individuals. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around populations of T. rockii. • Captive propagation for genetic storage and reintroduction— o Collect material for genetic storage and propagation for reintroduction. o Propagate for augmentation of existing populations if needed. • Reintroduction and translocation— o Reintroduce individuals into suitable habitat protected from threats. o Research weather conditions and possible conservation actions most favorable for natural regeneration in the wild. o Research effects of possible hybridization between the two varieties. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).
- Collect material for genetic storage and propagation for reintroduction. (USFWS, 2011)
- Propagate for augmentation of existing populations if needed. (USFWS, 2011)
- Research weather conditions and possible conservation actions most favorable for natural regeneration in the wild. (USFWS, 2011)
- Establish a baseline survey to determine the current population census of the species and track, if and how, the populations are changing over time. (USFWS, 2011)

- Control introduced invasive plant species around wild plants. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Remove feral ungulates from within existing large-scale fences surrounding naturally occurring individuals. (USFWS, 2011)
- Conduct taxonomic study to determine if this is a valid species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)
- New Management Actions: • Surveys and inventories—PEPP (Plant Extinction Prevention Program) and The Nature Conservancy (TNC) conducted recent surveys to determine the approximate range and numbers of individuals of both varieties of Tetramolopim rockii (Bakutis 2018b, in litt.). • Ungulate monitoring and control— o A portion of the known population at Mo‘omomi Preserve area is within the fence; however, axis deer are still present within the fenced area (TNC 2018; Bakutis 2018, in litt.). o Individuals are within a fence in the Kalaupapa National Historical Park (NHP) (NPS 2015). • Invasive plant monitoring and control—Both the Mo‘omomi Preserve and Kalaupapa NHP are monitored with nonnative plant removal (NPS 2015; TNC 2018). • Captive propagation for genetic storage and reintroduction— o Kalaupapa NHP reported thousands of seeds in storage (Kalaupapa NHP 2014). o The National Tropical Botanical Garden (NTBG) reported 2,000 seeds collected from Mo‘omomi in 1990; 100 seeds collected from plants east of Mo‘omomi in 2009, and 250 seeds collected from plants along the coastal strand of Kalaupapa peninsula in 2001 (NTBG 2017). • Stochastic events—Build resiliency and redundancy— o Currently, no individuals will be reintroduced in Mo‘omomi Preserve until all axis deer are removed from the fenced area (TNC) 2018). o Mokio Land Trust plans to outplant Tetramolopium rockii into the Mokio management area in the near future (Haase 2018, in litt.). o Kalaupapa NHP reported reintroduction of five individuals and dispersal of seeds at five locations in 2014 (USFWS, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species’ biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are updated or reiterated for the 5-year review for 2023. • Surveys and monitoring— Survey for additional populations of Tetramolopium rockii at historical populations and areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with at historical populations within and around all wild populations. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change, including increasing temperatures, periods between rain events, and frequency and intensity of hurricanes. Additional management actions may be needed, such as locating microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and implement effective methods for rodents and slugs around wild populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Build resiliency, redundancy, and representation — Increase species’ viability through habitat restoration, threat control, and reintroduction and translocation. Continue attempts at reintroduction into suitable

habitat that is being managed for known threats to this species to reduce impacts of erosion, treefall, flooding, and hurricanes. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2023).

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SPECIES ACCOUNT: *Thalictrum cooleyi* (Cooley's meadowrue)

Species Taxonomic and Listing Information

Listing Status: Endangered; 02/07/1989; Southeast Region (R4) (USFWS, 2017)

Physical Description

A small, rhizomatous, perennial herb with erect to lax stems, up to 1 m tall. Loose clusters of flowers are borne in June. The unisexual flowers lack petals, but the sepals are white, pale yellow, or pale green with lavender filaments. The leaves are narrow and lance-shaped. The fruits are single-seeded and winged. Phenology: Flowers appear mid to late June and fruit mature in August or September (NatureServe, 2015).

Taxonomy

Thalictrum cooleyi is distinguished from other such members of the genus, Thalictrum revolutum in particular, by the combination of leaflet narrowness (4 to 26 times as long as wide), lack of lobing in the majority of the leaflets, and absence of hairs, glands, or papillae on lower leaflet surfaces, petioles, peduncles, and achenes (Park 1992) (USFWS, 1994).

Historical Range

Three historic North Carolina populations--Brunswick, Columbus, and Pender Counties--are assumed extirpated, because recent surveys showed habitat destruction at the sites and no plants were found (North Carolina Natural Heritage Program 1992). Cooley's meadowrue has been reported from New Hanover County, North Carolina (Radford et al. 1968), but without documentation (USFWS, 1994).

Current Range

All of the known Thalictrum cooleyi populations occur in the Coastal Plain Province in NC, GA, and FL (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual, wind- and insect-pollinated (NatureServe, 2015)

Breeding Season

Adult: Flowering in June (Radford et al, 1968) (NatureServe, 2015)

Reproduction Narrative

Adult: Flowering in June (Radford et al, 1968). The winged, single-seeded fruits mature in August and September (Lowe et al. 1990), but the seed life is presumably short. A dioecious species, Thalictrum cooleyi has separate male and female flowers that are wind- and insect-pollinated (NatureServe, 2015).

Habitat Type

Adult: Pine Savanna (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Wetlands/intermittent fire (NatureServe, 2015; USFWS, 1994); soil pH 5.8-6.6 (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from NatureServe, 2015 and USFWS, 1994)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from NatureServe, 2015 and USFWS, 1994)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Sunny, moist places such as open, savanna-like forest edges and clearings, wet savannas over calcareous clays, and ecotones between wet savannas and non-riverine swamp forests. Soils are basic, sandy loams. Also on roadsides and power line rights-of-way in former savannas. It grows on circumneutral soils in wet pine savannas, grass-sedge bogs, and savanna-like areas, often at the border of intermittent drainages or swamp forests. Boggy savannah-like borders of low woodlands, roadside ditches, and power line rights-of-way. Usually associates with some type of disturbance, e.g., clearings, the edges of frequently burned savannas, power line right-of ways which are maintained either by fire or mowing, and roadside edges. Typically on Grifton soil. This plant is found on fine sandy loams that are at least seasonally (winter) moist or saturated and are only slightly acidic (pH 5.8-6.6). Sufficient moisture is critical to plant vigor and reproductive effort. This plant occupies a narrow hydrological niche, where soil is moist to saturated but water does not stand above the soil surface. This species occurs in moist to wet bogs and savannas and savanna-like openings on circumneutral soils and is dependent upon some form of disturbance to maintain the open quality of its habitat. Currently, artificial disturbances, such as power line and road right-of-way maintenance, and plowed firebreaks, are maintaining some of the openings historically provided by naturally occurring periodic fires (Murdock 1989).This species grows in circumneutral soil in moist to wet savannas and savanna-like areas kept open by frequent fire or other disturbance. "This borderline type of habitat would have been disturbed historically by naturally occurring savanna fires moving through at 1- to 5-year intervals, clearing litter from the soil surface and causing the cyclical advance and retreat of woody growth. A typical population of Cooley's meadowrue has robust reproductive plants among shrubs and in adjacent open savanna and repressed individuals in nearby dense shade" (Boyer 1994) (NatureServe, 2015; USFWS, 1994). Low tolerance range and clumped spatial arrangement are inferred based on the specific habitat needs of this species and the relatively low number of populations (NatureServe, 2015; USFWS, 1994).

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 1994)

Dispersal/Migration Narrative

Adult: Possibly propagate by breaking off and dispersal of vegetative parts in aquatic habitat (USFWS, 1994).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Species Trends:

Stable (USFWS, 2009)

Number of Populations:

19 (USFWS, 2020)

Population Size:

1 - 1000 total individuals (NatureServe, 2015)

Population Narrative:

Thalictrum cooleyi is intrinsically vulnerable in several ways. It is rhizomatous, so the number of ramets is far greater than the number of genets. It is dioecious, so the populations where only one sex persists are particularly vulnerable. It produces few seeds and apparently does not have a seed dispersal mechanism (USFWS 1989). (NatureServe, 2015) The total number of individuals is estimated at between 1 and 1000 and the number of populations between 6 and 20. In addition, the short-term population trend indicates a decline of 10-30% (NatureServe, 2015). Low representation, resiliency and redundancy are inferred based on species specific habitat needs, low number of populations and fragmentation of suitable habitat (NatureServe, 2015). In the 2008 Recovery Data Call, the status of Thalictrum cooleyi was listed as stable. Between 2005 and 2007, NCNHP staff or other knowledgeable botanists have visited 12 of 25 North Carolina subpopulations (representing 10 populations) of Thalictrum cooleyi. As of 2008, there were 9 extant populations in NC; 2 in GA; and 1 in FL (USFWS, 2009). In summary, several new EOs have been found in NC, including one entirely new population and four EOs that expand the size of a known population. One new discovery is a county record for New Hanover County, NC; however, it is located within a few hundred feet of the boundary with Pender County, where this species has been known since listing. One new population was discovered in Worth County, GA. Currently, state natural heritage programs recognize 19 extant populations (10 in NC, 8 in GA and 1 in FL). Of these, 10 populations (6 in NC, 3 in GA and 1 in FL) have some level of protection, and are either owned and/or managed for conservation by state agencies or private conservation organizations. (USFWS, 2020)

Threats and Stressors

Stressor: Agriculture (USFWS, 1994)
Exposure:

Response:
Consequence: Loss of habitat
Narrative: USFWS (1994) notes that land clearing for agriculture is a threat to this species.

Stressor: Succession (USFWS, 1994)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: USFWS (1994) notes that succession (due to lack of disturbance/fire) is a threat to this species.

Stressor: Forestry (USFWS, 1994)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: USFWS (1994) notes that forestry/logging is a threat to this species.

Stressor: Mining and Development
Exposure:
Response:
Consequence: Loss of habitat
Narrative: USFWS (1994) notes that mining and development are threats to this species.

Stressor: Draining (USFWS, 1994)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: USFWS (1994) notes that draining (for development/road construction) is a threat to this species.

Stressor: Road construction (USFWS, 1994)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: USFWS (1994) notes that highway construction is a threat to this species.

Stressor: Inadequacy of regulatory mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative: There are no known populations on federal lands (USFWS, 2009).

Recovery

Reclassification Criteria:
Not available

Delisting Criteria:

Cooley's meadowrue (Thalictrum cooleyi) will be considered for delisting when there are at least 16 self-sustaining, geographically distinct populations in existence that are protected to such a degree that the species no longer qualifies for protection under the Endangered Species Act (see criteria below). A self-sustaining population is a reproducing population that is large enough to maintain sufficient genetic variation to enable it to survive and respond to natural habitat changes. The number of individuals necessary and the quantity and quality of habitat needed to meet this criterion will be determined as one of the recovery tasks (USFWS, 1994).

Recovery Actions:

- Protect existing populations and essential habitat. Develop interim research and management plans in conjunction with landowners and managers. Search for additional populations and potential habitat. Rank populations for focus of protection efforts. Evaluate habitat protection alternatives (USFWS, 1994).
- Determine and implement management necessary for long-term reproduction, establishment, maintenance, and vigor. Determine population size, stage-class distribution and sex ratios for all populations. Study abiotic and biotic features of the species' habitat. Conduct long-term demographic studies. Determine the effects of past and ongoing habitat disturbance. Define criteria for self-sustaining populations and develop appropriate habitat management guidelines based upon the data obtained from Tasks 2.2 through 2.4. Implement appropriate management techniques as they are developed from previous tasks. Develop techniques and reestablish populations in suitable habitat within the species' historic range (USFWS, 1994).
- Maintain and expand cultivated sources for the species and provide for long-term maintenance of selected populations in cultivation (USFWS, 1994).
- Revisit known populations that have not been visited in the past three years; monitor the habitat condition of each site including threats; discuss conservation options with landowners where appropriate; update Natural Heritage Program files with this information (USFWS, 2009).
- Search for additional populations (USFWS, 2009).
- Prioritize known sites for protection (USFWS, 2009).
- Protect additional populations (USFWS, 2009).
- Develop management plans for all protected populations (USFWS, 2009).
- Develop monitoring protocols, initiate long term population monitoring and determine the criteria for sustaining populations (USFWS, 2009).
- Conduct research on general biology of the species including life history and reproductive biology (breeding systems, seed production and seedling survivorship) (USFWS, 2009).
- Compare, genetically, the populations of questionable taxonomy in Georgia with those known from North Carolina and Florida (USFWS, 2009).
- Work with North Carolina Botanical Garden to conserve seeds and develop propagation protocols (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The recommended actions listed in the 2009 5-year review (page 10 and 11 above) remain important to the conservation and recovery of Thalictrum cooleyi. Since the 2009 5-year review, progress has been made on several recommendations for future actions. For example, the Service and East Carolina University professors and graduate students have visited most of the known populations in NC and provided updated information to the

NCNHP. According to GADNR and FLNAI records, half of the known populations in GA and the single FL population have been visited since the last 5-year review and natural heritage program records have been updated. Surveys for new populations of Thalictrum cooleyi have resulted in the discovery of one new population in New Hanover County, NC and one new subpopulation was discovered near a known population in Pender County, NC. In addition, a new population was discovered in Worth County, GA. Additional surveys across the range of the species are needed and may result in the discovery of new populations. Such surveys could be guided by species distribution modeling. Researchers at East Carolina University recently conducted research on various aspects of the life history and reproductive biology and genetics of Thalictrum cooleyi. Their research also increased our knowledge of the propagation and culture of this species which will be used to guide future restoration efforts. (USFWS, 2020)

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SPECIES ACCOUNT: *Thelypodium howellii spectabilis* (Howell's spectacular thelypody)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Region (R1) (USFWS, 2016)

Physical Description

Howell's spectacular thelypody is an herbaceous biennial that reaches approximately 60 cm (24 inches) tall, with branches arising from near the base of the stem. The basal leaves are approximately 5 cm (2 inches) long with wavy edges and are arranged in a rosette. Stem leaves are shorter, narrow, and have smooth edges. It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August (USFWS, 2016).

Current Range

Endemic to the northeastern corner of Oregon, occurring in the Baker-Powder River valley in Baker and Union Counties (Fish and Wildlife Service 1999). Generalized current range of about 175 sq. km.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2016)

Breeding Season

Adult: Flowers in May (USFWS, 2016)

Reproduction Narrative

Adult: It is a root forming plant and is pollinated by insects. Flowers appear in loose spikes at the ends of the stems. Flowers have four purple petals approximately 1.9 cm (0.75 inches) in length, each of which is borne on a short stalk. Fruits are long, slender pods (Kagan 1986). The plant begins actively growing in April, flowers in May, fruits in June and goes dormant in August (USFWS, 2016).

Habitat Type

Adult: Wet alkaline meadows (USFWS, 2016)

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2016)

Habitat Narrative

Adult: The thelypody occurs in wet alkaline meadows in valley bottoms, usually in and around woody shrubs that dominate the habitat on the knolls and along the edge of the wet meadow habitat between the knolls. Soils are pluvial-deposited alkaline clays mixed with recent alluvial silts, and are moderately well-drained (Kagan 1986). Associated species include Sarcobatus vermiculatus (greasewood), Distichlis stricta (alkali saltgrass), Elymus cinereus (giant wild rye), Spartina gracilis (alkali cordgrass), and Poa juncifolia (alkali bluegrass) (Kagan 1986). The thelypody may be dependent on periodic flooding since it appears to rapidly colonize areas adjacent to streams that have flooded (Kagan 1986). Abundance fluctuates widely from year to year in response to annual climate and soil moisture (USFWS 2010, p. 4). Thelopody is readily consumed by cows. Thus, thelopody is typically only found under shrubs in areas that are intensively grazed during the growing season (USFWS 2010). In addition, this taxon does not compete well with encroaching weedy vegetation such as Dipsacus fullonum (teasel) (Davis and Youtie 1995) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Unknown (USFWS, 2016)

Number of Populations:

5 natural populations (13 sites). 1 introduced population (USFWS, 2023)

Population Size:

10,000 - 100,000 individuals (USFWS, 2016)

Population Narrative:

This taxon was thought to be extinct until rediscovered by Kagan in 1980 near North Powder (Kagan 1986a). The Recovery Plan identifies 11 different occurrences that are grouped into five separate “populations” The labeling of these geographically-clustered occurrences as “populations” is a loose application of the term, since we do not know the extent of genetic interchange among occurrences. The 2008 update of the Oregon Natural Heritage Information Center’s (ORNHIC) database documents 15 Howell’s thelypody occurrences (USFWS 2010). The known occurrences vary substantially in size and plant abundance. Some are small patches just several hundred square feet in size, while others extend over 10 to 20 acres. One additional population has been established since the subspecies was listed. Staff from ODA’s Native Plant Conservation Program translocated thelypody plants to three locations near Baldock Slough on a property that has a permanent conservation easement through the Wetland Reserve Program (Currin et al.2008). All of the known thelypody occurrences are on private land and many are not accessible for monitoring. Since Federal listing in 1999, population monitoring efforts have focused on three sites where there are mechanisms in place that allow for thelypody monitoring: 1) the Haines Rodeo Grounds site, 2) the Miles Ranch Easement, and 3) the Baldock Slough introduction site (USFWS 2010). At all of the monitored sites, the number of flowering plants tends to vary widely from year-to-year. The amount of early spring precipitation appears to be an important driver of annual abundance, with high precipitation levels correlated with

increased plant abundance. The biennial habit of thelypody also appears to play a role, with spikes in abundance tending to occur every two years (J. Stephenson, USFWS, pers. comm., 2015). In one ½-acre plot at the Haines Rodeo Grounds that was intensively monitored from 2008 to 2010, thelypody abundance fluctuated from 3,011 plants in 2008 to 25,600 plants in 2009, and back down to 3,135 plants in 2010 (EcoWest Consulting 2011). As this is a protected site, no livestock grazing or other land use activities occur that might negatively affect plant development. The inherent year-to-year variability in plant numbers make it difficult to assess long-term population trends, particularly since quantitative surveys are not conducted every year (J. . Stephenson, USFWS, pers. comm., 2015). During good years, the Haines Rodeo Grounds population is quite large (> 50,000 plants in 2009), however few plants were found during qualitative surveys in June 2014 leading to concerns that this population is declining. There is concern that the spread of invasive weeds, particularly cheatgrass, is outcompeting thelypody in this area. There is less quantitative survey data for the Miles Ranch Easement, but it is also a large population in good years (> 35,000 plants in 2009). The Baldock Slough introduced population contained approximately 400 plants in 2009, distributed in 7 small areas. By 2013, plants were found at only 3 of the 7 areas, and a survey in June 2014 tallied only 20 plants in those 3 remaining areas (D. Trochlell, Natural Resource Conservation Service, pers. comm. 2014). The other known thelypody locations are all located on private lands have either very limited or no access to the occupied sites (USFWS 2010). Where occurrences are visible from public roads, occasional presence/absence surveys have been done in June/early July (when flowering plants are highly visible) to document that the occurrence is still extant, while the less visible sites have not been observed in many years. Much uncertainty remains given the inability to access and monitor the majority of populations on private lands that have no special management protections. However, the overall status of thelypody has improved since listing because additional populations have been found and 3 populations have some protections in place for thelypody. The protection of these sites and some modest progress in developing compatible livestock grazing management practices have moved these subspecies further away from the threat of extinction (USFWS 2010) (USFWS, 2016). Surveys 0 Additional population information was collected in 201 1 (Oregon Department of Transportation 2013), where State highway crews documented approximately 35 plants growing on the side of Highway 84. This population had been documented previously in 2009, 1997 and 1996, is within the previously described range, and is located 0.15 miles from another population. 0 USDA-NRCS conducted a survey of seven sites on June 25, 2014. In four of the . seven experimental sites where the Oregon Department of Agriculture Native Plant Conservation Program had conducted transplants in 2002 and 2007, no T howellii ssp. spectabilis were found. USDA-NRCS attributed this decline to a competition from nonnative species including intermediate wheatgrass (Thinopyrum intermedium) and whitetop (Cardaria draba), which were thought to be outcompeting T. howellii ssp. spectabilis (U.S. Department of Agriculture- Natural Resource Conservation Service 2014) (USFWS, 2018). Research 0 In 2014, EcoWest Consulting Inc. and the USFWS finished an experiment titled “The influence of Population Dynamics, Grazing, and Precipitation Patterns on the Restoration of a Threatened Riparian Mustard to Former Habitat” (2014). Thelypodium howellii ssp. spectabilis was the subject of this Before/After Control/Impact (BACI) design study, which began in 2008 and concluded in 2014. The results of the study were largely inconclusive due to the life history and moisture and soil sensitivity of T. howellii ssp. spectabilis, which resulted in highly variable results. However, the researchers suggest that changes in grazing practice to late season grazing after post-seed dispersal may allow these plants to expand into other areas (USFWS, 2018). Howell’s spectacular thelypody, a biennial plant in the mustard family, continues to occur within the geographic area identified in

the recovery plan - the Powder Valley between North Powder, Haines, and Baker City in Union and Baker Counties, Oregon. The recovery plan described five Figure 1: Map of Howell's spectacular thelypody populations. Marshall and Brown (2021). Used with permission. natural populations, consisting of 13 sites (Figure 1), plus one introduced population at Baldock Slough (not mapped – located between North Baker and North Powder populations) (USFWS, 2023).

Threats and Stressors

Stressor: Development (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Habitat loss due to urban and agricultural development is listed as a threat to this species (USFWS, 2016).

Stressor: Habitat degradation (USFWS, 2016)
Exposure:
Response:
Consequence: Habitat loss/habitat degradation
Narrative: Habitat degradation due to livestock grazing and hydrological modification is listed as a threat to this species (USFWS, 2016).

Stressor: Grazing (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Consumption by livestock is listed as a threat to this species (USFWS, 2016).

Stressor: Herbicides (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of indivduals
Narrative: Use of herbicides or mowing during the growing season is listed as a threat to this species (USFWS, 2016).

Stressor: Competition (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition with exotic species such as teasel (Dipsacus fullonum), bull thistle (Cirsium vulgare), Canada thistle (C. canadensis), and yellow sweet clover (Melilotus officinalis) is listed as a threat to this species (USFWS, 2016).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8

Delisting Criteria:

The thelypody recovery plan calls for the protection of five self-sustaining thelypody populations throughout its extant and historic range. Each of the five populations should have management plans providing for the plant's long-term protection and have stable or increasing trends for 10 years. Currently, three populations of thelypody receive some level of protection from development and are managed for conservation (USFWS 2010). The Haines Rodeo Grounds is a purchased mitigation site specifically for thelypody conservation, and has a completed management plan for this species. The other two sites (the Miles Ranch Easement and the Baldock Slough introduction site) are easements managed for wetlands protection. While the Baldock slough will remain protected in the Wetland Reserve Program, it is not clear if the reintroduced population will become self-sustaining. In addition, there are also three small roadside populations managed by ODOT under a State Management Area. In the past, there were two populations on private lands near North Powder that were managed via conservation easements: the BLM has managed a population for several years until about 2006, and the TNC managed another population for 15 years. At this time there are no agreements for the management of these two populations and their status is unknown (USFWS, 2016).

Recovery Actions:

- Landowner Outreach — Work with local officials in Baker and Union counties to develop a Thelypody Conservation Proposal that includes participation incentives that would then be taken to landowners in thelypody habitat for their consideration. Such a proposal would likely include provisions for establishment of pastures with special management elements for thelypody conservation (e.g., rest or reduced grazing during the growing season) (USFWS, 2018).
- Grazing Research — Continue controlled studies to determine the response of thelypody to livestock grazing outside the plant's primary growing season, as well as the potential to use grazing as a tool to control competing vegetation (USFWS, 2018).
- Manage Haines Rodeo Grounds Site — Work with the Baker County Road Department to reinitiate implementation of the management plan for this site. Of particular concern at this site is control of competing vegetation in thelypody-occupied areas (USFWS, 2018).
- Management Plan for Miles Easement — Finalize a management plan for the Miles Easement and actively pursue its successful implementation (USFWS, 2018).
- Succeed at Baldock Slough — Continue the effort to successfully establish a the lypody population at Baldock Slough. Control of invasive weeds will need to be a key component of this effort (USFWS, 2018).
- Monitoring Plan — Develop and use a practical, standardized methodology for monitoring thelypody populations so that we can obtain comparable data across sites and across years. This methodology would also serve as the basis for a subsequent Post Delisting Monitoring Plan, satisfying one of the delisting criteria in the Recovery Plan (USFWS, 2018).
- All of the General Plant Conservation Measures (Section 3.13.1) apply for thelypody. In additional, livestock grazing will not be used to control or remove invasive and non-native vegetation at project sites occupied by Howell's spectacular thelypody, unless approved by the local Service office (USFWS, 2016).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Stakeholder engagement and landowner outreach – Create a stakeholder group, in cooperation with ODA, to increase communication and action on

thelypody conservation programs and promote community interest and involvement in the protection of this rare plant, and to help inform management plans. Partner with local officials in Baker and Union counties to develop a Thelypody Conservation Proposal that includes participation incentives that would then be taken to landowners in thelypody habitat for their consideration. Management of Haines Mitigation Site – Work with Baker County to update and reinitiate implementation of the management plan for this site and reinitiate its implementation. Of particular concern at this site is control of competing vegetation in thelypody-occupied areas. Management Plan for Miles Easement – Develop and finalize a management plan, in cooperation with ODA and the land owner, for the Miles Easement and actively pursue its successful implementation. Prioritize monitoring of this site. Regular monitoring at a subset of sites – Future monitoring should include a full thelypody population count (or sampling where appropriate) and mapping at least every two to four years at a subset of strategically selected sites. This will aid in understanding year to year population variability and population stability, along with changes in the spatial distribution of plants in wet versus dry conditions. Vegetation monitoring transects at Haines Mitigation Site (re-surveyed in 2023) should be repeated to better understand the changing plant composition over time. Succeed at Baldock Slough – Continue the effort to successfully establish a thelypody population at Baldock Slough. Site preparation and control of invasive weeds, especially whitetop (Lepidium draba), will need to be a key component of this effort. Continue the Seed-Increase Program – Continue to collect wild thelypody seed and bulk the seed by growing it over the full life cycle (i.e., 2 years to flower and set seed) in a greenhouse setting. Seeds should be collected following both wet and dry years to increase genetic diversity and resilience of the species to climate variability. Consideration should be given to the life expectancy of thelypody seeds, as viability may decrease with time. Seed should be collected from multiple sites and grown at more than one facility to improve representation and redundancy. Introductions on protected land – Explore options for population introduction at protected sites. Seek out potential sites that support the associated alkali plant community and have adequate hydrology. An analysis of soil composition and hydrology, along with invasive species management and site preparation, is recommended prior to population introduction. Research unknowns and emerging issues - Climate change is an emerging threat for most rare species, and Howell's spectacular thelypody may be particularly at risk due to its need for moisture and small geographical range. Research needs include determining what constitutes a "stable" population, including year to year variation in population size and distribution, and response to precipitation, temperature, and groundwater. Research seed viability and longevity (both in storage and in the wild), and continue research into grazing effects. Consider updating the recovery plan – After implementing the above recommendations and reviewing monitoring data and new research, consider whether to update the 2002 recovery plan using the new 3-part planning process (USFWS, 2023).

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SPECIES ACCOUNT: *Thelypodium stenopetalum* (Slender-petaled mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A biennial herb, glabrous, glaucous. Basal leaves oblanceolate to oblong, entire or wavy-margined, thickish; cauline leaves ascending, sessile, oblong-lanceolate, sagittate, entire to few-toothed or shallowly lobed. Petals linear, lavender, rarely white, blades crinkled at base. (NatureServe, 2015)

Taxonomy

Thelypodium, a genus in the mustard family (Brassicaceae), contains approximately 20 species located throughout western North America, with 8 species occurring in California (Rollins 1993). The biennial Thelypodium stenopetalum S. Wats., was first described in 1887 by Sereno Watson from a collection made by Samuel B. Parish the same year from Bear Valley, San Bernardino Mountains, California (Watson 1887). Schulz (1933) transferred the taxon into the genus Thelypodiopsis, subsequently changing the name to Thelypodiopsis stenopetala. Thelypodium stenopetalum is distinguished from other members of the genus by the sessile (attached directly to the stem), clasping leaves, paired filaments that are free, and the linear petals. No other species of Thelypodium occur within the range of Thelypodium stenopetalum (USFWS, 1998).

Historical Range

See current range/distribution.

Current Range

California endemic, restricted to meadows of Big Bear Basin in San Bernardino County (Skinner, 1997). The full range extent covers no more than 49 sq mi. (NatureServe, 2015)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Lifespan

Adult: 2 years? (USFWS, 2011)

Breeding Season

Adult: Mature plants produce an inconspicuous flower stalk with flowers arranged in an open raceme in May or June; flowers may be present on the stalk through July (USFWS, 2011).

Reproduction Narrative

Adult: Thelypodium stenopetalum is typically considered to be a biennial species, although this has not been verified (see Species-specific research section below) (Henderson 2003, p. 57), with individual plants completing their life cycle in 2 years. First year plants generally produce leaf rosettes only and rarely flower that year. Observations of T. stenopetalum during drier years have found that with less water the species can act as an annual and produce smaller flowers that fall off the plant earlier than during wet years (S. Eliason, U.S. Forest Service, pers. obs. 2010). Mature plants produce an inconspicuous flower stalk with flowers arranged in an open raceme in May or June; flowers may be present on the stalk through July. Pollination studies have not been conducted on this species. No information is available on seed dispersal though it appears that the small seeds do not disperse very far from the parent plant (USFS 2000b, p. 41) (USFWS, 2011).

Habitat Type

Adult: Meadow (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 2011)

Environmental Specificity

Adult: Narrow/specialist (Natureserve, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015 and USFWS, 2011)

Site Fidelity

Adult: High (inferred from NatureServe, 2015 and USFWS, 2011)

Habitat Narrative

Adult: Species inhabits mesic, alkaline meadows (Skinner, 1997) (NatureServe, 2015). Thelypodium stenopetalum is primarily found on vernally moist alkaline meadows at elevations. High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and restricted range in which it is found. from 1,600 to 2,500 meters (m) (5,250 to 8,200 feet (ft)) in the Big Bear Valley, San Bernardino Mountains of California. Alkaline flats and lakeshores are also considered suitable habitat (USFS 2000b, p. 41) (USFWS, 2011).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information is available on seed dispersal though it appears that the small seeds do not disperse very far from the parent plant (USFS 2000b, p. 41) (USFWS, 2011).

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

10 (USFWS, 2021)

Population Size:
897 (USFWS, 2021)

Population Narrative:
In 2020, USFS botanists visited Thelypodium stenopetalum-occupied meadows. They reported 897 plants across the 5 meadows visited (USFS 2020a). At two occurrences, they collected seed for ex situ conservation, and at four occurrences, they collected tissue for future genetic analysis (USFS 2020a) (Table 1). (USFWS, 2021)

Threats and Stressors

Stressor: Development (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Development of the Big Bear Lake Reservoir (1884) and the Big Bear Dam (1911) destroyed almost all of the natural meadowland within Big Bear Valley. As a result, habitat occupied by Thelypodium stenopetalum was reduced from 2,800 ha (7,000 ac) to about 400 ha (1,000 ac) (USFWS 1984, p. 34498). This construction appears to have affected the extinction of some of the plants, which formerly grew in the valley (Parish 1917, p. 164) and likely eliminated some T. stenopetalum populations. Residential and commercial development led to the extirpation of three known historical occurrences of T. stenopetalum (EOs 8, 9, and 11) in the decades prior to listing (Appendix 1). At the time of listing, about 80 percent of the remaining T. stenopetalum habitat (approximately 400 ha (1,000 ac)) was considered vulnerable to development (USFWS 1984, p. 34499). The threat of development remains high because the majority of Thelypodium stenopetalum occurrences are on private land (four of six EOs). Impacts of development pressures on private land are evident at a number of occurrences: the subdivision and development of the land for the Hamilton Ranch Erwin Lake Estates at the east end of Erwin Lake (EO 3) has significantly impacted T. stenopetalum and its habitat, some T. stenopetalum habitat east of Eagle Point (EO 2 not in parcel K) has been lost to housing development, the occurrence at the south shore of Baldwin Lake (EO 6) has been impacted by development, and the Belleville Meadow occurrence (EO 10) has been impacted by upstream development. The only T. stenopetalum occurrence that is considered fully protected from development impacts is at the north shore of Baldwin Lake (EO 1) on the Baldwin Lake Ecological Reserve (managed by CDFG), and residential construction activities are occurring adjacent to this reserve. There are no conservation measures in place that offer protection of these occurrences on private land from future development. The direct threat of development to T. stenopetalum therefore remains substantial and is currently impacting habitat at four of six extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Off-highway vehicles (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: The listing rule indicated that OHV activity eliminated colonies and damaged Thelypodium stenopetalum habitat (USFWS 1984, p. 34499). In 2000, a review by the Forest

Service found that approximately 1.1 miles (1.7 kilometers) (1.3 ha (3 ac)) of unauthorized roads bisect or are adjacent to known occupied meadow plant occurrences and that the unauthorized network of roads allow for an "unknown, though likely high, level of random and on-going impacts to threatened/endangered meadow plant habitat" (USFS 2000b, p. 99). Unauthorized routes are closed when they are found; however, illegal OHV use continues to impact moist meadow habitat by altering hydrology, compacting soil, and degrading habitat. Controlling OHV use within Thelypodium stenopetalum habitat has been difficult because much of the activity is either on private land or is unauthorized. Occurrences at the north and south shores of Baldwin Lake (EOs 1, 6) are particularly vulnerable to OHV use. At the south shore of Baldwin Lake (EO 6), OHV trails bisect the T. stenopetalum occurrence, connecting private land to the shoreline (USFS 2000b, p. 62). Fencing that may have provided protection to the occurrence at the north shore of Baldwin Lake (EO 1)—at the side of State Route 18, which could prevent unauthorized OHVs from entering—has been knocked down or has fallen down due to heavy snow drifts (Eliason, pers. obs. 2010). In 2010, the Forest Service placed boulders at the entrance of these roads to preclude OHV activity, which appears to be successful in reducing this threat on Forest Service lands (Eliason, pers. obs. 2010). At Belleville Meadow (EO 10), OHV activity in unauthorized areas has been observed on a closed road that bisects the area (USFS 2000b, p. 62) and has caused devegetation and alteration of surface hydrology in some areas (USFS 2005, p. 37). The Forest Service has closed and rehabilitated unauthorized roads at this occurrence (USFWS 2005, p. 220). Despite fencing and barriers, unauthorized OHV use still occurs at Belleville Meadow (USFWS 2005, p. 37). Currently, we believe OHV activity is negatively impacting T. stenopetalum rangewide (USFWS, 2011).

Stressor: Alteration of hydrology (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Thelypodium stenopetalum is susceptible to changes of the natural hydrological conditions within its habitat due to its apparent dependence on soil moisture (USFS 2000b, p. 37). Alteration of hydrology poses a threat to all T. stenopetalum occurrences (Eliason, pers. obs. 2010). Alteration of drainages and swales, depletion of groundwater, and conversion of drainages to flood control channels all have the potential to significantly impact populations of T. stenopetalum. In extreme cases, alteration of hydrology may result in the dewatering of the habitat by lowering the water table (USFS 2000b, p. 43). An increase in residential development and the subsequent installation of a large number of private wells has the potential to lower the water table and thereby alter the hydrology of moist meadow habitat (Krantz 1979, p. iv; Eliason, pers. obs. 2010). Additionally, development, roads, and OHV activity may alter the hydrology of an area by creating gullies, which can cut off the water supply to a meadow aquifer downstream by intercepting, concentrating, and diverting runoff (USFS 2002 p. 22). Alteration of soil hydrology or existing drainage patterns may have impacted several Thelypodium stenopetalum occurrences including Eagle Point (EO 2) and the north shore of Baldwin Lake (EO 1). At each of these locations, efforts were made to prevent hydrologyrelated impacts to the habitat and to the species. For instance, CDFG's purchase of private land containing the watershed for the north shore of the Baldwin Lake occurrence (EO 1; Baldwin Lake Ecological Reserve) in 1992 has helped to maintain natural hydrologic patterns. The Pan Hot Springs occurrence (EO 7) is found on deed restricted land; however, the water source for the habitat is not included in the deed restriction. Without control of water availability, the plants and their habitat at this occurrence remain threatened (USFS 2002, p. 25). While protection measures have lessened the threat of altered

hydrology at several occurrences, it remains a rangewide threat to five of six extant occurrences (Appendix 1) (USFWS, 2011).

Stressor: Invasive nonnative plants (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Since listing, invasive nonnative plants have been identified as a threat to five of six Thelypodium stenopetalum occurrences (Appendix 1). Nonnative species of grasses and forbs invade many plant communities often as an indirect result of habitat disturbance (Vitousek et al. 1997, p. 1). Development, roads, and other threats that disturb moist meadow habitat allow invasive nonnative plants to occupy and replace T. stenopetalum, and may decrease the amount of soil nutrients available to co-existing T. stenopetalum and eliminate natural pollinators (Levine et al. 2003, p. 777). Nonnative grasses may impact T. stenopetalum habitat by decreasing community water availability, which is often mediated by the displacement of species that use more water (Levine et al. 2003, p. 778). Invasion by nonnative grasses, may make it more difficult for T. stenopetalum to thrive because these grasses have a highly diffuse root system that is well positioned in the soil horizon to remove moisture that otherwise could support seedlings of T. stenopetalum (Levine et al. 2003, p. 778). Additionally, dead grasses may create a mat or thatch that impedes or prevents seedlings from becoming established. Thinopyrum intermedium (previously Elytrigia intermedia) (intermediate wheatgrass) has been identified as a threat to occurrences at the north and south shores of Baldwin Lake (EOs 1, 6), East of Eagle point (EO 2), Erwin meadows (EO 3), and in the south end of Pan Hot Springs (EO 7) (Eliason pers. comm. 2011). Thinopyrum intermedium invades T. stenopetalum habitat and outcompetes it for space. It also produces a thatch that T. stenopetalum seedlings cannot penetrate. Control methods, such as burning or mowing, have proven ineffective because the grass is a perennial that returns in subsequent years (Eliason pers. obs. 2010) (USFWS, 2011).

Stressor: Grazing/herbivory (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Since the time of listing, horse grazing and pasturing activities have been identified as threats that are impacting occurrences at Pan Hot Springs (EO 7), the south shore of Baldwin Lake (EO 6), and the east end of Erwin Lake (EO 3). Voluntary landowner agreements resulted in the relocation of equestrian activities away from rare plant habitat at Pan Hot Springs. These efforts were successful and recovery of Thelypodium stenopetalum populations has been observed at this location (USFS 2002, p. 19). Horse grazing and pasturing activities remain a threat at the east end of Erwin Lake (EO 3) and south Baldwin Lake (EO 6). These occurrences are on private lands and there is no formal protection in place to control this threat. As described in the species biology, Andrew's marble butterfly feed on members of Brassicaceae (mustard family) including Thelypodium stenopetalum. The extent that feeding by Andrew's marble butterfly impacts T. stenopetalum populations is unknown. Further research is necessary to determine the status of this threat (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: In summary, the Act is the primary Federal law that has provided protection for Thelypodium stenopetalum since its listing as endangered in 1984. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for T. stenopetalum absent its status under the Act. There are also unresolved conflicts between State protections afforded under CESA and NPPA and county weed abatement provisions. Therefore, we believe that State and other Federal laws and regulations have limited ability to protect the species in absence of the Act. Two of the six extant T. stenopetalum occurrences are however, afforded protection through local agencies by protecting land to conserve rare plant populations. Inadequacies in provisions or implementation in regulatory mechanisms are not considered threats to the species, although these inadequacies may permit or precipitate actual threats that are described under Factors A, B, C, and E (USFWS, 2011).

Stressor: Recreational activities (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Impacts associated with recreational activities have been identified as a rangewide threat to Thelypodium stenopetalum (Appendix 1). Recreational activities include, but are not limited to: hiking, dispersed camping, fishing, horse riding, mountain biking, and dog walking. The primary impact from recreational activities is trampling, which can crush and kill individual plants. Additional impacts include soil compaction, devegetation, escaped campfire threats, introduction or spread of nonnative species, and burial of plants with litter (USFS 2002, p. 23). Fencing and signage indicating the presence of sensitive species have proven effective at reducing the threat of recreational activities at the north and south shore of Baldwin Lake (EOs 1, 6). Moderate success has also been made in educating the public and heightening the awareness of the need for the protection and recovery of T. stenopetalum and numerous other listed and rare species in the vicinity of Big Bear Lake. The Big Bear Discovery Center at San Bernardino National Forest regularly presents public education programs on a variety of subjects, including threatened and endangered species (USFS 2000b, p. 80) (USFWS, 2011).

Stressor: Fire suppression measures (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Implementation of fire suppression measures has been identified as a threat at four of six extant Thelypodium stenopetalum occurrences. The San Bernardino County Land Use/Fire Hazard Abatement Division (see Factor D discussion) requires that owners must remove weeds and grasses in areas where this vegetation acts as a fuel that may pose a fire threat. Weeds and grasses are described by the County of San Bernardino generally as annuals that grow and dry out each year, and they did not discriminate for rare plants (County of San Bernardino 2010a, 2010b). Weed and grass removal generally involves mowing, which damages or destroys individual T. stenopetalum plants. If removal activities are conducted before or during T. stenopetalum flowering and fruit development, the plants reproductive output and germination may be significantly impacted (USFWS, 2011).

Stressor: Reduced populations (USFWS, 2011)

Exposure:
Response:
Consequence: Localized extinction and lack of genetic variability
Narrative: Fragmentation and isolation can adversely impact small populations of plants that are already reduced in distribution such as Thelypodium stenopetalum resulting in increased vulnerability to extirpation (Barrett and Kohn 1991, pp. 3–30). These effects may be the result of several factors, including small areas of suitable habitat, local extirpations, or ongoing natural or artificial factors limiting establishment and survival of the taxon. The small number of Thelypodium stenopetalum occurrences is a concern because it increases the possibility that impacts from urban development or other activities near moist meadow habitat could destroy all or a significant portion of the species' population. Thelypodium stenopetalum is distributed on less than 8.5 ha (21 ac) of moist meadow habitat (USFWS 1998, p. iii). Stochastic events outside the natural range of frequency and severity (such as floods, fires, contamination, or drought) can substantially reduce or eliminate species such as T. stenopetalum with a restricted range and small population, and increase the likelihood of extinction (Lande 1993, p. 912). Genetic effects may further influence population demography via inbreeding depression and genetic drift (Barrett and Kohn 1991, pp. 3–30; Menges 1991, pp. 58–61). Allee (1931, pp. 17– 50) suggested small, single populations are vulnerable to extirpation when opportunities for reproduction diminish because of reduced opportunity of individuals to reproduce (Allee effect or depensation) (Courchamp et al. 2008, pp. vi–216). Stephens et al. (1999, pp. 185–190), Dennis (2002, pp. 389–401) and Courchamp et al. (2008, pp. vi–216) suggest that the Allee effect is a density-dependent event that is inversely related to population size (USFWS, 2011).

Stressor: Climate change and drought (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species (including Thelypodium stenopetalum) or sites at this time. It seems likely that T. stenopetalum, a species restricted to montane meadows in a single small portion of a mountain range found on particular soils with particular hydrological needs, would be threatened rangewide by any differences in climatic regimes brought on by changes to the climate. A changing climate with spatial and temporal shifting of temperature and precipitation may cause this species specific adaptations to climate to work against its survival. A changing climate may also provide advantages to other native and nonnative plant species. Sharing information between scientists, land managers, and decision makers will increase our ability to address these threats. Increasing the success with which we address current threats to T. stenopetalum will increase our success of handling the uncertain effects of future climate change (USFWS, 2011).

Recovery

Reclassification Criteria:
Six populations of Thelypodium stenopetalum and adjacent suitable habitat are fully protected through land management agreements, land ownership by resource agency or conservation organization, conservation easement, or other permanent means of protection (USFWS, 2011).

Populations are stable or increasing with allowances for natural fluctuations (USFWS, 2011).

Recovery Actions:

- Four of the six extant occurrences are located, in part, on private land and receive no formal protection. Development on private land remains the predominant threat to Thelypodium stenopetalum. As the majority of occurrences receive no protection, the conservation efforts described above are not enough to meet reclassification criterion 1 for T. stenopetalum from endangered to threatened status (USFWS, 2011).
- The populations of Thelypodium stenopetalum are declining overall, with extirpation of two occurrences (EOs 4 and 5) since listing. All occurrences are impacted by multiple threats and though some populations are presumed extant, surveys are needed to verify their status (e.g., east end of Erwin Lake (EO 3)). Surveys are necessary to determine the status of all occurrences on private land, but observations in the field suggest that T. stenopetalum are not increasing and may be declining; therefore, reclassification criterion 2 has not been met (USFWS, 2011).
- Work with partners, in particular private landowners, to help conserve Thelypodium stenopetalum. Identify opportunities through the Service's Partners for Fish and Wildlife Programs to implement conservation opportunities on private lands (USFWS, 2011).
- Conduct monitoring to inventory actual occurrences and update the status of Thelypodium stenopetalum occurrences throughout the species range. While the occurrence on the east end of Erwin Lake (EO3) is presumed extant, surveys should occur because they have not been conducted at this species location for many years (USFWS, 2011).
- Conduct research on life history characteristics (e.g., pollination studies) and more specific habitat requirements. This information may be used for unoccupied habitat identification and potential reintroduction experiments (USFWS, 2011).
- Establish a seed bank focusing first on small, isolated populations that have the greatest potential to become extirpated (USFWS, 2011).
- Work with the State and San Bernardino County to resolve conflicts with the weed abatement plan (USFWS, 2011).
- Develop a threats-based recovery outline to guide conservation actions for the species (USFWS, 2011).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1. Collect additional seed from Thelypodium stenopetalum occurrences, to expand the ex situ conservation seed bank at California Botanic Garden (formerly Rancho Santa Ana Botanic Garden). 2. Study Thelypodium stenopetalum population genetics, including levels of genetic diversity and differentiation within and among occurrences, and levels of inbreeding, relatedness, and ploidy. This information will allow us to assess levels of current diversity and gene flow, assess whether genetic management is needed, and assess appropriate seed sources for potential future reintroduction or augmentation activities. 3. Conduct pollination studies to determine the mating system of Thelypodium stenopetalum (i.e., the level of self-compatibility, if any). 4. Develop a propagation protocol for Thelypodium stenopetalum. 5. Reach out to private landowners to identify opportunities for conservation on private lands. Work with private landowners, local governments, and conservation organizations to conserve and manage habitat. 6. Continue to monitor Thelypodium stenopetalum occurrences. (USFWS, 2021)

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SPECIES ACCOUNT: *Thlaspi californicum* (Kneeland Prairie penny-cress)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2015)

Physical Description

A perennial herb. Blooms May-June. Fruits on ascending stalks. (NatureServe, 2015)

Taxonomy

A distinct entity separated from related taxa by its ascending long slender silicles that are acute at the apex. The USFWS lists this taxon as Thlaspi californicum, which is also the name in Kartesz (1999) and Rollins (1993). Kartesz (1994) had treated this taxon as T. montanum var. californicum. (NatureServe, 2015)

Historical Range

See current range/distribution.

Current Range

Known global distribution of Noccaea fendleri ssp. californica is restricted to three small patches of serpentine outcrop (total 2.8 acres) located between 200 and 500 feet from each other within Kneeland Prairie, approximately 15 miles east of the Pacific Ocean, Humboldt County, California (USFWS 2011).

Critical Habitat Designated

Yes; 10/9/2002.

Legal Description

On October 9, 2002, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Thlaspi californicum (Kneeland Prairie penny-cress) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in California (67 FR 62897-62910).

Critical Habitat Designation

The critical habitat designation forThlaspi californicum includes one CHU in Humboldt County, California. This species critical habitat encompasses approximately 74 acres (ac) (30 hectares (ha)) (67 FR 62897-62910).

Critical habitat unit. Humboldt County, California. (i) From USGS. 1:24,000 scale Iaqua Buttes quadrangle.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Thlaspi californicum critical habitat consists of four components (67 FR 62897-62910):

(i) Thin rocky soils that have developed on exposures of serpentine substrates;

(ii) Plant communities that support a relatively sparse assemblage of serpentine indicator, or facultativeserpentine indicator, species, including various native forbs and grasses, but not trees or shrubs, such that competition for space and water (both above and below ground) and light is reduced, compared to the surrounding habitats. Known associated species include the following: Festuca rubra (red fescue), Koeleria macrantha (junegrass), Elymus glaucus (blue wildrye), Eriophyllum lanatum (woolly sunflower), Lomatium macrocarpum (large-fruited lomatium), and Viola hallii (Hall's violet);

(iii) Serpentine substrates that contain 15 percent or greater (by surface area) of exposed gravels, cobbles, or larger rock fragments, which may contribute to alteration of factors of microclimate, including surface drainage and moisture availability, exposure to wind and sun, and temperature; and

(iv) Prairie grasslands and oak woodlands located within 30 m (100 ft) of the serpentine outcrop area on Ashfield Ridge. Protection of these habitats is essential to the conservation of Thlaspi californicum in that it will provide connectivity among the serpentine sites, help to maintain the hydrologic and edaphic integrity of the serpentine sites, and support populations of pollinators and seed dispersal organisms.

Special Management Considerations or Protections

As noted in the Critical Habitat section, ''special management considerations or protection'' is a term that originates in the definition of critical habitat. We believe the critical habitat area may require special management considerations or protection because Thlaspi californicum occupies an extremely localized range. Potential threats to the habitat of T. californicum include: expansion of Kneeland Airport and CDFFP helitack base; road realignment; fires caused by airplane or vehicular accidents; contaminant spills; erosion; application of herbicides and pesticides; livestock grazing; and introduction and spread of exotic species. Additional special management is not required if adequate management or protection is already in place. Adequate special management considerations or protection are provided by a legally operative plan or agreement that addresses the maintenance and improvement of the primary constituent elements important to the species and manages for the long-term conservation of the species. Currently, no plans meeting these criteria have been developed for Thlaspi californicum.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Thlaspi californicum normally begins blooming in March, with seed set in April or May and dehiscence of fruits (release of seeds) beginning in June (USFWS, 2003)

Reproduction Narrative

Adult: The biology and ecology of Thlaspi californicum are poorly understood. The three semi-isolated colonies are all separated from each other by Mountain View Road and/or the Kneeland Airport runway. We do not know if the colonies are reproductively isolated. Thlaspi californicum normally begins blooming in March, with seed set in April or May and dehiscence of fruits

(release of seeds) beginning in June. Approximately 86 percent of the individual plants were reproductive in 1997 and 2001 (SHN Consulting Engineers & Geologists 2001). Absence of flowering was attributed to either grazing or immaturity (USFWS, 2003).

Habitat Type

Adult: Rock outcrops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits serpentine rock outcrops in coastal prairie habitat; 760 m in elevation (Federal Register, 9 Feb. 2000; cf. Skinner and Pavlik 1997) (NatureServe, 2015). High ecological integrity of the population and site fidelity, clumped spatial arrangement of the population as well as low tolerance ranges are inferred based on the specific habitat requirements of this species.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: The predominant wind direction in late spring and summer is northwest to northeast, when seed dispersal occurs. These results suggest future efforts to augment or introduce new colonies could be designed to effectively use natural dispersal patterns (USFWS, 2011).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2011)

Number of Populations:

1 - 5 (NatureServe, 2015)

Population Narrative:

11,000 plants in about 1997, with the population bisected by development; 200-500 plants seen at the site when visited in 1984. One occurrence, in Humboldt County (Kneeland Prairie); a purported 1942 collection south of Hoopa Valley was misidentified. Mendocino County sites reported in Skinner and Pavlik (1994, rev. 1997) also are now considered erroneous (Federal Register final listing, 9 Feb. 2000) (NatureServe, 2015). USFWS (2011) notes that populations are declining at a number of sites. Low resiliency, representation and redundancy are inferred

based on the low number of known populations and the relatively small geographic area this species inhabits. Most of the occupied or suitable habitat within Kneeland Prairie occurs on private property owned by a single landowner. Therefore, species monitoring, management, conservation, and recovery depend on access to occupied and suitable habitat on private lands. The highest priority action for this species is to continue efforts to secure a working relationship with the landowner. (USFWS, 2019)

Threats and Stressors

Stressor: Construction/land modifications (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: The Kneeland Airport serves as the primary backup airport when weather conditions preclude landing at other Eureka area airports (Humboldt County 2005). The final listing rule discussed proposed upgrades and slope stabilization efforts related to the Kneeland Airport, and possible realignment of Mountain View Road to accommodate the airport upgrade. Those improvements are yet to be initiated. Since the last 5-year review, Humboldt County completed an update to the airport master plan, which summarized past and future expected use, and reviewed design, safety, environmental and other issues related to operating the airport (Humboldt County 2005). The Master Plan predicts use of the airport to increase perhaps 15 percent by the year 2021, over 2001 levels. Three primary constraints were identified for expansion of the airport to meet future growth demand: Noccaea fendleri ssp. californica; the steep topography; and the helitack base. Expanding runway length and width, runway safety areas and aircraft parking, and creating obstacle free zones were all judged to either have significant impacts on N. f. ssp. californica, the critical habitat designated for the species, or be excessively expensive. As a result, the Master Plan recommends: maintenance and stabilization of the existing runway configuration, continuation of existing nonstandard setbacks, such as obstacle free zones; and foregoing expansion of some facilities, such as aircraft parking. Under these recommendations, realignment of Mountain View Road would not be necessary. However, Humboldt County has recently sought funding to implement a Phase 1 Runway Safety Area Improvement Study, which would reassess options for bringing the airport into compliance with FAA standards (H. Seeman, Humboldt County Environmental Services Manager, pers. comm. 2011). Subsequent phases of work would include environmental assessment, design, and implementation. No schedule for implementation of the work phases was available. The Service to date has not received any specific design proposals, nor issued a formal opinion regarding the impacts of any specific proposal on N. f. ssp. californica and its designated critical habitat. Noccaea fendleri ssp. californica habitat is also vulnerable to destruction as a result of its unobstructed, close proximity to the county road. Observations made from the county road overlooking the West colony in May 2011, indicated a substantial amount of large rock had been removed and displaced within the upper portion of the habitat (Imper unpublished data 2011). Large rocks are a key feature of the habitat for N. f. ssp. californica, undoubtedly influencing moisture and temperature regimes at the scale of the plant, and perhaps other factors important to the species. Due to an inability to access the property, the impact of the rock removal could not be quantified. In addition, the landowner has not indicated an interest in discussing habitat protection measures for the species. Therefore, the species remains vulnerable to habitat destruction and modification (USFWS, 2011).

Stressor: Grazing (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of individuals/habitat degradation
Narrative: Population monitoring conducted since 2005 has indicated, as high as 40 percent of the flowering plants in some areas were negatively affected by grazing. Plants located closer to cattle trails, the serpentine/pasture interface, or on moderate slopes were more likely to be grazed (Imper unpublished data 2011). Although these impacts may be important, we do not know at this time if the impacts of grazing are affecting the rate of population mortality or recruitment, or limiting recovery of the population in any way (USFWS, 2011).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: There has been no change in the imminence of this threat factor. Noccaea fendleri ssp. californica is not listed by the State of California. Therefore, protections under the California Endangered Species Act and Native Plant Protection Act do not apply. The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) affords the primary protection for the species under state law. The CEQA requires review of any project that is undertaken, funded, or permitted by the State or a local governmental agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or deciding that overriding considerations make mitigation infeasible (CEQA section 21002). Protection of listed species through CEQA is, therefore, dependent upon the discretion of the lead agency involved. With the exception of eight plants located on the CDFFP site in 2011, the entire distribution of Noccaea fendleri ssp. californica is currently located on privately owned grazing land. CEQA does not regulate grazing or many other activities on private land that could negatively affect the species. The primary protections under Federal law are afforded by the Endangered Species Act of 1973 (Act), as amended. Since all habitat occupied by Noccaea fendleri ssp. californica is either private or State-owned, the prohibitions on take afforded under Section 9 of the Act do not apply to otherwise legal activities. However, under Section 7(a)(2) of the Act, Federal agencies must consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed plant species. This section would apply to any project funded by the Federal Aviation Administration (FAA) that potentially could affect the species, or its occupied habitat. In addition, the airport occurs within the designated critical habitat for the species. Any airport project funded by the FAA that affects any portion of designated critical habitat is covered under Section 7 of the Act (USFWS, 2011).

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999; Cayan et al. 2005; IPCC 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher

precipitation events, or other effects. The available data suggests Noccaea fendleri ssp. californica may prefer relatively cool soil temperatures during the growing season, at least compared to conditions typical of the outcrops located near the airport (SHN Consulting Engineers and Geologists 2001). Therefore, if a warming trend is associated with climate change, the limited range in elevation and aspect available to N. f. ssp. californica nearby could hinder the ability of the species to escape detrimental changes in climate (USFWS, 2011).

Recovery

Reclassification Criteria:
The population as a whole, and all presently extant colonies, are protected and stable. Protected sites are defined as either 1) sites owned and/or managed by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or 2) sites protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species. To be deemed stable, the present largest population must maintain a running average population size (mean of annual mean population estimates) of at least 7,000 individuals, and the two other presently extant colonies must maintain a running average population size of at least 500 individuals each. Running averages will be determined over the most recent 10 years, or an appropriate period justified on the basis of population research (USFWS, 2011)

Reliable seed germination and propagation techniques for the species are understood and demonstrated (USFWS, 2011).

Genetic material, in the form of seeds adequately representing the genetic diversity within the species, is stored in a facility approved by the Center for Plant Conservation (USFWS, 2011).

Delisting Criteria:
The running average for the entire population is 10,000 or more individuals over a period of 10 years, or an appropriate period justified on the basis of population research (USFWS, 2011).

At least five protected and stable colonies (populations on distinct serpentine outcrops) are distributed throughout the current and historic range of the species. For a site to be considered protected, it must be either owned by a government agency or private conservation organization that identifies maintenance of the species as the primary management objective for the site, or the site must be protected by a permanent conservation easement or covenant that commits present and future landowners to the conservation of the species. To be deemed stable, the largest presently extant colony must maintain a running average population size of at least 7,000 individuals, and colonies on 4 additional outcrops must be shown to be naturally reproducing and maintain a running average population size of at least 500 individuals each for a period of 10 years, or an appropriate period justified on the basis of population research (USFWS, 2011).

Monitoring of population size, trends, other pertinent characteristics, and habitat quality has begun and will continue for the post-delisting monitoring period (USFWS, 2011).

Recovery Actions:

- Access has been denied to the largest colony (West colony) since 2003. Therefore, we cannot assess any progress made toward achievement of this criterion (USFWS, 2011).
- There has been no change in the protection status of the three extant colonies, or nearby suitable habitat since the recovery plan was completed. The two largest colonies (West and East colonies) are not protected. The CDFFP colony is covered under a draft protective policy implemented by the CDFFP. Access has been denied to monitor the West colony since 2003. Therefore, the information necessary to assess the stability of that colony is not being collected. Two other historical (and extant) occurrences are known, both of which have naturally reproduced since completion of the recovery plan. However, only the East colony exceeds the numerical threshold set in this criterion as of 2011 (see Section C below). The CDFFP colony has declined, and is on the verge of extirpation. As a result, this criterion has not been achieved (USFWS, 2011).
- Population-based monitoring of the two smaller colonies has been conducted since 2001. However, the large West colony has not been monitored since 2002 because due to an inability to access the property. This criterion has been partially achieved. Currently, all downlisting and delisting criteria are considered adequate and appropriate with respect to recovery of the species. The conservation strategy outlined by these criteria addresses all the currently known threats to the species. Components of the conservation strategy and criteria include habitat protection and management secured by appropriate agreements (such as conservation easements, covenants) to address listing factors A (habitat loss or modification, etc.); C (possible threat of predation); D (inadequate regulatory mechanisms); and E (other natural or manmade factors – specifically manmade random events, such as contaminant spills associated with the airport, that can be prevented or contained by appropriate management). Population sizes and number of protected populations included in the criteria in part address the threat of stochastic events under listing factor E. Seed banking also addresses the threat of stochastic events under listing factor E by ensuring that genetic material is available to reestablish any populations that become extirpated due to stochastic events (USFWS, 2011).
- Virtually all habitat occupied by Noccaea fendleri ssp. californica, or suitable for the species within Kneeland Prairie occurs on private property owned by a single landowner. Therefore, recovery of the species is almost entirely dependent on being permitted to access the population, and to implement protective measures and management on private lands. The highest priority action for this species is to continue efforts to secure a working relationship with the landowner (USFWS, 2011).
- Continued periodic monitoring of the portion of the population for which access is authorized is also crucial in order to: measure progress toward meeting the numerical recovery criteria; provide an early warning of threats to the population; provide further evidence of the importance of climate to the health of the population; and enable at least a gross assessment of habitat in the area for which access is not authorized (USFWS, 2011).
- Since the recovery criteria for Noccaea fendleri ssp. californica contain specific goals with respect to the number of individuals, research is needed to determine the degree of clonal growth within the population and develop a method to standardize identification of individuals for the purpose of population estimation (USFWS, 2011).
- Lastly, future efforts by Humboldt County to expand or maintain the airport may present opportunities for experimental restoration of serpentine substrate buried during past construction, or exposed where it is (naturally) situated near the ground surface. Those efforts, while not assured of success, are worth pursuing in order to expand the overall

distribution of the species (USFWS, 2011).

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5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California.

SPECIES ACCOUNT: *Thymophylla tephroleuca* (Ashy dogweed)

Species Taxonomic and Listing Information

Listing Status: Endangered; 07/19/1984; Southwest Region (R2) (USFWS, 2016)

Physical Description

Ashy dogweed is endemic to South Texas and occurs in open flat areas of shrubby grasslands and deep sandy pockets of fine sandy loam soils. Ashy dogweed is a short, woody-based, perennial sub-shrub plant, growing 3.9 – 11.8 inches in height and belongs to the Asteraceae (sunflower) family. It has mostly alternate, linear leaves with ashy-white pubescence due to fine, short hair glands that emit a pungent odor when crushed (U. S. Fish and Wildlife Service 1988). Flower heads are yellow to bright yellow and flowering typically occurs between March and May; however, such events are dependent on rainfall (USFWS 1984) and can occur as early as February (Correll and Johnston 1979). Ashy dogweed is an obligate out-crosser that has non-specialist pollinators from members of the families Buprestidae (beetles), Bombyliidae (bee flies), and Megachilidae (bees) (Dodson 2001, Williamson 2002, Poole et al. 2007).

Current Range

Several ashy dogweed populations are considered meta-populations based on relative distance between sites. Surveys conducted in the years since listing have identified five other extant populations in addition to the one known at the time of listing. These populations have increased the known range of the species from Webb to southern Zapata County. The loss, fragmentation and/or alteration of habitat may be increased at these meta-population sites as opposed to plants in populations that are farther apart. Ashy dogweed was first recorded in Starr County in 1932, near Rio Grande City, but is now considered extirpated from this area. This species was federally listed as endangered on July 19, 1984 and a recovery plan for the species was completed in 1988. At the time of listing, the ashy dogweed population was estimated to be 25 acres in size and contained approximately 1,300 individuals (USFWS 1984, 1987). Since then five additional populations have been found and the species' known range has expanded from Webb County into Zapata County, Texas (USFWS 2011). One of the six extant populations is partially on state-owned ROW lands that are maintained by TxDOT. The five remaining populations are found on private lands and three of the land owners have entered into Voluntary Conservation Agreements with TPWD (USFWS 2011). No critical habitat has been designated for ashy dogweed.

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Flower heads are yellow to bright yellow and flowering typically occurs between March and May; however, such events are dependent on rainfall (USFWS 1984) and can occur as early as February (Correll and Johnston 1979). Ashy dogweed is an obligate out-crosser that has non-specialist pollinators from members of the families Buprestidae (beetles), Bombyliidae (bee

flies), and Megachilidae (bees) (Dodson 2001, Williamson 2002, Poole et al. 2007).

Habitat Type

Adult: Grasslands

Environmental Specificity

Adult: Narrow (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Fine sand or sandy-loam soils on level or rolling grasslands that are often shrub-invaded. Freer mixed brush thorn woodland. Mesquite-Acacia thorn woodland. (NatureServe, 2015). Ashy dogweed is endemic to South Texas and occurs in open flat areas of shrubby grasslands and deep sandy pockets of fine sandy loam soils.

Dispersal/Migration

Population Information and Trends

Number of Populations:

6 (USFWS, 2022)

Population Narrative:

Several ashy dogweed populations are considered meta-populations based on relative distance between sites. Surveys conducted in the years since listing have identified five other extant populations in addition to the one known at the time of listing. These populations have increased the known range of the species from Webb to southern Zapata County. The loss, fragmentation and/or alteration of habitat may be increased at these meta-population sites as opposed to plants in populations that are farther apart. Ashy dogweed was first recorded in Starr County in 1932, near Rio Grande City, but is now considered extirpated from this area. This species was federally listed as endangered on July 19, 1984 and a recovery plan for the species was completed in 1988. At the time of listing, the ashy dogweed population was estimated to be 25 acres in size and contained approximately 1,300 individuals (USFWS 1984, 1987). Since then five additional populations have been found and the species' known range has expanded from Webb County into Zapata County, Texas (USFWS 2011). One of the six extant populations is partially on state-owned ROW lands that are maintained by TxDOT. The five remaining populations are found on private lands and three of the land owners have entered into Voluntary Conservation Agreements with TPWD (USFWS 2011). No critical habitat has been designated for ashy dogweed. At the time of the 5-year status review in 2011, six extant populations were known (Service, 2011). Three occur on private lands and one large extant meta-population partially occurs along the TXDOT U.S. Highway 83 right-of-way (ROW) on both state- and privately-owned lands (USFWS, 2022).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:

Narrative: Primary threats to the survival of the ashy dogweed have been identified as certain ranching activities, including invasion by non-native grasses planted to improve range conditions. Oil and gas development, highway development and roadside projects, and climate change (e.g. more frequent and/or extended droughts) also threaten the species.

Stressor: Habitat Loss
Exposure:
Response:
Consequence:
Narrative: Habitat loss for ashy dogweed has been largely due to the introduction of non-native pasture grass during the conversion of native rangeland to improved pasture; overgrazing; and ground disturbance activities associated with urban development, construction or improvement of highways and utility transmission systems necessary to support urban infrastructures

Stressor: Introduction of non-natives
Exposure:
Response:
Consequence:
Narrative: Many areas in South Texas are dominated by the introduced buffelgrass (Pennisetum ciliaris), an aggressive, exotic grass. Kleberg bluestem grass (Dicanthium annulatum), used for erosion control on roadway ROWs, also invades natural areas and is present at all ashy dogweed sites although not as extensively as buffelgrass (USFWS 2011).

Stressor: Drought
Exposure:
Response:
Consequence:
Narrative: Drought conditions can reduce plant populations and population size, decreasing genetic variability and viability, thus reducing the species ability to cope with a wide range of environmental stressors (USFWS 2011).

Stressor: Grazing
Exposure:
Response:
Consequence:
Narrative: Seedling establishment can be decreased by chaining, blading, dozing and disking activities that cause deep soil disturbance, along with surface compaction (Williamson 2002) potentially caused by heavy grazing pressures (USFWS 1988). Dodson's (2001) and Williamson's (2002) research suggests that some disturbance may be important for this species' colonization, spread, and/or growth; however, the level of preferred disturbance is unclear.

Stressor: Highway construction and improvements
Exposure:
Response:
Consequence:
Narrative: Highway construction and improvements may adversely impact ashy dogweed populations (USFWS 2011). Since the largest, extant meta-population of ashy dogweed occurs along US 83, roadway improvement projects, highway maintenance, and potential urban

development have the potential to continue to impact the species.

Stressor: Development
Exposure:
Response:
Consequence:
Narrative: The potential for development exists on private lands. An increase in development projects may increase the rate at which these populations are exposed to disturbance activities.

Stressor: Pesticides
Exposure:
Response:
Consequence:
Narrative: The use of herbicides to maintain ROW and control noxious weeds could directly harm a plant and could indirectly kill ashy dogweed pollinators or their host plants (USFWS 2011). Pesticide application to control crop pests, particularly aerial spraying and drift impacts, could also potentially impact populations if they are situated near agricultural areas.

Stressor: Oil and Gas Activity
Exposure:
Response:
Consequence:
Narrative: When ashy dogweed was listed in 1984, oil and gas activity was not mentioned as a threat to the species. Since 1984, oil and natural gas activities have steadily increased in both Webb and Zapata counties impacting land cover and soils with the development of oil wells, well pads, oil and gas roads, vehicular traffic and/or hydraulic fracturing ("fracking"). The Environmental Protection Agency (EPA) is conducting a study examining the pollution effects of fracking on ground and surface water. Oil and gas activities do not currently occur within the US 83 ROW, but do occur on private lands and are considered significant threats to the ashy dogweed (USFWS 2011).

Stressor: Climate Change
Exposure:
Response:
Consequence:
Narrative: Climate change is considered to be a potential threat to ashy dogweed. "Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level" (Intergovernmental Panel on Climate Change (IPCC) 2007). For the next two decades a warming of about 0.2°C (0.4°F) per decade is projected. After that time, temperature projections increasingly depend on specific emission scenarios (IPCC 2007). Various emissions scenarios suggest that by the end of the 21st century, average global temperatures are expected to increase 0.6°C to 4.0°C (1.1°F to 7.2°F) with the greatest warming expected over land (IPCC 2007). Localized projections suggest the southwest United States may experience the greatest temperature increase of any area in the lower 48 states. The IPCC describes the likelihood that hot extremes, heat waves, and heavy precipitation events will increase in frequency. There is also high confidence that many semi-arid areas like the western United States will suffer a decrease in water resources due to climate change (IPCC 2007). Climate change may act alone

or synergistically with the invasion of non-native invasive species to increase their spread and their ability to out-compete native varieties (Archer and Predick 2008). Temperature and precipitation changes, along with increases in atmospheric carbon dioxide and nitrogen, can enhance dispersal pathways for non-natives (Smith et al. 2000), allowing exotic plants to invade new areas and causing range reductions or possibly local extirpations of rare plant populations. Invasion of ashy dogweed habitat by buffelgrass has been described earlier. Due to its limited geographic distribution, and the fact that the largest number of individual plants occur in one meta-population, ashy dogweed is vulnerable to localized catastrophic events, such as flooding or drought, as well as to broader climate changes that could decrease suitable habitat, while simultaneously making conditions conducive to further exotic grass invasion. Extended periods of drought, becoming more common in South Texas also play a role in fire ecology by increasing the frequency, and potentially severity, of fires. Ashy dogweed's response to fire is unknown. However, most of the invasive grass species in south Texas appear to be positively fire adapted, so consequences of increasing drought conditions may include increasing the competiveness of these non-natives (Kuvlesky et al. 2002). Intensified and more frequent fire regimes can allow exotic grasses to form dense monocultures, including in areas where native species are able to persist. The increased amount of biomass and understory produced by these non-native grasses adds to the fuel load, and combined with a lack of precipitation forecast by potential climate change, could affect fire regime characteristics in ashy dogweed habitat including frequency, intensity, extent, type, and seasonality of fires (USFWS 2011). Climate change may also alter pollinator phenology (USFWS 1988). Since ashy dogweed appears to be insect pollinated, alterations in environmental conditions related to climate change, including precipitation and temperature, could alter the phenology of ashy dogweed such that the current blooming and fruiting patterns may not match the timing of pollinators that currently visit these plants, thereby stalling pollination (Sherry et al. 2007). Although it is reasonable to assume that ashy dogweed may be affected by climate change, we lack sufficient certainty to know how climate change will affect the species, and if so, to what extent.

Recovery

Reclassification Criteria:
Recovery Priority Number: 5

Recovery Actions:

- The primary objective of the recovery plan for ashy dogweed is to protect this species and its habitat from further destruction from human activities and to establish healthy populations in their natural habitat at levels that would allow the species to be down-listed to threatened and eventually delisted (USFWS 1987).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS The Service finds that impacts to the species from loss, fragmentation and/or alteration of habitat are continued threats to ashy dogweed. Current populations conditions remain unchanged and appear stable since the previous 5-year status review (Service, 2011). A complete evaluation of the biology through genetic studies, species monitoring on private lands and involvement with private landowners is recommended (USFWS, 2022).

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SPECIES ACCOUNT: *Thysanocarpus conchuliferus* (Santa Cruz Island fringepod)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest (R8) (USFWS, 2009)

Physical Description

A delicate annual herb with a slender stem, usually 6-15 cm tall, and with narrow, lobed leaves. A dense cluser of small pink-lavender flowers blooms in March and April, followed by fruits with a rounded top, fringed with wings that are strongly incurved towards the flat or concave lower side. (NatureServe, 2015)

Taxonomy

It was once recognized as a variety of Thysanocarpus laciniatus (Jepson 1925); however, it has been recognized as a distinct species since 1944 (Abrams 1944, Rollins 1993) (USFWS, 2009).

Historical Range

See current range/distribution.

Current Range

Species is endemic to Santa Cruz Island. Junak et al. (1995) reported that it occurs from the north slopes of the island between Lady's and Prisoner's Harbors, the Central Valley near Lagunitas Secas in Cañada de la Portezuela, and on the south side of the island on Sierra Blanca Ridge (USFWS, 2009).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Habitat Type

Adult: Rocky Outcrops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits dry canyon slopes, rocky ridges, and rock outcrops. Mostly on shaded n-facing rock faces, slopes, and canyon bottoms; chaparral, oak woodland; 800-1800 ft (245-550m) (Junak et al. 1995) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species specific habitat needs and relatively low number of known populations.

Dispersal/Migration

Population Information and Trends

Population Trends:

Not available

Threats and Stressors

Stressor: Competition with non-native species (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Past grazing and trampling by non-native animals has resulted in the conversion of native plant communities to non-native plant communities (Minnich 1980, Hobbs 1983). In the past, sources of incidental introductions of seed included wind-blown seed from the mainland and introductions from restocking non-native animals and operational equipment (vehicles and construction materials) (60 FR 37993). At the time of listing, several species of non-native, aggressive plant species were considered problematic invaders on the Channel Islands, including Australian fireweed (Erechtites glomerata), several species of iceplant (Carpobrotus spp., Mesembryanthemum spp.), several thistle species (Centaurea spp., Cirsium spp., Silybum sp.), German ivy (Delairea odorata), hoary cress (Cardaria draba), and Russian thistle (Salsola iberica). Santa Cruz Island has at least 170 non-native invasive plant species recorded. In particular, non-native annual grasses inhibit the establishment of Thysanocarpus conchuliferus individuals and expansion of populations (McEachern, pers. comm. 2007) (USFWS, 2009).

Stressor: Conservation actions (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Santa Cruz Island Restoration Plan proposed to remove large stands of fennel (by burning and subsequently applying herbicide) to help with the eradication of feral pigs because acres of dense stands of fennel complicate the eradication effort (McEachern 2004), and to benefit the native plant communities on the island; however, the efficacy of such a program is still being discussed (Wolstenholme, pers. comm. 2007). Currently, limited removal of fennel occurs along dirt roads and within 10 feet of the roads; Thysanocarpus conchuliferus does not occur within the roadside treatment areas (Cory, pers. comm. 2009). Additionally, both TNC and the NPS are taking precautions to minimize the spread of invasive species through visitor education programs because seeds of non-native plants can be spread by hikers and campers during recreational activities. The Service has been working with TNC, the NPS, and the County of

Santa Barbara to eradicate both woody and herbaceous non-native plant species from the island. The Service has provided funding to the County of Santa Barbara, through the Partners for Fish and Wildlife and Private Stewardship Grant programs, to implement a program that would remove non-native woody species. In addition, the County of Santa Barbara proposed to remove approximately 24 acres (9.7 hectares) of incipient weeds and enhance approximately 2 acres (0.81 hectare) of habitat for three federally endangered plants, including Thysanocarpus conchuliferus (Service 2007) (USFWS, 2009).

Stressor: Small population size (USFWS, 2009)
Exposure:
Response:
Consequence: Threat of extinction
Narrative: At the time of listing, Thysanocarpus conchuliferus was threatened by the risk of stochastic extinction due to its small population size. Conservation biology notes the vulnerability of taxa known from one or very few locations and/or from small and highly variable populations (Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). In particular, T. conchuliferus is subject to catastrophic environmental events, such as storms, drought, fire, or landslides that could destroy a significant percentage of individuals (62 FR 40954). Although more populations are known now than at the time of listing, the number of populations and the total number of individuals are still small, and remain as a concern for the species (USFWS, 2009).

Stressor: Change in fire frequencies (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire has been precluded as an ecological process on the Channel Islands for over 150 years. The life history requirements of Thysanocarpus conchuliferus are based upon the occurrence of fires to promote reproduction and reduce competition with other species. Due to ranching activities, characteristic fire intensities and durations have shifted from long duration and high intensity with brush fuels to short duration and light intensity with grass fuels because the fuel load (the amount of standing and downed vegetation) has changed from brush (heavy) to grass (light). The absence of fire created an imbalance in recruitment and regeneration of ecosystem components, including T. conchuliferus. Many of the brushland species will not regenerate without fire and with age will die. In addition, browsing and grazing animals had reduced the probability of survival for these fire-adapted species by removing seeds and seedlings, which could be devastating to recruitment following a fire event. Consumption of T. conchuliferus seedlings could effectively terminate the subsequent generation needed to re-establish the seed bank (60 FR 37993) (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in

a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to particular species at this time (USFWS, 2009).

Recovery

Delisting Criteria:

1. Discover or establish 5 additional populations on Santa Cruz Island (addresses Listing Factors A, C, and E). This criterion has not been met. This criterion is relevant with respect to the recovery of the species. However, the exact number, size, and configuration of the populations needed to assure recovery may need to be refined in the future based on the results of the longterm conservation and recovery research program described above (USFWS, 2009).

2. No decline after 10 years of downlisting (addresses Listing Factors A, C, and E). This criterion has not been met. This criterion is relevant with respect to the recovery of the species; however, what constitutes a "decline" over this period of time should be refined (USFWS, 2009).

Recovery Actions:

- 1. Continue to support restoration of the native habitats on Santa Cruz Island through existing partnerships and exploration of new opportunities (USFWS, 2009).
- 2. Assist the USGS-BRD, the NPS, and TNC to obtain additional funding to continue field surveys, demographic monitoring, outplantings, and population viability analyses to assess the overall health of the population. Additional information could reveal a trend in the status of Thysanocarpus conchuliferus and determine if this species is moving toward recovery or if more recovery efforts should be implemented. Additional research could further define life history strategies and population dynamics necessary to refine the delisting criteria and guide recovery efforts (USFWS, 2009).
- 3. Work cooperatively with NPS and USGS-BRD to refine the general downlisting criteria. Securing several populations of Thysanocarpus conchuliferus that each contains a minimum of 2,000 plants is an unrealistic goal and is not an accurate recovery target for this species (USFWS, 2009).

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SPECIES ACCOUNT: *Tinospora homosepala* (No Common Name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/02/2015; Pacific Region (R1) (USFWS, 2016)

Physical Description

Tinospora homosepala (NCN), a vine in the moonseed family (Menispermaceae). (USFWS, 2015)

Taxonomy

Tinospora homosepala differs from T. glabra in having equal-sized sepals (petal-like structures of the calyx) as opposed to the outer sepals being much smaller than inner sepals as in T. glabra. (USFWS, 2015)

Historical Range

Tinospora homosepala (NCN) is historically known only from Guam (Merrill 1914, p. 83; Stone 1970, pp. 27, 277; Costion and Lorence 2012, pp. 92–93). (USFWS, 2015)

Current Range

Known only on Guam (USFWS, 2015). Distribution: Guam (USFWS, 2020b).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Asexual (USFWS, 2015)

Reproduction Narrative

Adult: All known individuals of T. homosepala on Guam are said to be males that reproduce clonally (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.). (USFWS, 2015)

Habitat Type

Adult: Terrestrial (USFWS, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Shrublands, forests (USFWS, 2015)

Habitat Narrative

Adult: Currently, T. homosepala is known from the forest ecosystem (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.). This species is found in dry, moist, and wet shrublands on ridgecrests and steep slopes. (USFWS, 2015)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

3 (USFWS, 2015; USFWS, 2020b)

Population Size:

30 (USFWS, 2015; USFWS, 2020b)

Population Narrative:

Currently, T. homosepala is known from 3 occurrences totaling approximately 30 individuals, in the forest ecosystem (Yoshioka 2008, p. 15; Gawel et al. 2013, in litt.). (USFWS, 2015). There are only three known populations of Tinospora homosepala with an estimated overall population size of 30 individuals that are suspected to all be male. None of the three populations of T. homosepala are protected from ungulates or other threats to individual plants and their habitat. Only one plant is in genetic storage in the GPEPP nursery. (USFWS, 2020)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative:

Stressor: Limited genetic diversity (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: Clonal reproduction limits genetic diversity, reducing the ability of the species to form new genetic combinations to fit changing environmental conditions (Stebbins 1957, p. 352). (USFWS, 2015)

Stressor: Lack of female plants (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: T. homosepala, a single island endemic, has been reduced to roughly 30 individuals on Guam, and it is possible that no female representatives of this species remain. (USFWS, 2015)

Stressor: Small population size (USFWS, 2015)
Exposure:
Response:

Consequence:
Narrative: These few remaining individuals of the species are at risk of extinction, due to continued habitat loss and destruction from nonnative animals and plants, and typhoons, and by genetic limitations as a result of the possible loss of potential sexual reproduction. (USFWS, 2015)

Stressor: Climate change (USFWS, 2015)
Exposure:
Response:
Consequence:
Narrative: The Service anticipates the effects of climate change will further exacerbate many of these threats in the future. (USFWS, 2015)

Recovery

Reclassification Criteria:
Not available.

Delisting Criteria:
Not available.

Recovery Actions:
- Threat and Recovery Potential: Full species with a high degree of threat and a high degree of recovery potential. (USFWS, 2020b)

Conservation Measures and Best Management Practices:
- RECOMMENDATIONS FOR FUTURE ACTIONS • Determine population status, current distribution, and availability of sites for plant conservation—Determine the distribution and number of all individuals on each island. Assess the availability of sites for long-term conservation of plant populations. Assess the status and threats to each population to inform prioritization of conservation effort. • Conduct research to clarify life history information and reproduction within populations • Conduct research to determine the best way to control the brown treesnake, rodents, and invasive invertebrates. Assess development and land designation and zoning threats to conservation of habitat needed for recovery. • Ungulate monitoring and control—Construct and maintain fenced exclosures to protect wild and reintroduced individuals from the negative impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species and those that compete with Tinospora homosepala at all populations. • Captive propagation for genetic storage and reintroduction—Continue to collect propagative materials for storage and reintroduction. • Reintroduction and translocation—Develop populations via reintroductions to suitable sites and increase numbers of populations and individuals in suitable habitat to build resiliency and redundancy and reduce the impacts of disturbance. • Develop regulations and policy essential to recover the species and their habitats—Encourage the development of legislation to ensure protection of the listed species under Commonwealth or Territorial law. Develop and support the implementation of biosecurity plans to prevent the influx of new pests and invasive species into the Territory and inter-island movement of pests and invasive species • Alliance and partnership development—Continue to contribute to planning and implementation of ecosystem-level restoration and management to benefit this taxon. (USFWS, 2020)

- Current Management Actions: • Surveys and inventories – • The USFWS recommends all sites containing suitable habitat be surveyed for Tinospora homosepala prior to implementation of projects entailing vegetation or soil disturbance. • Joint Region Marianas (JRM) surveyed for ESA-listed species, including T. homosepala, at the Tarague Triangle, MSA Igloos, THAAD, and other projects to document locations and estimate population densities in sites that are proposed for ungulate exclusion and forest restoration (JRM 2019 and 2020). • Captive propagation for genetic storage and reintroduction – • The Guam Plant Extinction Prevention Program (GPEPP) currently holds one Tinospora homosepala in their nursery (GPEPP 2018). • Habitat protection – • A major biosecurity focus within the Mariana Islands is preventing the spread of BTS to the CNMI from Guam. Federal agencies support local capacity both in Guam and the CNMI. Efforts include inspection of all arriving cargo from Guam to the CNMI by BTS detection dogs as well as specialized trapping around all major ports of entry. The Department of Agriculture, Wildlife Services, in coordination with the National Wildlife Research Center (NWRC), U.S. DoD Environmental Security Technology Certification Program, and the Department of Interior-Office of Insular Affairs (U.S. Geological Survey, USFWS), are using aerial applications of acetaminophen to suppress BTS over forested areas in AAFB (Dorr, et al. 2016, in litt.; Phillips 2014, in litt; BTSTWG 2015, entire). In addition, repeated and sustained applications could drastically reduce BTS abundance on a landscape scale (Siers, et al. 2018, in litt.). • An island-wide Habitat Conservation Plan for Guam, that would provide a collaborative and comprehensive approach to endangered species conservation on non-federal lands, is beginning to be developed (USFWS 2020). • A 2020 Memorandum of Understanding between JRM and the USFWS outlined a mutual understanding regarding the intentions and future considerations of a Department of Defense Readiness and Environmental Protection Integration Initiative (REPI) to address conservation of upland vegetation communities (DON and USFWS 2020). • Tinospora homosepala is known to occur on one of the National Park units located near Asan, Guam, where the occupied area is not likely to be exposed to development. • Suitable habitat for Tinospora homosepala occurs at the Guam National Wildlife Refuge (NWR), Ritidian unit. Although T. homosepala is not known to occur at Ritidian Point, the Refuge unit receives some protections from invasive animals and plants, so if Tinospora homosepala were propagated and planted there, the conservation status of the species may be improved. (USFWS, 2020)

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SPECIES ACCOUNT: *Townsendia aprica* (Last Chance townsendia)

Species Taxonomic and Listing Information

Listing Status: Threatened; 08/21/1985; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

Last Chance townsendia (Townsendia aprica) is a small, stemless, mound-forming perennial plant in the sunflower family (Cronquist et al. 1994, Welsh et al. 2008). The species was first described in 1968 and is named for the yellow to apricot color of the flowers which distinguish it from other members of the Townsendia genus (USFWS 1993, Welsh et al. 2008). Plants measure less than 2.5 cm (one inch) tall and 2.5-5 cm (1-2 inches) wide with narrow leaves measuring about 1.25 cm (0.5 inch) long and covered with fine hairs. Leaves and flowers are borne at ground level. Townsendia flowers from mid-March through May and reproduces solely by seed (USFWS 1993, Welsh et al. 2008). Fruits are achenes and are compressed and ribbed with one seed. For a technical description of the species, see Welsh et al. (2008).

Current Range

Populations occur on BLM, National Forest, and NPS lands in Emery, Sevier, and Wayne counties of south-central Utah. Last Chance townsendia is endemic to the Colorado Plateau and occurs primarily in a long, narrow band, approximately 8 kilometers (5 miles) wide by 48 kilometers (30 miles) long, from near Interstate 70 in the north, southwest to the Fremont Junction area, then south to CRNP. Most localities appear to be isolated and less than an acre in size (USFWS 1993).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Reproduction in Last Chance townsendia is primarily sexual.

Reproduction Narrative

Adult: Reproduction in Last Chance townsendia is primarily sexual. Flowering occurs from mid-March to May and fruiting occurs May to June (USFWS 1993). Self-pollination is virtually non-existent (USFWS 1993). Pollination is accomplished by several species of native solitary bees and a few species of flies. Tepedino et al (2004) provide a complete list of known pollinators. Wind pollination may also occur.

Habitat Type

Adult: Mancos shale

Environmental Specificity

Adult: Moderate (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Last Chance townsendia occurs over a wide range of elevations and on a variety of soil substrates. The published elevation range of the species is 1,860 to 2,440 m (6,102 to 8,005 ft) (Welsh et al. 2008), but new populations of Last Chance townsendia have increased the upper elevation limit to 2,773 m (9,100 ft) (Clark 2011). The species occurs on a variety of geologic substrates with most populations found on soils within the Moenkopi Formation, Morrison Formation, Carmel Formation, Mancos Shale Group, and the San Rafael Group. However, the species appears to be restricted to fine-textured shale soils within each formation (Clark 2011). The plants often grow in association with volcanic ash strata within the Mancos shale (Welsh et al. 2008). Due to its wide elevational range, Last Chance townsendia occurs within several plant communities including the Castle Valley saltbush (Atriplex gardneri var. cuneata) plant community in the San Rafael Swell, openings of pinyon-juniper woodlands within the Fishlake Plateau, and in ponderosa pine woodlands in the upper Deep Creek mountains (Fertig and Beer 2005, Welsh et al. 2008). Commonly associated plant species include galleta grass (Pleuraphis jamesii), Utah Juniper (Juniperus osteosperma), blue grama (Bouteloua gracilis) and shadscale (Atriplex confertifolia) (Clark 2002). The presence of a well-developed cryptobiotic crust was documented at Last Chance townsendia populations in Sevier and Emery counties (Armstrong and Thorne 1991). Several other rare, endemic species also occur in the same habitat as Last Chance townsendia and include Pediocactus despainii, Pediocactus winkleri, Sclerocactus wrightiae, and Gilia tenuis (Armstrong and Thorne 1991).

Dispersal/Migration

Population Information and Trends

Number of Populations:

23

Population Size:

~7,184 (USFWS, 2019)

Population Narrative:

We have determined that there are 23 populations of Last Chance townsendia. We use the number of known individuals (6,848) as our best range-wide estimate for the total population of Last Chance townsendia. This estimate uses the latest plant count data for each population. We determine the actual plant count data is the best indicator of total population size at this time because it is consistent with total population estimates from 2008 (7,215 individuals) and 2009 (4,000 – 4,500 individuals) (Clark 2009b). We recognize the actual plant count likely under-represents the total population size for the species because of the difficulty of detecting seedlings and non-flowering individuals in the field, and may be considered a conservative estimate of abundance (USFWS 2013). Overall abundance of Last Chance townsendia has declined over the last 13 years and climate conditions are believed to be the primary cause of the decline (Clark 2008d, RMER 2011). Precipitation data from 1997 until 2011 show below average annual precipitation from 1997 to 2009, with 2002 and 2009 recording the lowest precipitation amounts during that time period (RMER 2011, USGS 2003). Sharp declines in abundance were documented during the 1999 – 2004 period at a number of populations on BLM and CRNP lands. The decline appeared to be more severe at lower elevations BLM and CRNP lands compared to higher elevations on USFS land (Clark 2002, Clark 2009b, RMER 2004). Survey and monitoring results since 2000 indicate sharp declines at many monitoring sites, with

80 – 90% mortality of mature plants in Capitol Reef in 2001 (Clark 2002). On USFS land, the population trend of Last Chance townsendia is less apparent because of infrequent monitoring; however, these populations appear to be stable (USFWS 2013). Annual monitoring efforts on BLM land provide the best documentation of the decline in abundance for the species. A long-term demography plot established in 1996 documents the decline from 232 individuals to 33 plants in 2009 (Clark 2009b). Mortality was equal to or greater than recruitment every year during the study period except for 2004 which was the only year with high recruitment. Mortality was greatest from 2000–2002, and in 2009. Additionally, the BLM has performed annual monitoring since 2002 with 114 monitoring sites within 14 populations (RMER 2011). The monitoring results document two periods of decline: 2002–2004 and 2009–2011 (RMER 2004, RMER 2011). The BLM annual monitoring data indicate the lower elevation populations of the species are sensitive to drought conditions. There are concerns that the species may now be extirpated at many of the monitoring sites, particularly at sites which supported less than 10 individuals in favorable years. Further study is required to document if there is a sufficiently large and long-lived seedbank such that the species can persist during long periods of drought conditions. A detailed look at the BLM annual monitoring data does show the species was dormant and not detectable for one to seven consecutive years at 11 monitoring sites. Thus, multiple years of monitoring may be necessary for a site to be considered extirpated. Furthermore, multiple years of surveys may be necessary to determine if Last Chance townsendia is present within suitable habitat (USFWS 2013). Last Chance townsendia begins to flower in the second year of life when they achieve a size of approximately 0.6–0.8 of an inch (1.5–2.0 cm) in diameter (Tepedino et al. 2004). Larger plants can produce up to 10 flowers (Tepedino et al. 2004). The number of flowers produced per plant is directly related to plant size and the larger the plant, the more flowers the plant is likely to produce (Tepedino et al. 2004, Clark 2008c). Tepedino et al. (2004) found that few individuals survived and grew larger than 1.6 inches (4 cm) in diameter. Clark (2008d) studied longevity of 232 Last Chance townsendia individuals at a demography plot. Most of the individuals did not survive past six years of age and the three longest-lived individuals in the plot had a minimum known age of 13 years (Clark 2008d). In the long-term plot, reproduction was positively correlated with the number of leaf rosettes. Over a ten year period, individuals with one leaf rosette flowered 35% of the time, individuals with four leaf rosettes flowered 80% of the time, and individuals with 16 or more leaf rosettes flowered 100% of the time (Clark 2008d). Reproduction in Last Chance townsendia is primarily sexual. Flowering occurs from mid-March to May and fruiting occurs May to June (USFWS 1993). Self-pollination is virtually non-existent (USFWS 1993). Pollination is accomplished by several species of native solitary bees and a few species of flies. Tepedino et al (2004) provide a complete list of known pollinators. Wind pollination may also occur. Low seed production in Last Chance townsendia was reported by botanists and identified in the Recovery Plan (USFWS 1993), yet we do not have data to document the extent and the frequency with which seed limitation occurs. Possible factors in limiting seed production include low pollinator numbers, inclement weather affecting pollinator flight activity, or small population size (Tepedino et al. 2004, USFWS 1993). Based on the latest survey data, our population estimate for Last Chance townsendia is 7,184 individuals, using the most recent plant count data, with no changes to the range or total number of populations. However, because some of the counts are more than a decade old (USFWS 2013), the actual plant count likely underrepresents the total population size for the species. In addition, plant counts are likely underestimated because of the difficulty of detecting seedlings and non-flowering individuals in the field, and unsurveyed suitable habitat within the range still exists (Clark 2013, USFWS 2013; CRNP 2017). Therefore, we believe this represents a conservative population estimate. All

together, the most recent information, though limited, suggests that Last Chance townsendia populations may have improved slightly since the last five-year review. (USFWS, 2019)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: The Service listed Last Chance townsendia as a threatened species under the ESA on August 21, 1985 (50 FR 33734). The 1993 Recovery Plan for the species identified mineral and energy development, road building, livestock grazing and trailing, and OHV use as threats to the species (USFWS 1993). Critical habitat for the species has not been designated. In 2013, the Service completed a Five-Year Review for the species with the purpose of evaluating whether or not the species' status had changed since the time it was listed (USFWS 2013). The Five-Year Review concluded that the 5C Recovery Priority Number for the species should remain unchanged from that assigned in the Recovery Plan. The 5C designation is assigned to species that face a high degree of threat and a low recovery potential that may be in conflict with economic activity.

Recovery

Delisting Criteria:
1. Maintain a documented total population of 30,000 individuals. (USFWS, 2019)

2. Maintain 20 populations of at least 500 individuals each, which have been demonstrated to be at minimum viable population levels. (USFWS, 2019)

3. Establish formal land management designations for these populations that provide long-term, undisturbed habitat for the species. (USFWS, 2019)

Recovery Actions:
- Since 1993 when the Recovery Plan was approved, many surveys have been conducted which have greatly expanded the known distribution of Last Chance townsendia (Clark 2007, USFWS 2013). The species is now known to be distributed across more than 9,000 acres of habitat compared to the 15 acres of occupied habitat documented in the Recovery Plan (USFWS 1993, 2013). Most of the known occupied habitat is on BLM land (4,830 acres) followed by the U.S. Forest Service (USFS) (2,620 acres) and CRNP (2,390 acres) (USFWS 2013). Although the known distribution of this species has increased, the current number of known individuals is 6,848 plants, which is only slightly larger than the 1993 population estimate of 6,000 plants (USFWS 2013).

Conservation Measures and Best Management Practices:
- Recommended future actions: We recommend rangewide surveys of known populations across National Park Service, BLM, and U.S. Forest Service lands that can be used to compile a robust, updated population estimate, as well as surveys of identified suitable habitat that may contain new occurrences or populations. Additional research that provides a better understanding of current population demographics, population trends, and impact of threats is also necessary to evaluate the

effectiveness of current protections and identify when recovery criteria are met is also needed. - The designation and management of protected areas that reduce impacts from identified threats remains necessary to facilitate this species' recovery. Additionally, we recommend revising the recovery plan and specifically reevaluating the recovery goals and criteria based on new population numbers, habitat requirements, connectivity analysis, and potential changes in threat type and intensity. (USFWS, 2019)

References

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SPECIES ACCOUNT: *Trichilia triacantha* (Bariaco)

Species Taxonomic and Listing Information

Listing Status: Endangered; Southeast Region (R4) 02/05/1988

Physical Description

Trichilla triacantha (bariaco) is an evergreen shrub or small tree which may reach 8 to 10 meters (26 to 33 feet) in height and 1.5 to 2 centimeters (3/4 to 7/8 inches) in diameter. The alternate leaves are pinnately or almost palmately compound with 3 to 7 oblong or wedge-shaped leaflets. The thick, leathery leaves, from 2 to 3 centimeters (3/4 to 1 1/4 inches) long, are clustered at the ends of the twigs. Each leaflet has 3 sharp spiny teeth, 2 to 3 millimeters (1/16 to 1/8 inch) in length, at the apex. The axis of each leaf is short (3 millimeters or 1/8 inch) and the leaves appear to be palmately compound. The upper surface is shiny with a sunken midvein and the lower surface is dull and paler (Little et al., 1974; Vivaldi and Woodbury 1981). The inflorescence is a panicle which may reach 4 centimeters (1 and 1/2 inches) in length. Flowers are perfect, sessil, and about 3 millimeters (1/8 inch) in diameter. The calyx is cupshaped with 4 to 5 minute teeth. The corolla of 4 petals is white and finely hairy on the outside. Fruits (undescribed until recently) are capsules with red arils (Vivaldi and Woodbury 1981) (USFWS, 1991).

Taxonomy

Trichilla triacantha, a member of the family Meliaceae, was first collected by Plee from the Pefiuelas area of southern Puerto Rico (USFWS, 1991).

Historical Range

Today, Trichilia triacantha is known from only two areas in southwestern Puerto Rico (Figure 1). Deforestation appears to have resulted in the elimination of the Pei7iuelas population. Although little forested area remains in this part of Puerto Rico, other small populations, as yet undescribed, may survive. Approximately 37 individuals are known to occur on 5 sites within the Guanica Commonwealth Forest and an additional 3 individuals are found at the Punta Guaniquilla area, the extreme southwestern corner of the island. All historic and presently known sites occur on limestone-derived soils at elevations of less than 100 meters (USFWS, 1991).

Current Range

Specimens (Figure 1 and Appendix I) and population sites (Figure 2) located with uncertainties smaller than 300 m occur at elevations from 25 to 175 m above sea level (Ventosa, 2007), on soils of the following series: Pitahaya-Limestone outcrop-Seboruco complex, La Covana-Limestone outcrop-Seboruco complex, Seboruco gravelly clay, El Papayo gravelly clay loam, Aguilita stony clay, San Germán-Duey complex, Tuque stony clay, and Yauco silty clay loam, most of them on slopes of 20-60%. Other specimen localities, but with inaccurate locality descriptions (inaccuracies from 2,000 to 15,620 m), were collected within the municipalities of Guánica, Yauco or Peñuelas (Figure 2) (USFWS, 2012).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 1991)

Breeding Season

Adult: Bariaco has been observed in flower from January to March (USFWS, 1991)

Reproduction Narrative

Adult: Bariaco has been observed in flower from January to March, the dry season in the Guanica Forest. Flower production is abundant but fruit set appears to be poor. Information available indicates that the majority of the fruits did not reach maturity during the 1989 season; however, this particular year was exceptionally dry. Mature fruit was observed during the month of June in the 1989 observations as well as in past studies (Vivaldi and Woodbury 1981). Pollination mechanisms are not known; however, other members of this genus are wind and/or insect pollinated. It has been suggested that this species is pollinated by bees (G. Breckon, pers. comm.). Although 12 mature individuals have been observed flowering and producing fruit in the Guanica Forest, seedlings have been observed beneath only one tree. The importance of vegetative reproduction and the ability to resprout has not been studied. However, coppicing in this dry forest is common, and many of the large specimens of Trichilia triacantha have multiple stems (USFWS, 1991).

Habitat Type

Adult: Subtropical dry forest (USFWS, 1991)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1991)

Site Fidelity

Adult: High (inferred from USFWS, 1991)

Habitat Narrative

Adult: Trichilia triancantha is found in the deciduous and the semi-evergreen seasonal forests of the subtropical dry forest life zone (Ewel and Whitmore 1973) of southwestern Puerto Rico at elevations of less than 100 meters. The subtropical dry forest life zone is the driest life zone of Puerto Rico and covers about 14 percent of the island area. Extensive areas of this life zone overlie limestone, including the area in which Trichilia triacantha is found. Here the vegetation is more xerophytic than on other soil types found within the life zone. Much of the land in this zone has been deforested for urban development, agriculture, pasture, and charcoal production; however, the majority of the known individuals occur within the Guanica Forest. This Forest has been protected from such activities for approximately 40 years (Silander et al., 1986) (USFWS, 1991). High ecological integrity and site fidelity and low tolerance range are inferred based on specific habitat requirements and low number of populations (USFWS, 1991).

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 2007)

Dispersal

Adult: Low (USFWS, 2007)

Dispersal/Migration Narrative

Adult: The evidence of very limited dispersal of this plant may suggest that a former natural disperser like a forest bird species may be reduced in number or no longer in this area (USFWS, 2007).

Population Information and Trends

Population Trends:

Not available

Number of Populations:

16 subpopulations; 7 populations (USFWS, 2022)

Population Size:

~162 total plants (USFWS, 2022)

Population Narrative:

Bariaco was listed as an endangered species on February 5, 1988. In this status review we found that the known natural populations of Bariaco have expanded, and natural populations now extend east to the municipality of Ponce, Puerto Rico. The species is currently known from about 15 populations: ten populations described by Ventosa (2007) (seven within Guánica Commonwealth Forest and the other three in Cabo Rojo, Sabana Grande and Yauco); "Trichilia Creek" in the Guánica Commonwealth Forest, and about four other sites from Yauco to Ponce. The current number of individuals is estimated at 162 plants (not including seedlings). Although the species has expanded its range and the number of natural individuals, the plant is threatened by urban and tourism development. Despite the increase in the number of populations and the finding of a new population with an outstanding number of individuals and apparently natural recruitment, down listing criteria have not been met and an evaluation of all currently known populations and the threats of those populations is required in order to proceed with a change in classification (USFWS, 2012). Low resiliency, representation and redundancy are based on low number of populations and individuals and the specific habitat requirements of this species (USFWS, 2012). The Plan specifies that T. triacantha could be considered for reclassification to a threatened species when: 1. the known population at Punta Guaniquilla is placed under protective status, and 2. at least three new populations capable of selfperpetuation have been established within protected units such as Puerto Rico Conservation Trust property or Commonwealth Forests. Criterion 1 has not been met. The Punta Guaniquilla population remains as a private property and the area is under current pressure for development. Criterion 2 has not been met. So far a strong propagation program for the species has not been initiated nor has any population been established within a protected area. Nonetheless, propagation of the species has proved to be successful as showed by Ventosa (2007) and new populations have been identified along the southern coast of Puerto Rico. The discovery of the Trichilia creek population in Guánica Commonwealth Forest is a great step

toward recovery especially because it seems to be the best example of a healthy and self sustainable population. Since the listing of the species, Trichilia triacantha has expanded in numbers and in documented natural populations. Currently, the majority (78%) of the only 162 known individuals are in a Commonwealth Forest. However, the majority of the new populations and the suitable habitat occur on private properties subject to urban development (USFWS, 2017). As per the new information, the current estimated number of bariaco individuals is 162, distributed in 16 subpopulations within 7 populations (i.e., geographical areas that provide connectivity among subpopulations) (USFWS, 2022)

Threats and Stressors

Stressor: Human caused habitat destruction (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Several areas in which this species occurs are under pressure for urban development including road construction and run-off control (USFWS, 2007).

Stressor: Human induced fires (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Fire is not a natural event in subtropical dry or moist forest in Puerto Rico and the U. S. Virgin Islands. Thus, most species found in this type of forest are not fire-adapted. Human induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., Leucaena leucocephala and Megathyrsus maximus) that may outcompete T. triacantha. The T. triacantha populations that occur between Peñuelas and Ponce may be susceptible to forest fires, particularly on private lands where fire could be accidentally or deliberately ignited. Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011). However, there is no direct evidence of fires affecting these populations. Furthermore, the core of the populations and individuals lies within the Guánica Commonwealth Forest. This protected area has an active fire control program and recent evidence of fire has frequently been seen in the coastal portions of the Guánica Commonwealth Forest (Omar A. Monsegur, Service, pers. obs. 2011) (USFWS, 2007).

Stressor: Hurricanes/Climate Change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Since the population dynamics of this species are poorly known and we do not have enough information to determine what constitutes a viable population, we believe that the impacts discussed above could be detrimental to the species as a whole. However, based on current information and since the majority of the known populations' lie within a protected area, we consider fires, hurricanes and climate change as a low and non-imminent threat to the species (USFWS, 2007).

Stressor: Present or threatened destruction, modification or curtailment of its habitat or range (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: The species' rarity and restricted distribution makes it vulnerable to habitat destruction and modification. However, most of the known populations and individuals are located on public lands within the Guánica Commonwealth Forest, which has been declared as a Biosphere Reserve by UNESCO and is managed for conservation. According to Ventosa (1997), about 60% of the known populations during his study were located within the Forest. Furthermore, these populations represent about 93% of the known individuals. In the Guánica Commonwealth Forest, T. triacantha is mostly found on the edge of trails, making the species more prone to be affected by management activities (e.g., widening of trails, clearing activities). Moreover, these populations consist of isolated clusters of adult individuals, and the majority of the seedlings are located adjacent to the parent shrub and there is no evidence of natural dispersion despite showy red seeds, which may 12 have been dispersed by an unknown bird species. The evidence of very limited dispersal of this plant may suggest that a former natural disperser like a forest bird species may be reduced in number or no longer in this area. Despite the low number of natural populations on private lands reported by Ventosa (1997, 2007), recent assessments have led to the identification of new populations of T. triacantha outside the Guánica Commonwealth Forest. This may indicate bias on previous sampling efforts. On the other hand, the number of T. triacantha populations found within the Guánica Commonwealth Forest is probably due to the extensive botanical and ecological studies that have been conducted within the boundaries of the forest. It also highlights the importance of surveying further areas that harbors suitable habitat for the species from Ponce to Cabo Rojo. Searching these areas is critical as some of them are actually adjacent to recently discovered populations of T. triacantha and have been proposed for urban and tourism developments. It is unknown if these recently found small populations contain genotypes that are not found in Guánica or may be part of a bigger population that has not been identified. In Peñuelas, T. triacantha is found in an area that is currently under pressure for urban development. In 2007, Service biologist Omar Monsegur (pers. obs.) as part of a study for the status of Cordia rupicola, reported a new population of T. triacantha on a drainage area located at El Peñón de Ponce, which is adjacent to a residential development called "Urbanización El Peñón". In 2007, Monsegur and Breckon (2007) reported that one individual of Cordia rupicola on this area was extirpated by the construction of a staging area for the improvement of the Puerto Rico Highway Num. 2. According to the authors, the vegetation was removed and the area was bulldozed, apparently to control run-off from the ravine. It is unknown if the individuals of T. triacantha were affected by the vegetation clearing. Future development projects are proposed for the surrounding areas threatening this population, making it more isolated, and possibly eliminating its connectivity with adjacent populations (genetic flow). In Yauco, the species occurs within a private property (Finca Catala) that may be subject to urban or agricultural development (Carlos Pacheco, Service, pers. comm., 2011). Urban development has encroached remnants of native dry forest areas in Yauco, resulting in the isolation or disjunction of rare plant populations, hence, reducing suitable habitat for the species. The area is also threatened by deforestation for agricultural practices such as cattle 13 and for the extraction of live fence posts (Alcides Morales, pers. comm., Sociedad Ornitologica Puertorriqueña, Inc., 2011). Based on the above discussion, the present or threatened destruction, modification, or curtailment of the species habitat or range is a current threat to the species. Since the majority of the known populations are affected by habitat

destruction or modification, we consider this threat as high in magnitude and imminent (USFWS, 2017).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: The Commonwealth of Puerto Rico approved Law No. 241 in 1999, known as "Nueva Ley de Vida Silvestre de Puerto Rico" (New Wildlife Law of Puerto Rico). The purpose of this law is to protect, conserve, and enhance both native and migratory wildlife species, declare as the property of Puerto Rico all wildlife species within its jurisdiction, regulate permits, hunting activities, and exotic species, among others. This law has provisions that protect habitat of this endangered plant. In 2004, the Puerto Rico Department of Natural and Environmental Resources (PRDNER) approved the "Reglamento para Regir el Manejo de las Especies Vulnerables y en Peligro de Extinción en el Estado Libre Asociado de Puerto Rico" (Regulation 6766 to regulate the management of threatened and endangered species in Puerto Rico). Bariaco has been included in the list of protected species and designated as endangered under Regulation 6766. Under Article 2.06, this regulation prohibits collecting, cutting, removing, among other activities, listed plant individuals within the jurisdiction of Puerto Rico. Based on the presence of Commonwealth laws and regulations protecting T. triacantha, we believe that the inadequacy of existing regulatory mechanisms should no longer be considered a threat to this species. However, it is important to note that enforcement on private lands continues to be a challenge as accidental damage or extirpation of individuals has occurred due to lack of knowledge of the species by private land owners (USFWS, 2017).

Stressor: Human-Induced Fires (USFWS, 2017).
Exposure:
Response:
Consequence:
Narrative: Fire is not a natural event in subtropical dry or moist forest in Puerto Rico and the U. S. Virgin Islands. Thus, most species found in this type of forest are not fire-adapted. Human induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of exotic plant species (e.g., Leucaena leucocephala and Megathyrsus maximus) that may outcompete T. triacantha. The T. triacantha populations that occur between Peñuelas and Ponce may be susceptible to forest fires, particularly on private lands where fire could be accidentally or deliberately ignited. Evidence of recent fires in the habitat and adjacent to known populations have been observed recently at Ponce (Omar A. Monsegur, Service, pers. obs. 2011). However, there is no direct evidence of fires affecting these populations. Furthermore, the core of the populations and individuals lies within the Guánica Commonwealth Forest. This protected area has an active fire control program and recent evidence of fire has frequently been seen in the coastal portions of the Guánica Commonwealth Forest (Omar A. Monsegur, Service, pers. obs. 2011) (USFWS, 2017).

Stressor: Hurricanes and Climate Change (USFWS, 2017).
Exposure:
Response:
Consequence:

Narrative: Hurricanes and tropical storms frequently affect the islands of the Caribbean. As a species endemic to the central Caribbean, and with a wide distribution in Puerto Rico, T. triacantha should be well adapted to tropical storms. Hence, cumulative effects of severe tropical storms may jeopardize small relict populations. Trichilia triacantha may be threatened by climate change to some extent, which is predicted to increase the frequency and strength of tropical storms. In addition, the possibility of severe droughts may contribute to an increase in the quantity and frequency of fires on the southern coast of Puerto Rico. Since the population dynamics of this species are poorly known and we do not have enough information to determine what constitutes a viable population, we believe that the impacts discussed above could be detrimental to the species as a whole. However, based on current information and since the majority of the known populations' lie within a protected area, we consider fires, hurricanes and climate change as a low and non imminent threat to the species (USFWS, 2017).

Recovery

Reclassification Criteria:
Trichilia tricantha could be considered for reclassification to a threatened species when: (1) the known population at Punta Guaniquilla is placed under protective status, and (USFWS, 1991).

(2) at least three new populations capable of self-perpetuation have been established within protected units such as Conservation Trust property or Commonwealth Forests (USFWS, 1991).

Recovery Priority Number: 11

Delisting Criteria:
Five (5) of the existing natural populations show a stable or increasing trend, evidenced by natural recruitment and multiple age classes, and four (4) of these populations must occur on lands protected via a conservation mechanism (addresses Factor A and E) (USFWS, 2019).

At least three (3) new populations containing genetic representation from Montes de Barinas, Guayanilla and Ponce-Penuelas are established or discovered on lands protected via a conservation mechanism, and these populations show a stable or increasing trend, evidenced by natural recruitment and multiple age classes (addresses Factors A and E) (USFWS, 2019).

Threat reduction and management activities have been implemented to a degree that the species will remain viable into the foreseeable future (addresses Factor A and E) (USFWS, 2019).

Recovery Actions:
- This action has not been met (USFWS, 2007)
- This action has not been met (USFWS, 2007)
- The recovery of the species should focus on the protection of the known populations and its suitable habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations (USFWS, 2017).
- The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species (USFWS, 2017).
- The recently discovered populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to

determine their impacts on the populations (USFWS, 2017).

- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2017).
- Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species germplasm (USFWS, 2017).
- A protocol for the propagation and reintroduction of bariaco should be developed in collaboration with partners. The protocol should address the feasibility of seed banking, and if deemed necessary, seed material should be storage at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation (NLGRP). Studies on the species genetics should be conducted to determine patterns of genetic diversity, and to provide baseline information for sound management of the species (USFWS, 2019).
- Due to the low number of populations and individuals, along with the little evidence of natural recruitment and limited dispersal, the reproductive biology and ecology of bariaco should be determined. In particular, the factors limiting seed dispersal and seedling recruitment should be studied. This should include the establishment of a long-term monitoring program (including permanent parcels) to document seedling recruitment and survival, and the conditions necessary for their establishment (USFWS, 2019).
- Due to the quality of the habitat, surveys of the Ponce-Penuelas, Guayanilla, and Montes de Barinas should be conducted in order to identify potential new populations of bariaco (USFWS, 2019).
- The recovery of the species should focus on the protection of the known populations and its suitable habitat. Conservation Agreements should be signed between the Service and private landowners to protect natural populations (USFWS, 2012).
- The populations that are actively reproducing need to be identified and monitored to collect seed material for propagation purposes. A protocol to collect seed should be created and implemented to avoid altering the natural recruitment of the species (USFWS, 2012)
- The recently discovered populations should be visited, and monitored on a regular basis; additional visits should be made after hurricanes, fires, or other major disturbances to determine their impacts on the populations (USFWS, 2012).
- The recovery plan should be revised to establish measurable criteria, including how many individuals constitute a self-sustainable population and how many populations would be needed to delist the species (USFWS, 2012).
- Studies should be conducted to determine the patterns of genetic variation within and among populations, in order to develop a plan to preserve the species germplasm (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. The species' recovery priority should be focused on establishing cooperative agreements with private landowners for the conservation of the species, and to guaranty the viability of the natural populations on private lands. 2. The populations that are actively reproducing need to be identified and monitored. 3. New populations should be assessed for viability and recruitment. 4. A protocol to collect seed should be developed and implemented to avoid affecting the natural recruitment of the species, to ensure appropriate storage and maintenance of seeds, and maximize genetic diversity of retained materials. a. Evaluate the feasibility for the long-term conservation of seed material of bariaco (seed banking). 5. Population

monitoring should be conducted to assess the response of the species to potential threats (i.e., after hurricanes, fires, or other major disturbances). 6. Studies should be conducted to determine the patterns of genetic variation within and among populations to develop a plan to preserve the species genetic variability and to manage populations effectively (USFWS, 2022).

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SPECIES ACCOUNT: *Trifolium amoenum* (Showy Indian clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest Region (R8)

Physical Description

An annual herb, 1-6 dm tall, hairy and often robust. Leaves are divided into 3 egg-shaped leaflets. Flowers (April-June) are purple with white tips and are borne in dense, round or oval heads, 2-3 cm long (NatureServe, 2015).

Taxonomy

A distinct species in a genus of about 300 species, most abundant in north temperate regions (NatureServe, 2015)

Historical Range

Historically in Alameda, Mendocino, Marin, Santa Clara, Solano, Sonoma, Napa counties, California (NatureServe, 2015)

Current Range

Currently believed extant only in Marin (native) and Sonoma (reintroduced) counties (NatureServe, 2015).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self pollination and outcrossing (NatureServe, 2015)

Reproduction Narrative

Adult: Mating system appears to include both cross-and self-pollination, as extant plants were found to have a higher level of heterozygosity than would be expected in a predominantly self-pollinating species (Knapp and Connors 1999 cited in USFWS 2007).; Mixed selfing and outcrossing (NatureServe, 2015).

Habitat Type

Adult: Grasslands (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine soil (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species is typically in low, wet swales in grasslands. Also on grassy hillsides at up to about 400 m elevation. Per the California Dept. of Fish and Game (2000): Open, sunny sites, sometimes on serpentine soil in coastal bluff scrub and valley and foothill grassland; most recently seen on a roadside that had been graded and on an eroding cliff face. Possibly requires disturbance-created openings for germination (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of this species and the low number of populations and individuals.

Dispersal/Migration

Population Information and Trends

Population Trends:

Decreasing (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2023)

Population Size:

1 - 1000 individuals (NatureServe, 2015)

Population Narrative:

Historically known from 25 sites but probably extirpated at all but 1 of these (although some viable seed may remain in seedbanks and may germinate if conditions are right). Loss of habitat to urbanization and agriculture was probably the primary reason for the extirpation of so many populations. Even since 1997 when this species was listed as Endangered, much habitat potentially suitable for restoration has been altered and is now unsuitable due to urbanization, agricultural operations, and changes in the biological community and hydrological conditions (USFWS 2007). Decline of >90% The one native occurrence had about 225 plants when it was discovered in 1996 (California Dept. of Fish and Game 2000). Had been thought extinct until the early 1990s. A single plant was found in 1993 at a site in Sonoma County, but that site has now been developed and the species is considered extirpated there. However, seeds were collected from the plant prior to its extirpation and were subsequently multiplied. In 2006, some of those seeds were used to establish experimental populations at two sites in Sonoma County and at several sites at Point Reyes National Seashore (Marin County). It is as yet unknown whether any of the experimental sowings will persist (USFWS 2007). Another population, the only native population currently extant, was discovered in 1996 in Marin County. In 1997, seed from those plants was used to establish a small experimental population (approximately 20 seedlings) at

Bodega Marine Laboratory (Sonoma County) (USFWS 2007). The Bodega experimental population had persisted as of 2007, but its long term fate is unknown (USFWS 2007) (NatureServe, 2015). NatureServe (2015) also notes that the short-term trend for this species is a decline of 10% and the long-term trend is a decline of 90%. Low resiliency, representation and redundancy are inferred based on the low number of known populations and individuals. The species was considered extinct until 1993 when a single plant with the "erect" phenotype was discovered on privately owned property in Occidental, Sonoma County. Following the species' discovery in Occidental, the locality site was developed, and the species is now extirpated from this site. Another native population with the "prostrate" phenotype was discovered in 1996 in Dillon Beach in Marin County on privately-owned property. The Dillon Beach population was the only known population at the time of listing (Service 1997, p. 55806). At the time of the Service's previous 5-year review for the species in 2012 the Dillon Beach population was still extant, and the Service and its partners had established an outplanted population at Point Reyes National Seashore as well as another outplanted population at the Bodega Marine Reserve in Sonoma County that was extirpated by the time of the 2012 5-year review (Service 2012, p. 3). Currently, the distribution of the species is unchanged from the species' previous 5-year review in 2012. Specifically, only the Dillon Beach and Point Reyes National Seashore populations, both possessing the "prostrate" phenotype, are known to remain in the wild (USFWS, 2023).

Threats and Stressors

Stressor: Urbanization (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Urbanization is listed as a threat to this species (USFWS, 2012).

Stressor: Agriculture (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Conversion of land to agriculture is listed as a threat to this species (USFWS, 2012).

Stressor: Erosion (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: In addition to the threat from erosion of the hillside, in a 2010 annual report, Dr. Connors states the possibility of an earthquake that could result in a significant portion of the Dillon Beach population being lost in a landslide since it is very close to the eroding cliff (Connors 2010) (USFWS, 2012).

Stressor: Trampling (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: A small trail providing local homeowners with access along the bluffs runs directly through the population. Although current use of the trail does not appear to threaten the

population, any increase in use or expansion of the trail could adversely affect the population (Connors 2006) (USFWS, 2012).

Stressor: Herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Herbivory by gophers and voles is listed as a threat to this species (USFWS, 2012).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The State's authority to conserve plants is comprised of four pieces of legislation: The California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA). Trifolium amoenum is not listed under CESA, therefore neither that Act nor the NPPA apply to this review. The California Environmental Quality Act (CEQA) (chapter 2, section 21050 et seq. of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects to not only federally listed species, but also to those considered "rare" by other agencies or professional associations. Trifolium amoenum, although not state listed, is considered a List 1B plant by the California Native Plant Society. Any impacts to T. amoenum would be subject to evaluation through CEQA. The CEQA also requires the avoidance or mitigation of those impacts, where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. However, CEQA does not guarantee that such conservation measures will be implemented. Currently there are no completed regional or county-wide Habitat Conservation Plans per the Federal Endangered Species Act (HCPs) or Natural Community Conservation Plans (NCCPs) per the Natural Community Conservation Planning Act at any of the known occurrences (USFWS, 2012).

Stressor: Non-native exotic plants (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The most significant long-term threat to the Dillon Beach 10 population is invasion by the non-native Carpobrotus edulis (iceplant or sea fig). This plant, which competes for habitat with Trifolium amoenum, was planted for fire and erosion control in the adjacent yard and reached the T. amoenum population for the first time in 1999. Dr. Connors has developed an agreement with that landowner on an iceplant control program involving both hand-pulling and herbicide (Roundup) application (Connors 2006). Though the landowners do not follow any practices that would be harmful to the population, the status of iceplant removal is unknown. Other invasive competitors already present at the site, including Lolium multiflorum (Italian ryegrass) and Plantago lanceolata (English plantain), may gain in population size or density at the expense of T. amoenum (Connors 2006, in litt.). In addition, the non-native grass Holcus lanatus (velvet grass) is not currently at the site but has invaded many coastal bluff plant communities in the area. It could be a strong invader of the T. amoenum population if it became established at

the Dillon Beach site (Connors 2006) (USFWS, 2012).

Stressor: Small population size and few populations (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: As discussed in the listing rule (Service 1997) and the 2007 5-year review, the conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (e.g., Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). In these situations, genetic diversity can become dangerously low. Also, as Dr. Connors reports, annual plants like clovers naturally fluctuate annually, likely due to regional patterns in amounts and timing of rainfall (Connors 2010). Yearly fluctuations in the Dillon Beach population have been large, with occasional 15 to 20-fold changes between subsequent years. Seedling density was high and quite similar in 2007, 2009 and 2010, but much lower in 2008 (Connors 2010). Seed production has been even more variable. Trifolium seeds are typically long-lived in suitable soils, and the importance of a seedbank in sustaining this T. amoenum population has been demonstrated by the strong rebounds of the population in 2007 and 2009 (Connors 2010). However, if several years of low germination in a small population are followed by a disruption to or removal of the seedbank, genetic diversity may be further diminished. That Trifolium amoenum occurs in small numbers and at few locations has not changed since the time of listing or the last 5-year review. Therefore, threats associated with these factors remain. The combination of a single native population, small range, and restricted habitat makes this species highly susceptible to extinction or extirpation due to random events, such as flood, drought, disease, or other occurrences (USFWS, 2012).

Recovery

Reclassification Criteria:
Recovery Priority Number: 2

Recovery Actions:

- No approved final or draft recovery plan for Trifolium amoenum has been completed or is in preparation. (USFWS, 2012).
- 1) Complete and implement a recovery plan for T. amoenum which outlines specific recovery criteria and recovery tasks (USFWS, 2012).
- 2) Continue to monitor known populations of T. amoenum so as to discern population sizes and the differences between natural and unnatural population fluctuations (USFWS, 2012).
- 3) Conduct range-wide surveys to identify additional populations for protection and outcrossing purposes (USFWS, 2012).
- 4) Expand the genetic base of the Occidental population, currently used for reintroduction experiments, to prevent further loss of evolutionary potential and the possibility of deleterious effects associated with inbreeding. Any additional plants found as a result of (3) above should be used to expand the genetic variability. If no additional individuals are identified, the Dillon Beach population should be used. Much care must be used during this process, however, as phenotypic difference between the two populations are likely adaptive. Through “controlled introgression”, a small proportion of the non-local Dillon Beach source seed could be mixed into the Occidental population over time, such that local adaptive variation is maintained while promoting adequate levels of within population

genetic variation (Knapp and Connors 1999) (USFWS, 2012).

- 5) Reintroduce both growth forms into suitable habitat. The two forms of T. amoenum should be treated separately in any reintroduction efforts, however, because these forms have morphological differences which may be adaptive. The establishment of a self-sustaining population in a preserved area would greatly increase the likelihood of recovery of this species. Suitable habitats might be found at the Bodega Marine Laboratory or on State or Federal lands in the area (USFWS, 2012).
- 6) Conduct research into (a) the role of herbivory, (b) whether the presence of gophers is beneficial or detrimental, (c) reasons for interannual variability in population numbers and seed productivity, (d) the tolerance of T. amoenum to different soil types, and (e) the effect of disturbance regimes on T. amoenum, among other topics (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: 1) Continue to monitor the Dillon Beach and Point Reyes National Seashore populations and implement management strategies to address threats to these populations. 2) Identify potential outplanting areas suitable for both the “prostrate” and “erect” phenotypes of the species and outplant additional “prostrate” and “erect” populations. 3) Collect fresh seed to re-invigorate the species’ seed multiplication program and continue to store seed from the “erect” and “prostrate” forms in service of future outplanting efforts. 4) Conduct research into improving outplanting success rates such as identifying optimal soil geology and chemistry. 5) Perform breeding crosses and genetic analyses of “prostrate” and “erect” individuals to determine whether the differing phenotypes of the species reflect reproductive isolation. (USFWS, 2022)

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SPECIES ACCOUNT: *Trifolium trichocalyx* (Monterey clover)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Southwest Region (R8)

Physical Description

A prostrate, spreading annual herb. The prostrate branches are sometimes only 3-4 cm long, but can reach 30 cm under favorable conditions. Flowers are borne in heads, 4-14 mm wide, the pale purple petals barely extending beyond the bristly calyces. Blooms April-June. (NatureServe, 2015)

Taxonomy

Trifolium trichocalyx (Figure 7) was first collected by Amos A. Heller in 1903 following a fire 2 years earlier "in sandy pine woods about Pacific Grove" (Heller 1904). The species was described by Heller the following year (Heller 1904). Laura F. McDermott considered the taxon a variety of T. oliganthum in her treatment of the genus (McDermott 1910), although this classification was not recognized in subsequent floras. Axelrod (1982) reported at least one researcher who suggested that Monterey clover was a sporadic hybrid between T. microcephalum and T. variegatum and recommended removing it from the list of Monterey endemic taxa. This view was challenged by V. Yadon (in litt. 1983) who had grown T. trichocalyx and observed it consistently producing up to seven seeds per pod, while both putative parent plants were two-seeded taxa. Trifolium trichocalyx has continued to be recognized as a distinct species by Abrams (1944), Munz and Keck (1959), Howitt and Howell (1964), and Isely (1993), and we accept it as such (USFWS, 2004).

Current Range

Monterey clover) is known from only one area (Huckleberry Hill) covering approximately 16 hectares (40 acres) on property owned by the Pebble Beach Company on the Monterey Peninsula. During 1996, two locations in the Huckleberry Hill area with a total of 22 plants were located (USFWS, 2004). In 2011, Trifolium trichocalyx was identified along logging roads in Mendocino County. Additional populations have since been found in Mendocino but the population sizes and area remain restricted. (USFWS, 2019).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Trifolium trichocalyx flowers between April and June (USFWS, 2004).

Reproduction Narrative

Adult: Trifolium trichocalyx appears to regenerate in large numbers during spring following a fire that removes the dense vegetative cover that shelters its seed bank. Trifolium trichocalyx populations will decline as shrubs and seedlings overshadow the plants as the forest begins to

recover following a fire. Trifolium trichocalyx appeared after the 1901 fire and again after the 1987 fire, thus possibly harboring a seed bank capable of surviving more than 90 years. Recent studies indicate light as the only germination requirement (Doak et al. 2000). However, seeds buried in the soil at Huckleberry Hill may require different germination cues than those seeds used in germination experiments because experimental seeds were never buried (Doak et al. 2000). Trifolium trichocalyx flowers between April and June. Small bees are likely pollinators as they are with other Trifolium clover species, although no pollinators were observed in previous studies (Jones and Stokes Associates 1996). Additionally, scarification may stimulate some Trifolium trichocalyx to bloom between fires (V. Yadon in litt. 2002) (USFWS, 2004).

Habitat Type

Adult: Pine forest (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Fire dependent (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits openings in and edges of Monterey pine forest. Ephemeral: plants persist for a few years following fire or other vegetation removal, but are shaded out or outcompeted after that. Soils are poorly drained, coarse loamy sands. < 100 m elevation (NatureServe, 2015).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Trifolium trichocalyx becomes scarce when the forest canopy closes, persisting primarily as a seed bank in the soil while shade and competition increase during succession of the forest community (USFWS, 2004).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2009)

Population Size:

Between 2,000 and 5,000 individuals have been observed across all the known Mendocino County populations since 2011 during annual surveys (Heise and Hulse-Stephens 2016, pp. 9-

16). (USFWS, 2019).

Population Narrative:

The species has not been observed since 1995 when 22 individuals were located (USFWS, 2009).

Threats and Stressors

Stressor: Urban and recreational (e.g., golf courses) development (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The Recovery Plan (Service 2004) identifies the most significant threat to the species has been the loss of potential habitat from urban and recreational (e.g., golf courses) development. At the time of listing, less than 20 percent of the historical Monterey pine forest on the Monterey Peninsula was estimated to remain, much of it in fragmented and increasingly isolated stands (Jones and Stokes Associates 1994 in Service 1998). Jones and Stokes Associates (1996) estimated that habitat for the species has declined approximately 69 percent, from 1,754 acres (710 ha) to 539 acres (218 ha) as of 1996. Of locations mapped for the species, the majority of occurrences appear to be within the Huckleberry Hill Natural Reserve and Morse Reserve; however, individuals have been identified adjacent to the south of the Huckleberry Hill Natural Reserve. A number of plants are presumed to have been extirpated when the Poppy Hills Golf Course was developed in 1980 (Service 2004). The Service is unaware of any potential habitat losses since the species was listed in 1998 (USFWS, 2009).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, regulatory mechanisms thought to have some potential to protect Trifolium trichocalyx included: (1) listing under the California Endangered Species Act (CESA); (2) the California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA); (3) the California Coastal Act; and (4) local land use laws, regulations, and policies. The listing rule (63 FR 43100) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis appears to remain currently valid. Trifolium trichocalyx was listed as endangered by the State of California in 1979. As such, projects that would affect Trifolium trichocalyx are subject to CESA and CEQA requirements. The lead CEQA agency with primary authority or jurisdiction over a project is responsible for conducting a review of the project and to consult with other agencies concerned about resources affected by the project. However, required biological surveys are not always adequate to identify the presence of Trifolium trichocalyx, as the species is not visible above ground while it exists as seed banks. In addition to the laws and regulations discussed above, local county regulations may also benefit Trifolium trichocalyx. This species occurs within a portion of the Monterey Peninsula included in the California Coastal Zone. The Del Monte Forest Land Use Plan of 1984 was developed to comply with the Coastal Act's requirement that all counties prepare a plan for those portions of the Coastal Zone within their jurisdiction. Once the Del Monte Forest Land Use Plan was certified by the CCC, development permits within the Del Monte Forest coastal zone became the responsibility of the County of Monterey. The County of Monterey also has designated certain areas, including a portion of where Trifolium trichocalyx is known to occur, as

ESHAs. Although the County of Monterey recognizes the importance of these areas, protection of listed species through the California Coastal Act and local land use designations is dependent upon the review of the lead agency involved. Additionally, while no development projects have been implemented in the area where Trifolium trichocalyx occurs since the time of listing, State and local regulations may not protect the species from indirect impacts that occur from such threats as changes in hydrology in adjacent areas and the spread of nonnative species (USFWS, 2009).

Stressor: Alteration of fire frequency (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat/loss of populations
Narrative: At the time of listing, the alteration of natural fire cycles was identified as a significant threat to the species' survival. The species is only known to occur within an area bordered by residential development and Pebble Beach Company facilities (e.g., golf courses, structures). This fact combined with the limited remaining habitat makes this species extremely susceptible to stochastic events. Trifolium trichocalyx seed banks within the Huckleberry Hill area are apparently viable after an extended period of time; however, due to fire suppression, the normal fire cycle in Monterey pines has been lengthened. Due to the lack of knowledge on the species, it is unknown what effect the lack of a natural fire regime will have on seed viability. In the absence of fire, or a reasonable habitat disturbance alternative, this species could become extirpated at certain locations or potentially be rendered extinct (CDFG 2005) (USFWS, 2009).

Stressor: Small numbers of individuals and populations (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of genetic diversity
Narrative: Conservation biology literature discusses that small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (Menges 1991). Based on historical records, we believe that urban and recreational development on the Monterey Peninsula has already reduced the distribution of this species in the area where it occurs. Indirect effects from urbanization in the Huckleberry Hill area could include changes in hydrology, vegetation, and an increase in nonnative species. While any one of these factors may not be enough to threaten the survival of Trifolium trichocalyx independently, its limited range and the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of the species (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, IPCC 2007). Recently, the potential impacts of climate change on the flora of California were discussed by Loarie et al. (2008). Based on modeling, they predicted that species' distributions will shift in response to climate change, specifically that the species will "move" or disperse to higher elevations and northward,

depending on the ability of each species to do so. Species diversity will also shift in response to these changes with a general trend of diversity increases shifting towards the coast and northwards with these areas becoming de facto future refugia. However, predictions of climatic conditions for smaller sub-regions such as California remain uncertain. It is unknown at this time if climate change in California will result in a warmer trend with localized drying, higher precipitation events, or other effects. While we recognize that climate change is an important issue with potential effects to listed species and their habitats, we lack adequate information to make accurate predictions regarding its effects to Trifolium trichocalyx at this time (USFWS, 2009).

Stressor: Climate change (USFWS, 2009)
Exposure:
Response:
Consequence:
Narrative:

Recovery

Reclassification Criteria:
1. At least five viable populations (i.e., populations that are stable or increasing based on a minimum of 12 years of monitoring) occur in suitable habitat. One of these populations is the Huckleberry Hill population (USFWS, 2009).

2. All five of the sites are on land that is protected from human-induced disturbance (i.e., development, recreation) that would negatively affect growth or reproduction of the plants. Funds must be available for appropriate long-term management. As determined by research, protected habitat must be of adequate size (large enough to support a functioning ecosystem [e.g., species present to support seed dispersal and pollination, areas that support fluctuating distributions, areas that harbor suitable unoccupied habitat for population expansion]) and configuration to ensure that ecosystem and community processes and associated species (e.g., hydrologic regime, fire, food webs, pollinator fauna, Monterey pine forest communities) are maintained, and that an adequate diversity of sites exist for population expansion and for colonization of new areas as microhabitat conditions change (USFWS, 2009).

3. The Huckleberry Hill population and four additional viable populations (as described in 1 above) have been managed so as to allow regeneration of plants and replenishment of the seed bank found in the soil within protected habitat (USFWS, 2009).

4. A seed bank has been established at a recognized institution certified by the Center for Plant Conservation (USFWS, 2009).

Delisting Criteria:
Delisting Criterion 1) threats are reduced or eliminated so that protected populations are capable of persisting without significant human intervention or perpetual endowments are secured for management necessary to maintain the continued existence of the species. We currently do not know what the specific habitat needs are for this species. To the best we know now, the most outstanding management need currently is: a) integrate, or find a replacement for, a fire regime as a means of revitalizing declining or senescing colonies; and b) research on

soil seed bank dynamics and conditions for germination. (USFWS, 2019).

Delisting Criterion 2) unoccupied habitat in the area has been assessed for its suitability for reintroduction efforts; the area in Mendocino County where colonies were discovered in 2011 should be assessed, as well as the Monterey Peninsula area. Also, two additional, new populations are established and protected where appropriate. (USFWS, 2019).

Delisting Criterion 3) all protected populations remain viable for at least 10 years to demonstrate long-term viability under a range of environmental conditions. Assuming that habitat was being managed to incorporate a fire regime to increase openness and to release fire-adapted seed, we would then expect above-ground population size to fluctuate annually, based on response to amount and timing of rainfall (e.g. see Fox et al. 2006). Therefore, a period of 10 years should be long enough to include most of the variability in rainfall that occurs in this region (Zedler & Black 1989; NOAA 2018). (USFWS, 2019).

Recovery Actions:

- No other populations have been discovered or re-introduced within the known historic range of the species; therefore, this criterion has not been met. Ensuring that five viable populations occur in suitable habitat may be relevant; however, the complexities associated with identifying discrete populations of this ephemeral plant make it difficult for us to measure this criterion. This criterion may need to be revised in future recovery plans and could be based on preserving all or portions of the species remaining potential habitat (USFWS, 2009).
- As discussed above, we currently have no appropriate method for measuring five viable populations of the species; therefore, this criterion may need to be revised in future recovery plans. The majority of Trifolium trichocalyx occurrences are within areas that have been permanently protected by easements (i.e., Huckleberry Hill Natural Reserve and Morse Reserve). However, we believe that any further development in the Huckleberry Hill area of the Monterey Peninsula would directly reduce the species remaining habitat. Undeveloped areas within the vicinity of Huckleberry Hill that are not protected by easements are important for potential expansion of the species, and we believe they require protection. Additionally, funds dedicated for long-term management of the species in protected areas have not been committed. This criterion has not been met (USFWS, 2009).
- As stated in criteria (1) and (2) above, we have no suitable method to determine five distinct populations of this ephemeral species. Currently, the areas where Trifolium trichocalyx is known to occur is not being managed to allow regeneration of plants and replenishment of the seed bank. This criterion has not been met (USFWS, 2009).
- Currently Trifolium trichocalyx seed is being stored at the Plant Genetic Resources Conservation Unit located on the Griffin Campus of the University of Georgia. Additionally, Trifolium trichocalyx seed is being stored at the U.S. Department of Agriculture's National Center for Genetic Resource Preservation in Fort Collins, Colorado. This criterion is relevant and up-to date. This criterion has been met (USFWS, 2009).
- 1. Work with Pebble Beach Company, Del Monte Forest Foundation, Pebble Beach Community Services District, and Pebble Beach residents to develop and implement a fire management plan that would mimic natural fire regimes within the Huckleberry Hill area. If a burn management plan is not implemented, burn box experiments should be conducted to determine where the species occurs within the Huckleberry Hill area (USFWS, 2009).

- 2. Surveys for Trifolium trichocalyx should be conducted following fires and/or following substantial scarification of potential habitat on the Monterey Peninsula (USFWS, 2009).
- 3. Experiment with establishment of new populations in similar habitat on the Monterey Peninsula or at Point Lobos State Reserve. If these efforts are successful, attempts to establish other populations could be undertaken on the Monterey Peninsula (USFWS, 2009).
- 4. Germination trials should be conducted that mimic natural soil conditions and germination cues to establish more clearly the conditions needed to facilitate germination (USFWS, 2009).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: The following actions are recommended based on the current 5-Year Review: 1. Annual surveys should be conducted within the historical range in Monterey County with attention given to areas where disturbance within the past 5 years is known to have occurred. 2. Annual surveys for populations in Mendocino County continue with attention given to frequency of use and any management actions taken. 3. Potential suitable habitat is identified and surveyed in areas between the northern and southern boundaries. 4. Seed from both populations are collected and stored within a seed bank. 5. Germination and outplanting strategies should be developed if an adequate amount of seed can be collected. Outplanting and monitoring should be attempted at potentially suitable habitat in both Mendocino and Monterey Counties. (USFWS, 2020)

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SPECIES ACCOUNT: *Urera kaalae* (Opuhe)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/29/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A tree or shrub, 3-7 m tall. Tiny flowers are borne in open inflorescences. (NatureServe, 2015)

Historical Range

Historically, Urera kaalae was known from the central to southern windward Waianae Mountains, from Waianae Ukato Kupehau Gulch (USFWS 1995, Wagner et al. 1990). (USFWS, 1998)

Current Range

Current range: Waianae Mountains of Oahu. (NatureServe, 2015)

Critical Habitat Designated

Yes; 9/18/2012.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Urera kaalae (Opuhe) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Urera kaalae (77 FR 57648-57862). The critical habitat designation includes 8 critical habitat units, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Urera kaalae includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Urera kaalae includes 8 critical habitat units, covering two ecosystem types, which encompass approximately 6,573 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Lowland Wet—Units 1, 2, 3, 4, 5.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Lowland Wet—Unit 1 [541 ac (219 ha)]. This area consists of 428 ac (173 ha) of State land and 112 ac (46 ha) of City and County of Honolulu land in the lowland wet ecosystem on the windward side of the Waianae Mountains, and partially within the Mokuleia and Waianae Kai Forest Reserves. Oahu—Lowland Wet—Unit 2 [20 ac (8 ha)]. This area consists of 19 ac (8 ha) of State land in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puuhapapa. Oahu—Lowland Wet—Unit 3 [29 ac (12 ha)]. This area consists of 29 ac (12 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains at Puukanehoa. Oahu—Lowland Wet—Unit 4 [27 ac (11 ha)]. This area consists of 27 ac (11 ha) in the lowland wet ecosystem on the windward side of the Waianae Mountains on State land at Puukaua. Oahu—Lowland Wet—Unit 5 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) of State land in the lowland wet ecosystem, on the windward side of the Waianae Mountains at Palikea.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Urera kaalae critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Urera kaalae occurs within the Lowland mesic and Lowland wet ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Lowland Wet—Units 1, 2, 3, 4, 5. (A) Elevation: <3,000 ft (<1,000 m). (B) Annual Precipitation: >75 in (>190 cm). (C) Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. (D) Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. (E) Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. (F) Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Urera kaalae to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Breeding Season

Adult: Spring (USFWS, 1998)

Reproduction Narrative

Adult: Urera kaalae has been observed flowering in the spring. It is difficult to predict when seeds will be produced, and, when they are produced, they are often sterile. This may be an indication of pollinator limitation. (USFWS, 1998)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Forest- hardwood, forest/woodland (NatureServe, 2015)

Geographic or Habitat Restraints or Barriers

Adult: Found at elevation of 300 to 820 meters (980 to 2,700 feet) (USFWS, 1998)

Environmental Specificity

Adult: Medium, with some key requirements (USFWS, 1998)

Habitat Narrative

Adult: Urera kaalae typically grows on slopes and in gulches in diverse mesic forest dominated by papala kepau at an elevation of 300 to 820 meters (980 to 2,700 feet) (USFWS 1995; Wagner et al. 1990). Associated species include alan, poola, ieie, mamaki, Urera glabra, kopiko, lama, papala kepau, and olopua (HHP 1997; USFWS 1995). (USFWS, 1998)

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available.

Population Information and Trends

Population Trends:

Not available.

Number of Populations:

<10 (USFWS, 2011)

Population Size:

21 wild (5 mature and 16 immature) (USFWS, 2019)

Population Narrative:

When the recovery plan was published in 1998, only ten populations were known with a total of 44 individuals. In 2009, Bakutis reported that only about 15 or 16 individuals remain in the wild on Oahu, between Palikea and Kaluaa at Ekahanui and Palawai (A. Bakutis, pers. comm. 2009; USFWS 2009, 2010). (USFWS, 2011). Currently there are five mature and 16 immature wild individuals of Urera kaalae in the Waiʻanae mountains of Oʻahu. A landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that U. kaalae is highly

vulnerable to the effects of climate change. Collection, propagation, and reintroductions are ongoing, with almost 500 plants reintroduced since the last 5-year review. Ungulate exclosures protect most wild and outplanted individuals of U. kaalae. Some rodent and slug control is conducted in two areas where U. kaalae occurs (USFWS, 2019)

Threats and Stressors

Stressor: Invasive introduced species (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Invasive introduced plant species have altered the habitat and compete for resources with Urera kaalae. These include Ageratina riparia (spreading mist flower), Aleurites moluccana (kukui), Bryophyllum pinnatum (airplant), Buddleia asiatica (dog tail), Clidemia hirta (Koster's curse), Deparia petersonii (NCN), Grevillea robusta (silk oak), Heliocarpus popayaensis (white moho), Lantana camara (lantana), Oplismenus sp.(basketgrass), Passiflora suberosa (corkystem passion flower), Physalis peruviana (Cape gooseberry), Pimenta dioica (allspice tree), Psidium guajava (common guava), Rubus argutus (blackberry), Rubus rosifolius (thimbleberry), Setaria parviflora (yellow foxtail), and Schinus terebinthifolius (Christmas berry). The introduced invasive plant species compete with the species for water, light, and nutrients. (USFWS, 2011)

Stressor: Habitat degradation by pigs and goats (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Feral ungulates, including pigs (Sus scrofa) and goats (Capra hircus), have caused degradation of the habitat where this species occurs. (USFWS, 2011)

Stressor: Damage by landslides and rolling rocks (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Many reports also include observations of damage and mortality of these trees from landslides and rolling rocks, which can be precipitated by these animals (Hawaii Biodiversity and Mapping Program 2009; Perlman 2010; Plant Extinction Prevention Program 2009; Wood 2010). (USFWS, 2011)

Stressor: Predation by rats and slugs (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: Rats (Rattus spp.) and slugs (unidentified species) have been noted to consume vegetative or floral parts of Urera kaalae (Perlman 2010; Wood 2010). (USFWS, 2011)

Stressor: Climate change (USFWS, 2011)
Exposure:
Response:
Consequence:

Narrative: Climate change may also pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. The Service anticipates high spatial resolution climate outputs by 2013. (USFWS, 2011)

Stressor: Few populations and demographic fluctuations (USFWS, 2011)
Exposure:
Response:
Consequence:
Narrative: In addition to all of the other threats, species like Urera kaalae that are endemic to small portions of a single island are inherently more vulnerable to extinction than widespread species because of the higher risks posed to a few populations and individuals by random demographic fluctuations and localized catastrophes such as hurricanes, landslides, flooding, and disease outbreaks. The extent of these natural processes on this single island endemic are exacerbated by anthropogenic threats, such as habitat loss for human development or predation by introduced species (USFWS 2010). (USFWS, 2011)

Stressor: Disease (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: —In 2016, Pucciniastrum boehmeriae (mamaki rust) was observed on Urera kaalae at Pu‘uhapapa; however, after two years the rust did not appear to cause significant negative effects to the health of the plants, even with heavy infestations (ANRP 2018). (USFWS, 2019)

Recovery

Reclassification Criteria:
1. A total of five to seven populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered. (USFWS, 1998)

Delisting Criteria:
1. A total of 8 to 10 populations of each taxon should be documented on Oahu and at least one other island where they now occur or occurred historically. (USFWS, 1998)

2. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of 300 mature individuals per population for short-lived perennials. (USFWS, 1998)

3. Each population should persist at this level for a minimum of 5 consecutive years. (USFWS, 1998)

Recovery Actions:

- Construct enclosures or strategic barrier fence to protect populations against feral ungulates. (USFWS, 1998)
- Control competing alien plant species within enclosures. Populations that have only a few remaining individuals (Kuma Kakii and Waianae Kai Forest Reserve) should immediately be weeded and protected where accessible. (USFWS, 1998)
- A coordinated fire protection plan for endangered plant species on State forest reserves (Waianae Kai), Federal (Schofield Barracks—West Range), and private lands (Honouliuli Preserve) should be developed and implemented. (USFWS, 1998)
- Continue to collect seed from all remaining wild individuals as well as reintroduced individuals for genetic storage and reintroduction. (USFWS, 2011)
- Construct large-scale fences around all naturally occurring and reintroduced individuals to control feral ungulates. (USFWS, 2011)
- Control invasive introduced plant species around all known populations. (USFWS, 2011)
- Continue reintroducing individuals into protected suitable habitat within historical range. (USFWS, 2011)
- Control rats in the vicinity of these populations. (USFWS, 2011)
- Develop and implement methods to control slugs. (USFWS, 2011)
- Work with Hawaii Division of Forestry and Wildlife and U.S. Army to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2011)
- Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species. (USFWS, 2011)

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats except for mamaki rust and new data on this taxon's vulnerability to climate change. There is no significant new information regarding the species' biological status since the last 5-year review in 2011. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2019. • Ungulate monitoring and control—Maintain fencing and monitor wild and introduced populations to protect plants from impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with Urera kaalae at all populations. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Predator and herbivore control—Continue to implement effective control methods for rodents and slugs at all wild and reintroduced populations. • Disease control—Investigate the effects of mamaki rust and determine if control is needed, implement controls if necessary. • Captive propagation for genetic storage and reintroduction—Continue seed collections from tagged wild and outplanted individuals, keeping close track of the maternal source for use in ex situ propagation. • Reintroduction—Augment and establish new populations and determine which reintroduction sites have the highest likelihood of success. • Alliance and partnership development—Work with the Division of Forestry and Wildlife and the ANRP to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)

- New Management Actions: • Ungulate control— o The Army Natural Resource Program-Oʻahu (ANRP) undertakes stabilization and management of other endangered species to fulfill the requirements of the Biological Opinions for U.S. Army activities in Mākua and Oʻahu training areas, and Urera kaalae may benefit from these actions (fencing, ungulate and predator control, nonnative plant control) in management areas. Wild and/or reintroduced individuals of Urera kaalae may occur in four areas with ungulate exclosures maintained by ANRP: ʻĒkahanui, Palikea, KaluaaWaiʻeli, and Pualiʻi (ANRP 2018; U.S Army Garrison Hawaiʻi 2010). o In 2014, a team of 21 participants from various agencies and organizations collaborated to construct an ungulate exclosure fence to protect five Urera kaalae in Pālāwai gulch. Post construction reports indicated that this fence effectively stopped a boulder that had come loose from above (PEPP 2014). • Rodent predation or herbivory—The ANRP has found that Goodnature™ A24 rat traps are more effective than the Victor® snap traps, and these traps are deployed in a large-scale grid at the ʻĒkahanui management unit. Traps are checked at 4- month intervals (ANRP 2018). • Slug herbivory—Testing showed that Ferroxx® is a more effective slug control than Sluggo®, and this toxicant is currently used to protect some managed species from herbivory by slugs at the Kaluaa–Waiʻeli management unit, and may also benefit Urera kaalae (ANRP 2018). • Captive propagation for genetic storage and reintroduction— o The Plant Extinction Prevention Program (PEPP) reports collections representing 100 percent of the founders at two subpopulations (PEPP 2017). o Lyon Arboretum Micropropagation Laboratory reports seven explants in storage representing one plant at Pālāwai (Lyon Arboretum 2018). The Lyon Arboretum Seed Conservation Laboratory reports collection and storage of more than 158,000 seeds representing 12 individuals from two populations (three subpopulations) (Lyon Arboretum 2018). o The Pahole Rare Plant Facility (PRPF) reports 10 plants in storage representing six individuals from one population at Pālāwai, with 25 plants grown for outplanting (PRPF 2018). • Reintroductions— o The ANRP outplants Urera kaalae to provide this host plant for Drosophila montgomeryi, an endangered endemic Hawaiian picture-wing fly (ANRP 2018). Since the fall of 2014, 300 Urera kaalae were outplanted at North Kaluaa, Central Kaluaa, Pualiʻi, and Palikea (ANRP 2018). Pualiʻi is the only site where outplanted U. kaalae are successfully reproducing. o The Plant Extinction Prevention Program (PEPP) also outplants Urera kaalae, and reports 185 outplanted individuals total at Kapuna, ʻĒkahanui, Waiʻeli, Pālāwai, and Pualiʻi, with currently 150 surviving (PEPP 2017). (USFWS, 2019)

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SPECIES ACCOUNT: *Varronia rupicola* (No common name)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/09/2014; Southeast Region (R4) (USFWS, 2016)

Physical Description

Varronia rupicola is a large shrub reaching up to 16 ft (5 m) in height. The alternate leaves are ovate to elliptic, 0.8 to 3.5 inches (in) (2 to 9 centimeters (cm)) long with an acute apex, rounded to obtuse at the base, and chartaceous (papery) (USFWS, 2014-2).

Taxonomy

Varronia was traditionally lumped into the genus Cordia, a group of about 250 or more species of trees and shrubs of tropical and subtropical regions. Varronia was recently recognized as a monophyletic genera based on vegetative, floral, and pollen morphology (Miller and Gottschling 2007, p. 163). Varronia comprises multistemmed shrubs with condensed inflorescence and evenly serrate leaves (Sa´nchez de Stapf 2010, p. 133). Varronia is currently represented in the West Indies by about 66 valid species (Acevedo-Rodri´guez and Strong 2012, p. 170). Axelrod (2011, p. 427) recognized seven species found in Puerto Rico, with V. bellonis and V. wagnerorum being endemic to the island, and V. rupicola extending to the island of Anegada, British Virgin Islands (USFWS, 2014-2).

Historical Range

The species has been historically recorded from the geographical area comprising the Gua´nica Commonwealth Forest in southwestern Puerto Rico, and the area of the Vieques National Wildlife Refuge (NWR) in the island of Vieques, eastern Puerto Rico (USFWS, 2014). However, it is important to notice that Varronia rupicola also occurs within privately owned lands outside the Guanica Commonwealth Forest, which makes it vulnerable to habitat destruction (USFWS, 2014).

Current Range

Varronia rupicola is currently known from at least seven main localities in Puerto Rico (Table 2) and several localities from the island of Anegada. Monsegur and Breckon (2007, p. 1) visited the historical localities in Puerto Rico and provided updated information about the status and distribution of the species. The distribution of V. rupicola in the Gua´nica Commonwealth Forest extents to at least six small populations or subpopulations within the east section of the forest. Another population was located on the west unit of the Gua´nica Commonwealth Forest by Alcides Morales (Sociedad Ornitologica Puertoriquena, Inc., pers. comm., 2012). This is the westernmost recorded distribution for the species. From the municipality of Penuelas, Monsegur and Breckon (2007, p. 6) found a single individual in a ravine area on the west side of El Peno´n site. This seems to be part of the same population identified by Breckon and Kolterman in 1995. In addition, the Service confirmed the presence of about eight clusters of the species in an area just north of the Ponce Holiday Inn in the municipality of Ponce (O. Monsegur, Service, and J. Sustache, DNER, unpubl. Data, 2013) (USFWS, 2014).

Critical Habitat Designated

Yes; 9/9/2014.

Legal Description

On September 9, 2014, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Varronia rupicola under the Endangered Species Act of 1973, as amended. The critical habitat designation includes seven critical habitat units (CHUs) in Puerto Rico (79 FR 53315-53344).

Critical Habitat Designation

The critical habitat designation for Varronia rupicola includes seven CHUs in St. Croix, Virgin Islands. This species critical habitat encompasses approximately 6,547 acres (ac) (2,648 hectares (ha)) (79 FR 53315-53344).

Montalava: Unit 1 consists of 992 ac (401 ha) of Commonwealth-owned lands located at Montalva Ward in the Municipality of Gua´nica, Puerto Rico. This unit is located just south of State Highway PR 324 and the Town of Gua´nica, and includes Cerro Montalva. It is within the geographical area occupied by the species at the time of listing. Due to the marginal agricultural value, these forests were minimally impacted by other land use practices (e.g., charcoal production and ranching). Therefore, the prime and essential habitat for the species has maintained its unique features, such as the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. Despite its conservation status the habitat has been affected by human-induced fires and maintenance of access roads and rightsof-way. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, hurricanes, and habitat modification (e.g., urban development).

Unit 2: Gua´nica Commonwealth Forest: Unit 2 consists of 584 ac (236 ha) of Commonwealth-owned lands located within Carenero and Barina Wards in the municipalities of Gua´nica and Yauco, Puerto Rico. This unit is located within the core of the east section of the Gua´nica Commonwealth Forest. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. Despite its conservation status, the habitat has been affected by human-induced fires and maintenance of access roads and rights-of-way. The PCEs in this unit may require special considerations to address threats of nonnative plant species, humaninduced fires, hurricanes, and habitat modification (e.g., urban development and right-of-way maintenance).

Unit 3: Montes de Barina: Unit 3 consists of 2,002 ac (810 ha) of privately owned lands primarily located along Indios Ward in the municipality of Guayanilla. A small section of this unit falls within the Barinas Ward in Yauco, Puerto Rico. This unit is located just south of State Highway PR 2. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. The unit is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, hurricanes, and habitat modification (e.g., urban development).

Unit 4: Pen˜ o´n de Ponce: Unit 4 consists of 2,174 ac (880 ha) of privately owned lands located along Encarnacio´n and Canas Wards in the municipalities of Pen˜uelas and Ponce, Puerto Rico. This unit is located just north of State Highway PR 2 in the area known as Punta Cucharas. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, hurricanes, and habitat modification (e.g., urban development).

Unit 5: Punta Negra: Unit 5 is a small peninsula that consists of 291 ac (117 ha) of Commonwealth-owned lands located within Puerto Real Ward on the island of Vieques, Puerto Rico. This unit is located about 1.5 mi (2.5 km) east of the town of Esperanza and west of Puerto Ferro, Vieques National Wildlife Refuge (NWR). This natural area is managed by the Puerto Rico DNER as part of the Puerto Mosquito Natural Reserve. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is adjacent to an area currently occupied by the species (Unit 6), forming a continuous habitat and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. However, there is no specific record of the species within this unit. This unit is essential for the conservation of the species because it contains the PCEs and because its designation will safeguard other established populations in case of any stochastic event that occurs within habitats currently occupied by the species. Further, we consider Units 5, 6, and 7 to be a single ecological unit. The species is expected to occur within this area, and ecological interactions and genetic flow between this area and Units 6 and 7 may be essential for the recovery of the species. It was not included as a single unit with Units 6 and 7 because these peninsulas are united by a narrow mangrove forest that does not provide habitat for the species. The PCEs in this unit may require special considerations to address threats of nonnative plant species, humaninduced fires, and hurricanes.

Unit 6: Puerto Ferro: Unit 6 is a small peninsula that consists of 381 ac (154 ha) of federally owned lands managed by the Service as the Vieques NWR, and is located within the Puerto Ferro Ward on the island of Vieques, Puerto Rico. This unit is located about 4 km (2.5 mi) east of the town of Esperanza. It is located just between Unit 5 and Unit 7, forming a continuous habitat and contains the dry coastal shrubland habitat PCEs and PBFs, and therefore we consider Units 5, 6, and 7 to be a single ecological unit. The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is within the geographical area occupied by the species at the time of listing and contains the dry coastal shrubland habitat PCEs and PBFs, including suitable climate, substrates, and associated native plants and forest structure. It was not included as a single unit with Units 5 and 7 because these peninsulas are united by a narrow mangrove forest that does not provide habitat for the species. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, and hurricanes.

Unit 7: Cerro Playuela: Unit 7 is a small peninsula that consists of 123 ac (50 ha) of federally owned lands managed by the Service as the Vieques NWR, and is located within Puerto Ferro

Ward on the island of Vieques, Puerto Rico. This unit is located about 0.5 km (0.31 mi) south of the former airport of Campamento Garci´a (Vieques NWR). The forested habitat in this unit was minimally impacted by other land use practices like charcoal production and ranching due to its marginal agricultural value; hence, it has maintained its unique features. It is adjacent to an area currently occupied by the species (Unit 6), forming a continuous habitat. However, there is no specific record of the species within this unit. This unit is essential for the conservation of the species because it contains the PCEs and because its designation would safeguard other established populations in case of any stochastic event that occurs within habitats currently occupied by the species. Further, we consider Units 5, 6, and 7 to be a single ecological unit. The species is expected to occur within this area, and ecological interactions and genetic flow between this area and Unit 6 may be essential for the recovery of the species. It was not included as a single unit with Units 5 and 6 because these peninsulas are united by a narrow mangrove forest that does not provide habitat for the species. The PCEs in this unit may require special considerations to address threats of nonnative plant species, human-induced fires, and hurricanes.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Varronia rupicola critical habitat consists of three components (79 FR 53315-53344):

(1) Remnants of native shrubland and scrubland forest on limestone substrate within the subtropical dry forest life zone. Dry shrubland and scrubland forest includes: (a) Shrubland vegetation with canopy from 6.5 to 9.8 ft (2 to 3 m) high; (b) Limestone pavement; (c) Associated native vegetation; and (d) A shrub layer dominated by Croton humilis, Eupatorium sinuatum, Lantana reticulata, and Turnera diffusa.

(2) Semi-deciduous dry forest on limestone substrate within the subtropical dry forest life zone. Dry limestone semi-deciduous forest includes: (a) Low forest with canopy from 8 to 15 ft (3 to 5 m) high; (b) Limestone pavement; (c) Associated dry forest native vegetation; and (d) A shrub layer dominated by Croton humilis, Eupatorium sinuatum, Lantana reticulata, and Turnera diffusa.

(3) The type locations described in PCEs (1) and (2), above, for this species should have shallow and alkaline soils derived from limestone rock and an average rainfall of 34 in (86 cm).

Special Management Considerations or Protections

Special Management Considerations or Protections: When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. Agave eggersiana and Varronia rupicola: The primary threats to the physical or biological features (PBFs) that Agave eggersiana and Varronia rupicola depend on include: (1) Habitat destruction and modification by development; (2) competition with nonnative plant species; (3) humaninduced fire; and (4) hurricanes and storm surge. The majority of these threats can be addressed by special management considerations or protection, while others (e.g., hurricanes and storm surges) are beyond the control of land owners and managers. Management activities that could ameliorate these threats include, but are not limited to, establishment of permanent conservation

easements or land acquisition to protect the species and its habitat on private lands; establishment of conservation agreements on private, nongovernment, and government lands to protect the habitat; implementation of control of invasive, nonnative plant species to reduce competition and prevent habitat degradation; implementation of management practices to control fires; and creation or revision of management plans for the identification of the areas where current developments exist and to better guide the implementation of conservation measures for the species. For A. eggersiana, precautions are needed to avoid inadvertent mowing and cutting of the species in the course of landscaping activities. In addition, for both A. eggersiana and V. rupicola, development of residential and tourism projects should avoid impacting these habitats directly or indirectly, and habitat fragmentation should be limited as much as possible to maintain connectivity between populations and to avoid habitat degradation due to the colonization by nonnative, invasive plants.

Critical habitat does not include manmade structures (such as buildings, bridges, docks, aqueducts, roads, and other paved areas) and the land on which they are located existing within the legal boundaries on October 9, 2014

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated (USFWS, 2014-2)

Dependency on Other Individuals or Species

Adult: Insect pollinators and Animal disperser (unknown) (USFWS, 2014)

Breeding Season

Adult: Flowering and fruiting December through January, and June through July (USFWS, 2014-2)

Key Resources Needed for Breeding

Adult: Insect pollinators

Reproduction Narrative

Adult: Studies on the distribution, abundance, and reproductive biology of Varronia rupicola have been conducted by scientists from the University of Puerto Rico, Mayaguez Campus (Breckon and Kolterman 1996, p. 6; Monsegur and Breckon 2007, p. 13). These authors reported the species flowering and fruiting in December through January (Breckon and Kolterman 1996, p. 4), and in June through July (Monsegur and Breckon 2007, p. 1). From February to April, all plants observed were sterile. Fruit production in the populations from the Gua´nica Commonwealth Forest and the municipality of Ponce seem to be high, and there is evidence of recruitment associated to the majority of the clusters of individuals (O. Monsegur, Service, pers. obs., 2013). Under greenhouse conditions, seed germination has been reported as not less than 67 percent (Wenger et al. 2010). Germination in the wild has also been observed to be high (O. Monsegur, Service, pers. obs., 2013). However, apparently there is also a high mortality of seedlings, and only few individuals make the transition (natural thinning) to sapling stages (O. Monsegur, Service, pers. obs., 2013). Monsegur and Breckon (2007, p. 2) reported numerous

seedlings (>140) and various saplings in the Gua´nica Commonwealth Forest. However, seedling recruitment on Vieques Island seems to be low, as it has not been recorded during recent assessments (Monsegur and Breckon 2007, p. 7; Hamilton, KEW, pers. comm., 2013). Despite the showy red fruits of Varronia rupicola, its dispersion seems to be almost limited by gravity, as the majority of the seedlings lie under the parent tree or downslope (O. Monsegur, Service, pers. obs. 2013). The wide range of the species suggests a former animal disperser (probably a bird). Patterns of plant-animal interactions were probably altered due to the previous extensive deforestation of the island of Puerto Rico. Some observations of seed dispersal by an undetermined vector have been reported from Anegada (Hamilton, KEW, pers. comm., 2013). If not extinct, possible dispersers may have altered their foraging behavior and now do not feed on the fruits of V. rupicola. Recent observations in Puerto Rico indicate that flowers of V. rupicola are visited by several insect species, including Apis mellifera (honey bee) and Electrostrymon angelia (fulvous hairstreak, a butterfly) (O. Monsegur, Service, pers. obs. 2013). Varronia rupicola material germinated in the greenhouse at Cabo Rojo National Wildlife Refuge in Cabo Rojo were flowering and producing fruits in about 1 year after germination (O. Monsegur, Service, pers. obs., 2013). The rapid reproductive development of the species and the finding of individuals along recently disturbed sites (new dirt roads) and natural forest gaps (openings) may indicate that V. rupicola is an early colonizer or pioneer species (USFWS, 2014-2).

Habitat Type

Adult: Subtropical dry forest (USFWS, 2014-2)

Dependencies on Specific Environmental Elements

Adult: Limestone substrate

Environmental Specificity

Adult: High (Inferred from USFWS, 2014-2)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 2014-2)

Site Fidelity

Adult: High (Inferred from USFWS, 2014-2)

Habitat Narrative

Adult: Varronia rupicola has been described from southwestern Puerto Rico, Vieques Island, and Anegada Island. All these sites lie within the subtropical dry forest life zone overlying a limestone substrate (Ewel and Whitmore 1973, p. 72). Subtropical dry forest life zones receive a mean annual rainfall ranging from 24 to 40 in (61 to 101 cm). The vegetation in this life zone is deciduous on most soils, with tree species dropping leaves during the dry season. The vegetation usually consists of a nearly continuous, single-layered canopy, with little ground cover. The leaves of dry forest species are succulent or coriaceous, and species with spines and thorns are common. Tree heights usually do not exceed 49 ft (15 m), and crowns are typically broad, spreading, and flattened (Ewel and Whitmore 1973, p. 72) (USFWS, 2014-2). High ecological integrity of the community, site fideilty and environmental specificity are inferred based on specific habitat needs and low number of populations, as is low tolerance range (USFWS, 2014-2). Varronia rupicola occurs within the subtropical dry forest life zone, overlying

limestone substrate (Ewel and Whitmore 1973). The species has been recorded in forested hills with open to relatively dense shrublands/scrublands 6.5 to 9.8 ft (2 to 3 m) in height; in low forest with canopy from 8 to 15 ft high (3 to 5 m); and at the edge of a dense low coastal shrubland forest (USFWS, 2023).

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 2014-2)

Dispersal

Adult: Low (USFWS, 2014-2)

Dependency on Other Individuals or Species for Dispersal

Adult: Yes/unknown seed disperser (possibly extinct) (USFWS, 2014-2)

Dispersal/Migration Narrative

Adult: Species is/was dispersed via an unknown animal that may now be extinct (USFWS, 2014-2)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

5 (USFWS, 2021)

Population Size:

~1,247 (USFWS, 2021)

Population Narrative:

Varronia rupicola has a somewhat extended distribution in southern Puerto Rico. However, the species is represented by small and fragmented populations, and about half of them occur within private lands subject to urban development, making the species prone to destruction, modification, or curtailment of its habitat (Factor A). Moreover, other natural or manmade factors such as invasive species, human induced fires, hurricanes, and climate change (Factor E) also pose threats to V. rupicola. Implementation and enforcement of regulatory mechanisms to protect the species have not been effective, particularly because enforcement on private lands continues to be a challenge (Factor D). Therefore, it is very likely that cumulative effects of these threats (e.g., poorly implemented regulatory mechanisms and habitat destruction) result in limitation, or even local extirpation, of V. rupicola populations. (USFWS, 2014-2). When V. rupicola was listed (2014) the number of known individuals in Puerto Rico (including Vieques) was estimated at approximately 109 adults and saplings, and by 2015, that number increased to 165 individuals. As of the time of this review, the V. rupicola populations are estimated at approximately 1,247 adult individuals (Puerto Rico: Guánica (193), Ponce (83), Vieques (12); BVI: Anegada West (629) and Anegada East (330)). In addition, approximately 262 saplings and 335 seedlings have been recorded as part of ongoing monitoring efforts (2012-2021). Nonetheless,

the increase in the number of known individuals might not necessarily be the result of a population increasing trend or expansion, instead, it could likely be the result of increased survey efforts. (USFWS, 2021). Varronia rupicola is currently known from five genetically unique populations across its range; Guánica, Ponce, Vieques, Anegada West and Anegada East (Hamilton 2016). (USFWS, 2021)

Threats and Stressors

Stressor: Habitat destruction (USFWS, 2014-2)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Degradation of habitat represents a threat to Varronia rupicola. About half of the known populations of V. rupicola and its suitable habitat are within privately owned land, which is being modified or is proposed to be modified for urban development. In addition, habitat fragmentation by clearing of vegetation, road constructions, and right-of-way maintenance (cutting plants and used of herbicides) can limit the species' survivability where these activities create the conditions for nonnative plants to outcompete V. rupicola. We expect that this threat would continue into the future (USFWS, 2014-2).

Stressor: Invasive species (USFWS, 2014)
Exposure:
Response:
Consequence:
Narrative: Although invasive plant species have not been documented as a current threat to Varronia rupicola, they may become so in the future. Studies conducted within the Guanica Commonwealth Forest indicate that some nonnative tree species (e.g., Leucaena leucocephala) can persist as a dominant canopy species for at least 80 years (Wolfe 2009, p. 2). The same is expected to occur with nonnative grass species (e.g., Megathyrsus maximus) (USFWS, 2014).

Stressor: Human Induced Fires (USFWs, 2014)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Human-induced fires may lead to destruction of the native vegetation seed bank and may create conditions favorable for the establishment of nonnative plant species adapted to fires (e.g., Leucaena leucocephala and Megathyrsus maximus) that may outcompete Varronia rupicola and Agave eggersiana. Furthermore, the presence of M. maximus and other grass species increases the amount of fuel and the intensity of fires that may affect endemic populations. Seedling mortality after fires is related to the differences on fuel loads and the different fire intensities (Santiago-Garci´a et al. 2008, p. 607). The V. rupicola populations that occur along the municipalities of Yauco, Pensuelas, and Ponce are susceptible to forest fires, particularly on private lands where fires are accidentally or deliberately ignited (USFWS, 2014).

Stressor: Hurricanes and Climate Change (USFWS, 2014)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals

Narrative: The reduced number and small size of Varronia rupicola and Agave eggersiana populations in Puerto Rico and St. Croix, respectively, make these species susceptible to hurricanes impacts (e.g., extirpation). In the case of A. eggersiana, the impacts may be exacerbated by the reproductive biology of the species (i.e., the species depends on asexual reproduction, plants dying after flowering, and limited dispersal of bulbils). Therefore, impacts to a population may compromise its natural recruitment. In addition, for V. rupicola, a severe hurricane could result in extensive defoliation and could cause stem damage. Populations of Varronia rupicola may be threatened by climate change, which is predicted to increase the frequency and strength of tropical storms and can cause severe droughts (Hopkinson et al. 2008, p. 260) (USFWS, 2014).

Recovery

Reclassification Criteria:
Recovery Priority Number: 8C

Delisting Criteria:
1. The genetic representation of the Ponce population is protected through conservation mechanism (e.g., land acquisition and conservation easements) and threats identified in the Final Rule are reduced to allow long-term viability of this population (Factors A and E; 79 FR 53303) (USFWS, 2023)

2. The threats identified at the Guánica population (Factors A and E; 79 FR 53303) are reduced to a point that would allow the long-term viability of this population (USFWS, 2023).

3. The Vieques population has been enhanced to a point that it is considered viable and able to withstand the threats from stochastic events and climate change (Factor E; 79 FR 53303) (USFWS, 2023).

4. Five or more new self-sustainable localities (representing each of the five known genetically unique populations) are established within suitable habitat in areas managed for conservation (e.g., Vieques NWR, Caja de Muertos Natural Reserve, El Convento Natural Protected Area), and these localities show evidence of natural recruitment over a timeframe of 5-10 years supporting a stable or increasing trend (Factor E; 79 FR 53303) (USFWS, 2023).

Recovery Actions:

- 1. Protect and manage V. rupicola natural populations and its habitat by implementing conservation practices (USFWS, 2023).
- 2. Develop and implement a propagation program, reintroduction/enhancement of the natural populations, and ex situ conservation efforts (USFWS, 2023).
- 3. Continue to gather information on the reproductive biology, ecology, distribution and abundance of V. rupicola along the southern coast of Puerto Rico (Guánica to Ponce), Vieques Island, and Anegada Island (USFWS, 2023).
- 4. Facilitate recovery of V. rupicola through public awareness and education (USFWS, 2023).
- 5. Refine recovery criteria and determine what additional actions are necessary to achieve recovery criteria for V. rupicola (USFWS, 2023)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Validate the existing germination and propagation protocols to support reintroduction and population enhancement efforts and to provide guidelines to partners regarding the management of propagated material (e.g., avoiding mixing material from the different genetically unique populations). • Secure ex situ collections from the five genetically unique populations (i.e., Guánica, Ponce, Vieques, Anegada West and Anegada East) by banking seed material and establishing living material collections in collaboration with other institutions (e.g., Fairchild Tropical Botanic Garden, Atlanta Botanical Garden, the Royal Botanic Garden, Kew). • Enhance (augment) of the natural populations (Vieques, and Guánica) to numbers that secure its viability. The minimum number of individuals should be at least 250 reproductive individuals per population, showing evidence of natural recruitment on a 5 to 10-year timeframe, and that recruitment supports a stable or improving population growth rate. Site selection must provide connectivity with existing individuals and the area must provide conditions that minimize risk of habitat modification, human induced fires, and habitat intrusion by exotic plants). Based on the availability of research-based data on the species' population genetics, planting material from different sources is not recommended to enhance natural populations. • Establish new populations to secure the genetic diversity of natural populations (i.e. Ponce, Vieques, Guánica, Anegada West, and Anegada East). The minimum number of individuals should be at least 250 reproductive individuals per population, showing evidence of natural recruitment on a 5 to 10 year timeframe, and that recruitment supports a stable or improving population. Site selection must provide connectivity with existing populations and the area must provide conditions that minimize risk of habitat modification, fires, and intrusion by exotic plants). • Develop a habitat suitability model by incorporating data on forest cover, geology, elevation, and the species current distribution, to identify remnants of suitable habitat that may harbor extant populations or that may serve as future reintroduction sites. • Develop a methodology using camera trapping to identify possible seed disperser and their role on the current distribution and abundance of V. rupicola, as well as to identify possible seed predators. • Expand ongoing research on the species population genetics to include samples from recently discovered localities (e.g., type locality from Indios Ward in Guayanilla). • Monitor for the presence and potential impacts from insect pest across the species range. (USFWS, 2021)

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SPECIES ACCOUNT: *Verbena californica* (Red Hills vervain)

Species Taxonomic and Listing Information

Listing Status: Threatened; 10/14/1998; California/Nevada Region (R8) (USFWS, 2016)

Physical Description

A perennial herb, 3-7.5 dm tall, that produces spikes of blue to purple flowers. Blooms May-September. (NatureServe, 2015)

Taxonomy

Verbena californica is a narrowly distributed biennial or perennial herb belonging to the vervain family (Verbenaceae). Verbena californica was first discovered in 1938 in Tuolumne County, California (Moldenke 1942) (USFWS, 2008).

Current Range

Currently, the entire range of Verbena californica is presumed to be an area of about 77 square kilometers (30 square miles) or 12 kilometers (7.5 miles) by 6.4 kilometers (4 miles). Within this narrow range, the total area occupied by the populations is estimated to be 50 hectares (124 acres) (CNDDB 2011). Verbena californica grows at elevations between 255 and 400 meters (837 to 1,310 feet) (CNDDB 2011). Most of the sites are within the expanded Red Hills Area of Critical Environmental Concern (ACEC) that now consists of about 4,042 hectares (9,988 acres, about 15.6 square miles) of public land south of the historic town of Chinese Camp in Tuolumne County (BLM 2011) (USFWS, 2012).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Formerly, the species was thought to also reproduce vegetatively through rhizomes, but Knox (1998) found no evidence of rhizomes when she dug up plants. In nature, seed germination has been observed as early as mid-October and probably continues throughout the winter (Knox 1998). The progress of seedling maturation has not been reported. Plants mature and can begin flowering by late May, with flowering continuing through September (Stone 1992; Tibor 2001) (USFWS, 2012).

Reproduction Narrative

Adult: Knox (1998) determined that soil moisture was the primary factor influencing the distribution and reproduction of this species. Underground springs were responsible for maintaining summer water flow in the stream reaches she studied. Nine of the total 11 V. californica occurrences are along streams in Pinus sabiniana (foothill pine) woodlands (USFWS, 2008). Seeds apparently are the primary means of reproduction for Verbena californica. Formerly, the species was thought to also reproduce vegetatively through rhizomes, but Knox (1998) found no evidence of rhizomes when she dug up plants. In nature, seed germination has

been observed as early as mid-October and probably continues throughout the winter (Knox 1998). The progress of seedling maturation has not been reported. Plants mature and can begin flowering by late May, with flowering continuing through September (Stone 1992; Tibor 2001). Flowering begins at the bottom of the flower cluster and progresses upward through the season (Stone 1992). Dates of seed formation in nature have not been reported, although transplants grown in an outdoor garden had mature seeds present in July (Knox 1998). Considering that each flower can produce as many as four seeds, Knox (1998) estimated that potential seed production at her three study sites ranged from 282 to 1,245 seeds per plant. The lowest estimate was at an atypical site in a meadow with compacted soils and severe competition (Knox 1998). Seed dispersal mechanisms are not known for V. californica (USFWS, 2012). Availability of pollinating insects is important for reproduction. Pollination of Verbena californica has not been studied in great detail, but insects visiting the flowers, and possibly transferring pollen, include butterflies, flies, beetles (Stone 1992), and bees (Moldenke 1972). The most frequent visitors according to Stone (1992) were butterflies in the genus Ochlodes (woodland skippers; family Hesperiidae). However, Moldenke (1972) reported only bees visiting the flowers of V. californica in 1970 and 1971, including two species of leafcutting bees (family Megachilidae), Anthidium edwardsii and Chalcidoma angelarum, and two cuckoo bees (family Anthophoridae), Anthophora urbana and Melissodes lupina (USFWS, 2012).

Habitat Type

Adult: Woodland/grassland (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Serpentine substrates (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species occurs along intermittent and perennial streams with serpentine substrates. 260-400 m elevation. Cismontane woodland, valley and foothill grassland / mesic, usually serpentine seeps or creeks; elevation 260-400m (California Native Plant Society 2001) (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the species limited number of populations and the species specific habitat requirements.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Seed dispersal mechanisms are not known for V. californica (USFWS, 2012).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2012)

Number of Populations:

15 presumed occurrences (USFWS, 2022)

Population Size:

2500 - 10,000 individuals (NatureServe, 2015)

Population Narrative:

The abundance of Verbena californica is much the same today as it was when it was listed and 15 sites are presumed extant (A. Franklin in litt. 2007; CNDDB 2011). However, other sites may have been extirpated in the past without having been documented. We believe that current populations likely have been fragmented and reduced in size from those that existed historically (USFWS, 2012). Low resiliency, redundancy and representation are inferred based on this species specific habitat needs and low number of populations. The current species distribution of Red Hills vervain is an area of about 82 square kilometers (32 square miles) or 9.7 kilometers (6 miles) by 8.6 kilometers (5.3 miles) in and around the Red Hills of Tuolumne County, similar to what we described in our 2012 review (Service 2012, p. 4). See Figure 1 for a map of distribution. Within this narrow range, the total area occupied by the species is estimated to be 85 hectares (210 acres) (Diversity Database 2021). At the time of listing, the species was known from nine occurrences across a range of about 16 kilometers (10 miles) (Service 1998, p. 49023). One of the described occurrences is known only from an herbarium specimen collected in 1972 and no details on habitat, population size, or threats are available (Diversity Database 2021). Similar to our 2012 5-year review, for the purposes of this 5-year review we do not consider this specimen an extant occurrence. At the time of our 2007 and 2012 5-year reviews, there were 11 and 15 presumed extant occurrences, respectively (Service 2007, p. 4; Service 2012, p. 5). The number of extant Diversity Database occurrences of Red Hills vervain has not changed since the 2012 5-year review (i.e., there are 15 presumed extant sites). Of these, nine occurrences have been verified since the 2012 5-year review and further fieldwork is necessary to determine the status of the other six occurrences. At the time of listing, about 85% of Red Hills vervain were on private lands (Service 1998, p. 49023). Now, most of the sites are protected within the Red Hills Area of Critical Environmental Concern that consists of about 4,042 hectares (9,988 acres, about 15.6 square miles) of public land south of the historic town of Chinese Camp in Tuolumne County. The Red Hills Area of Critical Environmental Concern is managed by the Bureau. The Bureau designated the southern 1,821 hectares (4,500 acres) of the Red Hills as an Area of Critical Environmental Concern in 1985, which was then expanded to its current range in 1993 (Service 2012, p. 11). The purpose of the designation is to protect the unusual serpentine soils and the rare or listed species that rely on the habitat, including rare plants, Red Hills roach (Hesperoleucus symmetricus ssp.), and bald eagles (Haliaeetus leucocephalus) (USFWS, 2022).

Threats and Stressors

Stressor: Recreational gold mining (USFWS, 2012)

Exposure:
Response:
Consequence: Loss of habitat
Narrative: Placer gold mining, which includes panning and dredging along streams, is a potential threat to occurrences of Verbena californica on lands administered by the BLM (J. Willoughby, BLM, in litt. 1990; California Department of Fish and Game 1993; A. Franklin, in litt. 2007). In the course of gold panning, the plants themselves can be trampled or dislodged and soil can be compacted. Currently, the California Department of Fish and Game is prohibited by court order from issuing suction dredge permits. Panning of gold along streams is still allowed (USFWS, 2012).

Stressor: Adjacent development (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Hydrological changes remain a threat to the Andrew Creek occurrence. Although the Verbena californica population is no longer threatened directly by residential development, runoff from the proposed houses and golf course on the table land above the drainage may affect the riparian area. Lowering of the water table that feeds springs in the riparian area is also a concern (California Department of Fish and Game 2005). The direct threat from housing development has decreased since listing. The Verbena californica habitat that was formerly on private land within the Andrew Creek drainage became public land in 2000. The acquisition was a cooperative effort among the BLM, the Tuolumne County Land Trust, the Trust for Public Lands, the California Wildlife Conservation Board, the Packard Foundation, and the California Department of Transportation (A. Franklin, in litt. 2002). In 2004, the Tuolumne County Land Trust acquired part of the Big Creek population with funding from the California Department of Transportation (E. Cypher, California Department of Fish and Game, pers. comm. 2006, 2007) (USFWS, 2012).

Stressor: Grazing (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals/degradation of habitat
Narrative: Currently, grazing on the BLM lands in the Red Hills occurs within two leases, one of which has Verbena californica. This lease is for 72 animal unit months over 1,178 acres within the Red Hills ACEC. Monitoring of V. californica, which began in 1998, uses a comparison of 2 grazed and 2 ungrazed (fenced) plots to evaluate grazing effects (BLM 2007b). No clear pattern of grazing effects has emerged from monitoring, i.e., it is not clear that the grazed or ungrazed plots are resulting in greater viability (BLM 2007b). However, grazing clearly does impact plants of V. californica. Clipped stems of V. californica have been observed both in the experimental plots and in other areas subjected to grazing. Trampling damage has been observed especially for the wet ground where V. californica occurs. Because the phenology of V. californica is relatively late, the grazing period was moved forward and now ends on April 15. We determined that the grazing program may adversely affect V. californica. No new grazing leases will be authorized in the Red Hills (BLM 2007b; Service 2007); however, the existing leases still remain (Peggy Cranston, Wildlife Biologist, Mother Lode Field Office, BLM, pers. comm. 2012) (USFWS, 2012).

Stressor: Inadequacy of Existing Regulatory Mechanisms (USFWS, 2012)

Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: The Endangered Species Act is the primary Federal law that provides protection for this species since its listing as threatened in 1998. Other Federal and State regulatory mechanisms provide discretionary protections for the species based on current management direction, but do not guarantee protection for the species absent its status under the Act. Therefore, we continue to believe other laws and regulations have limited ability to protect the species in absence of listing under the Endangered Species Act (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: The global average temperature has risen by approximately 0.6 degrees Celsius (1 degree Fahrenheit) during the 20th Century (IPCC 2001, 2007; Adger et al. 2007). There is an international scientific consensus that most of the warming observed has been caused by human activities (IPCC 2001, 2007; Adger et al. 2007), and that it is “very likely” that it is largely due to manmade emissions of carbon dioxide and other greenhouse gases (Adger et al. 2007). Ongoing climate change (Inkley et al. 2004; Kerr 2007; Adger et al. 2007; Kanter 2007) likely imperils Verbena californica and the resources necessary for its survival. Since climate change threatens to disrupt annual weather patterns, it may result in a loss of its habitat and/or increased numbers of its predators, parasites, and diseases. Where populations are isolated, a changing climate may result in local extinction, with range shifts precluded by lack of habitat, or in the case of plants the inability to disperse to newly suitable habitat at a rate equal to advance of newly unsuitable habitat caused by the change in environmental conditions (USFWS, 2012).

Stressor: Non-native plants (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative:

Stressor: Small populations (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Small populations may also be subject to increased genetic drift and inbreeding (Menges 1991; Ellstrand and Elam 1993). Populations that are continually small in size are particularly susceptible to genetic changes due to drift. However, drift may also cause genetic changes with populations that occasionally fluctuate to small sizes (e.g., undergo population bottlenecks). Increased homozygosity (reduced genetic variation) resulting from genetic drift and inbreeding may lead to a loss of fitness (ability of individuals to survive and reproduce) in small populations. In addition, reduced genetic variation in small populations may make any species less able to successfully adapt to future environmental changes (Ellstrand and Elam 1993) (USFWS, 2012).

Stressor: Recreational activities (USFWS, 2012)

Exposure:
Response:
Consequence:
Narrative: The Red Hills have mostly been used for recreation. Until 1991, the main recreational uses were target-shooting, off-road vehicle driving, camping, hunting, hiking, horseback riding, nature study, wildflower viewing, and hobby prospecting. In 1991, to protect the fragile biological resources of the area, target shooting and off-road vehicle use were prohibited on public land in the Red Hills (BLM 2009). Presently the main recreational activity in the Red Hills is equestrian use. Hiking, mountain biking and spring wildflower viewing are other popular activities (BLM 2007b). Overnight camping is no longer allowed within the Red Hills ACEC (BLM 2008) (USFWS, 2012).

Stressor: Herbivory and trampling (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Currently, the primary threats to Red Hills vervain throughout its range include: herbivory and trampling during unmanaged cattle grazing (USFWS, 2022).

Stressor: Drought (USFWS, 2022)
Exposure:
Response:
Consequence:
Narrative: Drought is listed as a primary threat to this species (USFWS, 2022).

Stressor: Fire, flash floods, competition with nonnative plants (USFWS, 202)
Exposure:
Response:
Consequence:
Narrative: Currently, the primary threats to Red Hills vervain throughout its range include: herbivory and trampling during unmanaged cattle grazing, drought, fire, flash floods, competition with nonnative plants, recreation, gold mining, and climate change (USFWS, 2022).

Recovery

Reclassification Criteria:
Recovery Priority Number: 14

Recovery Actions:

- No recovery plan or outline has been completed for this species (USFWS, 2012).
- Work with the BLM to revise the Red Hills ACEC management plan to include new data, new listings of species under the Endangered Species Act, newly acquired lands, and other lands added to the ACEC because of newly developed resource information (USFWS, 2012).
- Encourage the BLM to withdraw habitat from mining patents (USFWS, 2012).
- Establish reliable baseline data for monitoring plant occurrences. Monitor the status and trend of Verbena californica in order to track any threats, and to estimate current population sizes, the number and distribution of populations, and whether the species is stable, increasing, or declining (USFWS, 2012).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Here we propose several habitat conservation and ecological research recommendations which will aid in the recovery and conservation of Red Hills vervain. Some of these recommendations have already been discussed in previous 5-year reviews (Service 2007; Service 2012) and remain valid. 1. Verify Red Hills vervain occurrences recorded in the California Natural Diversity Database, especially occurrences with a currently unknown status, that have not been surveyed in the previous ten years, and/or that are on private land. 2. Establish reliable baseline data for monitoring Red Hills vervain occurrences. Monitor the status and trend of occurrences to (a) track any threats, (b) estimate current population sizes and the number and distribution of populations, and (c) determine whether the species is stable, increasing, or declining. 3. Research the hydrology of watersheds and streams in the Red Hills Area of Critical Environmental Concern to predict how climate change will impact water availability to Red Hills vervain. Monitor seasonal and yearly changes to stream flows. 4. Mitigate cattle grazing impacts on Red Hills vervain by maintaining the fence demarcating the boundary between the Red Hills Area of Critical Environmental Concern and private ranch lands at Diversity Database occurrence #12. Continue to monitor Diversity Database occurrence #8 for grazing impacts. 5. Determine the extent of impact of nonnative grasses on Red Hills vervain. Work with the Bureau to continue to monitor and control yellow star thistle, especially those adjacent to Red Hills vervain. Determine whether and where Red Hills vervain is impacted by Bermuda grass and panic grass to establish a management plan. 6. Create a management plan for recreational activities in the Red Hills Area of Critical Environmental Concern to mitigate the impact of recreational activities, including hiking, mountain biking, and equestrian use, on Red Hills vervain. Work with the Bureau to identify appropriate actions, such as signage and fencing to limit access to sensitive habitat areas. 7. Identify potential locations for outplanting and translocation of Red Hills vervain based on known habitat preference information, in case these activities are necessary due to irreversible change to current habitat, such as those due to climate change. 8. Determine length of seed viability in storage. Currently, Red Hills vervain seeds are stored at the University of California Botanical Garden at Berkeley (USFWS, 2022)

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SPECIES ACCOUNT: *Verbesina dissita* (Big-leaved crownbeard)

Species Taxonomic and Listing Information

Listing Status: Threatened; Pacific Southwest Region (R8)

Physical Description

A subshrub, generally 0.5-1 m tall, with distinctive bright green, rough-textured leaves. Yellow to yellow-orange flower heads bloom April-July (March-July in the Mexican populations). (NatureServe, 2015)

Taxonomy

Verbesina dissita is a member of the sunflower family (Asteraceae) (USFWS, 1996).

Historical Range

See current range/distribution.

Current Range

Verbesina dissita is found on rugged hillsides in dense maritime chaparral from Laguna Beach in Orange County south to the San Telmo area east of Cabo Colonet in Baja California, Mexico. In California it is known from two population centers less than 3.2 km (2 mi) apart (USFWS, 1996).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-compatible (USFWS, 2020)

Reproduction Narrative

Adult: Knowledge of Verbesina dissita reproductive biology is limited to observations of rhizomatous spreading, whereby multiple shoots are sent up from underground stems that represent a single genetic individual (genet) but have the appearance of multiple plants. The individual aerial stems are termed ramets. This growth mechanism makes it difficult to determine the abundance of V. dissita as it is challenging to observe where a genet begins and ends spatially (USFWS, 2010). Our understanding of sexual reproduction in Verbesina dissita is based on a pollination biology study conducted by the University of California Davis and California Department of Fish and Wildlife (Ayres and Showers 2006, p. 1). The study evaluated self-compatibility within V. dissita by excluding a portion of the inflorescences from pollinator visitation using a mesh barrier. The study concluded that V. dissita was self-incompatible based a higher seed set in open flowers (2.4 +/- 0.54) compared to closed or excluded flowers (0 +/- 0.57) (p=.01; Ayres and Showers 2006, p. 1; Ayers 2019, pers. comm.). (USFWS, 2020)

Habitat Type

Adult: Coastal hillsides/Maritime chaparral (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (inferred from NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits rugged coastal hillsides and canyons in dense southern maritime chaparral communities. Also known from coastal sage scrub and mixed chaparral communities. < 100 m elevation (NatureServe, 2015). Clumped spatial arrangement and narrow environmental specificity as well as High ecological integrity of the community and site fidelity (and low tolerance range) are all inferred based on the species specific habitat requirements, low number of known populations and low number of known individual plants.

Dispersal/Migration

Dispersal

Adult: Moderate (USFWS, 2010)

Dependency on Other Individuals or Species for Dispersal

Adult: Animals/Birds?

Dispersal/Migration Narrative

Adult: Since listing, additional research was conducted on Verbesina dissita to investigate seed viability, germination, and propagation of seeds and vegetative matter. In 2003, Michael Wall (Seed Program Coordinator, Rancho Santa Ana Botanical Garden (RSABG)) performed laboratory tests of seed viability following storage in uncontrolled conditions (room temperature) that resulted in moldy seeds with very low germination rates. Fruits collected in 2003 were stored frozen and tested for their ability to germinate in 2005, 2007, and 2008. Germination success was high with vigorous root and cotelydon (seed leaves) development. More recent analysis of the winged fruits has revealed a strong dispersal potential; fruits are now thought to be dispersed up to 200 m (656 ft) from the plant (Wall, pers. comm. 2010). The fruits have two distinct prongs, known as awns, which may aid in dispersal through attachment to animals. Dispersal by water is unclear, although it appears seeds may be buoyant for an extended amount of time before they become saturated with water (Wall, pers. comm. 2010). Plants found on the Todos Santos Islands off Baja California, Mexico (Junak and Philbrick 1994, p. 417) may have traveled to the islands by long-distance dispersal by birds. Sexual reproduction, pollination requirements, longevity of adults, and genetics continue to be poorly understood (USFWS, 2010).

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2010)

Number of Populations:

Two (USFWS, 2010)

Population Narrative:

In the United States, it is restricted to the Laguna Beach area of Orange County, California, though the greater portion of its historical range is in Baja California, Mexico. In Laguna Beach, it is known from two occurrences less than 0.8 kilometers (km) (0.5 mile (mi)) apart. The decline of V. dissita may have slowed after becoming federally listed; however, local policies guiding fire prevention and development on private land continue to reflect inadequate protection for this plant species (USFWS, 2010). Low resiliency, redundancy and representation are inferred based on the low number of poppulations and the restricted habitat of this species.

Threats and Stressors

Stressor: Residential development and urbanization (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Residential development and urbanization were considered the most immediate threats to plants and habitat of Verbesina dissita in the United States when the species was listed in 1996. Prior to Federal listing, but following state listing in 1990, at least four residences were built directly on habitat occupied by V. dissita in the vicinity of Nyes Place on Temple Hill (USFWS 1996, p. 52378). The location of most development appears to have been along the perimeter of the V. dissita range, but development has fragmented and interrupted the continuity of habitat. Such fragmentation has primarily occurred through the development of small scattered (0.2 ha (0.5 ac)) undeveloped lots within neighborhoods (Roberts 1989, p. 1). Much of this habitat loss and fragmentation has occurred in areas that were previously believed to be protected from development due to steepness of terrain. Since listing, development does not appear to be an imminent threat to either Verbesina dissita occurrence (EO 1 or EO 3) and we do not anticipate additional large scale habitat loss from this potential threat because it appears that the steep slopes where V. dissita occurs have been developed to their full potential. However, V. dissita occurs almost entirely on private land, so we cannot be certain that development will not continue to curtail habitat, even due to the steepness of the terrain where it occurs. Future habitat loss from development is less of a threat to EO 3 since most of this area occurs within the Reserve. Although V. dissita is not a covered species under the Central/Coastal NCCP/HCP, it has potential to benefit from the conservation mandate under this plan that requires that impacts to sensitive and covered species be minimized from infrastructure and recreation facilities that are permitted within the Reserve area (USFWS, 2010).

Stressor: Fuel modificatiun (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat

Narrative: Fuel modification prescribes various levels of removal of vegetation from a site to reduce the likelihood of the area supporting a fire. At the time of listing, creation of fuel modification zones required by local ordinances was identified as a threat to Verbesina dissita plants and habitat (USFWS 1996, p. 52378). The City of Laguna Beach required the creation of a fuel modification zone up to 46 m (150 ft) from residences (R. Drewberry, Laguna Beach Fire Department, pers. comm. 1991). At that time, over 20 percent of known V. dissita plants were within the fuel modification zone. Compliance with these ordinances caused a significant loss of V. dissita and its habitat. Loss of habitat due to fuel modification primarily affected EO 1. Methods for fuel modification included thinning vegetation with goats or hand tools, fire breaks, disking, and mowing (USFWS, 2010).

Stressor: Altered fire regimes (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Habitat for Verbesina dissita is also threatened by altered fire regimes. A large fire has the potential to cause a type-conversion from the shrub habitat of chaparral and coastal scrub to grassland (Zouhar et al. 2008, p. 185). In the southwest bioregion, increased invasion rates by nonnative species and alteration of fire regimes by humans have occurred concurrently in such a way that has resulted in the type-conversion of native-dominated chaparral and coastal scrub into grasslands dominated by nonnative species (Keeley 2001; Zouhar et al. 2008, p. 185). The particular process for type-conversion of shrublands into grasslands is known as the grass/fire cycle and has been documented in many ecosystems worldwide (Zouhar et al. 2008, p. 185). As described under Habitat or Ecosystem, V. dissita is not known to occur in grassland habitats. In contrast, control of fire through modification of habitat in an urban interface area may inhibit a fire-adapted species over time. The last large fire event in the relatively contiguous habitat of Laguna Beach occurred in 1993; however, there is no evidence that Verbesina dissita plants were burned. Should a large catastrophic wildfire occur in this region again, it has the potential to burn through all remaining populations of V. dissita simply due to this species' narrow distribution. If that were to occur, it is unlikely that this species would become extirpated as a result of fire alone. This is due to its evolved association with this natural event, which has possibly resulted in its ability to reproduce from rhizomes that persist underground for extended lengths of time. The fuel modification zone around the urban interface area of the City of Laguna Beach has allowed for settlement of invasive, nonnative grasses, providing a source for these species to establish themselves across a newly burned landscape. However, some invasive grasses will invade burned or unburned areas (Zouhar et al. 2008, p. 185). Impacts associated with nonnative plants will be discussed further under Factor E (USFWS, 2010).

Stressor: Agriculture (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Impacts from agriculture were cited as a threat to Mexican populations in the listing rule, and while this likely continues to be true, we have no quantified information on the extent of its severity. Agricultural practices are not a threat to Verbesina dissita in the United States (USFWS, 2010).

Stressor: Predation (USFWS, 2010)

Exposure:
Response:
Consequence: Loss of individuals
Narrative: Predation of V. dissita plants is a current threat associated with fuel modification activities because goat grazing is utilized to thin or remove vegetation along the steep urban wildland interface in Laguna Beach. Goats have potential to kill V. dissita by directly consuming plants and their reproductive structures, and from goats stripping bark from stems once more palatable vegetation has been consumed. The City of Laguna Beach's goat grazing program is implemented on an annual basis by the LBFD which hires goat herders to manage herds on a rotating basis throughout various areas along the urban-wildland interface. This program involves goat herders confining their goats to targeted areas where goats browse until a desired level of vegetation thinning is achieved, then moving the goats to another fuel modification zone (USFWS, 2010).

Stressor: Inadequacy of existing regulatory mechanisms (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, regulatory mechanisms considered to potentially provide some protection for Verbesina dissita included: (1) the Native Plant Protection Act (NPPA); (2) the California Endangered Species Act (CESA); (3) the California Environmental Quality Act (CEQA); (4) implementation of conservation plans pursuant to the Natural Community Conservation Planning (NCCP) Act; (5) the Act in cases where V. dissita occurs in habitat occupied by a listed species; and (6) land acquisition and management by Federal, State, local agencies, or by private groups and organizations (USFWS 1996, p. 52379–52381). The following discussion describes State and Federal regulatory mechanisms that currently may offer some level of protection to Verbesina dissita and its habitat. These mechanisms have remained largely unchanged since listing (USFWS, 2010). Federal Protections National Environmental Policy Act (NEPA) NEPA (42 U.S.C. 4371 et seq.) provides some protection for listed species that may be affected by activities undertaken, authorized, or funded by Federal agencies. Prior to implementation of such projects with a Federal nexus, NEPA requires the agency to analyze the project for potential impacts to the human environment, including natural resources. In cases where that analysis reveals significant environmental effects, the Federal agency must propose mitigations that could offset those effects (40 C.F.R. 1502.16). These mitigations usually provide some protection for listed species. However, NEPA does not require that adverse impacts be fully mitigated, only that impacts be assessed and the analysis disclosed to the public. Therefore, this regulatory mechanism may not be adequate to fully protect species (USFWS, 2010).

Stressor: Drought and climate change (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Although drought was not identified as a threat in the listing rule, it is likely that cyclical drought reduces local populations over the long term. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, p. 1; Cayan et al. 2005, pp. 1, 7–8; IPCC 2007, pp. 8–9). However, predictions of climatic conditions for smaller subregions such as California remain uncertain. It is unknown at this time if climate change in

California will result in a warmer trend with localized drying, higher precipitation events, or other effects. One study has predicted that 5 to 10 percent of California's native plant species would no longer find suitable habitat within the state, and thus be vulnerable to extinction, if average temperatures warmed 3° Celsius (5 to 6° Fahrenheit) (Morse et al. 1995, p. 393). Whether or not this would include Verbesina dissita is unknown (USFWS, 2010).

Stressor: Small population size (USFWS, 2010)
Exposure:
Response:
Consequence: Lack of genetic diversity
Narrative: The conservation biology literature commonly notes the vulnerability of species known from one or very few locations, or from small populations (e.g., Shaffer 1981, 1987; Primack 2006; Dunning et al. 2006). In particular, small population size and the likely low levels of genetic interchange among them make small populations potentially vulnerable to inbreeding depression and loss of genetic variability due to random fixation (e.g., genetic drift). Low genetic variation may influence the ability of populations to adjust to novel or fluctuating environments, survive stochastic events, or to maintain high levels of reproductive performance (Huenneke 1991). Small, fragmented populations may be visited by fewer pollinators and thus have reduced pollination and seed set, merely because the small number of available flowers attracts fewer pollinators (i.e., "Allee effect"; Groom 1998, pp. 487–496; Lennartsson 2002, p. 3068). In the United States, Verbesina dissita is known from only two occurrences within 0.8 km (0.5 mi) of each other, occupying an area of approximately 12 ha (30 ac). The western occurrence (EO 1) is divided by major barriers to distribution between the north and south, making genetic interchange across this boundary unlikely to occur in the future. Risks posed by a small population size may be more significant for V. dissita than currently understood due to the misleading appearance of the species, which has aerial stems that can appear to be multiple genets aboveground while actually representing several genetically identical stems supported by connected underground rhizomes. This may provide an inflated representation of the number of genetic individuals representing the population size. Additionally, interconnected groups of aerial stems may become separated if intervening rhizomes deteriorate. Therefore, the threats from small population size may be more significant if occurrences are actually composed of only a few genetically distinct types. Research on clonal diversity and breeding system for V. dissita should address this concern (USFWS, 2010).

Stressor: Transplantation (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of individuals/Loss of populations
Narrative: Small populations can be especially vulnerable to negative effects from transplantation efforts that are otherwise meant to benefit the species. Seeds and vegetative material of Verbesina dissita have been collected and propagated for mitigation measures when V. dissita plants were removed from EO 1 (Osborne, pers. comm. 2010; L. Robb, pers. comm. 2010). Preserving plants and genotypes is a positive step for the conservation of V. dissita; however, there may be a number of potentially negative impacts. These impacts include mixing genotypes, risking long term survivability of genotypes, damaging plants during the translocation process, and increasing the frequency of outcrossing if V. dissita is normally an inbreeder. Alternately, if V. dissita is an outbreeder, mixing genotypes could be beneficial. "Weedy" individuals of a species may be more generalist in their habitat requirements and thus may

survive the translocation process. These individuals may have higher survivability but lower genetic diversity, which means that translocation may effectively decrease the gene pool for the species. Lowered optimization of transplantation can result from a number of factors including lack of knowledge about habitat requirements, lack of appropriate preparation or funding, poorly timed or hasty transplanting, poor choice of transplantation site, lack of maintenance throughout the establishment period, and lack of monitoring (Hall 1987, p. 418). Data from a review of 15 transplantation projects for other rare plant species in Southern California indicate that maintenance and monitoring are the most frequently neglected variables contributing to the failure of transplantation projects (Hall 1987, p. 418). Mitigation sites that are not adequately monitored or maintained may put the displaced genetic source at risk of die-off in the long term. Conversely, mitigation sites that are over-maintained may misrepresent the success of transplantation, while also putting the genetic source at risk of die-off when the maintenance period is complete. Multiple genets of Verbesina dissita may be replaced by successfully transplanted genets with a smaller representative gene pool. This threat highlights the need for genetic research on V. dissita including identification of the extent and location of genetic variability and clonality within the small populations in the United States and between the United States and Mexico (USFWS, 2010).

Stressor: Stochastic events (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of populations/Extirpation
Narrative: The limited number of populations in a restricted geographic range, in addition to the small size of some of the remaining populations, makes Verbesina dissita susceptible to random catastrophic events, the most likely of which is fire. Fire has important evolutionary and ecological influences on chaparral and coastal scrub vegetation (Axelrod 1989; Rundel and Vankat 1989). Woody chaparral species often exhibit adaptations that enhance their ability to both survive fire and reproduce in postfire landscapes (Schwilk 2003; Zedler and Zammit 1989). These include resprouting from persisting root crowns, seeds that germinate after fire or have a fire-resistant seed coat, and heavy postfire seed production (Keeley 1987; Keeley and Fotheringham 1998; Keeley and Keeley 1981; Keeley and Zedler 1978). Herbaceous species that occur in chaparral communities may also have dormant, fire resistant seeds in a persistent seed bank that germinate after burning (Keeley and Fotheringham 1998). The only adaptation to fire evidenced by V. dissita is the presence of rhizomes noted above. We are not aware of any fruit/seed adaptations to fire or the presence of a seed bank for the species. The latter seems unlikely in light of the observations by Michael Wall as discussed above under the “Species Biology and Life History” section of this review, because plants require regeneration periods between fires. In summary, the primary threat associated with a catastrophic fire is unlikely to be extirpation due to incineration. Rather, the foreseeable threat appears to be type-conversion and displacement of Verbesina dissita and other native plants by nonnative plants (USFWS, 2010).

Stressor: Competition with nonnative plants (USFWS, 2010)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: At the time of listing, the establishment of nonnative plants used in landscaping (such as Atriplex semibaccata (Australian saltbush)) was noted as a current and future threat to the species Verbesina dissita directly competes for space and shade with landscaping materials such

as A. semibaccata, Nicotiana glauca (Tree tobacco), various Acacia spp., and other nonnative plants. This threat is best documented along the northernmost portion of EO 1 at urban interface areas where development and fuel modification have aided in the spread of nonnative plants since V. dissita was listed. The expansion of landscape plantings (such as Acacia spp.) from nearby residential areas is also a threat to EO 3. The LBFD Landscape/Fuel Modification Guidelines and Maintenance Program (Fuel Modification Guidelines) (LBFD 2010) require that any new plantings within the designated fuel modification zones be "replanted" using appropriate plants not listed on the Undesirable Plant Species List of the City of Laguna Beach (Schwartz 2010, p. 2), which includes all of the nonnative species listed above in addition to 57 other taxa (USFWS, 2010).

Recovery

Delisting Criteria:
While threats to Verbesina dissita have increased since listing, so too has the recognition that much suitable habitat remains unsurveyed and is potentially occupied in the United States. Additionally, more data is needed to assess impacts from new threats. Therefore, we recommend that this species remain listed as threatened and that comprehensive survey efforts be undertaken in the next 5 years to better understand the population size and distribution of V. dissita (USFWS, 2010).

Recovery Actions:

- 1) Work with partners and programs (such as the Partners for Fish and Wildlife Program) to organize surveys of the historical occurrences, extant occurrences, and likely suitable habitat, especially in isolated steep canyon areas during the flowering season, to detect presence and distribution of plants (USFWS, 2010).
- 2) Work with the LBFD to identify the distribution of Verbesina dissita in fuel hazard reduction zones and identify ways to minimize fuel modification impacts by identifying alternatives to thinning or clearing of habitat and introduction of nonnatives (USFWS, 2010).
- 3) Perform a clonal structure analysis from multiple sources across the range of the species, including Mexico. If large clumps are found to be single genetic individuals, conservation measures may need to be more aggressive to address the threats of a smaller population size. Patterns in genetic variability should be studied to understand the breeding system of Verbesina dissita and to address potential threats compounded by a small population size (USFWS, 2010).
- 4) Prepare site specific and species monitoring protocols to determine fine-scale habitat requirements and species fidelity to those requirements. This will allow us to discriminate between lack of seed dispersal and unsuitable habitat as explanations for discontinuities in plant distributions (USFWS, 2010).
- 5) Write a recovery plan with action items for Verbesina dissita and other rare associates that includes a restoration program to restore habitat required for healthy stands of V. dissita (USFWS, 2010).

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS: Since listing, efforts have been made to conserve habitat since habitat loss and degradation continues to be the primary threat. Conserving high quality habitat has helped conserve the species. Recovery will require a greater understanding of the species distribution, breeding system and genetic diversity throughout its range. We have

identified these recommendations to aid recovery of Verbesina dissita: 1. Develop and test a habitat suitability model to define potential suitable habitat and inform our understanding of the species distribution. 2. Create and implement a protocol for range wide surveys to better understand the distribution and abundance of the species, including surveying potentially suitable habitat in Aliso and Wood Canyons Wilderness Park. 3. Research genetic variability and population structure including the eastern occurrences and Mexican distribution. 4. Characterize the breeding system including potential pollinators, average seed set, the relative contribution of sexual and asexual reproduction, and conditions for seed germination. 5. Develop a monitoring plan to track occurrences over time and to investigate variations in plant phenology tied to weather conditions. 6. Conserve and restore suitable habitat including occurrences threatened by nonnative plant species. 7. Research transplantation opportunities outside of the core occupied habitat along the coast, to minimize the risk of stochastic events. 8. Utilize outreach and other techniques to limit future development impacts in occupied habitat. 9. Continue to conduct research to fill important gaps in species ecology (e.g., genet age to evaluate persistence, timing and triggers for germination, impact of nonnative plants particularly annual grasses on germination, threshold for rhizome persistence/carbohydrate storage following fires or fuel modification). (USFWS, 2020)

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SPECIES ACCOUNT: *Vernonia proctorii* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 04/27/1993; Southeast Region (R4)

Physical Description

Vernonia proctorii is a small, erect shrub which may reach a height of 1.5 meters. The stems and trunk are densely pubescent with silvery uniseriate hairs and with a knobby appearance due to the persistent petiole bases. Leaves are alternate, ovate to orbicular, subsessile or with the petioles appressed to the stem, and from 1.5 to 3.5 centimeters long and 1.0 to 2.6 centimeters wide. The upper blade surface is green to olive-green and moderately strigose with scattered glistening globular trichones. The lower surface is grayish-green, sometimes becoming rusty with age, and densely sericeous. The leaf margins are densely ciliate with silvery hairs. Flowers are borne in terminal clusters of 2 to 5 heads, each approximately 3 millimeters in length, and bright purple in color. Achenes are from 2 to 3 millimeters long and sericeous with silvery hairs (USFWS, 1994).

Taxonomy

Vernonia proctorii, of the family Asteraceae, was discovered in September of 1987 by Dr. George Proctor, Dr. Horst Haneke, and Paul McKenzie and later described by Urbatsch (1989). The family Asteraceae is the largest dicot family, consisting of more than 1,100 genera and more than 25,000 species. The family consists of the some thirteen tribes, of which the tribe Vernoniaeae includes about 1,456 species in 70 genera. More than half of the genera are monotypic, and two-thirds of the species belong to the genus Vernonia. V. proctorii is described as being closely related to V. albicaulis (ranging from Puerto Rico into the Lesser Antilles), V. arbuscula (of the Bahamas) and V. orbicularis (of Cuba) (Breckon and Kolterman 1994b). V. proctorii is currently known to occur only on the summit area of Cerro Mariquita in the range of hills known as the Sierra Bermeja (USFWS, 1994). Dr Harold Robinson, from the Department of Botany of National Museum of Natural History, Smithsonian Institute, conducted a comprehensive study about the American Vernonieae and concluded that none of the elements called Vernonia in the Eastern Hemisphere belong to the genera Vernonia, and they must all be transferred to other genera (Robinson 1999). The author used the pollen, style bases, raphids, inflorescence from involucres, anther appendage, and chemistry as some characters for the reclassification. Robinson changed 114 species from the genus Vernonia to the genus Lepidaploa, including Vernonia proctorii which the author called Lepidaploa proctorii (Robinson 1999). However, the Integrated Taxonomic Information System (ITIS) and the Germplasm Resources Information Network (GRIN) of USDA continue using Vernonia proctorii as the taxon and Lepidaploa proctorii as the synonymy. (USFWS, 2019).

Historical Range

Both Vernonia proctorii and Lyonia truncata var. proctorii are known only from the summit area of Cerro Mariquita in the Sierra Bermeja, municipality of Cabo Rojo. Elevations range from 270 to 300 meters. Proctor (1991) estimated the population of Vernonia proctoni at about 950 individuals in an area of several acres. The population of Lyonia truncata var. proctorii was estimated at 63 plants (Proctor 1991); however, because the species is found on extremely steep slopes this may be underestimated by as much as 50 percent (Breckon and Kolterman 1994a) (USFWS, 1994).

Current Range

At the time of listing, A. portoricensis was known from only two localities: at Cerro Mariquita in Sierra Bermeja and at Cerro Las Mesas in Mayagüez, both localities are in Puerto Rico. According to DNER herbarium voucher SJ014582, the plant was found and collected by E. L. Ekman in Pimar del Rio in Cuba Island (Ekman 1920, unpublished data). We were not aware of this locality at the time of listing and the information is considered as new information for the purpose of this review. Based on this information, A. portoricensis is not endemic to Puerto Rico and its current range of the species includes to Puerto Rico and Cuba (USFWS, 2007).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Breeding Season

Adult: Vernonia proctorii has been observed in flower and fruit during the months of April and May of 1994 (Breckon and Kolterman 1994b), although a previous author (Urbatsch 1989) stated that the species flowered and produced fruit during the rainy period, from August through December (USFWS, 1994).

Reproduction Narrative

Adult: During field studies, Vernonia proctorii has been observed in flower and fruit during the months of April and May of 1994 (Breckon and Kolterman 1994b), although a previous author (Urbatsch 1989) stated that the species flowered and produced fruit during the rainy period, from August through December. Plants found on the steeper slopes ranged in height from 89 to 152 centimeters and in crown area from 0.29 to 1.27 square meters. Plants on the steep slopes were domed or vase-shaped and they were larger, healthier and more robust than those on the summit (Breckon and Kolterman 1994b) (USFWS, 1994).

Habitat Type

Adult: Subtropical dry forest (USFWS, 1994)

Habitat Vegetation or Surface Water Classification

Adult: The vegetation in this zone forms a complete ground cover and is deciduous on most soils (USFWS, 1994).

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1994)

Site Fidelity

Adult: High (inferred from USFWS, 1994; USFWS, 2007)

Habitat Narrative

Adult: Both areas where these three species are located are found within the subtropical dry forest life zone (Ewel and Whitmore 1973), the driest life zone in Puerto Rico. The vegetation in

this zone forms a complete ground cover and is deciduous on most soils. Leaves are succulent or coriaceous, and species with spines and thorns are common. Tree heights usually do not exceed 15 meters and the crowns are typically broad, spreading, and flattened. Fire is common on many soils, and occurs frequently on lands where the plants are located. Successional, vegetation includes grasses and the accumulated organic debris serves as fuel for the frequent dry season fires (USFWS, 1994). In the Sierra Bermeja all three species grow in exposed rock crevices and are found associated with Aristida portoricensis (pelos de diablo, another endangered grass species), Digitaris eggersii, Comocladia dodonea (carrasco), Plumeria alba (alheli), Bursera simaruba (almcigo), Bucida buceras (iicar), Randia aculeata (tintillo), Croton sp., and Jacquinia berterii (G. Proctor, pers. comm.). The endangered bird the Puerto Rican nightjar (Caprimulgus noctitherus) has recently been reported from the slopes of the Sierra Bermeja (USFWS, 1994). High ecological integrity and site fidelity and low tolerance range is inferred based on species restricted habitat and two populations (USFWS, 1994; USFWS, 2007)

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 2007)

Population Information and Trends

Population Trends:

Not available

Number of Populations:

Two (USFWS, 2007)

Population Size:

~80 (USFWS, 2007). Proctor (1991c) estimated the Vernonia proctorii abundance in Cerro Mariquita at around 950 individuals. On January 26, 2008, a Service biologist estimated its population at 150 individuals on an area of 10 acres. The population of Vernonia proctorii is currently estimated at 986 individuals. During this review (2019 5-Year Review), we found no consistency and accuracy on any of these species' population estimates. (USFWS, 2019).

Population Narrative:

This species is known from two populations of approxiamately 75 and 7 individuals (USFWS, 2007). Low resiliency, representation and redundancy are inferred based on low number of populations and individuals.

Threats and Stressors

Stressor: Habitat destruction and modification (USFWS, 2007)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: When the plants A. chaseae, Lyonia truncata var proctorii and Vernonia proctorii were listed in 1993, the Service identified habitat destruction and modification as one of the factors affecting the continued existence of the species. At that time, these three species were found in

Sierra Bermeja, a privately owned site subjected to agricultural, rural and tourist development. In addition, the final rule for pelos del diablo also identified proposed copper and gold mining as a threat to the species in Cerro Las Mesas. In 1996, DOI acquired La Tinaja Farm (LTF) in the Sierra Bermeja mountain range. The Service incorporated this land to the Cartagena Lagoon National Wildlife Refuge, protecting 50% of the known populations of Lyonia truncata var proctorii, approximately 80% of the known individuals of Vernonia proctorii, and its suitable habitat, and about 50% of the populations of A. chaseae and pelos del diablo. However, the remaining individuals of these species in Sierra Bermeja are located in the adjacent Cerro Mariquita area, which remains under private ownership. Although the Cerro Mariquita area was classified by the Puerto Rico Planning Board as a District of Conservation Resource 1 (CR1) (the most restrictive for development, precluding tourist and residential development and mining activities), this classification allows agricultural (e.g. cattle grazing) and rural developments (one house in 25 acres of land). In 2006 and 2007, private landowners cut new roads to gain access through their properties to the peak of Cerro Mariquita affecting indeterminate amount of habitat for these species (Pacheco, USFWS 2009, field observations). Therefore, the threat of habitat destruction and modification still exist for A. chaseae, pelos del Diablo, Lyonia truncata var proctorii and Vernonia proctorii. Based on the above discussion, we believe that these four species are currently threatened by Factor A and the imminence or degree of the threat should be considered as moderate (USFWS, 2007).

Stressor: Competition (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: The rapid growth of exotic grasses on areas where these species occur is a threat because of competition and represent an increase in fuel that may increase the impact of fire (USFWS, 2007).

Stressor: Natural catastrophic events (USFWS, 2007)
Exposure:
Response:
Consequence:
Narrative: One of the most important factors affecting the continue survival of the species Lyonia truncata var proctorii and Vernonia proctorii, is their limited distribution. Lyonia truncata var proctorii is only found in a limited area on the edge of a precipice of the upper Jurassic chert in Cerro Mariquita. Vernonia proctorii is found on the steeper slopes of Cerro Mariquita. Any seismic event in this area and heavy rain that result in a landslide may affect a significant portion of the population. In September 2009, the Service observed three landslides at the Cerro Mariquita due to the heavy rain. Fortunately, no individuals of these species were affected (USFWS, 2007).

Recovery

Reclassification Criteria:
These three species could be considered for downlisting when (1) the known populations on privately owned land in the Sierra Bermeja are placed under protective status, and (USFWS, 1994) Criterion 1 for A. chaseae, Lyonia truncata var proctorii and Vernonia proctorii, and the first criterion for pelos del diablo has been partially met. At the time the plans were approved,

LTF and Cerro Mariquita were privately-owned and under grazing activities. A. chaseae, pelos del diablo, Lyonia truncata var proctorii and Vernonia proctorii were known to occur at these hills in Sierra Bermeja. The U.S. Department of Interior acquired LTF in 1996 and it is managed by the USFWS as part of the LCNWR for conservation of fish and wildlife resources. Currently, the known population of Lyonia truncata var proctorii, approximately 80% of the known individuals of Vernonia proctorii, and approximately half of the individuals of A. chaseae and pelos del diablo are located within LTF and thus protected. However, remaining individuals of A. chaseae, pelos del diablo and Vernonia proctorii in Sierra Bermeja occur in Cerro Mariquita which continue to be in privately-owned land under cattle grazing activities. For these reasons, we consider this criterion partially met (USFWS, 2007). Criterion 2 for A. chaseae, Lyonia truncata var proctorii and Vernonia proctorii, and has not been met. No studies have been conducted about number of self-sustained populations needed to establish a self-perpetuation of any of these species. Although several experiments to propagate the species were conducted, a propagation program for these species has not been established (USFWS, 2007).

(2) new populations (the number of which should be determined following the appropriate studies) capable of self perpetuation have been established within protected areas such as the Cabo Rojo National Wildlife Refuge (USFWS, 1994).

Delisting Criteria:
None listed

Recovery Actions:

- Protection of currently known natural populations occurring on privately owned lands by establishing long-term conservation mechanisms such as Habitat Conservation Plans (HCP), conservation easements and conservation agreements with the landowners. (USFWS, 2019).
- Develop conservation and management plans with landowners that includes education on species description and needs and fire management. (USFWS, 2019)
- Establishment of new populations on protected lands within the Sierra Bermeja or other suitable habitats in southwestern Puerto Rico. (USFWS, 2019).
- Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species (USFWS, 2007).
- Conduct comprehensive surveys of these four species at Sierra Bermeja to determine relative abundance and distribution (USFWS, 2007).
- Conduct surveys at Cerro Las Mesas to determine if pelos del diablo is still present at this area (USFWS, 2007).
- Conduct surveys at Punta Melones and Peñones de Melones to determine the status of A. chaseae at these areas (USFWS, 2007).
- Promote Conservation agreements with private landowners to protect and enhance existing populations (USFWS, 2007).
- Initiate propagation programs for these species to enhance existing populations in the Sierra Bermeja mountain range and establish new populations of A. chaseae and pelos del diablo in protected areas in southwestern Puerto Rico (USFWS, 2007).
- Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses (USFWS, 2007).

- Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season (USFWS, 2007).
- Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge (USFWS, 2007).
- Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild (USFWS, 2007).
- Determine the number of self-sustainable populations needed to delist the species (USFWS, 2007).
- Additional surveys should be conducted for the four species in Puerto Rico (USFWS, 2007).
- Continue protecting existing populations and their habitat (USFWS, 2007).
- Work closely with International Affairs to obtain information from pelos del diablo on the Island of Cuba (USFWS, 2007).

Conservation Measures and Best Management Practices:

- Future Recommended Recovery Actions Protection of currently known natural populations occurring on privately owned lands by establishing long-term conservation mechanisms such as Habitat Conservation Plans (HCP), conservation easements and conservation agreements with the landowners. Develop conservation and management plans with landowners that includes education on species description and needs and fire management. Establishment of new populations on protected lands within the Sierra Bermeja or other suitable habitats in southwestern Puerto Rico. (USFWS, 2019a)
- RECOMMENDATIONS FOR FUTURE ACTIONS Revise the recovery plans to include new information on the species and the development of measurable criteria for delisting the species. Conduct comprehensive surveys of these four species at Sierra Bermeja to determine relative abundance and distribution. Conduct surveys at Cerro Las Mesas to determine if pelos del diablo is still present at this area. Conduct surveys at Punta Melones and Peñones de Melones to determine the status of A. chaseae at these areas. Promote Conservation agreements with private landowners to protect and enhance existing populations. Initiate propagation programs for these species to enhance existing populations in the Sierra Bermeja mountain range and establish new populations of A. chaseae and pelos del diablo in protected areas in southwestern Puerto Rico. Work closely with private landowners in the Sierra Bermeja mountain range and Peñones de Melones to protect individuals on private lands from existing agricultural practices and control exotic grasses. Implement fire prevention practices in Sierra Bermeja, CNRWR and Peñones de Melones during dry season. Continue to provide technical assistance to Service's Refuge Division for the development of the CCPs for CRNWR and LCNWR and to address current threats within the refuge. Conduct comprehensive studies on habitat requirements, phenology, and recruitment success of the species in the wild. Determine the number of self-sustainable populations needed to delist the species. Additional surveys should be conducted for the four species in Puerto Rico. Continue protecting existing populations and their habitat. Work closely with International Affairs to obtain information from pelos del diablo on the Island of Cuba. (USFWS, 2019a)

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SPECIES ACCOUNT: *Vicia menziesii* (Hawaiian vetch)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/27/1978; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial vine with 1.5 - 20 m-long stems. Flowers are yellowish-white when young, turning rose-purple with age (NatureServe, 2015).

Taxonomy

The genus Vicia is in the legume family (Fabaceae or Leguminosae) and comprises some 160 species, occurring mostly in the north temperate zones (Mabberley 2008) (USFWS, 2012). The genus is worldwide, this species is endemic to Hawaii island. This species is believed to be closely related to a n. American & s. American species. This species was Hawaii's first federally listed endangered plant (1978) (NatureServe, 2015)

Historical Range

Recorded from the island of Hawaii on the volcanoes of Mauna Kea, Mauna Loa, and Hualala (NatureServe, 2015).

Current Range

During the past 150 years it had been known only from the northeastern slope of Mauna Kea (Warshauer and Jacobi 1982) (USFWS, 2012).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual: self-pollination, cross-pollination (USFWS, 2012)

Lifespan

Adult: < 10 years (inferred from USFWS, 2012)

Breeding Season

Adult: April - August (USFWS, 2012)

Key Resources Needed for Breeding

Adult: Honeycreepers (USFWS, 2012)

Reproduction Narrative

Adult: It is a short-lived perennial. At the Puu Waawaa site, this species has been observed to flower from April to August (Ralph et al. 1980; Giffin 2009). Mature pods have formed by July and may last into October or beyond (Ralph et al. 1980). Of the individuals studied by Ralph et

al. (1980), 23 percent of the flowers set fruit. The species can flower prolifically but does not flower until 2 or 3 years old (Ralph et al. 1980). The honeycreepers iiwi (Vestiaria coccinea) and amakihi (Loxops virens) have been observed feeding at Vicia menziesii, and given their downcurved bills, may pollinate the species (Lassetter and Gunn 1979; Ralph et al. 1980). Hopper reported that most (approximately 60 percent) papilionaceous legumes that were studied are self-compatible to some degree (USFWS, 2012).

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Mesic ohia-koa forest, montane koa-Myrsine forest (USFWS, 2012)

Geographic or Habitat Restraints or Barriers

Adult: 5,150 - 5,640 ft. elevation (USFWS, 2012)

Habitat Narrative

Adult: Inhabits moist montane forests on old volcanic substrates (NatureServe, 2015). The species occurs in wet to mesic forests of Metrosideros polymorpha (ohia)-Acacia koa (koa) in the Keauhou-Kilauea area, and in the upper montane zone in decadent (i.e., declining naturally) Acacia koa-Myrsine forests with a prominent fern understory at Puu Waawaa (Wagner et al. 1999; Giffin 2009). The elevation range for this species is 1,570 to 1,720 meters (5,150 to 5,640 feet) (USFWS, 2012).

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Not available

Population Information and Trends

Population Trends:

Presumed extinct until rediscovery in 1974 (USFWS, 2012)

Species Trends:

Declining (USFWS, 2012)

Number of Populations:

1 (USFWS, 2020)

Population Size:

22 (USFWS, 2019)

Population Narrative:

When the recovery plan was issued in 1984, there were an estimated 1,500 to 2,000 individuals within upper Keauhou Ranch (USFWS 1984). In 2010, the population census remained the same as recorded in 2009 with a total of 37 individuals located within 6 populations (Plant Extinction Prevention Program 2010). Until its rediscovery in 1974, the species had been considered

extinct, having not been seen since 1915 (Lassetter and Gunn 1979; Warshauer and Jacobi 1982) (USFWS, 2012). Currently there are 22 individuals in one population on the island of Hawai'i. This species remains in continual decline since listing, from hundreds or even thousands of individuals to just a couple dozen. A landscape-based assessment of climate change vulnerability for native plants of Hawai'i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that Vicia menziesii is vulnerable to the effects of climate change. One population is provided protection from feral ungulates by fencing. Nonnative plants are controlled within the same area. Plants from four extirpated locations and one extant locations have been propagated and reintroduced. The Division of Forestry and Wildlife has constructed seven small exclosures for reintroduction of individuals. Unfortunately, there is currently only a single individual represented in an ex situ living collection (nursery), and no seeds in storage. (USFWS, 2020)

Threats and Stressors

Stressor: Feral ungulates (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Ungulate degradation of habitat (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005): cattle (Bos taurus), goats (Capra hircus), feral pigs (Sus scrofa) were noted as a threat to the native forest outside of a fenced exclosure at the Hualalai site, which at the time contained three to five individuals of V. menziesii (D. Hopper, pers. comm. 2001); sheep (Ovis aries) (USFWS, 2012).

Stressor: Invasive plants (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Established ecosystem-altering invasive plant species degradation of habitat (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005); Passifloria tarminiana (banana poka), Rubus argutus (Florida prickly blackberry) (USFWS, 2012).

Stressor: Logging (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Logging was listed as an earlier threat to the survival of Vicia menziesii, but this activity has decreased (Warshauer and Jacobi 1982) (USFWS, 2012).

Stressor: Predation/herbivory (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Rodent predation or herbivory – Rats (Rattus spp.) (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005). Invertebrate predation or herbivory – Caterpillars (Anonymous 2004; Rubenstein 2007) (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Low numbers (Warshauer and Jacobi 1982; Hawaii Department of Land and Natural Resources 2005; Plant Extinction Prevention Program 2007b, 2008, 2009, 2010) (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species (USFWS, 2012).

Recovery

Reclassification Criteria:
Vicia menziesii may be considered for downlisting when: 1) There are 5 to 10 populations in suitable, protected habitat with 1,000 mature individuals per population; 2) All major threats are controlled around the target populations; 3) Populations are represented in an ex situ collection as defined in the Center for Plant Conservation guidelines (Guerrant et al. 2004) that is secure and well managed; and 4) All target populations have been stable, secure, and naturally reproducing for a minimum of 10 years. Species-specific management actions may continue to be necessary (USFWS, 2019).

Delisting Criteria:
Vicia menziesii may be considered for delisting when: 1) All of the downlisting criteria have been met; and 2) All target populations have been stable, secure, naturally reproducing, and within secure and viable habitats for a minimum of 20 years. Species-specific management actions must no longer be necessary, but an ongoing need for ecosystem-wide management actions may remain if long-term agreements are in place to continue management (USFWS, 2019).

Recovery Actions:
- Protect existing Vicia habitat from further degradation (USFWS, 1984).
- Conduct investigative and research studies for determination of recovery alternatives (USFWS, 1984).
- Instigate management to maintain and improve population status of V. menziesii (USFWS, 1984).
- Monitor the effects of management actions (USFWS, 1984).
- Develop and implement a public relations strategy to increase awareness and support of the recovery effort (USFWS, 1984).
- Captive propagation for genetic storage and reintroduction: Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation and genetic storage. Collect cuttings or seed from tagged individuals, keeping close track of the maternal source for use in ex situ propagation (USFWS, 2012).

- Reintroduction / translocation site identification – Reintroduction attempts should be made at Kilauea Forest, Keauhou Ranch, and Puu Waawaa within sites that are free from ungulates (fenced) and introduced invasive plant species (USFWS, 2012).
- Reintroduction / translocation implementation – Continue to reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosures: Continue to construct fenced exclosure around existing and reintroduced populations to provide protection from feral ungulates. Monitor fenced exclosures for evidence of breaching by feral ungulates (USFWS, 2012).
- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWs, 2012).
- Surveys / inventories – Survey the historical range of the species for additional individuals or populations, and to determine the current status of the species (USFWS, 2012).
- Genetic research – Carry out molecular studies to assess overall genetic variation among existing populations and individuals (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of timber management (logging) (USFWS, 2012).
- Predator / herbivore control – Control rodents around existing populations (USFWS, 2012).
- Invertebrate control research – Research the effects of invertebrates and caterpillars around existing and reintroduced populations. If research demonstrates there is an immediate threat, determine and implement effective control measures (USFWS, 2012).
- Alliance and partnership development – Work with Hawaii Division of Forestry and Wildlife, Three Mountain Alliance Partnership, and other landowners to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Revise recovery criteria – Update and define recovery objectives in a revised recovery plan for Vicia menziesii based on current, available scientific information (USFWS, 2012).
- Threat monitoring and control – Monitor populations for evidence of disease or other pests (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2020. • Surveys and inventories—Survey the historical range of the species for additional individuals or populations and determine the current status of the species. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of browsing and trampling by ungulates. • Invasive plant monitoring and control—Continue to control established ecosystem-altering nonnative invasive plant species, and those that compete with V. menziesii. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Predator and herbivore control— o Implement effective control measures for rodents. o Develop and implement effective control measures for caterpillars and other invertebrates. • Captive propagation for genetic storage and reintroduction— o Continue collection

and propagation efforts for maintenance of genetic stock and for reintroduction. o Track maternal source for use in ex situ propagation. • Reintroduction and translocation—Continue to determine optimal sites and continue to reintroduce individuals into areas that are being managed for known threats. • Population biology research—Conduct genetic studies to assess the overall genetic variation among remaining populations and individuals. • Site, area, and habitat protection—Continue to develop and implement effective management measures to reduce the impacts of timber logging. • Alliance and partnership development—Continue to work with the Division of Forestry and Wildlife and other managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—Surveys have been conducted for a private landowner and occurrences of Vicia menziesii were found at Puu Kūlani, Puʻulalaʻau, and Puu Kīpū (USFWS 2017, in litt.). The occurrence at Puʻuwaʻawaʻa has been searched for but not found (PEPP 2015, 2016, 2017). • Ungulate monitoring and control—The Division of Forestry and Wildlife reported construction of seven small exclosures (0.08 to 0.2 hectares (0.2 to 0.5 acres)) at Kaʻu and Hilo Forest Reserves for Vicia menziesii reintroductions (PEPP 2019). • Established ecosystem altering invasive plant species control—Nonnative plants are controlled within the exclosure at Puʻuwaʻawaʻa (PEPP 2016). • Captive propagation for genetic storage and reintroduction—Between 2012 and 2018, the Volcano Rare Plant Facility (VRPF) reported propagation and storage of 54 individuals representing 26 collections and 6 to 26 founders from five locations. Currently, however, there is only one plant in ex situ storage in the nursery (VRPF 2012-2019). • Reintroduction and translocation—Between 2012 and 2019, VRPF reported reintroduction of 18 individuals to Kūlani and 14 individuals to Niaulani representing 11 collections from four locations (VRPF 2012-2019). • Alliance and partnership development—Beginning in 2017, a private landowner (Kamehameha Schools) and the U.S. Fish and Wildlife Service partnered through a biological opinion for the issuance of a 10(a)(1)(A) Enhancement of Survival Permit in association with a Safe Harbor Agreement, regarding the effects of land management activities in order to provide a net conservation benefit for endangered species. Vicia menziesii is one of the endangered species that may be affected, but is not likely to be affected from issuance of this permit, and may benefit from overall minimization of impacts. These activities may include habitat restoration and native plant community outplantings, koa silviculture, and invasive weed control (USFWS 2017, in litt.). (USFWS, 2020)

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SPECIES ACCOUNT: *Vigna o-wahuensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 11/10/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Vigna o-wahuensis is a member of the Fabaceae, or pea family. It is a slender, short-lived, twining perennial herb with fuzzy stems that grow to 0.4 meter (1.3 feet). Leaves are compound, with three leaflets that are 1.2 to 8 centimeters (0.5 to 3.0 inches) long and 0.1 to 2.5 centimeter (0.04 to 1.0 inch) wide. Leaflets are sparsely to moderately covered with coarse hairs. Flowers occur in clusters of one to four, and have thin, translucent, pale yellow or greenish-yellow petals approximately 2.0 to 2.5 centimeters (0.8 to 1.0 inch) long. The calyx is sparsely hairy and 4.0 to 8.0 millimeters (0.2 to 0.3 inch) long with asymmetrical lobes. Fruits are slender pods of 4 to 9 centimeters (1.6 to 3.5 inches) in length and 5 millimeters (0.2 inch) in width. Pods may be slightly inflated and contain between 7 and 15 gray to black seeds that are less than 6.0 millimeters (0.2 inch) long (U.S. Army 2003a).

Historical Range

Historically, Vigna o-wahuensis was known from the islands of Hawaii, Maui, Molokai, Lanai, Kahoolawe, Nihoa, and Niihau (U.S. Army 2003a).

Current Range

Currently, it is known from Maui, Molokai, Lanai, Kahoolawe, and Hawaii (68 FR 25934; 68 FR 1220; 68 FR 39624). At least 86 individuals are believed to occur in 10 locations (U.S. Army 2003a). Thirty plants were located on the lower south and southwestern slope of Puu Nohonaohae during botanical surveys in the early 1980s, but only a single plant was observed in 2002 (Arnett 2002b).

Critical Habitat Designated

Yes; 5/14/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Vigna o-wahuensis under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 14 detailed critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Vigna o-wahuensis under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Vigna o-wahuensis (77 FR 57648-57862). The critical habitat designation includes 7 critical habitat units, which encompass approximately 7,823 acres on the Island of Oahu, Hawaii.

The critical habitat designation for Vigna o-wahuensis includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

On July 2, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Vigna o-wahuensis on the island of Hawaii (68 FR 39623 - 39722).

Critical Habitat Designation

The critical habitat designation for Vigna o-wahuensis includes 14 CHUs in Maui County, Hawaii with detailed unit information. There are also an unknown number of units on Lanai that contain this species (number of units is unknown because detailed unit descriptions for Lanai are not available) (81 FR 17790-18110).

Maui—Coastal—Unit 1 consists of 2 ac (1 ha) on Keopuka Rock on the northern coast of east Maui. This unit is State-owned, and is classified as a State Seabird Sanctuary. It is occupied by the plant Peucedanum sandwicense and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui-Coastal—Unit 1 is not known to be occupied by Brighamia rockii, Cyperus pennatiformis, Ischaemum byrone, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 1 consists of 1,516 ac (613 ha) of State land from Kaneloa to Lae o Kaule, including Aleale, along the southern and eastern coast of Kahoolawe. It is occupied by the plant Kanaloa kahoolawensis and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe—Coastal—Unit 1 is not known to be occupied by the plants Sesbania tomentosa or Vigna owahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 2 consists of 16 ac (6 ha) of State land, and 9 ac (4 ha) of privately owned land, from Wahinepee Stream to Moiki Point on the northern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 2 is not currently occupied by Brighamia rockii, Cyperus pennatiformis, Ischaemum byrone, Peucedanum sandwicense, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the physical or biological features necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, these species require suitable habitat and space

for expansion or reintroduction to achieve population levels that could achieve recovery.

Kahoolawe—Coastal—Unit 2 consists of 12 ac (5 ha) of State land on Puukoae, an islet off the southern coast of Kahoolawe. It is occupied by the plant Sesbania tomentosa and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Kahoolawe— Coastal—Unit 2 is not known to be occupied by Kanaloa kahoolawensis or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 3 consists of 10 ac (4 ha) of privately owned land at Pauwalu Point on the northern coast of east Maui. This unit is occupied by the plant Ischaemum byrone and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal— Unit 3 is not known to be occupied by Brighamia rockii, Cyperus pennatiformis, Peucedanum sandwicense, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Coastal—Unit 3 consists of 189 ac (76 ha) of State land from Laepaki to Honokanaia along the western coast of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Kahoolawe—Coastal—Unit 3 is not known to be occupied by Kanaloa kahoolawensis, Sesbania tomentosa, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 4 consists of 40 ac (16 ha) of State land, and 35 ac (14 ha) of privately owned land, from Papiha Point to Honolulu Nui Bay on the northeastern coast of east Maui. This unit is occupied by the plant Cyperus pennatiformis and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 4 is not known to be occupied by Brighamia rockii, Ischaemum byrone, Peucedanum sandwicense, or Vigna owahuensis, we have determined this area to be essential for the

conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 1 consists of 1,220 ac (494 ha) of State land, north of Waihonu Gulch on west Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry—Unit 1 is not known to be occupied by Gouania hillebrandii, Hibiscus brackenridgei, Kanaloa kahoolawensis, Neraudia sericea, Sesbania tomentosa, or Vigna owahuensis, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 5 consists of 26 ac (11 ha) of State land from Keakulikuli Point to Pailoa Bay on the northeastern coast of east Maui. This unit is occupied by the plant Ischaemum byrone and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal—Unit 5 is not known to be occupied by Brighamia rockii, Cyperus pennatiformis, Peucedanum sandwicense, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Kahoolawe—Lowland Dry—Unit 2 consists of 3,205 ac (1,297 ha) of State land from Lua o Kealialuna to Puu o Moaulaiki and Luamakika on the eastern side of Kahoolawe. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Kahoolawe—Lowland Dry— Unit 2 is not known to be occupied by Gouania hillebrandii, Hibiscus brackenridgei, Kanaloa kahoolawensis, Neraudia sericea, Sesbania tomentosa, or Vigna o-wahuensis, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 6 consists of 356 ac (144 ha) of State land at Kamanamana on the southern coast of East Maui. This unit is occupied by the plant Vigna owahuensis and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by

providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Coastal— Unit 6 is not known to be occupied by Brighamia rockii, Cyperus pennatiformis, Ischaemum byrone, or Peucedanum sandwicense, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 7 consists of 30 ac (12 ha) of State land, and 15 ac (6 ha) of privately owned land, from Kailio Point to Waiuha Bay, on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 7 is not currently occupied by Brighamia rockii, Cyperus pennatiformis, Ischaemum byrone, Peucedanum sandwicense, or Vigna owahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Coastal—Unit 8 consists of 493 ac (199 ha) of State land from Kiakeana Point to Manawainui on the southern coast of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the coastal ecosystem (see Table 5). Although Maui—Coastal—Unit 8 is not currently occupied by Brighamia rockii, Cyperus pennatiformis, Ischaemum byrone, Peucedanum sandwicense, or Vigna owahuensis, we have determined this area to be essential for the conservation and recovery of these coastal species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania

tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat desisgnation for Vigna o-wahuensis includes 15 critical habitat units, covering one ecosystem type, which encompasses approximately 1,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15.

Oahu—Coastal—Unit 1 [958 ac (388 ha)]. This area consists of 946 ac (383 ha) of State land, 11 ac (4 ha) of Federal land, and 2 ac (1 ha) of privately owned land in the coastal ecosystem along the northwestern coast of Oahu from Kaena Point east to Kauhao Pali and southeast to Keawaula. This unit is partially within Kaena Point State Park. Oahu—Coastal—Unit 2 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem on Mokuaula, an islet east of Kalanai Point on the northeastern coast of Oahu. This unit is State-owned and is classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 3 [15 ac (6 ha)]. consists of 15 ac (6 ha) in the coastal ecosystem, on the larger of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu–Coastal–Unit 4 [3 ac (1 ha)]. This area consists of 3 ac (1 ha) in the coastal ecosystem, the smaller of two islets (Moku Manu) off the windward coast of Oahu near Mokapu Peninsula. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 5 [12 ac (5 ha)]. This area consists of 12 ac (5 ha) in the coastal ecosystem, the larger of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is State-owned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 6 [9 ac (4 ha)]. This area consists of 9 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Mokulua Islands) off the windward coast of Oahu near Wailea Point. This unit is Stateowned, classified as a State Seabird Sanctuary.
Oahu—Coastal—Unit 7 [67 ac (27 ha)]. This area consists of 67 ac (27 ha) in the coastal ecosystem, on the larger of two islands (Manana Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary.
Oahu—Coastal—Unit 8 [10 ac (4 ha)]. This area consists of 10 ac (4 ha) in the coastal ecosystem, on the smaller of two islands (Kaohikaipu Island) off the windward coast of Oahu near Makapuu Point. This unit is Stateowned, classified as a State Seabird Sanctuary. Oahu—Coastal—Unit 9 [80 ac (33 ha)]. This area consists of 80 ac (33 ha) of State land in the coastal ecosystem on the leeward side of Makapuu Point (Puuokipahulu). Oahu—Coastal—Unit 10 [74 ac (30 ha)]. This area consists of 74 ac (30 ha) in the coastal ecosystem, owned by the City and County of Honolulu at Halona Point on the leeward side of Koko Crater, extending from Sandy Beach to Kahauloa. Oahu—Coastal—Unit 11 [20 ac (8 ha)]. Thi area consists of 20 ac (8 ha) of privately owned land in the coastal ecosystem, at Ihiihilauakea on Koko Head (Kaihuokapuaa).
Oahu—Coastal—Unit 12 [11 ac (5 ha)]. This area consists of 11 ac (5 ha) of City and County land in the coastal ecosystem, at Nonoula on Koko Head (Kaihuokapuaa). Oahu—Coastal—Unit 13 [23 ac (10 ha)]. This area consists of 19 ac (8 ha) of City and County land, 1 ac (0.5 ha) of State land, and 3 ac (1 ha) of privately owned land in the coastal ecosystem at Kalaeloa.
Oahu—Coastal—Unit 14 [4 ac (2 ha)]. This area consists of 2 ac (1 ha) of City and County of Honolulu land, and 2 ac (1 ha) of Federal land (U.S. Coast Guard) in the coastal ecosystem at Kalaeloa. Oahu—Coastal—Unit 15 [33 ac (13 ha)]. This area consists of 9 ac (4 ha) of State land, 2

ac (1 ha) of privately owned land, and 21 ac (9 ha) of Federal (Pearl Harbor NWR) land at Kalaeloa.

The critical habitat designation for Vigna o-wahuensis includes three units totaling 335 acres in Hawaii County, Hawaii. The units are Hawaii 4—Vigna o-wahuensis—a, b, c. Each unit provides habitat for 1 population of 300 mature, reproducing individuals of V. owahuensis. Each unit is essential to the conservation of the species because it supports habitat that is necessary for the establishment of additional populations in order to reach recovery goals. Each unit is geographically separated from other critical habitat for this multi-island species in order to reduce the likelihood of all recovery populations being destroyed by one naturally occurring catastrophic event.

Hawaii 4—Vigna o-wahuensis—a [(49 ha, 121 ac]: This unit contains most of Puu Pa cinder cone and lies in the Pohakuloa watershed in the southwest and in the Waikoloa/Waiulaula watershed in the northeast.

Hawaii 4—Vigna o-wahuensis—b [35 ha, 87 ac]: This unit contains most of the Holoholoku cinder cone and lies completely within the Pohakuloa watershed. This unit provides the easternmost critical habitat within the species' historical range.

Hawaii 4—Vigna o-wahuensis—c [51 ha, 127 ac]: This unit contains the upper portions of an unnamed cinder cone in the Pohakuloa watershed. This unit provides the southernmost critical habitat within the species' historical range.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Vigna o-wahuensis critical habitat consists of three components. Coastal (east Maui and Kahoolawe), Lowland dry (Lanai and Kahoolawe) and Lowland mesic (Lanai and Molokai) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Coastal. Elevation: <980 ft (<300 m). Annual precipitation: <20 in (<50 cm). Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. Canopy: Hibiscus, Myoporum, Santalum, Scaevola. Subcanopy: Gossypium, Sida, Vitex. Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Vigna o-wahuensis critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Vigna o-wahuensis was known historically (last observed > 20 yrs ago) from the indicated ecosystem in both the Koolau Mountain caldera complex and the Waianae Mountain caldera complex:

Oahu—Coastal—Units 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15. (A) Elevation: <980 ft (<300 m). (B) Annual Precipitation: <20 in (<50 cm). (C) Substrate: Well-drained, calcareous, talus slopes; dunes; weathered clay soils; ephemeral pools; mudflats. (D) Canopy: Hibiscus, Myoporum, Santalum, Scaevola. (E) Subcanopy: Gossypium, Sida, Vitex. (F) Understory: Eragrostis, Jacquemontia, Lyceum, Nama, Sesuvium, Sporobolus, Vigna.

Habitat features that are essential for this species include, but are not limited to, Dodonaea viscosa lowland dry shrubland.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative

ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Special management considerations or protections are necessary throughout the critical habitat areas designated for Vigna o-wahuensis to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat

destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

The Service publishes this final rule acknowledging that they have incomplete information regarding many of the primary biological and physical requirements for theis species. However, both the Act and the relevant court orders require the Service to to proceed with designation at this time based on the best information available. As new information accrues, the Service may consider reevaluating the boundaries of areas that warrant critical habitat designation.

The following management actions are important in providing a conservation benefit to the species: feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Life history information is unknown. The taxon has been observed flowering in March, April and July. Fruits were present in July. All individuals were classified as mature (U.S. Army 2003a).

Habitat Type

Adult: lowland dry to mesic grassland and shrubland

Habitat Narrative

Adult: Vigna o-wahuensis occurs in lowland dry to mesic grassland and shrubland at elevations from 10 to 1,370 meters (33 to 4,495 feet). Associated plant species include Sida fallax, Chenopodium sp., Dubautia menziesii, and Osteomeles anthyllidifolia (U.S. Army 2003a).

Dispersal/Migration

Population Information and Trends

Population Size:

between 180 and 500 (USFWS, 2020)

Population Narrative:

At least 86 individuals are believed to occur in 10 locations (U.S. Army 2003a). Thirty plants were located on the lower south and southwestern slope of Puu Nohonaohae during botanical

surveys in the early 1980s, but only a single plant was observed in 2002 (Arnett 2002b). New status information: Currently, there are 26 individuals of Vigna o-wahuensis in 5 populations on Molokai, Maui, and Kahoolawe (USFWS 2012a). On Molokai, 2 populations totaling 12 individuals are known from Makakupaia and Makolelau. On East Maui, there are approximately 10 individuals at Kanaio Beach. In 2014, a survey discovered approximately three individuals of V. o-wahuensis in a new location on Maui (Plant Extinction Prevention Program [PEPP] 2014). On Kahoolawe, there is a single individual. On Hawaii Island, in 2009 and 2010 there were 3 known populations containing 71 individuals (PEPP 2009, 2010). During 2011 to 2013, approximately 200 to 300 individuals of Vigna o-wahuensis were known from Pohakuloa Training Area (PTA) (U.S. Army Garrison Pohakuloa [U.S. Army] 2014). Overall, the numbers of individuals have increased from the approximately 72 wild individuals reported in the previous 5-year review to approximately 226 to 326 wild individuals in 2015 (USFWS 2012a; PEPP 2014; U.S. Army 2014) (USFWS, 2015). Currently, between 180 and to as many as 500 wild individuals of Vigna o-wahuensis that occur within PTA on the island of Hawai‘i, only 12 individuals on Moloka‘i, approximately 10 individuals on Maui, and possibly one individual remaining on Kaho‘olawe. A landscape-based assessment of climate change vulnerability for native plants of Hawai‘i using high resolution climate change projections was made by Fortini et al. (2013) and their analysis showed that V. o-wahuensis is vulnerable to the effects of climate change. Currently, of the previously reintroduced individuals, five survive. Two populations are provided protection from feral ungulates by fencing and ungulate control at PTA and Auwahi, with some nonnative plant management. Seed collections and germination trials are ongoing. (USFWS, 2020)

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: Threats to Vigna o-wahuensis include habitat degradation by feral ungulates, competition from non-native plant species, fire, effects of military activities, reduced reproductive vigor due to the small number of existing populations and individuals, and extirpation or extinction as the result of naturally-occurring events (U.S. Army 2003a).

Stressor: Nonnative bird predation or herbivory
Exposure:
Response:
Consequence:
Narrative: This species is often browsed by game birds at reintroduction sites thus leading to shorter statue plants and limited reproduction (U.S. Army 2010).

Stressor: Stochastic events
Exposure:
Response:
Consequence:
Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on V. o-wahuensis (PEPP 2013).

Recovery

Recovery Actions:

- Recommendations for Future Actions: Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).
- Important conservation actions needed for Vigna o¬wahuensis include the following: control of non-native plant species and feral ungulates; elimination of fire; and research on habitat requirements, population structure, reproductive biology, and seed biology. Management actions to protect existing V. o-wahuensis populations and habitat from fire should be developed. Ex situ propagation should be initiated and research on seed storage methodology continued to maintain adequate genetic stock and buffer against extinction of this species. Outplanting to enhance the remaining wild populations should begin when adequate propagated material is available, and fencing and weed control are underway. New populations should be established within the historic range of V. o-wahuensis in areas free from the impacts of feral ungulates and non-native plants (Service 1999). In addition, a Statewide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of V. o-wahuensis is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from specific actions occurring at the Pohakuloa Training Area on the island of Hawaii (and discussed in a subsequent section), the Service is unaware of species-specific conservation actions being conducted for Vigna o-wahuensis.
- New management actions: Surveys / inventories o A survey discovered approximately three individuals of V. o-wahuensis in a new location on Maui (PEPP 2014). o During 2011 to 2012, approximately 18.25 square kilometers (7.05 square miles) were surveyed at PTA (U.S. Army 2013). Surveys were completed within the following fence units: Haplostachys haplostachya (165 acres), Kadua coriacea (392 hectares [969 acres]), Kipuka Alala North (407 hectares [1,066 acres]), Puu Nohona O Hae (79 hectares [195 acres]), Puu Papapa (28 hectares [68 acres]), and Silene hawaiiensis (18 hectares [44 acres]). During that survey, only a single location was recorded for V. o-wahuensis (U.S. Army 2013). o In 2014, surveys conducted in previously un-surveyed areas and previously surveyed areas discovered approximately nine locations of V. o-wahuensis (U.S. Army 2015). Ungulate monitoring and control o All known locations of V. o-wahuensis that contain live plants are protected by the Puu Papapa and Nohona o Hae fence units at PTA (U.S. Army 2010). These fence units are ungulate free (U.S. Army 2014). The location in western 3 Keamuku Maneuver Area that formerly contained individuals of V. o-wahuensis is not fenced (U.S. Army 2010). Invasive plant monitoring and control – Weed control for this species is problematic due to the loose

and steep terrain associated with plants located on Puu Papapa (U.S. Army 2010). The Army Natural Resources Office at PTA is investigating alternative weed control methods for this species. Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013, 2014) had five individuals growing in their nursery and eight individuals were propagated for reintroduction activities to occur next year. o The Lyon Arboretum's Seed Conservation Laboratory (2014) has more than 4,300 seeds in storage from Maui, Kahoolawe, and Hawaii Island. o Waimea Valley (2014) has two plants in cultivation from Maui. o The National Tropical Botanical Garden (2014) has more than 300 seeds in storage from Maui and Hawaii Island. o Maui Nui Botanical Garden (2014) has thousands of seeds in genetic storage representing eight cultivated individuals from Kanaio. o During 2011 to 2013, more than 14,000 seeds from 35 accessions representing 1 group and 35 founders of V. o-wahuensis were collected and placed in long-term storage at PTA (U.S. Army 2014). There are now more than 33,000 seeds in storage from 55 accessions representing 1 group and 47 founders in long-term storage at PTA (U.S. Army 2014). Captive propagation protocol development – Propagation trials were conducted to determine appropriate storage and propagation techniques for V. o-wahuensis. The trials indicated that seeds from V. o-wahuensis germinated readily at a rate of more than 50 percent (U.S. Army 2015). Seed longevity for V. o-wahuensis is unknown (U.S. Army 2015). Population viability monitoring and analysis o The Plant Extinction Prevention Program (2013) monitored the wild population on Maui. o In 2010, annual monitoring recorded several new plant locations on Puu Papapa at PTA (U.S. Army 2010). In addition to annual monitoring, supplemental monitoring was conducted in 2010 but no additional management actions were required implementation (U.S. Army 2010). o In 2010, no individuals were observed in an area in western Keamuku Maneuver Area which formerly contained individuals of V. o-wahuensis (U.S. Army 2010). This location will continue to be monitored for regeneration of new individuals. o A new quarterly monitoring methodology was implemented for this species in 2010 at PTA (U.S. Army 2010). Elements of the protocol were started in October of 2009, with refinements made based on feedback and data collected. The new methodology was fully implemented in April 2010. Data collection objectives are to quantify plant abundance and plant cluster density at different times of the year so that seasonal variation and variation because of spatial and temporal gradients in resource availability can be accounted for in this ephemeral species. Plant stems are used to estimate abundance and vigor, since it is difficult to distinguish between individual plants of this species (U.S. Army 2010). Cluster counts were 4 not made until the last quarterly monitoring for this species where 27 plant clusters were found in the survey area. o Monitoring conducted in the first quarter of 2010 recorded 110 out of the 183 previously known plant stems in previously recorded plant clusters known from PTA (U.S. Army 2010). The prolonged drought from 2009 to 2010 seemed to have had a considerable impact on this and other species' abundance and vigor at PTA (U.S. Army 2010). During the second quarter monitoring only 25 out of the 183 previously known V. o-wahuensis stems remained alive. The number of remaining stems declined to just 3 stems in the fourth quarter. Preliminary results from monitoring in 2011 indicated that there are no living stems in the survey area (U.S. Army 2010). Reintroduction / translocation o During 2002 to 2012, a single individual of V. o-wahuensis was outplanted at Kipuka Alala South fence unit, another individual was outplanted in 2014, and one plant remained in 2014 (U.S. Army 2015). o Near Saddle Road on State-owned lands, 7 individuals were reintroduced during 2002 to 2012, no individuals were added in 2014, and no plants remained in 2014 (U.S. Army 2015). o In North Kona on State-owned lands, 100 seeds were broadcasted during 2004 to 2009 (U.S. Army 2015). o At Puu Waawaa

Cone Unit on State-owned lands, 42 individuals were reintroduced during 2005 to 2012 (U.S. Army 2015). In 2014, an additional five individuals were reintroduced and monitoring conducted during the same year, recorded only three reintroduced individuals remained (U.S. Army 2015). o On County-owned lands in North Kona, 11 individuals were reintroduced during 2008 to 2012 and no reintroduced individuals remained in 2014 (U.S. Army 2015). o The Waikoloa Dry Forest Initiative has 74 reintroduced individuals with many of those individuals reaching maturity and producing seeds (J. Lawson, Waikoloa Dry Forest Initiative, pers. comm. 2015). o In 2014, two individuals were reintroduced on private land in North Kona (Wagner 2014). Reintroduced / translocated population management and monitoring o In North Kona on State-owned lands, natural recruitment of a single immature individual was observed in 2014 (U.S. Army 2015). o At Puu Waawaa Cone Unit on State-owned lands monitoring conducted in 2014 recorded natural recruitment of a single immature individual of V. o-wahuensis (U.S. Army 2015). o On County-owned lands in North Kona, 11 individuals were outplanted during 2008 to 2012 and no outplants remained in 2014 (U.S. Army 2015). Climate change adaptation strategy – Fortini et al. (2013) conducted a landscapebased assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that V. o-wahuensis is minimally vulnerable to the impacts of climate change. 5 Listing and critical habitat designation o Fifteen units of critical habitat were designated for V. o-wahuensis on Oahu in the coastal ecosystem (USFWS 2012b). o Eight units of critical habitat for V. o-wahuensis were proposed in the coastal ecosystem on Maui and five units of critical habitat were proposed in the coastal and lowland dry ecosystems on Kahoolawe (USFWS 2012a). On Molokai, a single unit of critical habitat was proposed in the lowland mesic ecosystem (USFWS 2012a). On Lanai, critical habitat for V. o-wahuensis was proposed in three units in the lowland dry and lowland mesic ecosystems. The final rule for these critical habitat designations has not been published at the time of this review.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2020. • Surveys and inventories—Continue to conduct thorough surveys of all current and historical range for a current assessment of the species' status. • Ungulate monitoring and control—Continue to construct and maintain fenced exclosures to protect individuals from the negative impacts of habitat destruction and degradation, and browsing and trampling by ungulates. • Established ecosystem-altering invasive plant monitoring and control— Control established ecosystem-altering nonnative invasive plant species, and those that compete with Vigna o-wahuensis at all populations. • Fire monitoring and control—Continue to develop and implement fire management plans for wild and reintroduced populations. • Drought monitoring and control—Continue to monitor and control other threats to protect and increase vigor of Vigna o-wahuensis during times of drought. Maintain water catchments where needed. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Predation and herbivore control— o Implement effective control methods for rodents. o Conduct research on the damaging effects of nonnative insects on the seeds of V. o-wahuensis and if necessary, develop and implement effective control measures. o Monitor wild and reintroduced populations for seed predation by game birds and develop management strategies if

necessary. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction into protected suitable habitat within historical range. • Reintroduction and translocation—Determine optimal sites for reintroduction, especially on islands of historic occurrence, and continue to reintroduce individuals into these areas that are managed for known threats. • Population biology research—Continue germination and propagation research and implement best management practices. • Alliance and partnership development—Continue to work with the U.S. Army Garrison, the Department of Land and Natural Resources, and other partners and land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2020)

- New Management Actions: • Surveys and inventories—Field surveys to monitor and confirm the status of wild and reintroduced populations of Vigna o-wahuensis are conducted by the Plant Extinction Prevention Program (PEPP) on Maui and within PTA on the island of Hawai‘i by the U.S. Army Garrison (PEPP 2016, 2017, 2019; U.S. Army Garrison 2020, pp. 6, 13, 30). In 2020, a patch of uncounted plants was discovered at Kanaio on Maui (PEPP 2020). • Ungulate monitoring and control—Wild and reintroduced individuals on Maui are provided protection from ungulates by fencing at Auwahi (Auwahi 2019). • Ecosystem-altering nonnative plant control—Nonnative plants are controlled in fenced areas at Auwahi (PEPP 2017). • Fire threat control—There is partial control of fire threat at Auwahi on Maui (Auwahi 2019). • Drought control—PEPP reported repair of the water catchment at Kanaio in 2016 (PEPP 2016). • Rodent monitoring and control—There has been partial control of rats at the reintroduction site at Auwahi during the last five years (Auwahi 2019). • Captive propagation for genetic storage and reintroduction— o In 2016, PTA reported collection of 940 seeds representing three founders from Nohona o Hae. In 2018, PTA reported collection and storage of 630 seeds representing 41 founders from Nohona o Hae (PTA 2018). In 2019, PTA reported collection of 3,356 seeds from plants in the field (representing at least 74 founders) and more than 32,000 seeds from plants in the greenhouse (U.S. Army Garrison 2020, pp. 35, 37). o The Lyon Arboretum Seed Conservation Laboratory reported storage of 1,372 seeds collected from several individuals at Kanaio on Maui and from one individual at Nohona o Hae on the island of Hawai‘i (Lyon Arboretum 2019). o Maui Nui Botanical Garden (MNBG) reported propagation of 23 individuals of Vigna o-wahuensis and storage of hundreds of seeds (MNBG 2019). o The National Tropical Botanical Garden (NTBG) reported storage of 89 seeds collected from a plant in the living collection sourced from Maui (NTBG 2019). o In 2016 and 2019, the Volcano Rare Plant Facility (VRPF) reported three individuals each from two founders at Nohona o Hae in refugia (VRPF 2015–2019). • Reintroduction— o Of the 11 individuals of Vigna o-wahuensis reintroduced at Pu‘u Pāpapa, two remain (U.S. Army Garrison 2020, pp. 43-44). Of the individuals reintroduced between 2004 and 2015 at Pu‘uwa‘awa‘a, only two mature plants were observed (U.S. Army Garrison 2020, p. 48). o Of the 665 seedlings reintroduced at Auwahi, three mature individuals were observed flowering in 2019 (NTBG 2019). o PEPP reports grant funding to provide for reintroduction of 10 individuals of Vigna o-wahuensis at the PTA cinder cones on the island of Hawai‘i (PEPP 2019). • Reproductive biology—PTA conducted eight seed germination trials using 161 seeds that produced 35 seedlings (approximately 22 percent germination rate) (U.S. Army 2020, pp. 16, 40). Another trial reported testing of 21 seeds that germinated within 92 days (PTA 2018). (USFWS, 2020)

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SPECIES ACCOUNT: *Viola chamissoniana ssp. chamissoniana* (Pamakani)

Species Taxonomic and Listing Information

Listing Status: Endangered; Pacific Region (R1) (USFWS, 2016)

Physical Description

Viola chamissoniana ssp. chamissoniana is a short-lived perennial of the Violaceae (violet) family. It is a basal-branching woody shrub with branches 20 to 60 cm (8 to 23 in) long. Some occurrences, especially on steep cliffs, have plants with reclining or drooping branches; plants in other occurrences have erect branches forming upright shrubs. The triangular leaves are 2 to 4 cm (0.8 to 1.6 in) long and clustered at the ends of the stems. The flowers are large, white, and held above the leaves. The tiny, dark, egg-shaped seeds are borne in capsules that open as they dry (Wagner et al 1999; Makua Implementation Team 2003) (USFWS, 2016).

Current Range

Viola chamissoniana ssp. chamissoniana is endemic to the island of Oahu and is known only from the Waianae Mountains. It has been recorded throughout the mountain range on both the windward and leeward sides (USFWS, 2016).

Critical Habitat Designated

Yes; 6/17/2003.

Legal Description

On June 17, 2003, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Viola chamissoniana ssp. chamissoniana (Pamakani) under the Endangered Species Act of 1973, as amended (Act) (68 FR 35950-36348). On September 18, 2012 the Service published a Final Rule revising the 2003 designation of critical habitat designation for Viola chamissoniana ssp. chamissoniana (77 FR 57648-57862). The critical habitat designation includes 11 critical habitat units, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii.
The critical habitat designation for Viola chamissoniana ssp. chamissoniana includes areas that were determined by the Service to be occupied at the time of listing, and also includes unoccupied suitable habitat that is essential to the conservation of this species by providing the PCEs necessary for reintroductions and expansion of the existing wild populations within their historical range.

Critical Habitat Designation

The critical habitat desisgnation for Viola chamissoniana ssp. chamissoniana includes 11 critical habitat units, covering tw0 ecosystem types, which encompass approximately 7,332 acres on the Island of Oahu, Hawaii (77 FR 57648-57862). The designated critical habitats include: Oahu—Lowland Mesic—Units 1, 2, 3; Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8.

Oahu—Lowland Mesic—Unit 1 [4,448 ac (1,800 ha)]. This area consists of 3,565 ac (1,443 ha) of State land, 583 ac (236 ha) of City and County of Honolulu land, 22 ac (9 ha) of Federal land, and 277 ac (112 ha) of privately owned land in the lowland mesic ecosystem in the Waianae Mountains, encompassing a large area including the north slopes of Mt. Kaala, from the Pahole

NAR to the Kaala NAR, and south to the Waianae Kai Forest Reserve (FR). Oahu—Lowland Mesic—Unit 2 [1,063 ac (430 ha)]. This area consists of 1,063 ac (430 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Puuhapapa south to Puukaua. Oahu—Lowland Mesic—Unit 3 [353 ac (143 ha)]. This area consists of 353 ac (143 ha) in the lowland mesic ecosystem on the windward side of the Waianae Mountains, from Pohakea Pass to Kaiakuakai Gulch.

Oahu—Dry Cliff—Unit 1 [49 ac (20 ha)]. This area consists of 49 ac (20 ha) in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the rim of Makua Valley. Oahu—Dry Cliff—Unit 2 [412 ac (167 ha)]. This area consists of 320 ac (130 ha) of State land and 91 ac (37 ha) of City and County of Honolulu land in the dry cliff ecosystem, on the leeward side of the Waianae Mountains, along the ridge from Keaau to Ohikilolo. Oahu—Dry Cliff—Unit 3 [450 ac (182 ha)]. This area consists of 349 ac (141 ha) of City and County of Honolulu land and 101 ac (41 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the eastern rim of Makaha Valley along Kamaileunu Ridge. Oahu—Dry Cliff—Unit 4 [24 ac (10 ha)]. This area consists of 24 ac (10 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along Kauaopuu ridge, which divides Waianae Kai and Lualualei valleys. Oahu—Dry Cliff—Unit 6 [149 ac (60 ha)]. This area consists of 149 ac (60 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Lualualei Valley from Puukanehoa to Puukaua. Oahu—Dry Cliff—Unit 7a [68 ac (27 ha)]. This area consists of 68 ac (27 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley to Pohakea. Oahu—Dry Cliff—Unit 7b [38 ac (16 ha)]. This area consists of 38 ac (16 ha) of State land in the dry cliff ecosystem on the leeward side of the Waianae Mountains, along the rim of Lualualei Valley at Palikea. Oahu—Dry Cliff—Unit 8 [259 ac(105 ha)]. This area consists of 259 ac (105 ha) in the dry cliff ecosystem on the leeward side of the Waianae Mountains, on State land along the rim of Nanakuli Valley from Palehua to Puumanawanua, and partially within the Nanakuli Forest Reserve.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Viola chamissoniana ssp. chamissoniana critical habitat consists of the following components according to ecosystem type (77 FR 57648-57862). Note: Viola chamissoniana ssp. chamissoniana occurs within the Lowland mesic and Dry cliff ecosystems in the Waianae Mountain caldera complex:

Oahu—Lowland Mesic—Units 1, 2, 3. (A) Elevation: <3,300 ft (<914 m). (B) Annual Precipitation: 50–75 in (130–190 cm). (C) Substrate: Shallow soils, little to no herbaceous layer. (D) Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. (E) Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. (F) Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Oahu—Dry Cliff—Units 1, 2, 3, 4, 6, 7a, 7b, 8. (A) Elevation: unrestricted. (B) Annual Precipitation: < 75 in (<190 cm). (C) Substrate: >65 degree slope, rocky talus. (D) Canopy: None. (E) Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. (F) Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Special Management Considerations or Protections

Special management considerations or protections are necessary throughout the critical habitat areas designated for Viola chamissoniana ssp. chamissoniana to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by feral ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified for this species.

Life History

Food/Nutrient Resources

Lifespan

Adult: <10 years (USFWS, 2016)

Reproduction Narrative

Adult: Little is known about the breeding system of V. chamissoniana ssp. chamissoniana. The large, white, fragrant flowers held above the leaves suggest pollination by moths. Plant longevity probably is similar to that of other small shrubs that live less than 10 years (i.e., short-lived perennials) (Makua Implementation Team 2003). Other demographic information for V. chamissoniana ssp. chamissoniana in the wild is uncertain, including number of seeds produced, age at sexual maturity, survivorship to sexual maturity, number of years in reproductive condition, survivorship during reproductive life, timing of reproductive output, pollination and seed dispersal, vegetative reproduction and specific environmental requirements (USFWS, 2016).

Habitat Type

Adult: Cliffs/cliff ledges (USFWS, 2016)

Habitat Narrative

Adult: Viola chamissoniana ssp. chamissoniana occurs in mesic habitats at elevations of 700 to 1,000 m (2,297 to 3,281 ft). It is usually found on north-facing cliffs and cliff ledges that are sparsely to moderately vegetated with native shrubs, grasses, and sedges. Such sites are among the most native and undisturbed mesic habitats of the Waianae Mountains. This taxon also is found on gentle slopes in native shrubland (Makua Implementation Team 2003) (USFWS, 2016).

Dispersal/Migration

Population Information and Trends

Population Trends:

Increasing (USFWS, 2016)

Number of Populations:

8 (USFWS, 2019)

Population Size:

~ 200 mature and 300 immature (USFWS, 2019)

Population Narrative:

Currently, there are eight populations of Viola chamissoniana subsp. chamissoniana throughout the Waiʻanae mountains of Oʻahu, totaling approximately 200 mature and 300 immature wild individuals (Army Natural Resources Program-Oʻahu (ANRP) 2018). The are two additional occurences of 44 individuals at Puʻukūmakaliʻi and 50 individuals at Keaʻau; however, they have not been observed or reported on since 2004, and their current status is unknown. (USFWS, 2019)

Threats and Stressors

Stressor: Fire (USFWS, 2016)
Exposure:
Response:
Consequence: Loss of habitat/loss of indivduals
Narrative: Fire is listed as a threat to this species. Because of its overall relative abundance and population units in fire risk zones, V. chamissoniana ssp. chamissoniana has a high background risk of species extinction, and protection from existing and additional threats is needed to ensure its long-term persistence (USFWS, 2016).

Stressor: Climate change loss or degradation of habitat (USFWS, 2019)
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaiʻi using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Viola chamissoniana, on the species level, is vulnerable to the impacts of climate change, with a vulnerability score of 0.375 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions may be needed to conserve this taxon into the future, such as locating key microsites that overlap with current and future climate envelopes for outplanting efforts. (USFWS, 2019)

Recovery

Delisting Criteria:
Due to limited knowledge of life history requirements for short-term and long-term survival, the recovery plan for this species specifies interim objectives to downlisting and delisting that involve utilizing stabilization populations to aid in recovery (Service 1995a, 1998a) (USFWS, 2016).

Recovery Actions:

- The Makua Implementation Team (2003) has developed stabilization criteria for Viola chamissoniana ssp. chamissoniana, which are incorporated in the Army's Makua Implementation Plan Addendum (U.S. Army Garrison 2005a). In addition, this species occurs

in four management units where it will benefit from population unit and/or ecosystem-level protection. The management units include Makaha, Palikea, and Puu Kumakalii, which are not fenced, and Ohikilolo, which is fenced. Viola chamissoniana ssp. chamissoniana is easy to propagate from seeds and cuttings. Seeds can be stored at appropriate conditions for several years with 60 percent germination success, and cuttings are also about 60 percent successful. Seed is difficult to collect because wild plants produce very few flowers and seeds at a time. Flowering of some greenhouse plants is more prolific, but most of the fruits are aborted. The Army is conducting nursery pollination experiments to determine limiting factors to seed production (U.S. Army Garrison 2005b). Current ex situ collections for this species include 31,000 seeds in seed storage (Lyon Arboretum Seed Storage Facility) (Service 2005b) (USFWS, 2016).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Other than the new data on this taxon's vulnerability to climate change, we are not aware of any new threats. There is no significant new information regarding the species' biological status since the last 5-year review in 2013. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2019. • Ungulate monitoring and control—Complete construction, maintain, and monitor ungulate exclosures for each population to protect plants from the impacts of feral ungulates. • Invasive plant monitoring and control—Control established ecosystem-altering nonnative invasive plant species, and those that compete with Viola chamissoniana subsp. chamissoniana at all populations. • Fire management—Implement fire management plans and coordinate fire response efforts. • Climate change adaptation strategy—Assess the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Captive propagation for genetic storage and reintroduction—Continue cuttings and seed collections from tagged wild and outplanted individuals, keeping close track of the maternal source for use in ex situ propagation. • Reintroduction—Augment and establish new populations and determine which reintroduction sites have the highest likelihood of success. • Genetic research—Assess genetic variability within extant populations. • Population viability research—Study Viola chamissoniana subsp. chamissoniana populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Alliance and partnership development—Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species. (USFWS, 2019)
- New Management Actions: • Captive propagation for genetic storage and reintroduction— o Lyon Arboretum Micropropagation Laboratory reports 158 explants in storage representing two individuals at Hālona, five individuals Pu‘uhapapa, two individuals from Pu‘ukūmakali‘i and five individuals from Makaleha (Lyon Arboretum 2018). o The ANRP reports propagation of 155 individuals representing 28 wild individuals from populations at Hālona, Makaleha, Pu‘uhapapa, and Pu‘ukūmakali‘i (U.S. Army 2018).

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SPECIES ACCOUNT: *Viola helenae* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

An erect, unbranched subshrub, 3-8 m tall. Leaves are long and narrow. Flowers are pale lavender or white. (NatureServe, 2015)

Taxonomy

Viola helenae was first collected in the Wahiawa Mountains by J. M. Lydgate in 1908 and described the following year by Lydgate and C. N. Forbes based on this same specimen (Forbes 1909). They named it for Lydgate's wife, Helen. J. F. Rock (1911) described a similar species from Lanai as a variety of Viola helenae, but the Lanai plant is generally regarded by botanists as a distinct species V lanaiensis (Rock) W. Becker (Becker 1916, St. John 1979, Wagner et al. 1990). Viola, a genus of 300 to 500 species widespread in mainly temperate regions of the world, is represented in Hawai'i by 7 endemic species, 6 of which are the only woody members of this genus (Wagner et al. 1990). No vernacular names are known for this species (USFWS, 1994).

Historical Range

See current range/distribution

Current Range

Current range: Wahiawa Mountains of Kauai; historically no additional range.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Viola helenae on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for Viola helenae includes one unit totaling 1,510 acres in Kauai County, Hawaii. The unit is Kauai 10—Viola helenae—a.

Kauai 10—Viola helenae—a: This unit is critical habitat for Viola helenae and is 610 ha (1,510 ac) on State (Lihue-Koloa Forest Reserve) and private land. This unit contains portions of Kanaele Swamp and Kahili Summit. This unit provides habitat for five populations of 250 mature, reproducing individuals of the short-lived perennial Viola helenae and is currently occupied with 137 plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable. The habitat features contained in this unit that are essential for this species include, but are not limited to, stream drainage banks or adjacent valley bottoms in light to moderate shade in Metrosideros polymorpha-Dicranopteris linearis lowland wet forest or Metrosideros polymorpha-Cheirodendron wet forest. This unit is at

an appropriate size to avoid the destruction of all recovery populations by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Stream drainage banks or adjacent valley bottoms in light to moderate shade in Metrosideros polymorphaDicranopteris linearis lowland wet forest or Metrosideros polymorphaCheirodendron wet forest and containing one or more of the following native plant species: Antidesma platyphyllum var. hillebrandii, Broussaisia arguta, Dicranopteris linearis, Diplazium sandwichianum, Dubautia spp., Freycinetia arborea, Hesperomannia lydgatei, Melicope spp., or Pritchardia spp.; and

(ii) Elevations between 522 and 1,006 m (1,712 and 3,301 ft).

Special Management Considerations or Protections

Existing manmade features and structures within the boundaries of the mapped areas, such as buildings; roads; aqueducts and other water system features, including but not limited to pumping stations, irrigation ditches, pipelines, siphons, tunnels, water tanks, gaging stations, intakes, reservoirs, diversions, flumes, and wells; existing trails; campgrounds and their immediate surrounding landscaped area; scenic lookouts; remote helicopter landing sites; existing fences; telecommunications equipment towers and associated structures and equipment; electrical power transmission lines and distribution, and communication facilities and regularly maintained associated rights-of-way and access ways; radars, telemetry antennas; missile launch sites; arboreta and gardens; heiau (indigenous places of worship or shrines), and other archaeological sites; airports; other paved areas; and lawns and other rural residential landscaped areas do not contain one or more of the primary constituent elements described for each species in paragraph (b) of this section and therefore are not included in the critical habitat designations.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Likely insect pollinated (USSFWS, 1994)

Reproduction Narrative

Adult: Little is known about the life history and ecology of Viola helenae. Wagner et al. (1990) stated that the flowers are all chasmogamous (open at maturity for access by pollinators), none being cleistogamous (remain closed and self-fertilize in the bud) as in certain other violets. It is likely that its flowers require pollination by insects for seed set. Mature flowering plants do produce seed (D. Lorence, pers. obser. 1992), however, seed viability may be low and microhabitat requirements for germination and growth may be very specific. Seeds planted at the HPCC nursery failed to germinate (K. Leeling-Rosenberger, pers. comm. 1992), although they may not have been sufficiently mature when collected and violet seeds are often very slow to germinate (Derral Herbst, USFWS, pers. comm. 1993). The seeds are jettisoned when the capsule splits open, as in most species of the genus (D. Lorence and Flynn, T. pers. obser. 1991) Viola helenae was first collected in the Wahiawa Mountains by J. M. Lydgate in 1908 and described the following year by Lydgate and C. N. Forbes based on this same specimen (Forbes 1909). They named it for Lydgate's wife, Helen. J. F. Rock (1911) described a similar species from Lanai as a variety of Viola helenae, but the Lanai plant is generally regarded by botanists as a distinct species V lanaiensis (Rock) W. Becker (Becker 1916, St. John 1979, Wagner et al. 1990). Viola, a genus of 300 to 500 species widespread in mainly temperate regions of the world, is represented in Hawai'i by 7 endemic species, 6 of which are the only woody members of this genus (Wagner et al. 1990). No vernacular names are known for this species (USFWS, 1994).

Habitat Type

Adult: Wet forest/shrubland (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (NatureServe, 2015)

Site Fidelity

Adult: High (NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits wet forests and shrublands in gulch bottoms, gulch slopes, and on exposed ridgetops. (NatureServe, 2015). Clumped spatial arrangement of the population, high ecological integrity of the community and site fidelity and low tolerance ranges are based on there being one population, with low species numbers.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: Dispersal vectors are not indicatted for this species.

Population Information and Trends

Population Trends:

Unknown

Number of Populations:

2 (USFWS, 2022)

Population Size:

51 (25 mature, 26 immature) (USFWS, 2022)

Population Narrative:

Fragility unknown. CURRENTLY 13 PLANTS KNOWN. 1 HISTORICAL OCCURRENCE. (NatureServe, 2015). Low resiliency, representation and redundancy are inferred based on there being only one known occurrence of this species with a low number of individuals and the species apparent restricted habitat requirements (restricted to the Wahiawa Drainange Basin) (NatureServe, 2015) New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2008 there were two populations totaling fewer than 20 individuals in the Wahiawa drainage on the island of Kauai. In 2016, the IUCN Red List of Threatened Species estimated there to be one population totaling six individuals (Clark 2016). Currently, there are two populations in the same area totaling approximately 30 individuals (one location with seven plants) (PEPP 2017). It may be possible that the IUCN Red List accidentally omitted the larger population (USFWS, 2017). Island Distribution: Kauai (USFWS, 2021c) Number of Populations: 2 (USFWS, 2021c) Estimated Number of Individuals: 30 (USFWS, 2021c) Populations and Life History Characteristics: Narrow extant range (USFWS, 2021c) Currently, Viola helenae is known from two populations in the Wahiawa drainage on Kaua‘i totaling 25 mature and 26 immature individuals (Kishida and Perlman 2017a; 2017b) (USFWS, 2022).

Threats and Stressors

Stressor: Feral pigs (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat/loss of individuals
Narrative: Habitat degradation and browsing by feral pigs is a major threat to this species (USFWS, 2008).

Stressor: Invasive plants (USFWS, 2008)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Habitat degradation by and competition with introduced invasive plant species is a major threat to this species (USFWS, 2008).

Stressor: Stochastic events (USFWS, 2008)
Exposure:
Response:
Consequence: Extinction
Narrative: Risk of extinction from stochastic events such as landslides and other erosion, and hurricanes is a major threat to this species (USFWS< 2008).

Stressor: Reduced reproductive vigor (USFWS, 2008)

Exposure:
Response:
Consequence: Extinction
Narrative: Reduced reproductive vigor due to the small number of wild individuals is listed as a threat to this species (USFWS, 2008).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Viola helenae is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.744 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, this species has no overlap between current and future climate envelopes, and is unlikely to tolerate expected changes in climate at its current location. This means that this species must persist within suitable microrefugia, or move to newly available climate-compatible areas to avoid extinction. Therefore, additional management actions are needed to conserve this taxon into the future.

Recovery

Reclassification Criteria:
The five listed Wahiawa species can be considered for down-listing to threatened status once: (1) the population of each species has been stabilized by removal of threats; (2) each species occurs in at least three populations, each with at least 250 reproductive individuals; and (3) the full genetic diversity of each population is backed up as living and stored material at one or more nurseries or botanical gardens. These populations should be as genetically diverse as possible, and if artificially established, they must be within the historical range of the species. Each species should be able to reproduce naturally, i.e. , complete its life cycle within the population areas, with percentages of adults, juveniles and seedlings necessary for long-term maintenance of population numbers and genetic diversity. This objective is considered to be biologically reasonable and attainable, but it should be reevaluated as new information becomes available (USFWS, 1994).

Number of populations and individuals needed to meet Preventing Extinction Stage based on population and life history characteristics: 3 Populations, 100 Mature Individuals per Population (USFWS, 2021c). Number of populations and individuals needed to meet Interim Stage based on population and life history characteristics: 3 Population, 300 Mature Individuals per Population (USFWS, 2021c). Number of populations and individuals needed for Downlisting based on population and life history characteristics: 10 Populations, 500 Mature Individuals per Population (USFWS, 2021c).

Recovery Priority Number: 2

Delisting Criteria:

The target for delisting includes locating, or establishing if necessary, at least 2 additional wild populations, for a total of at least 5 reproductively stable populations, each with at least 250 reproductive individuals, per species. These populations should be stable over an estimated ten year period. Further field exploration on Kaua'i is likely to yield additional populations of at least some of these species. If more populations are discovered, they should be augmented to reach the target size. If new populations are established, they should have optimum genetic composition and be within the historical range of the species. All five populations should be unmanipulated and able to sustain themselves indefinitely without such human intervention as fencing and alien plant control. The numbers of individuals and populations given in the above objectives were chosen, based on our current understanding of these species, they should provide for the maintenance of the majority of the genetic diversity of each species, and provide some assurance that a single catastrophic event will not destroy all members of a species. Much basic research on the life history and reproductive biology of all five species needs to be conducted in order to ascertain whether these objectives are indeed valid. This recovery plan should, therefore, be modified to incorporate any new information as it becomes available (USFWS, 1994).

Number of populations and individuals needed for delisting based on population and life history characteristics: 10 Populations, 500 Mature Individuals per Population (USFWS, 2021c).

Recovery Actions:

- Recommendations for Future Actions: No new threats and no other significant new information regarding the species' biological status have been reported since the last 5-year review in 2008. Therefore, the following recommendations for future actions are reiterated for the 5-year review for 2017. • Surveys and inventories—Search for new populations of Viola helenae, and regularly visit the sites where the species formerly grew to search for any seedlings that might germinate at the sites from a seedbank. • Ungulate monitoring and control—Continue to construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Continue to protect all occurrences against disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Captive propagation protocol—Determine best method for seed germination to produce more individuals for reintroduction. • Captive propagation for genetic storage and reintroduction—Continue propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historical range that is being managed for known threats to this species. • Stochastic events—Build resilience and redundancy—Increase numbers of populations and individuals scattered throughout historic range to reduce impacts from landslides and erosion. • Population biology research—Study Viola helenae populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2017).
- Search for new populations of Viola heleana, and regularly visit the sites where the species formerly grew to search for any seedlings that might germinate at the sites from a seedbank (USFWS, 2008).
- Control introduced invasive plant species around the remaining population (USFWS, 2008).
- Fence the remaining population to control ungulates (USFWS, 2008).

- Find the most effective propagation method, and best horticultural techniques for growing this species (USFWS, 2008).
- Study new or reintroduced Viola helenae populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2008).
- Develop a plan for conserving the species' genetic diversity in ex situ collections and in reintroduced populations (USFWS, 2008).
- New Management Actions: • NTBG and PEPP have been collecting seeds from both populations for storage and propagation at Lyon Arboretum and the Kokee Rare Plant Facility (NTBG 2017; PEPP 2010, 2011, 2012, 2013, 2014, 2015, 2016). There is one founder from the larger population represented at the Kokee Rare Plant Facility (DOFAW 2016). There is one founder at the NTBG nursery (NTBG 2017). • PEPP has outplanted four individuals in a fenced exclosure at Kanaele Bog (PEPP 2011, 2014). In 2014, two outplanted individuals remained. Currently, all plants have died (PEPP 2017). • Lyon Arboretum has one founder represented in tissue culture. There are two founders from the small population and eight founders from the larger population represented in the seed bank (Lyon Arboretum 2017).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated and updated for the 5-year review for 2022. • Surveys and inventories—Continue to survey for populations throughout the historic range and suitable habitat and monitor known populations of Viola helenae. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates and continue to protect all occurrences against disturbances from feral ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with V. helenae. • Site and habitat protection—Develop and implement effective control measures to reduce the impact of ungulates. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy to reduce impacts of climate change, stochastic events, reduced viability due to small population size, and other threats. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within and between populations and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2022).

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SPECIES ACCOUNT: *Viola kauaiensis var. wahiawaensis* (Nani wai`ale`ale)

Species Taxonomic and Listing Information

Listing Status: Endangered; 10/10/1996; Pacific Region (R1) (USFWS, 2016)

Physical Description

A perennial herb with subterranean rhizomes. Flowers are solitary. Petals are white on the upper surface; the lower surface is purple or blue to white. (NatureServe, 2015)

Taxonomy

Charles Noyes Forbes collected a specimen of Viola kauaiensis var. wahiawaensis on Kauai in 1909. In 1920, he described the variety, naming it for Wahiawa Bog where it was first collected (USFWS 1996) (USFWS, 1998).

Historical Range

See current range/distribution

Current Range

Current range: Wahiawa area of Kauai; historically no additional range. Genus widespread in temperate regions of world. Species endemic to Kauai and Oahu, variety endemic to Kauai.

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designate critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Viola kauaiensis var. wahiawaensis on the island of Kauai, Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for Viola kauaiensis var. wahiawaensis includes one unit totaling 1,623 acres in Kauai county, Hawaii. The unit is Kauai 10—Viola kauaiensis var. wahiawaensis—a.

Unit description not available.

Primary Constituent Elements/Physical or Biological Features

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Machaerina angustifoliaRhynchospora rugosa lowland bog or mixed wet shrubland and adjacent Metrosideros polymorpha wet forest and containing one or more of the following native plant species: Antidesma platyphyllum var. hillebrandii, Bidens forbesii, Chamaesyce remyi, Chamaesyce sparsiflora, Coprosma spp., Cyanea fissa, Dicranopteris linearis, Diplopterygium pinnatum, Dubautia imbricata, Dubautia raillardioides, Gahnia vitiensis, Leptechophylla tameiameiae, Lobelia kauaensis, Machaerina angustifolia, Machaerina

mariscoides, Melicope spp., Psychotria wawrae, Sadleria pallida, Scaevola gaudichaudii, Sphenomeris chinensis, Syzygium sandwicensis, Tetraplasandra oahuensis, or Vaccinium dentatum; and

(ii) Elevations between 394 and 1,006 (1,291 and 3,301 ft).

Special Management Considerations or Protections

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Two types of flowers are present. One is self-pollinating and does not open, while the other opens and requires cross-pollination. Five plants were seen flowering by botanists from the National Tropical Botanical Garden while conducting a bog survey in December 1994 (Steve Perlman, personal communication 1997). No additional life history information for this species is currently available (USFWS, 1998).

Habitat Type

Adult: Montane bogs (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (USFWS, 1998)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1998)

Site Fidelity

Adult: High (inferred from USFWS, 1998)

Habitat Narrative

Adult: Wet habitats. Montane bogs, and on ridges. (NatureServe, 2015). Viola kauaiensis var. wahiawaensis is found in open bog surrounded by low scrub ofohia, uluhe Diplopterygiumpinnatum and ohia ha at about 640 meters (2,100 feet) elevation and in wet shrubland dominated by uluhe ground cover, with scattered ohia and Syzygium sp., at about 865 meters (2,840 feet) elevation (USFWS 1996) (USFWS, 1998). High ecological integrity of the population and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirements of the species and the fact that there is only one known population.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: No information found

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Number of Populations:

1? New population that has not been confirmed (USFWS, 2022).

Population Size:

100? New population that has not been confirmed (USFWS, 2022).

Population Narrative:

Fragility unknown. No counts or estimates. 1 current and no historical occurrences. (NatureServe, 2015). Low resiliency, redundancy and represenation are inferred based on the fact that there only two known populations with few individuals (NatureServe, 2015). New Status Information: In addition to those populations cited in the previous 5-year review, new observations include the following: • At the time of the last 5-year review in 2009 there were two populations totaling fewer than 50 individuals in the Wahiawa bog and on the ridge between the summits of Kapalaoa and Kahili on the island of Kauai. Currently, there is one population in the same area totaling between one and two individuals (PEPP 2017; Walsh 2017, in litt.). Another population of more than 100 individuals was discovered at Kawaikini; however, the identity of these plants has not been confirmed (PEPP 2015) (USFWS, 2017). Island Distribution: Kauai Known or estimated number of populations: 1 (USFWS, 2021c). Known or estimated number of individuals: 1-2 (USFWS, 2021c). Viola kauaensis var. wahiawaensis was last observed in 2013 at one population from the Wahiawa bog on Kaua‘i (Kishida and Perlman 2013). No plants were observed at the same population during the most recent survey in 2017 (Kishida and Perlman 2017). The previous 5-year review reported another population of more than 100 individuals was discovered at Kawaikini; however, the identity of these plants has not been confirmed (Plant Extinction Prevention Program [PEPP] 2015). Surveys to locate additional plants are ongoing (PEPP 2021) (USFWS, 2022).

Threats and Stressors

Stressor: Reduced vegetative vigor (USFWS, 2009)
Exposure:
Response:
Consequence: Extinction
Narrative: Reduced reproductive vigor due to the small number of existing populations and individuals is considered one of the main threats to this species (USFWS, 2009).

Stressor: Feral pigs (USFWS, 2009)
Exposure:

Response:
Consequence: Loss of habitat/habitat degradation
Narrative: Habitat degradation from the rooting activities of feral pigs (Sus scrofa) is a major threat to this species (USFWS, 2009).

Stressor: Invasive plants (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Competition with introduced invasive plants such as Juncus planifolius (broadleaf rush) and Pterolepis glomerata (False meadowbeauty) (Factor E) (Lorence and Flynn 1991; Wood 1994; USFWS 1996, 1998, 2003) is listed as a threat to this species (USFWS, 2009).

Stressor: Over collection (USFWS, 2009)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Collection other than for conservation purposes is considered a threat to this species due to the detrimental effect that collection may pose to the small population (Factor B) (USFWS 1998, 2003) (USFWS, 2009).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: Climate change may pose a threat to this species. Fortini et al. (2013) conducted a landscape-based assessment of climate change vulnerability for native plants of Hawaii using high resolution climate change projections. Climate change vulnerability is defined as the relative inability of a species to display the possible responses necessary for persistence under climate change. The assessment by Fortini et al. (2013) concluded that Viola kauaensis var. wahiawaensis is highly vulnerable to the impacts of climate change, with a vulnerability score of 0.622 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). Therefore, additional management actions are needed to conserve this taxon into the future.

Recovery

Reclassification Criteria:
For downlisting, a total of five to seven populations of each taxon should be documented on Kauai where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of5 consecutive years before downlisting is considered (USFWS, 1998).

Recovery Priority Number: 6

Delisting Criteria:

For delisting, a total of 8 to 10 populations of each taxon should be documented on Kauai where they now occur or occurred historically. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum of300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of5 consecutive years (USFWS, 1998).

Recovery Actions:

- Recommendations for Future Actions: Since the last 5-year review in 2009, a new population of Viola was observed, but it is uncertain at this time if it is Viola kauaensis var. wahiawaensis. Therefore, the following recommendations for future actions reflect this potentially new population and are reiterated for the 5-year review for 2017. • Surveys and inventories—Survey geographical and historic range for a thorough current assessment of the species. • Ungulate monitoring and control—Continue to construct and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. Continue to protect all occurrences against disturbances from feral ungulates. • Invasive plant monitoring and control— o Control established ecosystem-altering nonnative invasive plant species around all populations. o Control invasive nonnative plant species around all populations that compete with the species. • Captive propagation for genetic storage and reintroduction—Implement propagation efforts for maintenance of genetic stock. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species. • Population biology research—Study Viola kauaensis var. wahiawaensis populations to determine viable population size and structure, geographical distribution, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats. • Species identification and taxonomy – Determine the species of the Viola population discovered at Kawaikini (USFWS, 2017).
- Collect genetic resources for storage, future propagation and reintroducing into protected suitable habitat within historical range (USFWS, 2009).
- Enhance current natural population to increase numbers of individuals and establish new populations as material becomes available from propagation (USFWS, 2009).
- Expand existing exclosure fences to protect all individuals from the negative impacts of feral pigs and construct new fences within suitable habitat, and eradicate introduced invasive plant species within the exclosures (USFWS, 2009).
- Work with the Kauai Watershed Alliance to continue and expand ecosystem-level management of the Wahiawa Bog area (USFWS, 2009).
- Survey geographical and historical range for a thorough current assessment of the species (USFWS, 2009).
- Assess genetic variability of extant populations (USFWS, 2009).
- Study Viola kauaiensis var. wahiawaensis populations with regard to population size and structure, geographical distribution, flowering cycles, pollination vectors, seed dispersal agents, longevity, specific environmental requirements, limiting factors, and threats (USFWS, 2009).
- New Management Actions: • PEPP has outplanted four individuals in a fenced exclosure at Kanaele Bog and monitors this area (PEPP 2015). • We are unaware of any ex situ collections of this species.

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: No significant new information regarding the species' biological status has been reported since the last 5-year review in 2017. Thus, the following recommendations for future actions are reiterated or updated for the 5-year review for 2022. • Surveys and inventories—Continue to survey within and adjacent to the historical range and suitable habitat and monitor known populations of Viola kauaensis var. wahiawaensis. • Ungulate monitoring and control—If Viola kauaensis var. wahiawaensis is found during surveys, construct and maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates and maintain small-scale fenced exclosures around all populations to prevent imminent extinction. • Invasive nonnative plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species, and those that compete with Viola kauaensis var. wahiawaensis. • Site and habitat protection—Develop and implement effective control measures to reduce the impacts of drought and landslides. • Fire prevention and control—Continue to develop and implement fire prevention management plans. • Climate change adaptation strategy—Research suitability of habitat for reintroduction of this species in the future due to the impacts of climate change. • Captive propagation for genetic storage and reintroduction—Implement propagation efforts to maintain genetic stock. • Reintroduction and translocation—Reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within the population and plan an effective breeding program. • Species identification and taxonomy – Determine the species of the Viola population discovered at Kawaikini (USFWS, 2022).

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SPECIES ACCOUNT: *Viola lanaiensis* (No common name)

Species Taxonomic and Listing Information

Listing Status: Endangered; 09/20/1991; Pacific Region (R1) (USFWS, 2016)

Physical Description

A small, erect, unbranched or few-branched subshrub 10-40 cm tall. Leaves long and narrow, and are clustered toward the upper part of the stem. Flowers are white tinged purple or with purple veins. (NatureServe, 2015)

Taxonomy

Viola lanaiensis was first formally described by Rock as a variety of Viola helenae (Viola helenae var. lanaiensis) from his own collection of the plants from 1910 (Rock 1911). Before Viola helenae had been described (Forbes 1909), Hillebrand (1888) had noted that a plant collected by Remy on Lana'i was probably Viola robusta. This plant must have been Viola lanaiensis, since it is the only taxon of Viola that occurs on Lana'i (Becker 1916, MacCaughey 1918, St. John 1989, Skottsberg 1940, Wagner et al. 1990). Wilhelm Becker described the taxon as Viola lanaiensis (Becker 1916) independently and without knowledge of Rock's 1911 publication (USFWS 1991). Skottsberg accepted Rock's taxonomy (Skottsberg 1940), but St. John reinstated Becker's designation of the plant as a separate species (St. John 1979) (USFWS, 1994).

Historical Range

See current range/distribution

Current Range

Current range: Lanai. Historically no additional range.

Critical Habitat Designated

Yes; 3/30/2016.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Viola lanaiensis under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes an unknown number of critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

Critical Habitat Designation

The critical habitat designation for Viola lanaiensis includes an unknown number of CHUs in Maui County, Hawaii. The number of CHUs is unknown because detailed CHU information is not available fot the island of Lanai (81 FR 17790-18110).

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Viola lanaiensis critical habitat consists of three components. Montane wet (Lanai), Dry cliff (Lanai) and Wet cliff (Lanai) (81 FR 17790-18110):

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Dry Cliff. Elevation: unrestricted. Annual precipitation: <75 in (<190 cm). Substrate: >65 degree slope, rocky talus. Canopy: None. Subcanopy: Antidesma, Chamaesyce, Diospyros, Dodonaea. Understory: Bidens, Eragrostis, Melanthera, Schiedea.

Ecosystem: Wet Cliff. Elevation: unrestricted. Annual precipitation: >75 in (>190 cm). Substrate: >65 degree slope, shallow soils, weathered lava. Canopy: None. Subcanopy: Broussaisia, Cheirodendron, Leptecophylla, Metrosideros. Understory: Bryophytes, Ferns, Coprosma, Dubautia, Kadua, Peperomia.

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire,

drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Unknown (USFWS, 1994)

Reproduction Narrative

Adult: When approximately 21 plants were observed in October 1992 (R. Hobdy, L. Loope, A. Medeiros, and P. Thomas, personal observation 1992), one small fruit was noted; however, October may not have been the optimum time to observe flowering or fruiting. One sighting of this plant was on a relatively new landslide CHHP 1991); the rapid establishment of this taxon under these circumstances may reflect a high sensitivity to competition. Flowering time, pollination vectors, seed dispersal agents, longevity of plants and seeds, specific environmental requirements, and other limiting factors are unknown (USFWS, 1994).

Habitat Type

Adult: Moist forests and wet cloud forests (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (Inferred from USFWS, 2012)

Environmental Specificity

Adult: Narrow/specialist (Inferred from USFWS, 2012)

Tolerance Ranges/Thresholds

Adult: Low (Inferred from USFWS, 2012)

Site Fidelity

Adult: Low (Inferred from USFWS, 2012)

Habitat Narrative

Adult: Species inhabits moist forests and wet cloud forests on gulch slopes and gulch bottoms (NatureServe, 2015). The habitat of the Awehi population of Viola lanaiensis is stratified, with the middle to upper slopes consisting of Metrosideros polymorpha (ohia)- Dicranopteris linearis (uluhe) lowland mesic forest. A distinct change occurs along the lower slopes, where the community is composed of Nestegis sandwicensis (olopua), Myrsine lanaiensis (kolea), Scaevola chamissoniana (naupaka), Kadua affinis (manono), Antidesma platyphyllum (hame), Pouteria sandwicensis (alaa), and Freycinetia arborea (ieie) (Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010). At Kunoa Gulch, Viola lanaiensis is found in a Metrosideros polymorphaDicranopteris linearis lowland wet to riparian forest associated with Pittosporum confertiflorum (hoawa), Pipturus albidus (mamaki), Perrottetia sandwicensis (olomea), Scaevola chamissoniana, Broussaisia arguta (kanawao), Cyrtandra grayana (haiwale), Freycinetia arborea, Sadleria pallida (amau), and Diplopterygium pinnatum (uluhe lau nui) (Wood 2005). The discovery of a colony of 27 individuals (all size classes) of Viola lanaiensis in Kunoa Gulch in 1991 on a relatively new landslide suggests that it is a pioneer species that does not respond well to competition (USFWS 1995; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010). Havran (2008) characterized known populations as typically being distributed on steep banks dominated by Metrosideros polymorpha (ohia), but was unable to conclude whether extant populations represent the optimal range of this species, or whether the species has been displaced from its preferred native range by invasive introduced plants and ungulates (USFWS, 2012). Clumped spatial arrangement of the population, narrow environmental specificity, low tolernace ranges and high site fidelity and

ecological integrity of the population are inferred based on the specific habitat requirements of this species and the apparent need for a lack of competition in order to truly thrive in its habitat.

Dispersal/Migration

Dispersal

Adult: Unknown (USFWS, 1994)

Dispersal/Migration Narrative

Adult: Seed dispersal agents are unknown (USFWS, 1994)

Population Information and Trends

Population Trends:

Decreasing (USFWS, 2012)

Number of Populations:

8 Total. 3 on Lanai, 5 on Maui (USFWS, 2023)

Population Size:

23 Total Lanai. ~300 Maui (USFWS, 2023)

Population Narrative:

Fragility unknown. Fewer than 90 plants known. 3 current (between 1982 and 1997) and 7 historical occurrences. (NatureServe, 2015). In 1991, there were 38 to 40 individuals in the vicinity of Kunoa Gulch (Hawaii Biodiversity and Mapping Program 2010). These populations have not since been reported as extant, but Wood (2005) reported a new sighting of a single individual in 1997 in Kunoa Gulch (Hawaii Biodiversity and Mapping Program 2010). Subsequently, no individuals were observed in Kunoa until nine individuals were found scattered in the main gulch and a tributary in 2007 (Plant Extinction Prevention Program 2007). In 2008, an additional four individuals were found in another subgulch (Plant Extinction Prevention Program 2008). The latest census totals are: two populations (Kunoa Gulch and Awehi) with 20 mature individuals (Plant Extinction Prevention Program 2009, 2010; USFWS 2010) and 6 seedlings (H. Oppenheimer, pers. comm. 2010) (USFWS, 2012). Low resiliency, representation and redundancy are inferred based on the low number of individuals and populations as well as the specific habitat requirements for the species (USFWS, 2012). New Status Information: • A new population of 140 individuals of Viola sp. was discovered on west Maui in 2010. The genetic and morphological analysis by Havran et al. (2012) showed that the west Maui population is indistinguishable from (conspecific with) Viola lanaiensis. It is not known whether the populations on Lānaʻi and west Maui represent vestiges of a much larger population that was continuous throughout Maui Nui, or if the presence of the species on either island represents the result of interisland dispersal (Havran et al. 2012). • Currently, there are three populations on Lanai totaling approximately 300 individuals and two subpopulations on west Maui totaling about the same number of individuals (Oppenheimer 2018, in litt.; PEPP 2012, 2015, 2017a, b, 2018). The population at Kunoa Gulch on Lānaʻi is gone (Oppenheimer 2018, in litt.). • In 2012, the Service revised critical habitat for Viola lanaiensis, and the proposed rule identified six critical habitat units in three ecosystems (montane wet, dry cliff, and wet cliff) on Lānaʻi (2,044 ac, 828 ha) (77 FR 34464, July 11, 2012). In the final rule, the Service excluded critical habitat for

this species on the island of Lānaʻi because, as demonstrated by the ongoing conservation activities by the private landowner, their commitment to develop the Lānaʻi Natural Resources Plan, and a memorandum of understanding with the Service, exclusion from critical habitat would provide greater long-term benefits to the species than designation of critical habitat (USFWS 2015; 81 FR 17790, March 30, 2016). • In 2016, no critical habitat units were designated on west Maui for V. lanaiensis because the identity of the west Maui occurrence was not assured at the time of document preparation (USFWS,2018). Currently, there are 3 wild populations on Lānaʻi totaling 23 total individuals, 18 mature and 5 immature plants, and 5 wild populations on Maui totaling approximately 300 individuals, approximately 200 mature and 100 immature plants (PEPP 2022). There is one reintroduced population on Maui with 26 total plants, 12 mature, and 14 immature individuals (PEPP 2018). There is also one reintroduced population on Lānaʻi totaling 8 individuals (PEPP 2018). • Currently, there are approximately 6 founder lines represented in ex situ storage and propagation collections. o Lyon Arboretum Seed Conservation laboratory reports approximately 2,740 seeds in storage representing 5 founder lines (Lyon Arboretum 2022). o National Tropical Botanical Garden (NTGB) reports 19 seeds in storage representing one founder (NTGB 2022). o There are no reported propagules of Viola lanaiensis in storage at Lyon Arboretum Micropropagation Laboratory (Lyon Arboretum 2022). o Olinda Rare Plant Facility (ORPF) reports 23 individual plants in cultivation representing 6 founders (ORPF 2023) (USFWS, 2023).

Threats and Stressors

Stressor: Ungulate degradation (USFWS, 2012)
Exposure:
Response:
Consequence: Habitat loss/habitat degradation
Narrative: Ungulate degradation of habitat – Axis deer (Axis axis) (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Invasive plants (USFWS, 2012)
Exposure:
Response:
Consequence: Habitat loss/habitat degradation
Narrative: Established ecosystem-altering invasive plant species degradation of habitat (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) o Melinis minutiflora (molasses grass) o Morella faya (firetree) o Psidium cattleianum (strawberry guava) o Rubus rosifolius (thimbleberry). Established invasive plant species competition (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; Wood 2005; H. Oppenheimer, pers. comm. 2010) o Adiantum hispidulum (rough maiden-hair) o Blechnum appendiculatum (palm fern) o Christella parasitica (no common name) o Cinnamomum burmanii (Padang cassia) o Deparia petersenii (no common name) o Leptospermum scoparium (New Zealand tea) o Pluchea carolinensis (sourbush) (USFWS, 2012).

Stressor: Landslides and flooding (USFWS, 2012)
Exposure:
Response:

Consequence: Loss of habitat
Narrative: Landslides and flooding (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Ungulate predation or herbivory (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Ungulate predation or herbivory – Axis deer (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Rodent predation or herbivory (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Rodent predation or herbivory – Rats (Rattus spp.) (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

Stressor: Nonnative bird predation (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Nonnative bird predation (Plant Extinction Prevention Program 2008, 2009, 2010; Hawaii Biodiversity and Mapping Program 2010; H. Oppenheimer, pers. comm. 2010) o Feral turkeys (Meleagris gallopavo) o Chickens (Gallus gallus domesticus) o Black francolin (Francolinus francolinus) (USFWS, 2012).

Stressor: Fire (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Fire is listed as a threat to this species (USFWS, 2012).

Stressor: Drought (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Drought is listed as a threat to this species (USFWS, 2012).

Stressor: Ungulate trampling (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: Ungulate trampling is listed as a threat to this species (USFWS, 2012).

Stressor: Low numbers (USFWS, 2012)
Exposure:
Response:
Consequence: Extinction
Narrative: Low numbers is listed as a threat to this species (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Climate change may pose a threat to this species. However, current climate change analyses in the Pacific Islands lack sufficient spatial resolution to make predictions on impacts to this species. The Pacific Islands Climate Change Cooperative (PICCC) has currently funded climate modeling that will help resolve these spatial limitations. We anticipate high spatial resolution climate outputs by 2013 (USFWS, 2012).

Stressor: Predation and herbivory by slugs
Exposure:
Response:
Consequence:
Narrative: Predation and herbivory by slugs is noted to be a threat to Viola lanaiensis on west Maui (Oppenheimer 2018, in litt.; PEPP 2017a).

Stressor: Climate change loss or degradation of habitat
Exposure:
Response:
Consequence:
Narrative: We previously reported that climate change may pose a threat to this species, anticipating an analysis by 2013. The assessment conducted by Fortini et al. (2013) concluded that Viola lanaiensis is extremely vulnerable to the impacts of climate change, with a vulnerability score of 0.922 (on a scale of 0 being not vulnerable to 1 being extremely vulnerable to climate change). In addition, the assessment classified V. lanaiensis as a “wink-out” species. “Wink-out” species are those species with no future climate envelope. No projected suitable climate areas exist for the species to persist in the future. Therefore, additional management actions are needed to conserve this taxon into the future, such as identifying suitable microsites where climate change is anticipated to occur more slowly and considering suitable habitat on islands outside of its known range.

Stressor: Treefall (USFWS, 2023)
Exposure:
Response:
Consequence:
Narrative: Treefall (USFWS, 2023)

Recovery

Reclassification Criteria:

For downlisting, a total of five to seven populations of each taxon should be documented on Lanai and at least one other island where they now occur or occurred historically. In certain cases, however, a particular taxon may be eligible for downlisting even if all five to seven of the populations are on only one island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not in danger of extinction throughout all or a significant part of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials, and a minimum of 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years before downlisting is considered (USFWS, 1994).

Recovery Priority Number: 2

Delisting Criteria:
For delisting, a total of 8 to 10 populations of each taxon should be documented on Lanai and at least 1 other island where hey now occur or occurred historically. As with downlisting, there may be cases in which a particular taxon may be eligible for delisting even if all 8 to 10 of the populations are on only 1 island, provided all of the other recovery criteria have been met and the populations in question are widely distributed and secure enough that one might reasonably conclude that the taxon is not likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. Each of these populations must be naturally reproducing, stable or increasing in number, and secure from threats, with a minimum of 100 mature individuals per population for long-lived perennials and a minimum or 300 mature individuals per population for short-lived perennials. Each population should persist at this level for a minimum of 5 consecutive years (USFWS, 1994).

Recovery Actions:
- Current conservation efforts: ? Ungulate exclosure: o Castle and Cooke have begun the construction of approximately 35 kilometers (22 miles) of fencing around Lanaihale to control the depredations of feral axis deer. The fence will be completed in three increments. The first increment is completed and the second increment is well under construction (H. Oppenheimer, pers. comm. 2010). o The Awehi population is in a fenced exclosure of about 2 hectares (5 acres). Besides Viola lanaiensis, the Awehi exclosure also protects the only two known individuals of Cyanea munroi, several individuals Labordia tinifolia var. lanaiensis, and Pleomele fernaldii. o Staff of the Maui Nui Plant Extinction Prevention Program inspect the fenced exclosure at Awehi on a regular basis and makes repairs as necessary. Currently, erosion is undermining the fence, which was not constructed with a complete ground secured apron around the perimeter (H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).
- Current conservation efforts: ? Captive propagation for genetic storage and reintroduction: o In 2011, the National Tropical Botanical Garden (2011) reported 31 seeds in genetic storage. o The Plant Extinction Prevention Program (2009) reported a single immature fruit was collected from the Awehi population for tissue culture by Lyon Arboretum; seeds have been collected several times but have not been successfully germinated (H. Oppenheimer, pers. comm. 2010). o The Lyon Arboretum Micropropagation Laboratory reported a single individual in genetic storage (Harold L. Lyon Micropropagation Laboratory 2010). ? Population viability monitoring – Individuals located within the Awehi exclosure and at Kunoa Gulch have all been numbered, tagged, and mapped with a Global Positioning System

to ensure traceable seed parentage, and are being closely monitored for seed production (Plant Extinction Prevention Program 2007; H. Oppenheimer, pers. comm. 2010) (USFWS, 2012).

- Recommendations for Future Actions: Herbivory by slugs is noted as a new threat to the species; however, we are not aware of significant new information regarding the species' biological status since the last 5-year review in 2012. Thus, the following recommendations for future actions are added or reiterated for the 5-year review for 2018. • Surveys and inventories—Continue to conduct thorough surveys of suitable habitat where Viola lanaiensis was last observed. • Ungulate monitoring and control— o Protect all populations from disturbances by feral ungulates. o Complete the Lānaʻihale fencing project and repair fence apron to prevent ungulate ingress. o Monitor all fences, including those at ʻĀwehi and Puhielelu on Lānaʻi. o Assess the need for fencing at the west Maui occurrences. • Invasive plant monitoring and control—Control established ecosystemaltering nonnative invasive plant species around populations of V. lanaiensis. • Habitat and natural process management and restoration—Develop and implement effective measures to reduce the impacts of tree fall, drought, landslides, and erosion. • Captive propagation for genetic storage and reintroduction— o Continue to collect seeds and track individuals carefully for use in ex situ propagation to maximize genetic variation. o Continue to collect soil from areas of previously known individuals for germination trials. • Reintroduction and translocation— o Continue to reintroduce individuals at protected sites within historical range. o Determine new sites for reintroduction that have the highest likelihood of success. • Predator and herbivore control— o Implement effective control methods for rats. o Determine and implement effective control methods for slugs. o Study the impact of predation by nonnative birds and if necessary, determine and implement effective control methods. o Monitor wild and reintroduced populations of V. lanaiensis for evidence of insects and diseases, and implement effective control methods if necessary. • Climate change adaptation strategy—Assess the effects of climate change on this species and use to determine future landscape needed for the recovery of the species. • Alliance and partnership development—Work with the Hawaiʻi Division of Forestry and Wildlife, the PEPP, Pūlama Lānaʻi, and other land managers to initiate planning and contribute to ecosystem-level restoration and management to benefit this species (USFWS, 2018).
- ? Captive propagation for genetic storage and reintroduction o Continue to collect seeds from tagged individuals, keeping close track of the maternal source for use in ex situ propagation. o Continue to collect seeds from all existing populations and send to at least two or three different venues for propagation (USFWS, 2012).
- Reintroduction / translocation protocol development – Maximize the genetic variation among individuals at each reintroduction site, based on microsatellite data and detailed information from crossing records (USFWS, 2012).
- Reintroduction / translocation site identification – While surveying for new populations or reintroduced populations, determine which sites are least invaded by invasive introduced plant species and which appear to have the highest likelihood of maintaining new reintroductions (USFWS, 2012).
- Reintroduction / translocation implementation – Once sites are identified and protected from feral ungulates, reintroduce the species back into its known historical range (USFWS, 2012).
- Ungulate exclosure: o Complete repairs of fenced exclosure at Awehi by securing an apron around the perimeter of the fence to prevent erosion. o Complete the Lanaihale fencing

project. o Continue to monitor all fences for any signs of breaching (USFWS, 2012).

- Ungulate control – Protect all populations against disturbances from feral ungulates (USFWS, 2012).
- Ecosystem-altering invasive plant species control – Control invasive introduced plant species around all populations (USFWS, 2012).
- Predator / herbivore control – Implement effective control methods for rodents (USFWS, 2012).
- Threats research – Study the impact of nonnative bird predation on populations of Viola lanaiensis. If necessary determine and implement effective control methods (USFWS, 2012).
- Threat monitoring and control – Monitor newly established reintroduced and wild populations for evidence of plant disease and insect predation. If threats are found implement effective control methods (USFWS, 2012).
- Site / area / habitat protection – Develop and implement effective measures to reduce the impact of tree fall, drought, and landslides and erosion (USFWS, 2012).
- Surveys / inventories – Continue to conduct thorough surveys of all suitable habitats where Viola lanaiensis was historically seen (USFWS, 2012).
- Alliance and partnership development – Work with Castle and Cooke and other land managers to initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2012).
- Threats research – Assess the modeled effects of climate change on this species, and use to determine future landscape needed for the recovery of the species (USFWS, 2012).
- New Management Actions: • Surveys and inventories—The Plant Extinction Prevention Program (PEPP) surveys for new populations and monitors the known population of Viola lanaiensis on Lanai and west Maui (PEPP 2012, 2013, 2014, 2015, 2016, 2017a, 2018). Soil samples at Kunoa Gulch and Puhielelu on Lanai are tested for possible seed banks. • Ungulate monitoring and control—Fences are checked and repaired as necessary (PEPP 2015, 2016). • Invasive plant monitoring and control—PEPP monitors and controls nonnative plants at all occurrences of V. lanaiensis (PEPP 2012, 2013, 2014, 2015, 2016, 2017a, 2018). • Captive propagation for genetic storage and reintroduction— o PEPP collects seeds for storage at Lyon Arboretum and for propagation at the Olinda Rare Plant Facility (ORPF) (PEPP 2012, 2016, 2017a). o The Lyon Arboretum micropropagation facility reported 142 containers of propagules of Viola lanaiensis in storage. The Lyon Arboretum Seed Conservation Laboratory reported 130 seeds in storage from the Awehi population in 2013; 2,166 seeds in storage in from ʻĀwehi and 22 seeds from Launiupoko in 2014; 87 seeds in storage from ʻĀwehi in 2015, and 2 seeds in storage from Launiupoko in 2016, for a total of over 2,400 seeds (Lyon Arboretum 2017). o The Olinda Rare Plant Facility (ORPF) reported seven plants in propagation representing four individuals from Puhielelu (ORPF 2013, 2014, 2015, 2017). • Reintroduction and translocation—In 2013, four individuals were outplanted at Lihau on west Maui. In 2014, 14 individuals were outplanted at Launiupoko on west Maui. In 2015, four individuals were outplanted at Awehi on Lanai. In 2018, 56 were outplanted at Awehi, with 35 currently remaining at that site (PEPP 2013, 2014, 2015, 2018).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: Herbivory and predation by rats and treefall are noted as no threats, however, no significant new information regarding the species' biological status has been reported since the last 5-year review in 2018. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2023. • Surveys and monitoring—Survey for

additional populations of Viola lanaiensis in areas of potentially suitable habitat. • Ungulate monitoring and control—Continue to maintain fenced exclosures and construct new fences to protect individuals from the negative impacts of browsing by ungulates. • Invasive nonnative plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Viola lanaiensis within and around all wild and translocated populations. • Fire prevention and control—Continue to develop and implement fire prevention management plans and monitor populations after fire occurrence. • Climate change adaptation strategy—Research suitability of habitat for viability of species, including where to conduct translocations in the future due to the impacts of climate change, including increasing temperatures, periods between rain events, and frequency and intensity of hurricanes. Additional management actions may be needed, such as locating microsites that overlap with current and future climate envelopes for translocation efforts. • Predator and herbivore monitoring and control—Determine and implement effective methods for rodents and slugs around wild and translocated populations. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Build resiliency, redundancy, and representation — Increase species' viability through habitat restoration, threat control, and reintroduction and translocation. Continue reintroduction into suitable habitat that is being managed for known threats to this species to reduce impacts of erosion, treefall, flooding, and hurricanes. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species (USFWS, 2023).

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SPECIES ACCOUNT: *Warea amplexifolia* (Wide-leaf warea)

Species Taxonomic and Listing Information

Listing Status: Endangered; 05/29/1987; Southeast Region (R4)

Physical Description

Warea amplexifolia is an annual herb in the mustard family (Brassicaceae). Plants may be 30 to 100 cm tall and the stalk may be unbranched or, more often, branching midway up the stem. Leaves are alternate, from 2 to 5 cm long, and 1 to 3 cm wide, smaller as they ascend the stalk, with a rounded apex and entire margin. On young plants, the leaves are slightly folded along the midrib, tipped upward, and the lobes at the base of leaves reach around the stem. This characteristic has led to one of the common names for the species, clasping warea. The heart-shaped clasping leaf bases and its pale green, slightly glaucous leaves readily distinguish W. amplexifolia from the three other species in its genus in Florida. The characteristic leaves can be used in field identification even if the plants are not flowering. The pale lavender flowers of W. amplexifolia vary in individuals from almost white to almost purple. Flowers appear at the ends of the branches in spherical clusters about 5 to 6 cm across. Superficially, the flowers look like small versions of the garden cleome (Cleome hasslerana), a member of the family Capparaceae. The inflorescences are dainty, and in the field the flowering plants look almost fluffy. Individual flowers are about 1.5 cm across, with four petals and six long stamens. Warea amplexifolia is also readily identifiable in seed, even as the stalk turns brown and the leaves wither, by the clusters of narrow down-curving seed pods, from 5 to 7 cm long. The pods split longitudinally, with small black seeds on either side of the center membrane. (USFWS, 1999)

Taxonomy

Warea amplexifolia was originally described by Thomas Nutall in 1822 from a specimen collected in central peninsular Florida by N.A. Ware. Nutall at first placed this plant in the genus Stanleya, but in 1834 transferred it to the genus Warea and provided an amplified description that accommodated specimens from the Florida panhandle. The panhandle specimens were later recognized as a distinct species, Warea sessilifolia, by Nash. Shinners (1962) proposed a new name for the peninsular species, Warea auriculata, but most authors consider W. amplexifolia the correct name (Payson 1922, Channel and James 1964, Judd 1980). (USFWS, 1999)

Historical Range

Judd (1980) believed the former range of W. amplexifolia included Lake County, western Orange County, extreme northwestern Osceola County, and northern Polk County, Florida. (USFWS, 1999)

Current Range

Endemic to the Lake Wales Ridge of central Florida in Lake, Orange, and Polk counties (USFWS, 2017)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Sexual (Produces seeds) Abiotic (wind), Biotic (Hymenoptera; Lepidoptera) (USFWS, 1999)

Lifespan

Adult: Annual (USFWS, 1999)

Breeding Season

Adult: Flowering occurs from mid-August to early October, and fruiting occurs from late September to mid-November (USFWS, 1999)

Reproduction Narrative

Adult: Warea amplexifolia flowers from mid-August to early October, and fruiting occurs from late September to mid-November. Senescence occurs just before the fruit matures, and the population overwinters as seeds. The showy flowers are pollinated by various Hymenoptera (bees) and Lepidoptera (butterflies). Reproduction is exclusively sexual, with seeds probably released from the pods by wind action. The small seeds generally fall near the parent plant (FWS 1986). Experimental propagation to field plots at Bok Tower Gardens suggests that the number of flowering plants is related to the amount of rainfall during the December prior to the growing season. They also found that plants grew from seeds that had been sown into the experimental plots 2 to 4 years earlier, which indicates that seed banking in the soil is important in this species (Bok Tower Gardens 1994). (USFWS, 1999)

Habitat Type

Adult: Terrestrial (NatureServe, 2015)

Habitat Vegetation or Surface Water Classification

Adult: Oak sandhills and sand pine-scrub oak scrub (NatureServe, 2015)

Dependencies on Specific Environmental Elements

Adult: Sunny openings with exposed sand in longleaf pine/turkey oak sandhills and sand pine-scrub oak scrub. (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (inferred from NatureServe, 2015)

Environmental Specificity

Adult: Narrow/Specialist (NatureServe, 2015)

Habitat Narrative

Adult: Warea amplexifolia is endemic to high pine ecosystems of Florida. The high pine refers to the hilly portions of the ecosystem rather than the stature of the pines themselves. The undulating xeric sand ridges supporting the high pine are known as sandhills and the entire community is referred to by the same term. Sandhills are maintained under natural conditions by frequent patchy summer fires sparked by lightning. The resulting habitat condition is an open, often sparse over-story plant assemblage of longleaf pine (Pinus palustris), longleaf

pine/turkey oak (Quercus laevis), or live oak/bluejack oak (Q. geminata/Q. incana) with an open, park-like understory. The ground cover consists of perennial grasses and forbs interspersed with deciduous clonal oaks (Myers 1990). Warea amplexifolia occurs on welldrained, sterile, yellow sands and is typically widely scattered in the sunny openings of the sandhills. (USFWS, 2017)

Dispersal/Migration

Motility/Mobility

Adult: Moderate (NatureServe, 2015)

Dispersal

Adult: Abiotic (wind) (NatureServe, 2015)

Dispersal/Migration Narrative

Adult: Seed is dispersed by wind (NatureServe, 2015)

Population Information and Trends

Number of Populations:

9 naturally occurring (USFWS, 2022)

Population Size:

over 10,000 individual plants (USFWS, 2017)

Population Narrative:

The most recent data suggest there are over 10,000 plants in the 9 extant natural populations (Peterson 2016); however, the Warea Tract in Lake County and the Ocklawaha property (Ocklawaha North EOR #28 and Ocklawaha South EOR #30) in Marion County typically account for greater than 95% of the plants range-wide. Lake Griffin State Recreation Area historically had a larger population, but the recent surveys suggest the population appears to be declining. The remaining six populations generally have low population numbers. (USFWS, 2017). Nine extant populations that were documented in the previous 5-year review (2017) still persist. Four populations occur on public lands while the remaining five are in private ownership. Current plant counts for these locations are not included in this reporting. The Florida Forest Service Warea Tract in Lake County and the Ocklawaha Corridor in Marion County (Duke Energy and private ownership) are the largest populations and account for ~95% of the plants range-wide (USFWS, 2022).

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: Habitat destruction, modification, and degradation on private lands remain the primary threat to the species range-wide. Populations occurring on private lands remain subject to habitat destruction or fragmentation due to development. In addition, the absence of habitat management on private lands results in unsuitable conditions for the species to successfully

flourish and reproduce. Publicly owned conservation lands typically are afforded controlled access and may even have enforcement personnel on-site to prevent destructive activities. These lands also have management plans to create, restore, or maintain desirable habitat conditions; however, budget shortfalls and staffing constraints may preclude beneficial activities in some years. Also, depending on the management plan for various public lands, not all public conservation lands where the species occurs are specifically managed to benefit W. amplexifolia. The management is often a balance of the multiuse activities occurring on the sites and prioritized accordingly to available budget and respective mission (e.g. state park, state forest, county or city utility property, etcetera). Currently, four of the extant populations (Lake Griffin State Recreation Area, Warea Tract, Sugarloaf Mountain, and Schofield Sandhill) occur on public lands, four populations (Ferndale Ridge, Bissett Property, Mountain Lake Estates, and Ocklawaha North and South) are under private ownership, and one population (Twin Lakes) occurs on private property and in a road/utility easement. (USFWS, 2017)

Stressor: Inadequacy of existing regulatory mechanisms
Exposure:
Response:
Consequence:
Narrative: The Florida Administrative Code 5B-40 (Preservation of Native Flora of Florida) provides the Florida Department of Agriculture and Consumer Services (FDACS) with limited authority to protect plants on State and private lands (primarily from the standpoint of illegal harvest). Warea amplexifolia is listed as an Endangered Plant under this statute, which requires anyone wishing to "willfully harvest, collect, pick, remove, injure, or destroy any plant listed as endangered growing on the private land of another or on any public land or water" to "obtain the written permission of the owner of the land or water or his legal representative" (FAC 5B-40.003(1)(a)). A permit is also required to transport "for the purpose of sale, selling, or offering for sale any plant contained on the endangered plant list which is harvested from such person's own property" (FAC 5B-40.003(1)(c)). (USFWS, 1999)

Stressor: Other natural or manmade factors
Exposure:
Response:
Consequence:
Narrative: Drought, fire suppression, and invasive plant species encroachment continue to negatively affect W.amplexifolia populations. The Intergovernmental Panel on Climate Change (IPCC) concluded that warming of the climate system is unequivocal (Pachauri et al. 2014). Effects associated with changes in climate have been observed including changes in arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, and wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves, and the intensity of tropical cyclones (Pachauri et al. 2014). Species that are dependent on specialized habitat types, limited in distribution, or at the extreme periphery of their range may be most susceptible to the impacts of climate change (Byers and Norris 2011; Anacker et al. 2012). However, while continued change is certain, the magnitude and rate of change is unknown in many cases. The magnitude and rate of change could be affected by many factors (e.g., circulation patterns), but we have no additional information or data regarding these factors with respect to W.amplexifolia. There is evidence that some terrestrial plant populations have been able to adapt and respond to changing climatic conditions (Franks et al. 2013). Both plastic (phenotypic change such as leaf size or phenology) and evolutionary (shift in allelic frequencies)

responses to changes in climate have been detected. Both can occur rapidly and often simultaneously (Franks et al. 2013). Relatively few studies are available, however, that (1) directly examine plant responses over time, (2) clearly demonstrate adaptation or the causal climatic driver of the responses, or (3) use quantitative methods to distinguish plastic versus evolutionary responses (Franks et al. 2013). (USFWS, 2017)

Recovery

Reclassification Criteria:
1. When 10 geographically distinct, self-sustaining populations are protected and managed (USFWS, 1993).

Recovery Priority Number: 2C

Delisting Criteria:
1. When 20 such populations are protected and managed, and each has been monitored for at least 8 years. Recovery will require a minimum of 10 years (until 2003), if establishment of new populations is prompt and obviously successful (USFWS, 1993).

Recovery Actions:

- Determine current distribution of W. amplexifolia. Conduct surveys of W. amplexifolia. Maintain distribution of known populations and suitable habitat in GIS database. Use GIS to map existing populations and to assess the species? status and trends over time. The database should contain information on locations, population sizes, and status. This information should also be used for project review, in land acquisition activities, and to coordinate updates with the FNAI database. Currently, the Lake Wales Ridge Ecosystem Working Group and Archbold Biological Station are proposing to map the entire central ridge. This information would show potential habitat for scrub and high pine endemics based on their habitat needs. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding areas has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. (USFWS, 1999)
- Continue research on life history characteristics of W. amplexifolia. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)
- Continue monitoring the existing populations of W. amplexifolia. Evaluate the effectiveness of the monitoring protocol used to assess population trends for W. amplexifolia. Monitor and detect changes in demographic characteristics., such as growth, survival, and mortality. Monitor the effects of various land management actions on W. amplexifolia. Continue to work with private landowners. Monitor introduced plants. (USFWS, 1999)
- Provide public information about W. amplexifolia. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery

of W. amplexifolia and other rare species require a self- sustaining, secure, number of natural populations. (USFWS, 1999)

- Habitat-Level Recovery Actions: Prevent degradation of existing habitat. Secure habitat through acquisition, landowner agreements, and conservation easements. Manage and enhance habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and high pine and their unique biota. (USFWS, 1999)
- Revise the current recovery plan to include objective and measurable recovery criteria that are related to reducing and/or eliminating threats to W. amplexifolia as well as updated on the species distribution and ecology (USFWS, 2007).
- Provide funding and technical support for further research on: The effects of prescribed burning and other management tools on W. amplexifolia. Continue working with public managers to increase the management on their sites. Additional life history needs. Information is needed on how W. amplexifolia plants and seeds are affected by years of drought. Genetic inbreeding depression. This information will help us determine what constitutes a stable population. The most appropriate methodology to germinate seeds, grow seedlings, and successfully out-plant seedlings to native habitats. The various pollinators (e.g. Hymenoptera and Lepidoptera), as well as how different species assist with seed dispersal (USFWs, 2007).
- Encourage non-Federal agencies to protect and manage habitat under the Partners for Fish and Wildlife Program (USFWS, 2007).
- Update the range-wide survey, that was completed by Dr. Jack Stout in 200, on all known and potential sites occupied by W. amplexifolia and determine population size. Current distribution information is needed to determine where plants currently exist and to prioritize recovery actions (USFWS, 2007).
- Consider reintroduction and monitoring of W. amplexifolia on additional publicly owned lands with suitable habitat. Prior to reintroduction, research on the microhabitat needs of W. amplexifolia should be considered. Reintroduction of W. amplexifolia could help to increase the number of populations on protected sites and augment populations where needed (USFWS, 2007).
- Acquisition and management of the remaining known populations on private lands. Areas within the Ocklawaha and Ferndale Ridge developments where native sandhill habitat still exists would be the primary areas to target near-term. (USFWS, 2017)
- Active management of the four natural populations on public lands to maintain or create openness of the habitat and to control the invasive plant species encroachment. (USFWS, 2017)
- Yearly monitoring of the natural populations and the introduced populations on public lands will be necessary to accurately determine future population viability. (USFWS, 2017)
- Continued research on life history, biology, and ecology (population genetics, seed germination, spatial seedling recruitment patterns, demography, pollination biology, microhabitat factors, etcetera). (USFWS, 2017)
- Update range-wide survey to determine number of extant populations and individual plant abundance at each location. (USFWS, 2017)
- . Continue population introductions and population augmentations. (USFWS, 2017)
- Compare sites with long-term data sets from different locations within close proximity to one another and their associated management to increase the understanding of the ecological conditions that influence population abundance. (USFWS, 2017)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES • Acquisition and management of the remaining known populations on private lands. Areas within the Ocklawaha and Ferndale Ridge developments where native sandhill habitat still exists would be the primary areas to target near-term. • Active management of the four natural populations on public lands to maintain or create openness of the habitat and to control the invasive plant species encroachment. • Update range-wide survey to determine number of extant populations and individual plant abundance at each location. • Continue collaboration with Duke Energy Corporation on compatible habitat management activities within the Ocklawaha Corridor population occurring in their right-of way (USFWS, 2022).

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SPECIES ACCOUNT: *Warea carteri* (Carter's mustard)

Species Taxonomic and Listing Information

Listing Status: Endangered; 2/20/1987; Southeast Region (R4)

Physical Description

Warea carteri is an annual herb, 0.2 to 1.5 m tall with erect green stems. The plants usually have many slender, ascending branches forming an open, rounded crown. The leaves lack stipules and are arranged alternately on the stem. Lower leaves are lost by the time the plant flowers. Leaf size and shape varies with age and position on the plant. At the time of flowering, leaf petioles range from 0.8 to 3.9 mm with blades 1to 3 cm long. Towards the tips of stems, the leaves are smaller and narrowly elliptical to almost linear, while closer to the bases of stems and branches, the leaves are larger and oblanceolate or spatulate. All leaves are rounded at the tip, their margins entire, and their bases attenuate to cuneate. The lower leaves can also be undulate, margined or lobed. The many inflorescences of W. carteri are dense, rounded racemes with many flowers (60 or more). The flowers are radially symmetric, with four white linear-oblanceolate sepals, about 4.5 mm long, and curved toward the center of the flower at the tip. The four petals are white, about 6.0 mm long, with more than half their length in the form of a slender claw. The petal's blade is nearly round with irregular margins. The six spreading stamens are irregularly subequal in length and arise from a nectar-producing floral disc. The ovary is superior, cylindric, about 2.3 mm long, and raised on a slender stalk (gynophore) about 2 mm long. The sessile stigma has two lobes. W. carteri is protandrous: the anthers begin to dehesce within an hour or two after the flower has opened. The stigmas are receptive until 2 to 4 days afterwards, by which time the stamens on that flower have dropped. Warea carteri's fruit is a silique, long, slender pod divided lengthwise by a partition (septum). The pod is flattened, cylindrical in cross-section and gently curved along its length, which is 4 to 6 cm long and 1.5 mm wide. The pod is borne on a gynophore, which is a stalk-bearing pistil 5 to 6 mm long,above a spreading pedicel, which is around 8.5 mm long.The pod carries numerous oblong seeds, each 1.5 mm long (Kral 1983). Fruits split apart passively to shed the seeds. (USFWS, 1999)

Taxonomy

Warea carteri was named by Small in 1909. A review of the genus by Channel and James in 1964 retained Small's treatment of the species. There are no scientific synonyms (Nauman 1980). Common names for the species include Carter's mustard, Carter's warea, and Carter-warea. (USFWS, 1999)

Historical Range

Carter's mustard was once found in Miami-Dade County, Florida, as well as Lake, Polk, and Highland Counties, Florida. Extirpated from extirpated from Miami-Dade County.

Current Range

On the Lake Wales Ridge in Lake, Polk, and Highlands counties, Florida (USFWS, 2019).

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Self-pollinating

Breeding Season

Adult: Flowering occurs in September and October. Fruiting occurs in October and November (USFWS, 1999)

Other Reproductive Information

Adult: Large fluctuations observed in above ground population size suggest the possibility that seed banking plays a significant role in W. carteri's biology. Environmental cues necessary for germination were explored experimentally at Archbold Biological Station. Moisture and light were found to be necessary for germination. The use of an oak leachate did not significantly affect germination. Some seeds stored in dry, dark conditions for 2 years germinated, demonstrating the potential of W. carteri's seeds to remain dormant at least that long. Fire-related cues such as heat do not stimulate germination, but germination does require light and seeds may remain dormant for more than 2 years. (USFWS, 1999)

Reproduction Narrative

Adult: Experiments have demonstrated that Warea carteri is self-pollinating, autogamous, and self-compatible (Evans et al., in press). Autogamy and self-compatibility allow isolated or sparsely distributed individuals to reproduce. Natural levels of fruit- and seed-set are quite high, with a fruit-set of 62 percent, and seed-set of 50 percent (Evans et al. in press). Self-pollinated flowers showed significantly lower fruit- and seed-set, 41 percent fruit-set and 28 percent seed-set. This indicates that insect-mediated pollination is important in keeping fruit- and seed-set high, and individual fecundity high. Pollinators appear to be the limiting factor in fruit and seed production. Because aboveground populations fluctuate wildly, autogamy helps ensure fecundity and may be a key life history trait. Germination in W. carteri occurs in late winter through early spring (January-March). Flowering occurs in September and October. Fruiting occurs in October and November, and dispersal follows in November and early December (Kral 1983). Preliminary observations of insect activity on W. carteri indicate it is a generalist with respect to pollination. A great diversity of insects visit the flowers, including native solitary bees, bumblebees, syrphids (known as hoverflies or bee-flies), wasps, flies, beetles, etc. Within-plant movements by insects appear to predominate over among-plant movements. Because of this, and in combination with the close proximity of male and female flowers in an inflorescence, self-pollination probably is a regular method of reproduction in this species. (USFWS, 1999)

Habitat Type

Adult: Upland sandy areas; xeric, shrub-dominated habitats

Environmental Specificity

Adult: Moderate (inferred from USFWS, 1999)

Habitat Narrative

Adult: Carter's mustard is found almost exclusively in upland areas and is a soil generalist, being found on yellow, gray, or white sands (Menges et al. 2007). It is found primarily in sandhills and scrubby flatwoods, and often at the ecotone between these two vegetation types. In the northern part of its range, most sites are on sandhill. This is also true for sites at Tiger Creek Preserve, a site in the central part of its range, which supports the greatest number of plants. At this site, the species is found in both high-quality, frequently burned sandhill, as well as in overgrown sandhill that could also be termed xeric hammock (Menges in litt. 2008d). Near the south end of its range (e.g., ABS), Carter's mustard is fond primarily in scrubby flatwoods, often just downhill from a ridge of yellow sand (Menges in litt. 2008e). These habitats have a range of fire return intervals from 2 to 15 years (Menges 2007). Although Carter's mustard has a large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire (Menges in litt. 2008f). Although preferring post-fire or disturbed sites, Carter's mustard is not a gap specialist. Plants often grow among dense shrubs in scrubby flatwoods or shrubby sandhill sites.

Dispersal/Migration

Dispersal/Migration Narrative

Adult: There are no obvious specialized forms of seed dispersal in W. carteri. The siliques do not open explosively; rather, the external walls of the fruit peel away from the central septum as the fruit slowly dries, exposing the mature seeds inside. The seeds drop passively to the ground or they may be flung a bit further if the plant is brushed. It's not likely that seeds are moved by wind once they reach the ground. Collection or movement of seeds of W. carteri by ants or other animals has not been studied, but there are no obvious specialized structures on the seed that would encourage such movement. (USFWS, 1999)

Population Information and Trends

Number of Populations:

50 known occurrences (USFWS, 2019)

Population Narrative:

The most recent FNAI Element Tracking Summary (FNAI 2015) reported 50 known occurrences for Carter's mustard, of which 41 were found on 12 managed areas. Historical populations in Brevard and Miami-Dade Counties are believed extirpated. Although Carter's mustard has large populations after fire, it can also recover from a persistent soil seed bank after many years or even decades without fire . Carter's mustard populations fluctuate widely from year to year. For burned populations especially, these fluctuations are biennial (peak every two years) and dampen over time. Fires usually initiate cycles, with the largest population sizes occurring the year following fire. (USFWS, 2019)

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:

Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19 percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which this species depends. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species. (USFWS, 2019)

Stressor: Limited geographic range.
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation

seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Recovery

Reclassification Criteria:

1. When enough demographic data are available to determine the appropriate numbers of self-sustaining populations required to assure 95 percent probability of persistence for 100 years (USFWS, 1999)

2. When these populations, within the historic range of W. carteri are adequately protected from further habitat loss, degradation, and fire suppression (USFWS, 1999)

3. When these sites are managed to maintain the scrubby flatwoods and turkey oak dominated high pine to support W. carteri (USFWS, 1999)

4. When monitoring programs demonstrate these sites support sufficient population sizes, are distributed throughout the historic range, and are sexually reproducing at sufficient rates to maintain the population (USFWS, 1999)

Delisting Criteria:

1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in yellow sand scrub or scrubby flatwoods habitats are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of W. carteri. Some portions of W. carteri's range have been well surveyed, yet a total distribution has not been ascertained for this species. A thorough survey is needed to determine the distribution for this species. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases, isolated. For this reason, existing populations are in need of protection from a variety of threats. (USFWS, 1999)
- Conduct research on life history characteristics of W. carteri. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species' more specific biological information is needed. (USFWS, 1999)
- Monitor existing populations of W. carteri. (USFWS, 1999)
- Provide public information about W. carteri. It is important for the recovery of this species that governmental agencies, conservation organizations, and private landowners be appropriately informed about this species. (USFWS, 1999)

- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat and ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS • Better land management is needed so that protected populations remain extant. Periodic burning is recommended to ensure that aboveground populations are replenished before seed banks decline. Adaptive management can be used based on data collected on Carter's mustard responses to various fire regimes. • Data on management activities (e.g., fire, mechanical treatments) should be gathered in management units where level 2 monitoring is being done. These can serve to link information specific to those units, including population size and trends, with detailed demographic models that are keyed to management (e.g., prescribed fire). • Detailed demographic data from three sites (Quintana-Ascencio et al. 2008) could be used as the basis of a population viability analysis that addresses questions such as how Carter's mustard responds to different fire regimes and what is the prognosis for populations of different sizes. They could also be used to make specific predictions for populations where there were estimates of population sizes. • For some or all managed sites, collection of additional data on population sizes (level 2 monitoring). These data are being collected at two sites (LWRSF and TNC Tiger Creek Preserve. For Carter's mustard, level 2 monitoring will have to be concentrated in September and October, when plants are visible and more easily counted. • More data on the response of Carter's mustard to management activities such as roller chopping, mowing, gyro-tracking, logging, and chain-saw felling. • If significant unprotected populations of Carter's mustard are discovered, these populations should be protected by land purchase or management agreements. (USFWS, 2021)

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SPECIES ACCOUNT: *Yermo xanthocephalus* (Desert yellowhead)

Species Taxonomic and Listing Information

Listing Status: Threatened; 03/14/2002; Mountain-Prairie Region (R6) (USFWS, 2016)

Physical Description

A deeply taprooted perennial herb with 1-several hollow stems that reach 3 dm in height. Leaves are leathery, alternate, lance-shaped to oval, and often folded on the midrib. Numerous flower heads, each composed of about 4-6 yellow disk flowers borne above yellow bracts, bloom in a crowded terminal cluster (the yellow involucre bracts are nearly unique in the Asteraceae). This is a highly distinctive species - a new genus was named to accommodate it, and the genus itself is easily separated from all other genera of the Asteraceae in most of the world. The closest taxonomic relatives of this desert plant occur in more moist habitats over 1000 km east. Dorn (1991) speculated that Y. xanthocephalus and these more mesic species were derived from a common ancestor, noting that temperate deciduous forests once existed in the now-arid part of Wyoming where Y. xanthocephalus is found, but that these habitats began to move eastward as regional conditions became drier during the Miocene. (NatureServe, 2015)

Taxonomy

Desert yellowhead was discovered by botanist Robert Dorn in the Beaver Rim area of central Wyoming in 1990 (Dorn 1991). Dorn estimated approximately 500 plants occurred in 1.0 hectare (ha) (2.5 acres (ac)) of sparsely vegetated, sandy hollows among sandstone outcrops. He determined this unusual plant was a member of the Aster family (Asteraceae). Upon closer examination and research, Dorn realized that the species had not been previously described and represented a new genus. Dorn (1991) described and named his discovery Yermo xanthocephalus, or literally “desert yellowhead.” Asteraceae is one of the largest plant families in the world and is comprised of many tribes (Heidel 2002). Since the original species description, more recent taxonomic work has indicated that not only is Yermo xanthocephalus the only member of a monotypic genus, Yerino, but it is the only Wyoming species in a new subtribe Tussilagininae (Cass.) (Dumort) (Barkley 1999). Preliminary results from a study comparing six species of subtribe Tussilagininae showed the specimens of desert yellowhead has less variation as a species than some other members of the subtribe (Van Vleet 1996, as cited in Scott and Scott 2009). Additionally, desert yellowhead did not overlap with the other species. In other words, individual desert yellowhead plants are very similar to each other, but very different from other Asteraceae species within the same subtribe (USFWS, 2012).

Current Range

State endemic restricted to the Beaver Rim area in the Sweetwater River Plateau in Fremont County, Wyoming. Desert yellowhead is an endemic herbaceous perennial plant that occupies two areas in Fremont County, Wyoming (see Figure 1). The two populations are located approximately 8 kilometers (km; 5 miles (mi)) apart and are on public lands administered by the BLM. (USFWS, 2020)

Critical Habitat Designated

Yes; 3/16/2004.

Legal Description

On March 16, 2004, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Yermo xanthocephalus (Desert yellowhead) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes one critical habitat unit (CHU), in Wyoming (69 FR 12278-12290).

Critical Habitat Designation

The critical habitat designation for Yermo xanthocephalus includes one CHU in Fremont County, Wyoming. This species critical habitat encompasses approximately 360 acres (146 ha) (69 FR 12278-12290).

Fremont County, Wyoming. (i) From U.S. Geological Survey 7.5? quadrangle maps Dishpan Butte and Sweetwater Station, Wyoming. T. 31 N., R. 95 W., SW¼ sec. 27, NW¼ sec. 34, and W½ W½ NE¼ sec. 34.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Yermo xanthocephalus critical habitat consists of three components (69 FR 12278-12290):

(i) Recent soils derived from sandstones and limestones of the Split Rock Formation at its junction with the White River Formation. These are shallow, loamy soils of the Entisol order that can be classified as course-loamy over sandy-skeletal, mixed, Lithic Torriorthent. The surface stratum has little organic matter, and subsurface layers show no accumulation of humus, clay, gypsum, salts, or carbonates.

(ii) Plant communities associated with Yermo xanthocephalus that include, but may not be limited to, sparsely vegetated cushion plant communities with scattered clumps of Oryzopsis hymenoides (Indian ricegrass) between 2,043 and 2,073 m (6,700 and 6,800 ft) in Fremont County, Wyoming. Species common to these communities include Arenaria hookeri (Hooker's sandwort), Astragalus kentrophyta (thistle milkvetch), Hymenoxys acaulis (stemless hymenoxy), and Phlox muscoides (squarestem phlox). These cushion-plant communities also contain natural openings.

(iii) Topographic features/relief and physical processes, particularly hydrologic processes, that maintain the shape and orientation of the hollows characteristic of Yermo xanthocephalus and maintain moisture below the surface of the ground.

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated/Vegetative buds (USFWS, 2012)

Lifespan

Adult: 21+ years (USFWS, 2012)

Breeding Season

Adult: Desert yellowhead usually flowers from mid-June to August and may prolong flowering, or flower for a second time in September (Heidel 2002). The growing season has an average of 124 days (Scott and Scott 2009) (USFWS, 2012).

Reproduction Narrative

Adult: Desert yellowhead is a long-lived perennial that produces sexually by seed and asexually by vegetative buds (Scott and Scott 2009). At least some desert yellowhead plants have a lifespan of a minimum of 21 years (Scott and Scott 2009). This species is typically described as a classic 'K' selected species, characterized by a long-lived perennial growth form, adaptation to severe habitats, and low annual reproductive output (Fertig 1995). Desert yellowhead usually flowers from mid-June to August and may prolong flowering, or flower for a second time in September (Heidel 2002). The growing season has an average of 124 days (Scott and Scott 2009). This species is likely pollinated by visually-oriented insects attracted to its bright disk flowers and bracts (Dom 1991). Ants and nectar-feeding butterflies were noted as frequent visitors to desert yellowhead flowers (Heidel et al. 2011). The butterfly was identified as the small wood nymph (Cercyonis oetus), a common species in Wyoming that typically feeds on the nectar of yellow composite flowers. Additionally, small skipper butterflies (Hesperiidae family) visit desert yellowhead; however, these butterflies were not identified to species (Scott and Scott 2009). Flowering levels of desert yellowhead appear to decline in drought years; however, no specific studies have been conducted. Preliminary inferences regarding seed dispersal include the capacity for wind or water dispersal (Dom 1991; Heidel 2002). The hairy seeds mature in the latter half of summer when they are dispersed by wind (Heidel et al. 2011) (USFWS, 2012).

Habitat Type

Adult: Barren outcrops (NatureServe, 2015)

Spatial Arrangements of the Population

Adult: Clumped (NatureServe, 2015)

Environmental Specificity

Adult: Narrow/specialist (NatureServe, 2015)

Tolerance Ranges/Thresholds

Adult: Low (inferred from NatureServe, 2015)

Site Fidelity

Adult: High (inferred from NatureServe, 2015)

Habitat Narrative

Adult: Species inhabits barren outcrops of white silty clay of the Split Rock Formation. Topography is bowl-like, allowing for snow accumulation. (NatureServe, 2015). High ecological integrity of the community and site fidelity as well as low tolerance ranges are inferred based on the specific habitat requirement of the species as well as the relatively low number of known populations.

Dispersal/Migration

Dispersal

Adult: Wind (USFWS, 2012)

Dispersal/Migration Narrative

Adult: Preliminary inferences regarding seed dispersal include the capacity for wind or water dispersal (Dom 1991; Heidel 2002). The hairy seeds mature in the latter half of summer when they are dispersed by wind (Heidel et al. 2011) (USFWS, 2012).

Population Information and Trends

Population Trends:

Unknown (NatureServe, 2015)

Population Growth Rate:

Unknown (NatureServe, 2015)

Number of Populations:

2 (USFWS, 2020)

Population Narrative:

The two populations are located approximately 8 kilometers (km; 5 miles (mi)) apart and are on public lands administered by the BLM. (USFWS, 2020)

Threats and Stressors

Stressor: Oil and gas development (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: Based on conservation actions by the BLM, oil and gas development are considered to be low in severity and magnitude and not an immediate threat to the species. If desert yellowhead is proposed to be delisted, the Wyoming BLM Standard Mitigation Guidelines for Surface Disturbing Activities would not apply as the protections of this document are for federally threatened and endangered species. Instead, it is anticipated that the Service would request the BLM continue to apply Conditions of Approval on Applications for Permit to Drill within the populations of desert yellowhead prohibiting all surface disturbing activities. Additionally, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). Therefore, in the absence of protections under the ESA, we anticipate that the threat from oil and gas development would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Mineral extraction (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: we consider the threat from mineral extraction to be low in severity and magnitude and not an immediate threat to the species. In the absence of ESA protections, the BLM's 6840

Manual Sensitive Species designation would provide some protections to the species for five yçars following delisting and potentially longer (see ection 2.3.2.4. for further discussion). Additionally, if desert yellowhead is proposed to be delisted, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine whether the withdrawal should remain in effect. Therefore, in the absence of protections under the ESA, we anticipate that the threat from mineral extraction would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Motor Vehicles and Off-Road Vehicles (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: We consider the threat from motor vehicles and off-road vehicles to be low in severity and magnitude and not an immediate threat. In the absence of ESA protections, the BLM' s 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). Additionally, if desert yellowhead is proposed to be delisted, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine whether the road closure should remain in effect. In general, motor vehicle policies on Federal lands have been moving towards more strategic transportation plans, closing excess roads and trails. We anticipate that these roads would remain closed. Therefore, in the absence of protections under the ESA, we anticipate that the threat from motor vehicles and offroad vehicles would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Invasive species (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: The level of threat from invasive species has been reduced to low in severity and magnitude and is not an immediate threat. In the absence of ESA protections, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). If desert yellowhead is proposed for delisting, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine appropriate conservation measures to ensure continued protection of the species. Therefore, in the absence of protections under the ESA, we anticipate that the threat from invasive species would remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Disease (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: In August 2010, botanists noticed a few desert yellowhead plants had turned chiorotic (the yellowing or whitening of normally green plant tissue because of a decrease amount of chlorophyll, often as a result of disease or nutrient deficiency) (Heidel et al. 2011). This condition appeared to cause mortality; however, it developed after flowering and did not affect reproduction. More than one subpopulation contained plants that were chiorotic (Heidel 2012a, pers. comm.). We have no other reports of disease. Therefore, the threat of disease is considered

to be low in severity and magnitude and not an immediate threat. In the absence of protections under the ESA, the severity, magnitude, and immediacy of this threat are not anticipated to increase (USFWS, 2012).

Stressor: Livestock and Wild Ungulate Grazing and Trampling (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of individuals
Narrative: The threat of grazing and trampling by wild ungulates and/or cattle is low in severity and magnitude and the threat is not immediate. In the absence of ESA protections, the BLM's 6840 Manual Sensitive Species designation would provide some protections to the species for five years following delisting and potentially longer (see Section 2.3.2.4. for further discussion). Additionally, if desert yellowhead is proposed to be delisted, it is anticipated that the Service would enter into discussions with the BLM prior to the delisting to determine appropriate conservation measures to ensure continued protection of the species. Therefore, in the absence of protections under the ESA, the threat of grazing and trampling by wild ungulates or cattle is likely to remain low in severity and magnitude and not an immediate threat to the species (USFWS, 2012).

Stressor: Small population size (USFWS, 2012)
Exposure:
Response:
Consequence: Exctinction
Narrative: While small population size remains an issue of concern, there is no evidence that the plant has occurred outside of the area currently occupied or in substantially larger numbers any time in the recent past. More information on this issue is required to assess the degree of this vulnerability. Specifically, we need to improve our understanding of the species demographics to assess the risk associated with the species' limited distribution and small population size. An ongoing study (mentioned above in Section 2.3.1.) conducted through the University of Wyoming aims to provide demographic information on both populations of desert yellowhead and develop a population viability assessment (USFWS, 2012).

Stressor: Genetic Vulnerability (USFWS, 2012)
Exposure:
Response:
Consequence: Extinction
Narrative: Populations of plants that remain very small for several generations or populations that have gone through a past episode of rapid population decline may lose much of their previous genetic variability (Godt et al. 1996). The loss of genetic variability may reduce a species ability to respond to changing environmental conditions. In addition, the potential for inbreeding depression increases. Inbreeding depression can decrease fertility and survival rates. Although environmental and demographic factors usually supersede genetic factors in threatening species viability, inbreeding depression and the low genetic diversity may enhance the probability of extinction of rare plant species (Levin et al. 1996). On the other hand, some plant species have shown no evidence of inbreeding depression, despite low genetic diversity. There are a lot of unknowns regarding the historical distribution and genetic viability of desert yellowhead and how these issues affect the species. However, monitoring of desert yellowhead has not indicated that any of these factors are currently causing a decline in the species. At this time, we do not

have enough information regarding the small population size and genetic vulnerability of desert yellowhead. Recommendations to improve our knowledge are included in Section 4 (USFWS, 2012).

Stressor: Climate change (USFWS, 2012)
Exposure:
Response:
Consequence: Loss of habitat
Narrative: In general, a trend of warming in the mountains of western North America is expected to decrease snowpack, hasten spring runoff, and reduce summer flows (IPCC 2007). While this change could affect desert yellowhead and its habitat, to date, a negative impact has not been documented. A significant degree of uncertainty exists as to how projected climate changes, alone and in concert with other threats, will affect the desert yellowhead or its habitat in the future. While fewer cold days and nights could result in increased vegetative yield in colder environments, increased summer heat and areas affected by drought may increase (IPCC 2007). Desert yellowhead is adapted to a low moisture enviromrient that is susceptible to flooding and erosion events. However, we have limited evidence of reduced reproduction in drought conditions. More research on the drought tolerance of the species is needed. Another factor to consider regarding desert yellowhead's ability to adapt to climate change is the species' origin. Several hypotheses have been proposed (Heidel 2002, Scott and Scott 2009). The hypothesis most often cited is that desert yellowhead is a relict species that has become restricted in its distribution. This hypothesis is supported by the extreme restricted distribution pattern of desert yellowhead and the absence of the species on similar adjacent surfaces. However, the fact that the Sand Draw population and the Cedar Rim population differ in several habitat conditions supports the hypothesis that desert yellowhead was once more widespread and its distribution has become restricted (Heidel et al. 2011). If this second hypothesis is correct, the species may be more adaptable as it has survived through a variety of selective pressures. Conversely, if desert yellowhead has a more recent origin and has always occupied a restricted habitat, the species may not be able to adapt well in the face of changing climatic conditions. More studies on this species' responses to changes in climate need to be completed. Overall, it appears possible that the desert yellowhead or its habitat may be affected negatively by climate change (USFWS, 2012).

Recovery

Reclassification Criteria:
Recovery Priority Number: 13

Delisting Criteria:
1. Long term, renewable protections from mineral resource extraction are in place for both the Sand Draw and Cedar Rim populations, and will remain in place for at least 10 years following delisting. (USFWS, 2022)

2. The Sand Draw and Cedar Rim populations are secure, as evidenced by: a. A stable or increasing population trend; and b. More than 5,797 individuals counted in Sand Draw's monitored quadrats and more than 242 individuals counted in Cedar Rim's monitored transects for 8 out of 10 consecutive survey years. (USFWS, 2022)

3. Both the Sand Draw and Cedar Rim populations show evidence of sexual reproduction as evidenced by the production of at least one seed with a mature embryo over a 10-year period. (USFWS, 2022)

4. A banked seed source containing seeds from both the Sand Draw and Cedar Rim populations of desert yellowhead is secured in a Center for Plant Conservation (CPC)- affiliated institution. (USFWS, 2022)

Recovery Actions:

- Priority 1 Actions 1. Protect Cedar Rim from disturbance: Eliminate the current and future threat of landaltering disturbance to the Cedar Rim population by removing it and the surrounding area from settlement, sale, or surface-disturbing development (Criterion 1). 2. Renew Sand Draw protections from disturbance: Renew the existing protections in place for Sand Draw that match the existing mineral withdrawal and critical habitat boundaries when the mineral withdrawal expires in 2028 (and continue to renew as needed thereafter) (Criterion 1). (USFWS, 2022)
- The BLM has committed to implement several conservation measures with regard to grazing for the protection of the Sand Draw population of desert yellowhead. These measures are detailed to in the U.S. Fish and Wildlife Service's (Service) Biological Opinion on the BLM's Lander Priority 2 Actions 3. Monitor populations: Annually monitor the abundance of individual plants at both the Sand Draw and Cedar Rim populations using quadrat and transect methodologies, and use these data to track population trends and lambda (λ) (Criterion 2). Monitoring will be conducted following the historical average abundance protocols for a period of 10 years. 4. Monitor seed viability: Annually monitor the viability of seeds in both the Sand Draw and Cedar Rim populations by visual examination on the plant (Criterion 3). As soon as evidence of successful sexual reproduction exists, this monitoring can shift to every 3 years to focus efforts on other recovery actions. The presence of a large number of viable seeds at either population in any given year will enable seed baking (Recovery Action 6). 5. Monitor and reduce other stressors: Annually monitor potential stressors range-wide so that their influence on each population, if any, can be tracked. This includes the potential stressors identified in the SSA (Service 2019, pp. 19–28): invasive species; grazing and trampling by livestock, wild horses, and native ungulates; off-road vehicle recreation; and wildfire. If a stressor is identified as posing a current or imminent impact to desert yellowhead, develop and implement management appropriate to reduce the threat. These threats are not currently affecting desert yellowhead at the population level, but may in the future especially in the face of climate change. 6. Bank seeds: Establish and maintain an ex-situ collection of desert yellowhead seeds from both populations in a Center for Plan Conservation-affiliated institution (Criterion 4). Collect seeds according to the CPC best practices for collecting seeds from wild rare plant populations (CPC 2020). To protect the species against a catastrophic event, having seeds from both populations banked will ensure preservation of as much genetic diversity as possible. Collecting a representative year of seeds from both the Sand Draw and Cedar Rim population (if possible) may help capture this genetic variation as well as provide seed should reintroduction of a patch of plants or population become warranted in the future. Collection from another population, if found during the implementation of this Recovery Plan, would be conducted based on that population's demographic parameters. (USFWS, 2022).
- Priority 3 Actions 7. Maintain partnerships: Maintain consistency and momentum of conservation efforts for desert yellowhead rangewide through communication and

collaboration across jurisdictions and agencies with partners and stakeholders. (USFWS, 2022)

Conservation Measures and Best Management Practices:

- RECOMMENDATIONS FOR FUTURE ACTIONS Proceed with the development of a Recovery Plan for the desert yellowhead that includes specific, objective, and quantifiable recovery criteria and actions, including: o Collaborate with a team of experts to determine recovery requirements for the species o Develop an inter-agency conservation plan between the Service and the BLM that defines specific commitments to maintain conservation measures that ensure future long-term viability of the species. (USFWS, 2020)

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SPECIES ACCOUNT: *Zanthoxylum hawaiiense* (A`e, Hawaiian yellow wood)

Species Taxonomic and Listing Information

Listing Status: Endangered; 03/04/1994; Pacific Region (R1) (USFWS, 2016)

Physical Description

Zanthoxylum hawaiiense is a member of the Rutaceae, or citrus family. It is a tree which can range in height from 3 to 8 meters (10 to 26 feet) tall, with trunks that can be 25 centimeters (10 inches) in diameter. Leaves are alternate and are comprised of three, leathery triangular-oval or lance-shaped, gland-dotted, lemon-scented, toothed leaflets. These leaflets are 3.4 to 10 centimeters (1.3 to 3.9 inches) long and 1.5 to 5 centimeters (0.6 to 2.0 inches) wide. The stalk of the opposite leaflets has one joint and the central, terminal leaflet has two. Trees are dioecious, having either male or female flowers. Inflorescences contain 15 to 20 flowers, each with four triangular sepals. Fruits are sickle-shaped follicles which range in length from 8 to 10 millimeters (0.3 to 0.4 inch). The fruits contains a single black seed of approximately 7 to 8 millimeters (0.3 inch) in diameter. The species is distinguished from other Hawaiian species by its leaves, presence of only one joint on some the leaflet stalks, and length and shape of the follicle (U.S. Army 2003a).

Historical Range

Historically, Zanthoxylum hawaiiense occurred on Kauai (central portion), Molokai (east side), Lanai (central), Maui (eastern portion, on the southern slopes of Haleakala), and Hawaii (Kohala Mountains).

Current Range

This species has been extirpated from Lanai but still persists on Hawaii, Molokai, Maui and Kauai. On these islands, approximately 262 to 312 individuals are found in 10 to 13 occurrences (U.S. Army 2003a). Island Distribution: Found on Kauai, Molokai, Maui and Hawaii. Extirpated on Lanai (USFWS, 2021c)

Critical Habitat Designated

Yes; 2/27/2003.

Legal Description

On March 30, 2016, the U.S. Fish and Wildlife Service (Service) designated critical habitat for Zanthoxylum hawaiiense (A`e) under the Endangered Species Act of 1973, as amended (Act). The critical habitat designation includes 21 critical habitat units (CHUs), in Hawaii (81 FR 17790-18110).

On February 27, 2003, the U.S. Fish and Wildlife Service (Service), designated critical habitat pursuant to the Endangered Species Act of 1973, as amended (Act), for Zanthoxylum hawaiiense on the island of Hawaii (68 FR 9116 - 9479).

Critical Habitat Designation

The critical habitat designation for Zanthoxylum hawaiiense includes 21 CHUs in Maui County, Hawaii (81 FR 17790-18110).

Molokai—Lowland Mesic—Unit 1 (and) Palmeria dolei—Unit 37—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 37— Lowland Mesic This area consists of 3,489 ac (1,412 ha) of State land, and 5,281 ac (2,137 ha) of privately owned land, from Waianui Gulch to Mapulehu, in central Molokai. These units are occupied by the plants Alectryon macrococcus, Ctenitis squamigera, Cyanea dunbariae, C. mannii, C. profuga, Cyperus fauriei, Cyrtandra filipes, Gouania hillebrandii, Labordia triflora, Neraudia sericea, Santalum haleakalae var. lanaiense, Schiedea lydgatei, S. sarmentosa, Silene alexandri, S. lanceolata, Spermolepis hawaiiensis, and Zanthoxylum hawaiiense, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Mesic—Unit 1 is not known to be occupied by Asplenium dielerectum, Bonamia menziesii, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea procera, C. solanacea, Diplazium molokaiense, Festuca molokaiensis, Flueggea neowawraea, Isodendrion pyrifolium, Kadua laxiflora, Melicope mucronulata, M. munroi, M. reflexa, Phyllostegia haliakalae, P. mannii, P. pilosa, Sesbania tomentosa, Stenogyne bifida, or Vigna o-wahuensis, or the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 1 (and) Palmeria dolei—Unit 38—Lowland Wet (and) Pseudonestor xanthophrys—Unit 38— Lowland Wet This area consists of 2,195 ac (888 ha) of State land, and 754 ac (305 ha) of privately owned land (partly within The Nature Conservancy's Pelekunu Preserve), from Pelekunu Valley to Wailau Valley, in north-central Molokai. These units are occupied by the plant Cyrtandra filipes, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 1 is not known to be occupied by Asplenium dielerectum, Bidens wiebkei, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea dunbariae, C. grimesiana ssp. grimesiana, C. solanacea, Lysimachia maxima, Melicope reflexa, Peucedanum sandwicense, Phyllostegia hispida, P. mannii, Plantago princeps, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 1 consists of 11,465 ac (4,640 ha) of State land, 2,069 ac (837 ha) of federally owned land, and 3 ac (1 ha) of privately owned land, from Kanaio to Kahualau Gulch on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Cenchrus agrimonioides, Flueggea neowawraea, Melicope adscendens, Santalum haleakalae var. lanaiense,

and Spermolepis hawaiiensis, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 1 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Canavalia pubescens, Colubrina oppositifolia, Ctenitis squamigera, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Sesbania tomentosa, Solanum incompletum, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 2 (and) Palmeria dolei—Unit 39—Lowland Wet (and) Pseudonestor xanthophrys—Unit 39— Lowland Wet This area consists of 1,356 ac (549 ha) of State land and 594 ac (241 ha) of privately owned land, from Kahanui to Pelekunu Valley, in north-central Molokai. These units are occupied by the plant Lysimachia maxima, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Lowland Wet—Unit 2 is not known to be occupied by Asplenium dielerectum, Bidens wiebkei, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea dunbariae, C. grimesiana ssp. grimesiana, C. solanacea, Cyrtandra filipes, Melicope reflexa, Peucedanum sandwicense, Phyllostegia hispida, P. mannii, Plantago princeps, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 2 consists of 1,851 ac (749 ha) of State land at Keokea on the southern slopes of east Maui. This unit is occupied by the plants Bonamia menziesii, Canavalia pubescens, and Hibiscus brackenridgei, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 2 is not known to be occupied by Alectryon macrococcus, Bidens micrantha ssp. kalealaha, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are

essential to achieving population levels necessary for recovery.

Molokai—Lowland Wet—Unit 3 consists of 94 ac (38 ha) of State land, and 3,125 ac (1,265 ha) of privately owned land, from Waiahookalo gulch to Moaula stream and Puniuohua, on eastern Molokai. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland wet ecosystem (see Table 5). Although Molokai—Lowland Wet—Unit 3 is not known to be occupied by Asplenium dielerectum, Bidens wiebkei, Canavalia molokaiensis, Clermontia oblongifolia ssp. brevipes, Cyanea dunbariae, C. grimesiana ssp. grimesiana, C. solanacea, Cyrtandra filipes, Lysimachia maxima, Melicope reflexa, Peucedanum sandwicense, Phyllostegia hispida, P. mannii, Plantago princeps, Stenogyne bifida, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 3 consists of 188 ac (76 ha) of privately owned land, at Keauhou on the southern slopes of east Maui. This unit is occupied by the plant Canavalia pubescens, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Dry—Unit 3 is not known to be occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 1 (and) Palmeria dolei—Unit 40—Montane Wet (and) Pseudonestor xanthophrys—Unit 40— Montane Wet This area consists of 1,545 ac (625 ha) of State land, and 1,851 ac (749 ha) of privately owned land, from the headwaters of Waialelia Stream and above Pelekunu Valley, eastward along the summit area to Mapulehu, in northcentral Molokai. These units are occupied by the plants Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. profuga, Phyllostegia hispida, and Pteris lidgatei, and include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 1 is not known to be occupied by Adenophorus periens, Cyanea procera, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Melicope reflexa, Phyllostegia mannii, P. pilosa, Platanthera holochila, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria

dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Dry—Unit 4 consists of 1,266 ac (512 ha) of State land (including the Department of Land and Natural Resources) at Ahihi-Kinau Natural Area Reserve on the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland dry ecosystem (see Table 5). Although Maui—Lowland Dry—Unit 4 is not currently occupied by Bidens micrantha ssp. kalealaha, Bonamia menziesii, Canavalia pubescens, Cenchrus agrimonioides, Colubrina oppositifolia, Ctenitis squamigera, Flueggea neowawraea, Hibiscus brackenridgei, Melanthera kamolensis, Melicope mucronulata, Neraudia sericea, Nototrichium humile, Santalum haleakalae var. lanaiense, Sesbania tomentosa, Solanum incompletum, Spermolepis hawaiiensis, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these lowland dry species because it provides the PCEs necessary for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 2 (and) Palmeria dolei—Unit 41—Montane Wet (and) Pseudonestor xanthophrys—Unit 41— Montane Wet This area consists of 871 ac (353 ha) of State land, and 39 ac (16 ha) of privately owned land, from Honukaupu to Olokui (between Pelekunu and Wailau valleys), in north-central Molokai. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). Although Molokai— Montane Wet—Unit 2 is not known to be occupied by Adenophorus periens, Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. procera, C. profuga, C. solanacea, Hesperomannia arborescens, Lysimachia maxima, Melicope reflexa, Phyllostegia hispida, P. mannii, P. pilosa, Platanthera holochila, Pteris lidgatei, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Molokai—Montane Wet—Unit 3 consists of 77 ac (31 ha) of State land, and 726 ac (294 ha) of privately owned land, above the east rim of Wailau Valley on eastern Molokai. This unit is occupied by the plant Melicope reflexa, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane wet ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Molokai— Montane Wet—Unit 3 is not known to be occupied by Adenophorus periens, Bidens wiebkei, Clermontia oblongifolia ssp. brevipes, Cyanea mannii, C. procera, C. profuga, C. solanacea, Hesperomannia

arborescens, Lysimachia maxima, Phyllostegia hispida, P. mannii, P. pilosa, Platanthera holochila, Pteris lidgatei, Schiedea laui, Stenogyne bifida, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these montane wet species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Lowland Mesic—Unit 2 consists of 1,034 ac (419 ha) of State land, and 113 ac (46 ha) of privately owned land, from Honokohau to Launiupoko on the western slopes of west Maui. This unit is occupied by the plants Ctenitis squamigera, Remya mauiensis, Santalum haleakalae var. lanaiense, and Zanthoxylum hawaiiense, and includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). This unit also contains unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Lowland Mesic—Unit 2 is not known to be occupied by Asplenium dielerectum, Bidens campylotheca ssp. pentamera, or Colubrina oppositifolia, we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs necessary for the reestablishment of wild populations within its historical range. Due to its small numbers of individuals or low population sizes, this species requires suitable habitat and space for expansion or reintroduction to achieve population levels that could approach recovery.

Maui—Lowland Mesic—Unit 3 (and) Palmeria dolei—Unit 1—Lowland Mesic (and) Pseudonestor xanthophrys—Unit 1— Lowland Mesic This area consists of 477 ac (193 ha) of State land at Ukumehame on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the lowland mesic ecosystem (see Table 5). Although Maui—Lowland Mesic—Unit 3 is not currently occupied by the plants Asplenium dielerectum, Bidens campylotheca ssp. pentamera, Colubrina oppositifolia, Ctenitis squamigera, Remya mauiensis, Santalum haleakalae var. lanaiense, or Zanthoxylum hawaiiense, or by the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these lowland mesic species because it provides the PCEs for the reestablishment of wild populations within the historical ranges of the species. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 1 (and) Palmeria dolei—Unit 18—Montane Mesic (and) Pseudonestor xanthophrys—Unit 18— Montane Mesic This area consists of 6,593 ac (2,668 ha) of State land, 707 ac (286 ha) of privately owned land, and 3,672 ac (1,486 ha) of federally owned land (Haleakala National Park), from Kealahou to Puualae, nearly circumscribing the summit of Haleakala on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Asplenium dielerectum, A. peruvianum var. insulare, Clermontia lindseyana, Cyanea horrida, C. obtusa, Cyrtandra ferripilosa, C. oxybapha, Diplazium molokaiense, Geranium arboreum, G. multiflorum, Huperzia mannii,

Melicope adscendens, and Neraudia sericea. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 1 is not known to be occupied by the plants Alectryon macrococcus, Bidens campylotheca ssp. pentamera, B. micrantha ssp. kalealaha, Cyanea glabra, C. hamatiflora ssp. hamatiflora, C. kunthiana, C. mceldowneyi, Phyllostegia bracteata, P. mannii, Santalum haleakalae var. lanaiense, Wikstroemia villosa, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 2 (and) Palmeria dolei—Unit 19—Montane Mesic (and) Pseudonestor xanthophrys—Unit 19— Montane Mesic This area consists of 124 ac (50 ha) of State land at Helu and the upper reaches of Puehuehunui on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Lysimachia lydgatei, Remya mauiensis, and Santalum haleakalae var. lanaiense. These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 2 is not known to be occupied by the plants Geranium hillebrandii, Huperzia mannii, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 3 (and) Palmeria dolei—Unit 20—Montane Mesic (and) Pseudonestor xanthophrys—Unit 20— Montane Mesic This area consists of 174 ac (70 ha) of State land at Lihau on the southwestern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plant Geranium hillebrandii, and contain unoccupied habitat that is essential to the conservation of this species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 3 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 4 (and) Palmeria dolei—Unit 21—Montane Mesic (and) Pseudonestor xanthophrys—Unit 21— Montane Mesic This area consists of 72 ac (29 ha) of State land at Halepohaku on the southern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). Although Maui—Montane Mesic—Unit 4 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Mesic—Unit 5 (and) Palmeria dolei—Unit 22—Montane Mesic (and) Pseudonestor xanthophrys—Unit 22— Montane Mesic This area consists of 170 ac (69 ha) of State land at the upper reaches of Manawainui Gulch on the southeastern slopes of west Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane mesic ecosystem (see Table 5). They are occupied by the plants Remya mauiensis and Santalum haleakalae var. lanaiense, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Montane Mesic—Unit 5 is not known to be occupied by the plants Ctenitis squamigera, Cyanea magnicalyx, Diplazium molokaiense, Geranium hillebrandii, Huperzia mannii, Lysimachia lydgatei, Stenogyne kauaulaensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these montane mesic species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Montane Dry—Unit 1 consists of 2,962 ac (1,199 ha) of State land, and 563 ac (228 ha) of federally owned land (Haleakala National Park), from Kanaio to Naholoku and Kaupo Gap along the southern slopes of east Maui. This unit includes the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the montane dry ecosystem (see Table 5). Although Maui—Montane Dry—Unit 1 is not known to be occupied by the plants Alectryon macrococcus, Geranium arboreum, Melicope knudsenii, M. mucronulata, Santalum haleakalae var. lanaiense, or Zanthoxylum hawaiiense, we have determined this area to be essential for the conservation and recovery of these montane dry species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 1 (and) Palmeria dolei—Unit 24—Subalpine (and) Pseudonestor xanthophrys—Unit 24— Subalpine This area consists of 10,785 ac (4,365 ha) of State land, 1,622 ac (656 ha) of privately owned land, and 3,568 ac (1,444 ha) of federally owned land (Haleakala National Park), from Kanaio north to Puu Nianiau on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants Bidens micrantha ssp. kalealaha and Geranium arboreum, and contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui—Subalpine—Unit 1 is not known to be occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Asplenium peruvianum var. insulare, Geranium multiflorum, Phyllostegia bracteata, Schiedea haleakalensis, or Zanthoxylum hawaiiense, or by the forest birds, the akohekohe (Palmeria dolei) and kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

Maui—Subalpine—Unit 2 (and) Palmeria dolei—Unit 25—Subalpine (and) Pseudonestor xanthophrys—Unit 25— Subalpine This area consists of 50 ac (20 ha) of privately owned land, and 9,836 ac (3,981 ha) of federally owned land (Haleakala National Park), from the summit north to Koolau Gap and east to Kalapawili Ridge on east Maui. These units include the mixed herbland and shrubland, the moisture regime, and canopy, subcanopy, and understory native plant species identified as physical or biological features in the subalpine ecosystem (see Table 5). They are occupied by the plants Argyroxiphium sandwicense ssp. macrocephalum, Geranium multiflorum, and Schiedea haleakalensis, and by the forest bird, the akohekohe (Palmeria dolei). These units also contain unoccupied habitat that is essential to the conservation of these species by providing the PCEs necessary for the expansion of the existing wild populations. Although Maui— Subalpine—Unit 2 is not known to be occupied by the plants Asplenium peruvianum var. insulare, Bidens micrantha ssp. kalealaha, Geranium arboreum, Phyllostegia bracteata, or Zanthoxylum hawaiiense, or by the forest bird, the kiwikiu (Pseudonestor xanthophrys), we have determined this area to be essential for the conservation and recovery of these subalpine species because it provides the PCEs necessary for the reestablishment of wild populations within their historical range. Due to their small numbers of individuals or low population sizes, suitable habitat and space for expansion or reintroduction are essential to achieving population levels necessary for recovery.

The critical habitat designation for Zanthoxylum hawaiiense includes one unit totaling 1,292 acres in Kauai County, Hawaii. The unit is Kauai 11—Zanthoxylum hawaiiense—a.

Kauai 11—Zanthoxylum hawaiiense—a [523 ha; 1,292 ac]: This unit is critical habitat for Zanthoxylum hawaiiense and is 523 ha (1,292 ac) on State land (Alakai Wilderness Preserve and Puu Ka Pele Forest Reserve), containing portions of Kawaiiki Valley. This unit provides habitat for two populations of 100 mature, reproducing individuals of the long-lived perennial Zanthoxylum hawaiiense and is currently occupied with three plants. This unit is essential to the conservation of the taxon because it supports an extant colony of this species and includes habitat that is important for the expansion of the present population, which is currently considered non-viable.

The habitat features contained in this unit that are essential for this species include, but are not limited to, lowland dry or mesic forests dominated by Metrosideros polymorpha or Diospyros sandwicensis. This unit provides for two populations within this multi-island species' historical range on Kauai that are some distance away from the other critical habitat for this species, in order to avoid all recovery populations from being destroyed by one naturally occurring catastrophic event.

Primary Constituent Elements/Physical or Biological Features

Primary constituent elements (PCEs) are the physical and biological features of critical habitat essential to a species' conservation. The PCEs of Zanthoxylum hawaiiense critical habitat consists of seven components. Lowland dry (east Maui), Lowland mesic (west Maui and Molokai), Lowland wet (Lanai and Molokai), Montane wet (Molokai), Montane mesic (east Maui and west Maui), Montane dry (east Maui) and Sub-alpine (east Maui) (81 FR 17790-18110):

Ecosystem: Lowland Dry. Elevation: <3,300 ft (<1,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Weathered silty loams to stony clay, rocky ledges, littleweathered lava. Canopy: Diospyros, Myoporum, Pleomele, Santalum. Subcanopy: Chamaesyce, Dodonaea, Leptecophylla, Osteomeles, Psydrax, Scaevola, Wikstroemia. Understory: Alyxia, Artemisia, Bidens, Chenopodium, Nephrolepis, Peperomia, Sicyos.

Ecosystem: Lowland Mesic. Elevation: <3,300 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Shallow soils, little to no herbaceous layer. Canopy: Acacia, Diospyros, Metrosideros, Myrsine, Pouteria, Santalum. Subcanopy: Dodonaea, Freycinetia, Leptecophylla, Melanthera, Osteomeles, Pleomele, Psydrax. Understory: Carex, Dicranopteris, Diplazium, Elaphoglossum, Peperomia.

Ecosystem: Lowland Wet. Elevation: <3,330 ft (<1,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Clays; ashbeds; deep, well drained soils; lowland bogs. Canopy: Antidesma, Metrosideros, Myrsine, Pisonia, Psychotria. Subcanopy: Cibotium, Claoxylon, Kadua, Melicope. Understory: Alyxia, Cyrtandra, Dicranopteris, Diplazium, Machaerina, Microlepia.

Ecosystem: Montane Wet. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: >75 in (>190 cm). Substrate: Well-developed soils, montane bogs. Canopy: Acacia, Charpentiera, Cheirodendron, Metrosideros. Subcanopy: Broussaisia, Cibotium, Eurya, Ilex, Myrsine. Understory: Ferns, Carex, Coprosma, Leptecophylla, Oreobolus, Rhynchospora, Vaccinium.

Ecosystem: Montane Mesic. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: 50–75 in (130–190 cm). Substrate: Deep ash deposits, thin silty loams. Canopy: Acacia, Ilex, Metrosideros, Myrsine, Nestegis, Nothocestrum, Pisonia, Pittosporum, Psychotria, Sophora, Zanthoxylum. Subcanopy: Alyxia, Charpentiera, Coprosma, Dodonaea, Kadua, Labordia, Leptecophylla, Phyllostegia, Vaccinium. Understory: Ferns, Carex, Peperomia.

Ecosystem: Montane Dry. Elevation: 3,300–6,500 ft (1,000–2,000 m). Annual precipitation: <50 in (<130 cm). Substrate: Dry cinder or ash soils, loamy volcanic sands, blocky lava, rock outcroppings. Canopy: Acacia, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Chamaesyce, Coprosma, Dodonaea, Dubautia, Leptecophylla, Osteomeles, Wikstroemia. Understory: Bidens, Eragrostis, Melanthera, Vaccinium.

Ecosystem: Subalpine. Elevation: 6,500–9,800 ft (2,000–3,000 m). Annual precipitation: 15–40 in (38–100 cm). Substrate: Dry ash, sandy loam, rocky, undeveloped soils, weathered lava. Canopy: Chamaesyce, Chenopodium, Metrosideros, Myoporum, Santalum, Sophora. Subcanopy: Coprosma, Dodonaea, Dubautia, Geranium, Leptecophylla, Vaccinium, Wikstroemia. Understory: Ferns, Bidens, Carex, Deschampsia, Eragrostis, Gahnia, Luzula, Panicum, Pseudognaphalium, Sicyos, Tetramolopium.

Within this unit, the currently known primary constituent elements of critical habitat include, but are not limited to, the habitat components provided by:

(i) Lowland dry or mesic forests dominated by Metrosideros polymorpha or Diospyros sandwicensis, and containing one or more of the following associated plant species: Alectryon macrococcus, Antidesma platyphyllum, Charpentiera elliptica, Dodonaea viscosa, Melicope spp., Myrsine lanaiensis, Pisonia spp., Pleomele aurea, Streblus pendulinus, or Zanthoxylum dipetalum; and

(ii) Elevations between 332 and 1,151 m (1,089 and 3,774 ft).

Special Management Considerations or Protections

When designating critical habitat, we assess whether the specific areas within the geographical area occupied by the species at the time of listing contain features that are essential to the conservation of the species and which may require special management considerations or protection. In identifying critical habitat in occupied areas, we determine whether those areas that contain the features essential to the conservation of the species require any special management actions. Although the determination that special management may be required is not a prerequisite to designating critical habitat in unoccupied areas, special management is needed throughout all of the critical habitat units in this final rule. The following discussion of special management needs is therefore applicable to each of the Maui Nui species for which we are designating critical habitat in this rule. In this final rule, we are designating critical habitat for 125 of the 135 species for which we proposed critical habitat. For the reasons described below (see Exclusions Based on Other Relevant Factors), we are not designating critical habitat for eight plants (Abutilon eremitopetalum, Cyanea gibsonii, Kadua cordata ssp. remyi, Labordia tinifolia var. lanaiensis, Pleomele fernaldii, Portulaca sclerocarpa, Tetramolopium lepidotum ssp. lepidotum, and Viola lanaiensis) and two tree snails (Partulina semicarinata and P. variabilis). The 125 species for which we are designating critical habitat include 108 plant and animal species that are currently found in the wild on Molokai, Maui, and Kahoolawe; (10 plant species which were historically found on one or more of these islands, but are currently found only on other Hawaiian Islands (Adenophorus periens, Clermontia peleana, Cyanea grimesiana ssp. grimesiana, Cyperus trachysanthos, Eugenia koolauensis, Gouania vitifolia, Isodendrion pyrifolium, Kadua coriacea, Nototrichium humile, and Solanum incompletum), 6 plant species that may not be currently extant in the wild (Acaena exigua, Cyanea glabra, Phyllostegia bracteata, P. haliakalae, Schiedea jacobii, and Tetramolopium capillare), and 1 plant species, Kokia cookei, which exists only in cultivation. For each of the 108 species currently found in the wild on Molokai, Maui, and Kahoolawe, we have determined that the features essential to their conservation are those required for the successful functioning of the ecosystem(s) in which they occur (see Tables 5 and 6, above). As described earlier, in some cases, additional species-specific primary constituent elements were also identified (see Table 6, above). Special management considerations or protections are necessary throughout the critical habitat areas designated here to avoid further

degradation or destruction of the habitat that provides those features essential to their conservation. The primary threats to the physical or biological features essential to the conservation of all of these species include habitat destruction and modification by nonnative ungulates, competition with nonnative species, hurricanes, landslides, rockfalls, flooding, fire, drought, and climate change. Additionally, the rosy wolf snail poses a threat to the Newcomb's tree snail and mosquito-borne diseases pose threats to the two forest birds. The reduction of these threats will require the implementation of special management actions within each of the critical habitat areas identified in this final rule. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative ungulates (pigs, goats, mouflon sheep, axis deer, and cattle). Nonnative ungulates also impact the habitat through predation and trampling. Without this special management, habitat containing the features that are essential for the conservation of these species will continue to be degraded and destroyed. All designated critical habitat requires active management to address the ongoing degradation and loss of native habitat caused by nonnative plants. Special management is also required to prevent the introduction of new nonnative plant species into native habitats. Particular attention is required in nonnative plant control efforts to avoid creating additional disturbances that may facilitate the further introduction and establishment of invasive plant seeds. Precautions are also required to avoid the inadvertent trampling of listed plant species in the course of management activities. The active control of nonnative plant species would help to address the threat posed by fire to 31 of the designated ecosystem critical habitat units in particular: Maui-Coastal—Units 4 through 7; Maui-Lowland Dry—Units 1 through 6; Maui-Lowland Mesic—Units 1 and 2; Maui-Montane Mesic—Units 1, 2, and 5; Maui-Dry Cliff—Units 1, 5, and 7; Kahoolawe-Coastal—Units 1 through 3; Kahoolawe-Lowland Dry—Units 1 and 2; Molokai-Coastal—Units 1, 2, 3, 6, and 7; Molokai-Lowland Dry—Units 1 and 2; and Molokai-Lowland Mesic— Unit 1. This threat is largely a result of the presence of nonnative plant species such as the grasses Andropogon virginicus (broomsedge), Cenchrus spp. (sandbur, buffelgrass), and Melinis minutiflora (molasses grass), that increase the fuel load and quickly regenerate after a fire. These nonnative grass species can outcompete native plants that are not adapted to fire, creating a grass-fire cycle that alters ecosystem functions (D'Antonio and Vitousek 1992, pp. 64–66; Brooks et al. 2004, p. 680). Nine of the ecosystem critical habitat units (Maui-Lowland Wet—Units 1 and 4; Maui-Montane Wet—Units 1 through 3; Maui-Montane Mesic—Unit 2; MauiWet Cliff—Units 6 and 7; and MolokaiMontane Wet—Unit 1) may require special management to reduce the threat of landslides, rockfalls, and flooding. These threaten to further degrade habitat conditions in these units and have the potential to eliminate some occurrences of 50 plant species (e.g., Adenophorus periens, Alectryon macrococcus, Asplenium peruvianum var. insulare, Bidens campylotheca ssp. pentamera, B. campylotheca ssp. waihoiensis, B. conjuncta, B. wiebkei, Bonamia menziesii, Clermontia oblongifolia ssp. brevipes, C. oblongifolia ssp. mauiensis, C. samuelii, Ctenitis squamigera, Cyanea asplenifolia, C. copelandii ssp. haleakalaensis, C. duvalliorum, C. hamatiflora ssp. hamatiflora, C. horrida, C. kunthiana, C. magnicalyx, C. mannii, C. maritae, C. mceldowneyi, C. profuga, C. solanacea, Cyrtandra filipes, C. munroi, Diplazium molokaiense, Dubautia plantaginea ssp. humilis, Geranium hanaense, G. multiflorum, Hesperomannia arborescens, Huperzia mannii, Kadua laxiflora, Lysimachia lydgatei, L. maxima, Melicope balloui, M. ovalis, Phyllostegia hispida, P. mannii, P. pilosa, Plantago princeps, Platanthera holochila, Pteris lidgatei, Remya mauiensis, Santalum haleakalae var. lanaiense, Schiedea laui, Stenogyne bifida, S. kauaulaensis, Wikstroemia villosa, and Zanthoxylum hawaiiense) found on steep slopes and cliffs, or in narrow gulches.

The following management actions are important: Feral ungulate control; wildfire management; nonnative plant control; rodent control; invertebrate pest control; maintenance of genetic material of the endangered and threatened plant species; propagation, reintroduction, and augmentation of existing populations into areas deemed essential for the recovery of the species; ongoing management of the wild, outplanted, and augmented populations; maintenance of natural pollinators and pollinating systems, when known; habitat management and restoration in areas deemed essential for the recovery of the species; monitoring of the wild, outplanted, and augmented populations; rare plant surveys; and control of human activities/access.

Life History

Food/Nutrient Resources

Reproduction Narrative

Adult: Trees are dioecious, having either male or female flowers. Inflorescences contain 15 to 20 flowers, each with four triangular sepals. Fruits are sickle-shaped follicles which range in length from 8 to 10 millimeters (0.3 to 0.4 inch). The fruits contains a single black seed of approximately 7 to 8 millimeters (0.3 inch) in diameter. The species is distinguished from other Hawaiian species by its leaves, presence of only one joint on some the leaflet stalks, and length and shape of the follicle (U.S. Army 2003a).

Habitat Type

Adult: Lowland dry or mesic forests/ montane dry forests, and on lava

Habitat Narrative

Adult: Zanthoxylum hawaiiense typically grows in Metrosideros-dominated lowland dry or mesic forests, in montane dry forests, and on lava at elevations that range from 550 to 1,740 meters (1,804 to 5,709 feet). The species is associated with Antidesma platyphyllum and Streblus pendulinus on the island of Maui and with Myrsine lanaiensis, Sophora chrysophylla, and Myoporum sandwicense on the island of Hawaii. Individuals of this species are widely scattered and rarely will more than a few plants be found in close proximity to one another (U.S. Army 2003a). At the Pohakuloa Training Area (PTA) on the island of Hawaii, Z. hawaiiense is found on lava and in a variety of plant community types including sparse Metrosideros Treelands, Open Metrosideros Treelands with dense shrub understory, Intermediate Metrosideros Mixed Treelands, Myoporum Shrublands, and Myoporum-Dodonaea Shrublands.

Dispersal/Migration

Population Information and Trends

Number of Populations:

10 - 13. ~10 (USFWS, 2021c)

Population Size:

262 - 312. 916 (USFWS, 2021c). 560 (USFWS, 2021b)

Population Narrative:

This species has been extirpated from Lanai but still persists on Hawaii, Molokai, Maui and Kauai. On these islands, approximately 262 to 312 individuals are found in 10 to 13 occurrences (U.S. Army 2003a).

Threats and Stressors

Stressor:
Exposure:
Response:
Consequence:
Narrative: Threats to Zanthoxylum hawaiiense include habitat degradation and browsing by feral and domestic animals, competition from non-native plant species, seed predation by rodents, fire; trampling, and effects of military activities (U.S. Army 2003a).

Stressor: Invasive species degradation of habitat
Exposure:
Response:
Consequence:
Narrative: The wild population on east Maui is threatened by Bocconia frutescens (tree poppy), Melinis minutiflora (molasses grass), Melinis repens (natal red top), and Neonotonia wightii (glycine) (PEPP 2010). o On Kauai, Schinus terebinthifolius (Christmasberry) is a threat to the wild population (PEPP 2012) USFWS, 2015).

Stressor: Ungulate herbivory
Exposure:
Response:
Consequence:
Narrative: Feral axis deer (Axis axis) are a threat to the population on Maui (PEPP 2012) (USFWS, 2015).

Stressor: Stochastic events
Exposure:
Response:
Consequence:
Narrative: Drought mortality or reduced viability – Drought may exacerbate the effects of ungulates and has direct adverse impacts on Z. hawaiiense (U.S. Army 2012; PEPP 2012, 2014) (USFWS, 2015).

Stressor: Slug predation or herbivory
Exposure:
Response:
Consequence:
Narrative: On Molokai, herbivory by slugs were reported as a threat (PEPP 2013) (USFWS, 2015),

Stressor: Landslides and flooding degradation of habitat
Exposure:
Response:
Consequence:

Narrative: Erosion is a threat to this species on West Maui (PEPP 2012) and on Kauai (PEPP 2014) (USFWS, 2015).

Recovery

Recovery Actions:

- Recommendations for Future Actions: • Surveys / inventories – Survey geographical and historical range for a current assessment of the species' status. • Captive propagation for genetic storage and reintroduction – Continue collection of genetic resources for storage, propagation, and reintroduction into protected suitable habitat within historical range. • Reintroduction / translocation – Additional populations should be established across the species' range to increase the number and occurrences of individuals to account for the dioecious behavior of this species. • Ungulate monitoring and control – Maintain existing exclosures and monitor for potential incursions. • Invasive plant monitoring and control – Eradicate invasive introduced plants within ungulate exclosures and maintain exclosures free of invasive plants. • Population viability monitoring and analysis – Continue monitoring wild and outplanted individuals. • Fire monitoring and control – Develop and implement a fire management plan at the existing exclosures. • Climate change adaptation strategy – Research the suitability of habitat for reintroducing this species in the future due to the impacts of climate change. • Alliance and partnership development – Initiate planning and contribute to implementation of ecosystem-level restoration and management to benefit this taxon (USFWS, 2015).
- The following important conservation actions are needed for Zanthoxylum hawaiiense: control of non-native plant species, feral ungulates, and rodents; elimination of fire; and research on habitat requirements, population structure, reproductive biology, and seed biology. Steps should be taken to ensure that populations remain viable on each of the four islands on which Z. hawaiiense presently occurs. Additional populations should be established across the species' range to increase the number of individuals. The widely scattered distribution and dioecious behavior of this species may suggest that larger areas are required to maintain viable populations for the survival and recovery of Z. hawaiiense. Rodent control in existing and reintroduced populations is necessary to allow for successful recruitment (Service 1996a). In addition, a State-wide management plan that identifies areas and landscapes for the long-term conservation of all known occurrences of Z. hawaiiense is needed. As part of this management plan, landowners and managers should delineate management units to conserve this species and other native species through threat control and habitat restoration. Ongoing Conservation Actions: Aside from any actions occurring at the PTA (and discussed the section below), the Service is unaware of species-specific conservation actions being conducted for Zanthoxylum hawaiiense.
- New management actions: 3 • Surveys / inventories o A survey discovered approximately 85 new locations of Z. hawaiiense at PTA (U.S. Army 2015). o In 2012, a survey conducted on West Maui found 20 additional plants (PEPP 2012). In 2013, another survey was conducted below the known population and discovered three new individuals (PEPP 2014). • Ungulate monitoring and control – In May 2014, a damaged 10-acre fenced exclosure in Upper Puu Anahulu/Puu Waawaa was repaired and will provide protected habitat for reintroducing individuals of Z. hawaiiense and other dry to mesic plants (DLNR 2014a). • Captive propagation for genetic storage and reintroduction o The Volcano Rare Plant Facility (2013) has a single individual in their nursery. The Facility propagated two plants for reintroduction next year. Meanwhile, two individuals were reintroduced at Puu Waawaa. In 2014, the

Volcano Rare Plant Facility had a single individual in their nursery and a single individual was reintroduced at Puu Waawaa (Volcano Rare Plant Facility 2014). o The Olinda Rare Plant Facility (2013) has one potted plant in their nursery. o The Lyon Arboretum's Seed Conservation Laboratory (2014) had 54 seeds from Molokai in storage; however, only four seeds remain in storage after conducting viability trials. o The Natural Resources Office PTA (U.S. Army 2015) has 45 seeds from two founders in genetic storage. • Captive propagation protocol development – Propagation trials were conducted to determine appropriate storage and propagation techniques for Z. hawaiiense. The trials indicated that seeds from Z. hawaiiense had a low germination rate over an extended yearly time span (exact amount of years not specified) and seeds remained viable for more than 10 years (U.S. Army 2015). • Population viability monitoring and analysis o The wild individual on East Maui was monitored for seeds, none was collected (PEPP 2009, 2010, 2012). o The population on West Maui was monitored for seeds, none was collected (PEPP 2010). In 2011, the population was monitored again and all known plants were numbered and tagged (PEPP 2012). More than 200 seeds were collected from the ground under three wild individuals. The seeds were sent to Olinda Rare Plant Facility (PEPP 2012). o In April of 2012, the wild individual on Kauai was monitored and two air layers were created (PEPP 2012). In August of 2012, the individual was monitored again and one of the air layers died but the other air layer is surviving (PEPP 2013). In September of 2013, the plant was monitored (PEPP 2014). Another single wild individual on Kauai was monitored in March of 2014 (PEPP 2014). o In 2013, a single wild individual on Molokai was monitored (PEPP 2013, 2014). o The wild population at Kauaula on Maui was monitored and only one of the four trees known from the area was observed (PEPP 2014). That plant was in poor condition and heavily damaged by black twig borers (USFWS, 2015).

Conservation Measures and Best Management Practices:

- Recommendations for Future Actions: We are not aware of any new threats or significant new information regarding the species' biological status since the last 5-year review in 2015. Thus, the following recommendations for future actions are reiterated for the 5-year review for 2021. • Surveys and inventories— o The historical range of Zanthoxylum hawaiiense should be surveyed intensively and determine if historical populations are extirpated. o Determine sites that have the highest likelihood of maintaining reintroductions. • Ungulate monitoring and control—Continue to maintain fenced exclosures to protect individuals from the negative impacts of browsing by ungulates. • Invasive plant monitoring and control—Continue control of established ecosystem-altering nonnative invasive plant species, and those that compete with Zanthoxylum hawaiiense. • Site and habitat protection—Develop and implement effective control measures to reduce the impact of drought. • Fire monitoring and control—Continue to develop and implement fire prevention management plans. • Predator and herbivore monitoring and control—Determine and implement effective methods to control insect pests, including the black twig borer. • Captive propagation for genetic storage and reintroduction—Continue collection and propagation efforts for maintenance of genetic stock and for reintroduction. • Reintroduction and translocation—Continue to reintroduce individuals into suitable habitat within historic range that is being managed for known threats to this species to build resiliency and redundancy. • Population biology research— o Determine which species may act as pollinators and which may assist with fruit dispersal. o Conduct genetic studies to determine genetic variation within the population (and between populations) and plan an effective breeding program. • Alliance and partnership development—Continue to work with partners and other land managers in planning and implementation of ecosystem-level restoration and management to benefit this species. • Climate change adaptation strategy—Assess

the modeled effects of climate change on this species and use to determine future landscape needed for the recovery of the species. (USFWS, 2021b)

- New Management Actions: • Surveys and inventories—PEPP continues to monitor, collect seeds, and attempt airlayers of individuals of Zanthoxylum hawaiiense (PEPP 2020, p. 2). • Ungulate monitoring and control—Fencing is monitored and maintained at several management units on the island of Hawai‘i, and deer mesh collars were installed near trunks of individuals were ungulate browsing was observed (PEPP 2020, pp. 3-7). • PEPP collected approximately 4,450 seeds from 16 individual trees in one population on the island of Hawai‘i in 2019 (PEPP 2020). Almost all seeds were opened at Volcano Rare Plant Facility after they failed to germinate and were discovered to be empty with no viable embryos inside (VanDeMark pers. comm. 2021). • Captive propagation for genetic storage and reintroduction— o Olinda Rare Plant Facility (ORPF) reported 3 Zanthoxylum hawaiiense plants in storage in 2020 representing 2 wild individuals, one each from Maui and Moloka‘i (ORPF 2020). o National Tropical Botanic Garden (NTBG) reports 67 seeds in storage representing 3 founders from Maui (NTBG 2020). o The Lyon Seed Conservation Laboratory at Lyon Arboretum reports 722 seeds in storage from 44 founders. Seeds from 41 of the founders are maintained for genetic storage, while seeds from 3 founders are utilized for research (Lyon Arboretum 2020). However, no seeds germinated and these are from the same collection where VRPF found almost no viable seeds; this collection is therefore not expected to be viable. o The Pōhakuloa Controlled Propagation Facility (PCPF) reported 6 individual plants from 2 founders (PCPF 2020). o The Volcano Rare Plant Facility (VRPF) reported 4 individual plants maintained in propagation (VRPF 2020). • Reintroduction—VRPF reported 45 individuals were outplanted between 2019- 2020 at Pu‘u Wa‘awa‘a (VRPF 2020). (USFWS, 2021b)

References

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Threats to Zanthoxylum hawaiiense include habitat degradation and browsing by feral and domestic animals, competition from non-native plant species, seed predation by rodents, fire

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SPECIES ACCOUNT: *Zanthoxylum thomasianum* (St. Thomas prickly-ash)

Species Taxonomic and Listing Information

Listing Status: Endangered; 12/20/1985; Southeast Region (R4)

Physical Description

Zanthoxylum thomasianum is and evergreen tall shrub or small tree reaching 20 feet (6 meters) in height with a stem diameter of 4 inches (10 centimeters). The alternate leaves are primarily compound, up to 5 inches (12 centimeters) long with 5 to 13 ovate to obovate leaflets. The leaflets are usually pointed at the apex, rounded at the base, leathery, and shiny green on the upper surface. The stems, twigs, and leaves are armed with prominent, ¼ inch (6 millimeter) spines, of which 1 to 3 may project from the midvein on the lower surface of each leaflet. The species is dioecious – tiny male and female flowers are borne in axillary clusters on different plants. The fruits are small, egg shaped capsules containing a shiny black seed approximately 3/16 inch (5 millimeters) in diameter (USFWS, 1988).

Taxonomy

Zanthoxylum thomasianum, a member of the citrus family (Rutaceae), was first described in 1896 as Fagara thomasiana by Krug and Urban. They based their determination on specimens collected in 1880 by H.F. Eggars at Flag Hill on St. Thomas, where the largest known population of this species survives today. In 1911, Percy Wilson transferred the species to genus Zanthoxylum, an alternative generic treatment that is usually preferred to Fagara (Brizicky 1962). In 1913, Britton and Shafer found the species on St. John, while R.O. Woodbury first collected it on Puerto Rico in the early 1960's at two localities near Coamo (USFWS, 1988).

Historical Range

See Current Range

Current Range

The available information on the distribution of St. Thomas prickly-ash indicates that its distribution includes the islands of St. Thomas and St. John in U.S. Virgin Islands, the municipalities of Coamo, Salinas, and Isabela in Puerto Rico (USFWS 1988), and later reported in the British Virgin Islands in Gorda Peak National Park on Virgin Gorda (Clubbe et al. 2003), and at Hawk's Nest on Tortola (Pascoe 2014) (USFWS, 2015).

Critical Habitat Designated

Yes;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Dioecious (USFWS, 2015)

Breeding Season

Adult: Observations of the St. Thomas population, where the species reaches its greatest density, indicate that while flowering occurs regularly at the onset of the wet season (May), seed production is very low (1988).

Reproduction Narrative

Adult: Zanthoxylum thomasianum is dioecious, producing tiny male and female flowers on separate plants. Pollination is probably effected by insects or wind, although the pollination biology of this species has not been studied. Observations of the St. Thomas population, where the species reaches its greatest density, indicate that while flowering occurs regularly at the onset of the wet season (May), seed production is very low. This suggests that the present population density is so low or the sex ration skewed to the point that pollination is inhibited. The numbers of seedlings observed reflects the level of seed production: within one group approximately 100 plants covering nearly 3 acres, only 9 seedlings were found, and nearly all of the mature plants fell into a single size class. If recruitment remains this low, population decline can be expected. Elsewhere in the species range, populations are sufficiently small that pollination and seed set are probably even less likely to occur. In addition, recent germination tests (Popenoe, pers. Comm) indicate that viable seed is not always produced. The importance of vegetative regeneration to population growth appears to be minimal. The species does not root-sucker, although resprouting (coppicing) has observed where plants have been cut near ground level. The multistemmed growth form exhibited by most of the plants of this and other species on St. Thomas and St. John seems to have developed in response to cutting during earlier land clearing (USFWS, 1988).

Habitat Type

Adult: Subtropical Dry Forest (USFWS, 1988)

Habitat Vegetation or Surface Water Classification

Adult: Single canopy forest with virtually no undergowth (USFWS, 1988)

Tolerance Ranges/Thresholds

Adult: Low (inferred from USFWS, 1988)

Site Fidelity

Adult: High (inferred from USFWS, 1988)

Habitat Narrative

Adult: Zanthoxylum thomasianum is typical of the plant species comprising the evergreen component of the semideciduous forests of Puerto Rico and the Virgin Islands, which have been classified by Ewel and Whitmore (1973) as subtropical dry forests. The species has also been found in one seemingly anomalous location in the moist forest zone of northern Puerto Rico, although the summits of the limestone hills of this region are edaphically dry, and often support tree species typical of dry forests to the south (USFWS, 1988). The dry forests within which Zanthoxylum thomasianum occurs can be termed semideciduous, with more than half the species dropping leaves during the dry season. Where Zanthoxylum thomasianum occurs in the limestone karst region of northern Puerto Rico, soil development and available moisture, topographic position, and resulting physiognomy of the vegetation are analogous to conditions found in the otherwise distinct climatic and geologic regions elsewhere within the species range.

Many of the associated species, particularly the dominants, are the same as those found in the dry forest communities where the species is found (USFWS, 1988). High ecological integrity of the community, low tolerance range and high site fidelity are inferred from USFWS (1988) due to low number of populations and specific habitat requirements.

Dispersal/Migration

Motility/Mobility

Adult: Low (USFWS, 1988)

Dispersal

Adult: Low (USFWS, 1988)

Population Information and Trends

Population Trends:

Not available

Population Growth Rate:

Low (USFWS, 2015)

Number of Populations:

5 (USFWS, 2015)

Population Size:

~748 total (USFWS, 2022)

Minimum Viable Population Size:

Unknown (USFWS, 2015)

Population Narrative:

Ray and Stanford (2005) found that recruitment of new seedlings was very low in four of five populations, despite relatively large seed crops present at all sites. For example, they found that 84% of the individual plants tagged in the four populations had produced a total of 8 (4.8%) seedlings. Ray and Stanford (2005) also found that the size class distribution of the five populations was biased towards moderate and older age classes and indicated the finding was indicative of an aging population lacking recruitment of young individuals (USFWS, 2015). Ray and Stanford (2005) documented a mean abundance of 37.8 individuals across the five surveyed populations. The populations ranged in size from 6 individuals at Johnson Bay Ridge, to 112 at Point Rendezvous on Gifft Hill (Table 1), which contrasts with the 50 individuals reported in the Recovery Plan for that area (USFWS 1988). Mean density for all sites was 35.3 individuals per hectare with population areas averaging one hectare (Table 1). According to Ray and Stanford (2005), the Point Rendezvous population was probably larger because the privately-owned land east of the surveyed area has not been searched systematically. In fact, three of the five populations studied by Ray and Stanford (2005) grow on private land, and a total of 138 (74%) of individuals tagged during the survey derived from private property (USFWS, 2015). There is no information to determine what constitutes a viable population (USFWS, 2015). Based on the current available information, we have documentation of an estimated 748 individuals in the

Puerto Rico, USVI and BVI (USFWS, 2022)

Threats and Stressors

Stressor: Habitat modification/road construction (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Information from St. Thomas and St. John suggests that habitat modification or destruction is probably the main threat to the species outside the Virgin Islands National Park. For example, an aerial photo from 2009 shows that Flag Hill in St. Thomas was impacted by the construction of a road, which resulted in areas of deforestation (Google Earth, St. Thomas, USVI, 2009). On the island of St. John, land surveying and road construction caused significant damage to a St. Thomas prickly-ash population by cutting 12% of its individuals, and at least 15 shrubs were subsequently eliminated by bulldozing for a road construction (Ray and Stanford 2005). Human-induced threats are expected to increase as road construction already has permanently converted forest habitat, and excavation for home sites and driveways is likely to triple the area of lost habitat, further reducing the St. Thomas prickly-ash population according to Ray and Stanford (2005). Excavation for subdivision roads, driveways and home sites are expected to continue, posing a threat to the species. Moreover, Ray and Stanford (2005) indicated that edge effect and increase in light penetration from perimeter areas of small wood lots will encourage weed infestation, which can reduce the habitat quality for the species (see factor E). Within the Virgin Islands National Park boundaries, however, the native forest habitat described for the species by Ray and Stanford (2005) is well represented. This park covers over half of the island of St. John, and probably harbors undetected populations of St. Thomas prickly-ash. (USFWS, 2015).

Stressor: Predation (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of habitat/Loss of individuals
Narrative: Predation by feral ungulates may be a threat to St. Thomas prickly-ash in the U.S. Virgin Islands. Feral goats, key deer, and donkeys roam freely in areas where St. Thomas prickly-ash is found in St. John, posing a threat to the species (Ray and Stanford 2005). However, grazing by these herbivores may be considered a secondary, low-level threat, as clearing for residential development is probably the main threat to St. Thomas prickly-ash on St. John and St. Thomas (Ray and Stanford 2005). The main impacts from feral ungulates may be more related to the modification of microhabitat conditions necessary for natural recruitment and trampling of small individuals (see Factor E) (USFWS, 2015).

Stressor: Hurricanes and Landslides (USFWS, 2015)
Exposure:
Response:
Consequence: Loss of populations and individuals
Narrative: Hurricanes frequently affect the islands of the Caribbean. As a species endemic to the Puerto Rican Bank, St. Thomas prickly-ash should be adapted to tropical storms. However, despite adaptation, the loss of any population or individuals poses a threat to the species by making them more susceptible to stochastic events such as hurricanes. Furthermore, the heavy rains associated with tropical storms and hurricanes in the Caribbean, sometimes up to two to

three feet of rain in a single storm event, often lead to landslides. In fact, a landslide actually occurred on the lower portion of El Costillar haystack where St. Thomas prickly-ash is found on the very edge of a cliff. A landslide in that area would not only take out the plants, but will also affect their seed bank and substrate as well. In addition, landslides create openings in the vegetation that allow other plants (native or non-native, herbaceous or woody) to become established. At present, there is no information regarding the competitive abilities of St. Thomas prickly-ash in such a situation (USFWS, 2015).

Stressor: Genetic variation (USFWS, 2015)
Exposure:
Response:
Consequence: Decrease genetic variability
Narrative: Along with decreasing population size, negative impacts of habitat fragmentation may result in erosion of genetic variation through the loss of alleles by random genetic drift (Honnay and Jacquemyn 2007). Given the scattered distribution of St. Thomas prickly-ash and the small size of the majority of the populations, its genetic variability is likely to be an important factor. In fact, information from the island of St. John on the genetics of this species indicates a low genetic variability among sampled populations (Ray and Stanford 2005). Therefore, although the phenology and pollination biology of the species are unknown, we can confidently say that, within in Puerto Rico, and between the U.S. and British Virgin Islands, the distances are big enough to exclude any genetic exchange (D. Kolterman and J. D. Chinea, UPRM, pers. comm., 2012. (USFWS, 2015).

Recovery

Reclassification Criteria:
The recovery plan specifies that St. Thomas prickly-ash could be considered for reclassification to a threatened species when: 1. With the help of material supplied through ex-situ propagation, at least two separate populations capable of self-perpetuation are established within appropriate units of the Commonwealth Forest System of Puerto Rico (Guánica or Guajataca) or on lands designated to protect the species, and (USFWS, 2015). Criterion 1: Has not been met. No propagation or reintroduction project has been implemented within the Puerto Rico's Commonwealth Forest System. So far all the naturally occurring populations in Puerto Rico lie within private lands and are relatively small (USFWS, 2015).

2. a) at least one large, self-perpetuating population has either been identified or established within the Virgin Islands National Park, and b) a significant portion of the St. Thomas population has been protected through redesignation of lands in Flag Hill area. Criterion 2: Has been partially met. Natural populations of St. Thomas prickly-ash have been identified within the Virgin Islands National Park in St. John. Nonetheless, the Flag Hill area in St. Thomas remains privately owned and unprotected. This is the type location of the species and supported the largest known population of St. Thomas pricklyash at the time of listing (USFWS 1988) (USFWS, 2015).

Recovery Priority Number: 5C

Delisting Criteria:

1. The two (2) natural populations within the Virgin Islands National Park boundaries in the U.S. Virgin Islands, and the one (1) natural population within the boundaries of Gorda Peak National Park in the British Virgin Islands show a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (USFWS, 2022).

2. The natural populations within private lands on St. John (3), St. Thomas (1), and Puerto Rico (1) are protected through a conservation mechanism, and populations show a stable or increasing trend, evidenced by natural recruitment, and multiple age classes (addresses Factors A and E) (USFWS, 2022).

3. At least two (2) new populations (genetically representing the Puerto Rico population) are established on lands protected by a conservation mechanism in Puerto Rico (Guanica or Guajataca Commonwealth Forests, or lands designated for conservation). New populations show stable or increasing population trends, evidenced by natural recruitment, and multiple age classes (addresses Factor A and E). (USFWS, 2022).

4. At least one (1) new population (genetically representing the St. Thomas population) is established on lands protected by a conservation mechanism (Vieques National Wildlife Refuge). The new populations indicate a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factor A and E) (USFWS, 2022).

At least one (1) new population (genetically representing the St. Thomas population) is established on lands protected by a conservation mechanism (e.g., Vieques National Wildlife Refuge). The new populations show a stable or increasing population trend, evidenced by natural recruitment, and multiple age classes (addresses Factor A and E) (USFWS, 2019).

5. Threat reduction and management activities have been implemented to a degree that the species is viable into the foreseeable future (addresses Factor A and Factor E) (USFWS, 2022).

Recovery Actions:

- A protocol for the propagation and reintroduction of St. Thomas prickly-ash should be developed in collaboration with partners (e.g., UPR, KEW, Fairchild Tropical Botanic Garden, PRDNER, Para La Naturaleza and Natural Resources Conservation Service). The protocol should address the feasibility of seed banking this species, and if deemed necessary, seed material should be stored at the Millennium Seed Bank (KEW) and USDA National Laboratory for Genetic Resources Preservation (NLGRP) in Fort Collins. Studies on the species' population genetics should be conducted to determine patterns of genetic diversity across the species natural distribution (including BVI), and to provide baseline information for sound management of the species. Recovery task: 33 (USFWS, 2019).
- Due to the low number of populations and individuals, along with the little evidence of natural recruitment and limited dispersal, the reproductive biology and ecology of St. Thomas prickly-ash should be determined. In particular, the factors limiting seed dispersal and seedling recruitment should be studies. This should include the establishment of a long-term monitoring program (including permanent parcels) to determine seedling recruitment and survival, and the conditions necessary for their establishment. Recovery task: 31 and 32 (USFWS, 2019).
- Since the core populations of St. Thomas prickly-ash extend to the BVI, the Service foresees collaboration with overseas partners (KEW and National Park Trust) in order to maximize the

species recovery (e.g., exchange of species information and prioritization of research needs). Recovery task: 21, 31, 32 and 33 (USFWS, 2019).

- Invasive feral mammals (i.e., white-tail deer, goats and wild hogs) pose a serious threat to the native vegetation of St. John (particularly natural recruitment). Thus, a management plan for the control of feral mammals within the Virgin Islands National Park (St. John) should be developed and implemented. Recovery task: 11 and 12 (USFWS, 2019).

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES 1. Protection of privately-owned lands in Puerto Rico and USVI should be given a high priority for conservation through land acquisition, conservation easements, private landowners programs, due to its importance for the recovery of the St. Thomas PricklyAsh. 2. Since the Flag Hill population in St. Thomas is located entirely on a private land, it is recommended that the USVI Department of Planning and Natural Resources provide guidance to private landowners about the importance of maintaining native dry forest vegetation. Due to the species dioecious condition (separate male and female plants), low seed germination rate and limited seed dispersal, the protection of this known population should be considered a priority. 3. A critical step for the long-term conservation of the species is the accession of seed (seed banking) and live material from all known localities across the species range (Puerto Rico, USVI and BVI) into ex situ conservation. 4. Due to the species' dioecious nature and unknown sex ratios in the known populations, research on the species phenology is needed to determine the sex ratio and reproductive status of known localities. 5. A germination protocols should be developed to optimize the species propagation and maximize the use of the little seed material available. The protocol must also include propagation by cuttings. 6. Research is needed to determine the populations' genetics, and the relative importance of each population for the long-term conservation of the species. Ongoing research on the species phylogenetics needs to continue to clarify the taxonomic boundaries of the species. 7. The Service and partners (e.g., Kew and PRDNER) should continue habitat assessments across the species range (USFWS, 2022).

References

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SPECIES ACCOUNT: *Ziziphus celata* (Florida ziziphus)

Species Taxonomic and Listing Information

Listing Status: Endangered; 8/28/1989; Southeast Region (R4) (USFWS, 2015)

Physical Description

Ziziphus celata is a spiny shrub that averages between 0.5 to 1.5 m in height, but can grow to over 2 m. Plants occur in groups of stems, arising from what are assumed to be connected root systems. The primary branches are jointed and bent, and give rise to short, straight, spiny, branchlets. The oblong-elliptic to obovate leaves are alternate and deciduous. The leaves are characterized by rounded tips, cuneate bases, and entire margins. The upper leaf surface is dark glossy green, while the underside is a dull light green. Leaves vary from 4.5 to 21 mm in length, and from 3 to 13 mm in width. Fragrant Z. celata flowers are small, axillary, and solitary, but are tightly bundled on short shoots. Flowers are perfect, with five greenish-yellow sepals, and five white petals clasping five stamens; however, three-and four-merous flowers have been observed (Race and Weekley 1996). The bright yellow drupes range from 10 mm to 20 mm long, and 3 mm to 10 mm wide (Judd and Hall 1984, DeLaney et al. 1989, Race and Weekley 1996). (USFWS, 1999)

Taxonomy

Ziziphus celata was originally collected near Sebring in 1948. A second specimen was collected in 1954, perhaps from the same site as the original specimen, but the location of the latter collection is unknown. The plant remained unidentified and unnamed until 1984, when Judd and Hall (1984) named the original herbarium specimen Ziziphus celata. When it was named, the Florida ziziphus was thought to be extinct. However, it was rediscovered in 1987 at a site in Polk County (DeLaney et al. 1989). (USFWS, 1999)

Historical Range

See Current Range.

Current Range

Florida ziziphus is known only from a few sites on the Lake Wales Ridge in southern Polk and northern Highlands counties, in Florida. (USFWS, 2019)

Critical Habitat Designated

No;

Life History

Food/Nutrient Resources

Reproductive Strategy

Adult: Insect pollinated; Asexual (USFWS, 1999)

Breeding Season

Adult: Begins to flower in late December or early January and flowering continues through late February (varying by site and year), while the branches are still bare.

Other Reproductive Information

Adult: Research on the genetics, reproductive biology, and demography of Florida ziziphus for over a decade has quantified limited genetic variation in the wild populations. Breeding system experiments have demonstrated that Florida ziziphus is self-incompatible and that most genotypes are also cross-incompatible. The combination of limited genetic variation and a limited range of mating types explains why most populations are self-sterile. Demographic research has shown that populations are stable with high survival but variable levels of clonal recruitment. Without augmentation, most populations are predicted to undergo slow decline in numbers (Menges 2012). (USFWS, 2019)

Reproduction Narrative

Adult: Ziziphus celata is deciduous, losing its leaves in late fall. It begins blooming in late December or early January and blooming continues through late February (varying by site and year), while the branches are still bare (Burkhart et al. 1997). Fruits begin to develop in March, with new leaves forming at the same time or soon after. The fruits ripen in May or early June. No seedlings have been found in the wild, so it is not known whether the seeds germinate in the summer or later in the year. Common pollinators (bees and flies) have been observed visiting the flowers, although it is not known if these are pollinators of Ziziphus. No viable seeds have been observed in the wild. Natural fruit set has been observed twice in the wild, but few fruit were produced, and of those all aborted before maturity. Lack of sexual reproduction may be due to the absence of compatible genotypes at a given site and/or the age of the above ground stems (Burkhart et al. 1997). Ziziphus celata spreads asexually by sending shoots up from its roots. These additional stems give Z. celata a clump-like appearance, where individual plants in the clump are not distinguishable. Like other members of its genus, Z. celata is capable of parthenocarpic production of fruit, but it differs from others in its genus by not being dichogamous, having pistils and stamens that mature at different times to prevent self-fertilization (Burkhart et al. 1997). (USFWS, 1999)

Habitat Type

Adult: Oak-hickory scrub

Environmental Specificity

Adult: Narrow (inferred from USFWS, 2019)

Habitat Narrative

Adult: Florida ziziphus is a thorny clonal shrub found only on yellow sand xeric habitats that historically supported longleaf pine/wiregrass sandhills and similar vegetative communities. Most Florida ziziphus habitat has been converted to citrus groves and cattle ranches. (USFWS, 2019)

Dispersal/Migration

Population Information and Trends

Number of Populations:

13 wild, 3 introduced (USFWS, 2024)

Population Narrative:

Florida ziziphus is known only from a few sites on the Lake Wales Ridge in southern Polk and northern Highlands counties. Only four of the 14 known populations occur in publicly protected sites. Most populations are self-sterile due to limited genetic diversity and the isolation of population. The most recent FNAI Element Tracking Summary (FNAI 2015) reported 10 known occurrences for Florida ziziphus, of which 5 are protected at 4 different managed areas. In addition, four new populations have been established since 2008. Florida ziziphus has been reintroduced using.transplants and seeds to four sites, including The Nature Conservancy's Tiger Creek Preserve, the Lake Wales Ridge State Forest, and the Lake Wales Ridge NWR. (USFWS, 2019) In 2009 there were 14 extant populations. Since that review, the monitoring schedule for the plant has been altered to be less frequent than previously, and the most recent survey data are from 2021. As of 2021, there are 13 extant wild populations and 3 introduced populations (Table 1; Heron pers. comm 2024). This is a reduction from the 16 documented wild populations because three of those located on private lands have been extirpated (Herron pers. comm 2024). Several of the extant wild populations also occur on private land and are at risk of loss. These populations are vital to recovery, as plants on public property represent a small fraction of genetic diversity. The Masterpiece site (including the Masterpiece North and South populations), which has a conservation easement, supports over half of known plants and much of the genetic diversity in this species. Most populations on privately owned sites have declined steadily over the past decade (Smith et al. 2013) and will continue to decline without efforts to promote sexual reproduction (Ellis et al. 2007). The recent transfer of the Gulfstream/Mitigation site to the Service has also aided in the conservation of Florida ziziphus. This parcel is now known as the Arbuckle unit and is part of the Everglades Headwater National Wildlife Refuge. Several translocations of Florida ziziphus have occurred (Table 2; for details, see David and Herron 2023). Only one plant remains from the initial augmentation at one of the Avon Pines sites, and it is unclear whether the second augmentation has yet resulted in sexually mature and reproducing plants. Two larger augmentations at Arbuckle Everglade Headwaters National Wildlife Refuge in 2003 and 2006 have been successful in flowering, producing fruit, and producing one second generation seedling. However, survival has been relatively low in this disturbed sandhill (USFWS, 2024).

Threats and Stressors

Stressor: Habitat destruction or modification
Exposure:
Response:
Consequence:
Narrative: This species is restricted to xeric scrub habitats in one or more of the interior Central Florida counties of Polk, Highlands, Hendry, Osceola, and Lake, where habitat destruction from development continues to occur and development pressure remains high. Areal extent of post-Columbian xeric upland habitat loss on the Lake Wales Ridge is estimated to exceed 85 percent (Weekley et al. 2008a). Increasing pressure from population growth is likely to result in further loss of these habitats going forward. Carr and Zwick (2016) analyzed existing land use and landscape patterns to identify areas (including central Florida) most likely for development to accommodate a growing human population. They suggests that Florida's 2070 population will be early 15 millionpersons greater than in 2010, for an estimated total of 33,721,828. Using these figures, they estimated relative losses to agriculture, open space, and conservation to other land uses. If trends continue, they estimate 34 percent of land will be developed by 2070, up from 19

percent in 2010. At the same time, conservation lands will increase less than 1 percent (from 9,269,000 acres in 2010 to 9,525,000 acres by 2070). Overall, loss of habitat to development, primarily on private lands, will likely continue in Central Florida, eliminating populations and reducing the area of suitable habitat for these species. Therefore, habitat on protected lands are critical for the recovery of this scrub plants. (USFWS, 2019)

Stressor: Lack of adequate fire management
Exposure:
Response:
Consequence:
Narrative: This species occurs occur within a relatively limited geographic range in Central Florida. The limited geographic range in combination with the loss of habitat has resulted in a highly fragmented landscape where the remaining scrub areas and their residing species have become more and more isolated from each other, thereby making resiliency, redundancy, and representation more challenging to achieve. The effects of habitat fragmentation on species richness have been exhaustively studied (MacArthur and Wilson 1967, Diamond 1975, 1978; Simberloff and Abele 1976, 1982; Zimmerman and Bierregaard 1986). For most taxonomic groups, large habitat patches in close proximity to each other provide for the greatest species diversity and minimize extinction probabilities. On the contrary, small patches that are isolated are less likely to preserve species that would otherwise be common in the mosaic of communities that existed before isolation. Since at least the Pleistocene, Florida scrub has been characterized by an insular, discontinuous distribution, but the degree of habitat fragmentation seen today is unprecedented and certainly will contribute to increases in extinction rates among scrub-dependent plants and animals. (USFWS, 2019)

Stressor: Limited geographic range
Exposure:
Response:
Consequence:
Narrative: Fire is necessary to maintain the scrub habitats upon which short-leaved rosemary, Avon Park harebells, Garrett's mint, scrub mint, snakeroot, Highlands scrub hypericum, scrub blazing star, Lewton's polygala, wireweed, sandlace, Carter's mustard, and Florida ziziphus depend. Historically, lightning-induced fires were a vital component in maintaining native vegetation within the scrub community. Fire suppression started on a regional scale on the Central Florida ridges about 80 years ago. Due to the extent of residential and agricultural development throughout Central Florida, fire has all but disappeared from the region as a widespread, natural phenomenon. Prescribed fire is a crucial management component for maintenance of all scrub habitats. Because of the difficulties of applying prescribed fire on an ever-increasing urban landscape, imperiled species on unmanaged sites will almost certainly disappear over time (Turner et al. 2006). In managed areas, prescribed fire is essential to manage habitats and restore or maintain suitable conditions for scrub species, including short- leaved rosemary, Avon Park harebells, Garrett's mint, scrub mint, snakeroot, Highlands scrub hypericum, scrub blazing star, Lewton's polygala, wireweed, sandlace, Carter's mustard, and Florida ziziphus. (USFWS, 2019)

Stressor: Fire suppression or lack of adequate fire regime (USFWS, 2024)
Exposure:
Response:

Consequence:
Narrative: Fire suppression is a continuing threat to the habitat of Florida ziziphus. In studies of Florida ziziphus introduced to one sandhill site, Menges et al. (2008) found that resprouting oaks encroached with negative effects on plant survival. The number of oaks increases under fire suppressed conditions. Fire return intervals for Florida ziziphus should be in the 5- to 20-year range (Menges et al. 2020), however most private property owners do not apply prescribed fire at this frequency. Fire suppressed conditions will likely continue on most private sites, to the detriment of potential Florida ziziphus habitat. Prescribed fire implementation on some public lands is behind schedule due to insufficient resources coupled with logistical obstacles. Smoke, public safety, and property liability issues, along with public perceptions relating to aesthetics still pose obstacles to implementing prescribed fire (USFWS, 2024).

Stressor: Invasive plants (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Non-native invasive plant species are a threat to Florida ziziphus at sites, especially those that are adjacent to modified landscapes and those that have been converted to pasture. In pastures, the dominant groundcover of pasture grasses may be a factor in the lack of recruitment from seeds in the few reproductive populations, but this has not been investigated. In addition, non-native vines pose a threat and can grow over Florida ziziphus. These vines compete for sunlight, space, water, and nutrients and may cause a decrease in the survival and reproductive success of Florida ziziphus. Invasive plants are managed at the protected sites and are not a significant threat to Florida ziziphus at these sites (USFWS, 2024).

Stressor: Paucity of recruitment from sexual reproduction (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Few fruits and seedlings have been documented in populations. Because populations are fragmented and beyond likely pollination distance, crosses among populations only occur when plants are brought together or manually pollinated. The destruction of unprotected populations on private land could result in additional loss of genotypes critical to conservation and recovery of the species. In particular, if the remaining genetic diversity drops, sexual reproduction may become impossible further threatening the species (USFWS, 2024)

Stressor: Climate change (USFWS, 2024)
Exposure:
Response:
Consequence:
Narrative: Effects of climate change on the habitat of Florida ziziphus are not known. Increases in temperature and changes in precipitation patterns could be important in the future. Forecasts of more severe droughts and higher rainfall between droughts could mean that fires would be more severe and that prescribed fires harder to control. This could harm Florida ziziphus populations. Sea level rise in coastal Florida is already a reality and may lead to an increase in development in interior Florida, thus increasing the vulnerability of Florida ziziphus habitats (Volk et al. 2017). The National Climate Assessment (Melillo et al., 2014) reports that the average precipitation has decreased in central Florida since 1900; however, heavy downpours are increasing in frequency

and intensity since 1970. Future projected precipitation changes in seasonality for central Florida indicate 0 to +10% in winter, 0 to -10% in spring, -10 to -20% in summer, and +10 to +20% in fall will occur. Statewide annual rainfall is projected to increase from 0 to +20% by 2100. In additional to changes in precipitation, Florida has undergone increases in average temperatures since the beginning of the 20th century (Runkle et al. 2022). Warming is expected to increase in the future and will result in declines in soil moisture loss. Consecutive dry days are expected to increase 10 to 20% for most of Florida. Predictions of increased drought frequency, intensity, and duration could result in plant losses due to prolonged drought conditions (Melillo et al., 2014). However, this plant and other xeric species are relatively drought-resistant, but seasonality changes may affect seedling recruitment and general phenology of the species. Although Florida's coastal areas will likely be influenced by sea level rise, based on our understanding of current sea level rise models and the species occurrences inland on well drained soils (e.g., ancient ridges mainly in central Florida), sea level rise does not currently pose a threat to this species. The Service has no direct evidence that climate changes observed to date have had any adverse impact on the species or its habitat (USFWS, 2024).

Recovery

Reclassification Criteria:
Not defined. (USFS, 1999)

Recovery Priority Number: 5

Delisting Criteria:
1. At least 40 populations exhibit a stable or increasing trend, evidenced by natural recruitment and multiple age classes. (USFWS, 2019)

2. Populations (as defined in criterion 1) in sand hill habitat are distributed across the known range of the species. (USFWS, 2019)

3. Populations are protected and managed via a conservation mechanism to a degree that enough suitable habitat is present for the species to remain viable for the foreseeable future. (USFWS, 2019)

Recovery Actions:

- Determine current distribution of Z. celata. It is possible that populations of this species have yet to be discovered. Currently, three of the sites for Z. celata are in pastures and the other two are in restricted remnant areas. A complete survey has not been made of the Lake Wales Ridge for this species, making defining a distribution difficult. (USFWS, 1999)
- Protect and enhance existing populations. Much of the native xeric uplands on the Lake Wales Ridge and surrounding counties has been converted to agriculture or urban development. The remaining habitat is fragmented into small parcels and in many cases is isolated. Within the islands of xeric habitat, this species is found in only two remnant natural sites and three pastures sites, indicating how little habitat is left for Z. celata. For this reason, existing populations are in need of protection. (USFWS, 1999)
- Continue research on life history characteristics of Z. celata. Much of the basic biology and ecology of this species remains poorly understood. To effectively recover this species more specific biological information is needed. (USFWS, 1999)

- Continue monitoring existing populations of Z. celata. (USFWS, 1999)
- Provide public information about Z. celata. It is important for the recovery of this species that governmental agencies, conservation organizations such as the Florida Native Plant Society, and private landowners be appropriately informed about this species. Care is needed, though, to avoid revealing specific locality information about Z. celata. Public outreach efforts must also continue to address the increasing concern that horticultural demand for this and other rare species may not benefit conservation of threatened and endangered species. Public education should identify that commercial production and horticultural uses of endangered species provide little benefit to species, since the recovery of Z. celata and other rare species requires a self-sustaining, secure, number of natural populations. (USFWS, 1999)
- Habitat-level Recovery Actions: Prevent degradation of existing habitat. Restore areas to suitable habitat. Conduct habitat-level research projects. Monitor habitat/ecological processes. Provide public information about scrub and its unique biota. (USFWS, 1999)

Conservation Measures and Best Management Practices:

- RECOMMENDED FUTURE ACTIVITIES Recovery actions outlined in the initial recovery plan (Service 1999) and the amendment to the recovery plan (Service 2019) are mostly ongoing or partially complete. Stakeholders (e.g., state agency, private conservation groups) are actively working toward the recovery of this plant, including maintaining ex situ collections, monitoring, and protecting existing populations. Recovery Activities • Continue to maintain captive populations to use for reintroductions and/or to increase genetic diversity at extant sites. • Maintain regular fire-return intervals across the inhabited landscape Monitoring and Research Activities • Continue regular census of extant populations, determine genetic makeup of populations. • Search appropriate habitat types in private lands (that have yet to be scouted) for potential additional populations. • Monitor sites post-fire to understand how long after fire FL ziziphus will recover/resprout. • Maintain collaboration and data sharing agreements with state agencies and the Archbold biological station to ensure that all data on monitoring of extant populations are collated and shared with appropriate parties (USFWS, 2024).

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